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Hypnotic suggestibility, cognitive inhibition, and dissociation

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ABSTRACT

We examined two potential correlates of hypnotic suggestibility: dissociation and cognitive inhibition. Dissociation is the foundation of two of the major theories of hypnosis and other theories commonly postulate that hypnotic responding is a result of attentional abilities (including inhibition). Participants were administered the Waterloo-Stanford Group Scale of Hypnotic Susceptibility, Form C. Under the guise of an unrelated study, 180 of these participants also completed: a version of the Dissociative Experiences Scale that is normally distributed in non-clinical populations; a latent inhibition task, a spatial negative priming task, and a memory task designed to measure negative priming. The data ruled out even moderate correlations between hypnotic suggestibility and all the measures of dissociation and cognitive inhibition overall, though they also indicated gender differences. The results are a challenge for existing theories of hypnosis.

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1. Introduction

In response to suggestion, highly hypnotizable participants report and display a wide variety of interesting responses (Hilgard, 1965). They report hallucinations, negative hallucinations (not seeing or hearing a stimulus that is present), and clinically significant degrees of pain reduction. They display selective amnesia, partial paralyses, and vastly reduced Stroop interference (e.g. Raz, Shapiro, Fan, & Posner, 2002). With the exception of the Stroop effect modulation, one might suspect that these are merely enacted responses performed in compliance with the perceived demand characteristics of the experimental situation. However, behavioural and physiological data converge to indicate that these reports and responses reflect genuine changes in experience (e.g. Kinnunen, Zamansky, & Block, 1994; Kirsch, Silva, Carone, Johnston, & Simon, 1989; Oakley, 2008).

One of the most notable characteristics of hypnosis is the stability of individual differences in responsiveness to suggestion. Test–retest correlations of .75 have been reported for a standard measure of hypnotic suggestibility over a 25-year interval (Piccione, Hilgard, & Zimbardo, 1989). Despite the prominence and reliability of individual differences in responding, correlates of hypnotic suggestibility are notoriously difficult to find. This is disappointing because theories of hypnosis suggest that various predictors of hypnotic suggestibility should be detectable. For example, dissociation theories (e.g. Hilgard, 1986; Woody & Bowers, 1994) regard hypnosis as involving a fractionation in the normal cognitive control systems. Dissociation theories are consistent with the association of hypnotisability with dissociative disorders in clinical populations (Bryant, Moulds, & Guthrie, 2001; Frischholz, Lipman, Braun, & Sachs, 1992; Stutman & Bliss, 1985). But these theories also predict that in non-clinical as well as clinical populations people who are highly responsive to hypnotic suggestion should

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be more liable than low suggestible people to dissociate in everyday life (see Kirsch & Lynn, 1998, and Woody & Sadler, 2008, for comprehensive reviews of these theories). Surprisingly, the self-reported tendency to dissociate in everyday life has not been found to reliably predict hypnotic responding (e.g. Kirsch & Council, 1992; Nadon, Hoyt, Register, & Kihlstrom, 1991; though for an exception see Butler & Bryant, 1997). Other theories postulate that hypnosis involves a particular deployment of attention in ways unavailable to low suggestible people (e.g. Crawford & Gruzelier, 1992; Raz, Fan, & Posner, 2005). Indeed, one of the most frequently replicated correlates of hypnotic suggestibility is self-reported absorption in imaginative activities (e.g. Barnier & McConkey, 1999; Lyons & Crawford, 1997; Tellegen & Atkinson, 1974; Wilson & Barber, 1981; contrast Jamieson & Sheehan, 2002). Even so, when methodological artefacts are controlled, absorption only accounts for about 1% of the variance in hypnotic responding (Kirsch & Council, 1992). Because these low correlations counter influential theories, we will explore further the relation between hypnotic suggestibility and dissociation, and between hypnotic suggestibility and cognitive inhibition – an aspect of attentional functioning theoretically important for hypnosis.

Dissociation is 'a disturbance or alteration in the normally integrative functions of identity, memory, or consciousness' (DSM), involving a lack of integration of mental processes with ongoing conscious experience or a consciously experienced sense of disconnection (e.g. Cardeña, 1994). Dissociation is the basis of two of the most popular theories of hypnosis, neo-dissociation theory (Hilgard, 1986) and dissociated control theory (Woody & Bowers, 1994). According to neo-dissociation theory, hypnotic responding consists of splitting the central executive so that one part controls hypnotic responding without the other part being aware of it. According to dissociated control theory, hypnotic responding consists of splitting an action schema from central executive control, so that it is activated directly by the hypnotist's words. Both theories postulate that high hypnotic suggestibility results from an ability to produce the relevant fractionation. If either theory is right, there ought to be a substantial association between tendencies to dissociate and hypnotic suggestibility. Although the empirical data fail to demonstrate an association between dissociation and suggestibility (Kirsch & Council, 1992), this failure may be due to characteristics of the scale that is most commonly used to assess tendencies to dissociate.

Dissociation is most commonly assessed on the Dissociative Experience Scale (DES; Bernstein & Putnam, 1986). The DES was developed by people who worked with clients with dissociative disorders and is focused on people who dissociate frequently. As a result, the scale is highly skewed when administered to non-clinical populations, with most people scoring at the extreme low end of the scale. The extreme skew of the DES with non-clinical populations may be the reason for the low correlations with hypnotic suggestibility (e.g. Nadon et al., 1991).

Wright and Loftus (1999) reported a revised form of the DES (the Dissociative Experience Scale-Comparative; DES-C) specifically geared toward decreasing the skew of the scale when assessing dissociation in a normal population. Skew was reduced by amending the response scale for the DES. In the original, participants had to estimate the number of times that they had each of 28 dissociative experiences. Instead, Wright and Loftus asked their participants how often they had each experience compared with other people. This small change made the overall score roughly normally distributed with their samples of university students.

We used the revised DES-C as a predictor of hypnotic suggestibility. A meaningful association with hypnotic responding would provide empirical support for neo-dissociation theory and dissociated control theory. Conversely, an only trivial association would count against neo-dissociation and dissociated control theories.

To respond successfully to hypnotic suggestions, participants apparently focus attention on the experience that is suggested and ignore competing ideas (Barber, Spanos, & Chaves, 1974; Hilgard, 1970; Kirsch, Burgess, & Braffman, 1999). Thus, it is natural to suggest that hypnotic suggestibility involves an ability to block or inhibit potentially competing information. For example, neo-dissociation theory (Hilgard, 1986) proposes that highly hypnotisable subjects (henceforth 'highs') have a special means, namely dissociation, for blocking information from reaching consciousness. Other theorists have argued hypnotisability can be seen as consisting of the ability to disattend information (cf. Crawford, Brown, & Moon, 1993; Crawford & Gruzelier, 1992). Crawford and Gruzelier argue that highs are especially able both to disattend from some stimuli and to focus on others. Gruzelier (1998) and Gruzelier and Warren (1993) argued that the ability of highs to sustain this attentional state allows them to exhaust their frontal abilities during an induction, and hence end up frontally impaired in a way that constitutes the hypnotic state. By contrast, Crawford (e.g. Crawford, Knebel, & Vendemia, 1998) saw hypnotic responding to stimuli such as pain as dependent on the continued effective functioning of the executive and inhibitory system in highs. Similarly, Baars (1988) thought hypnosis consisted of keeping contradictory information out of awareness. The view that highly hypnotisable subjects have a special ability in cognitive inhibition (or anything else) can be contrasted with the view that they simply have appropriate attitudes, interpretations, and beliefs (cf. Spanos, 1986). It is thus theoretically important to establish whether highs do have any special ability to inhibit information.

The relation between inhibitory ability without a hypnotic induction and hypnotic suggestibility has been studied most directly using the Stroop effect, random number generation, pro-active interference, and more recently with a memory priming paradigm. Studies using the Stroop test have produced conflicting findings. Without hypnotic induction or suggestions being used, most studies have found no significant difference between highs and lows on Stroop interference (Aikens & Ray, 2001; Egner, Jamieson, & Gruzelier, 2005; Kaiser, Barker, Haenschel, Baldeweg, & Gruzelier, 1997; Kallio, Revonsuo, Hämäläinen, Markela, & Gruzelier, 2001). Dixon, Brunet, and Laurence (1990) and Dixon and Laurence (1992) found significantly *more* Stroop interference in highs than lows; however, Rubichi, Ricci, Padovani, and Scaglietti (2005) found significantly *less* Stroop interference in highs rather than lows. On a related task, Iani, Ricci, Gherri, and Rubichi (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.

Random number generation requires inhibitory ability. For subjects to be successful at randomising their output, they need to inhibit clichéd responding (such as counting upwards) and inhibit recent responses to avoid them being disproportionately likely. Graham and Evans (1977) found that highs were better than lows at random number generation. Replicability is unfortunately low: Evans (1991) reports replications by three other teams of this relationship while Crawford et al. (1993) found no significant relationship between hypnotic suggestibility and random number generation, and cite three other null findings, but none with a significant difference in the opposite direction. In sum, results are sporadic but significant results have only been found with highs outperforming lows, suggesting highs may have a greater inhibitory ability than lows. On the other hand, they may reflect the greater motivation of highs rather than lows to perform difficult tasks in a hypnosis lab.

Farvolden and Woody (2004) tested pro-active interference in highs and lows. Participants were trained on one set of paired associates (AB) then on three study-test trials of a second set (AC). On the first test trial of the second set, highs made more errors in recalling C to the cue A than lows did. This may be due to an inability by highs to inhibit the AB pairings, though overall ability to recall was not statistically controlled in testing the difference between highs and lows on the AC trial.

A further way of assessing cognitive inhibition is with a negative priming task, in which participants are instructed to attend to some stimuli and ignore others (Neill, Valdes, & Terry, 1995). The increase in latency to identify previously ignored stimuli compared to control stimuli is referred to as negative priming and interpreted as an indication of cognitive inhibition. David and Brown (2002) used a memory priming task fitting this specification. In an initial phase participants were instructed either to attend to or to ignore a set of words. In the test phase, participants classified the same words into categories. David and Brown argued that to-be-ignored words were actively inhibited, making them slower to later be classified. They obtained significant correlations (about .40) between suggestibility and response latency to classifying the to-be-ignored words, a finding they interpreted as showing highs were good at inhibition.

Although the David and Brown (2002) study appears to support the hypothesis that hypnotic suggestibility is associated with cognitive inhibition, there are two problems with their interpretation of the data. First, the statistical analysis did not control for response latencies to stimuli to which they had been instructed to attend during the priming task. Indeed, Kirsch and Braffman (2001) reported a small but significant association between hypnotic suggestibility and simple reaction time. Negative priming refers to *differences* in processing between responses to control stimuli and previously ignored stimuli. Therefore, by failing to control of response times to control stimuli, the association they obtained may not have involved negative priming at all. Instead, it may have been a replication of the association of suggestibility with simple reaction time, as reported by Kirsch and Braffman (2001). The second problem is that without a control group who only classified the words without pre-exposure to them, it is impossible to know whether any difference between to-be-attended and to-be-ignored words results from inhibition of the to-be-ignored words or positive priming for the to-be-attended words. Strictly, cognitive inhibition was not assessed in the David and Brown (2002) study.

In sum, while various theories depend on the notion of highs having a special ability to inhibit information, there are no convincing data indicating that highs are better than lows at cognitive inhibition. If cognitive inhibition is a stable ability as such, it should express itself on a range of relevant tasks. Therefore, we investigated the relation between hypnotic suggestibility and cognitive inhibition using three measures of inhibitory ability. First, we used the David and Brown (2002) task to determine whether it provides a measure of inhibition or positive priming and whether either such attentional measure correlates with hypnotic suggestibility. Second, we used a spatial negative priming task in which participants searching for a shape are slower to indicate the shapes location when it occurs in a location in which a to-be-ignored distracting shape occurred on the previous trial (see Tipper, 2001). We used this task because it was one of the earliest and is one of the most well investigated measures of negative priming. Third, we used a latent inhibition paradigm introduced by Lubow and Kaplan (1997) because it has been shown to relate to individual differences in expected ways (i.e. it correlated negatively with schizotypy; Lubow, Kaplan, & De la Casa, 2001, as predicted by the diminished latent inhibition sometimes shown in acute schizophrenia, e.g. Baruch, Hemsley, & Gray, 1988), and thus it itself is a meaningful measure of individual differences. In this paradigm, participants search for a fixed target shape amongst distractors all of the same shape. Latent inhibition is shown by participants later being slower when the previous distractor shape becomes a target shape, compared to when the target shape is either novel or remains the old target. This paradigm also allows a measure of individual differences in pre-attentive processing as shown by the novel pop out effect, i.e. the tendency for attention to be drawn to a novel item in a familiar background.

As well as performing the three inhibition tasks, all participants also completed the normalised dissociative experiences questionnaire of Wright and Loftus (1999). To prevent associations being inflated because participants knew the variables were being jointly investigated, contextual cues linking hypnotic suggestibility screening and measuring dissociation and inhibition were minimised. Council, Kirsch, and Hafner (1986) showed that participants aware that a study was aimed at investigating the relation between hypnosis and other variables produced stronger correlations than participants unaware of the connection between the measures. Thus, hypnotic suggestibility screening took place in one location and was presented as a study of hypnosis, and the other measures were taken in another location at a different time and presented as a study of processing speed.

Our main interest was the overall relation between hypnotic suggestibility and the other measures but we also tested correlations separately for each gender. We had no theoretical basis for expecting gender differences in the relation between hypnotic suggestibility and cognitive inhibition. However, Lubow et al. (2001) found that latent inhibition correlated with schizotypy only for females, indicating that the role of cognitive control in producing subjective experiences may be different for males and females. Relatedly, Townshend and Duka (2005) found the effect of alcohol on cognitive inhibition was different for females and males and Wang et al. (2009) also found evidence for different brain circuits for cognitive inhibition in men and women.

2. Method

2.1. Participants

Two hundred and ninety three participants from the University of Sussex Subject Panel were screened on the Waterloo-Stanford Group Scale of Hypnotic Susceptibility, Form C (WSGC; Bowers, 1998) in exchange for 1-h course credit or 5 pounds (∼US$8). Screening occurred in groups of 4–12 participants. Nine weeks after the final hypnosis session, all 293 participants were contacted under the guise of an unrelated study. They were asked to take part in a 30 min experiment in a different location investigating the relationship between reaction times and everyday experiences. Again, subjects were offered either pro rata course credits or payment. The first 180 subjects to respond (mean age = 21.7, SD = 6.4; 149 females and 31 males) took part in the second phase of the study. Assuming meaningful population correlations of .30 or above, 180 participants gives a power of at least 98%.

A further 50 participants were recruited from the University of Sussex Subject Panel to form a control group for the David and Brown (2002) task. These participants performed only the classification phase of the David and Brown task and no other tasks.

2.2. Measures

2.2.1. Hypnotic suggestibility

The Waterloo-Stanford Group Scale of Hypnotic Susceptibility, Form C (WSGC; Bowers, 1998) consists of a hypnotic induction followed by 12 standard hypnotic suggestions (i.e. suggestions for automatic movement, partial paralyses, selective amnesia, and positive and negative hallucinations). Bowers (1993) reported Cronbach's alpha for the WSGC to be .80 in one sample and .81 in another. A correlation of .85 with the individually administered SHSS:C (Weitzenhoffer & Hilgard, 1962) indicates that this group adaptation is a valid measure of hypnotic response (Bowers, 1993). The score was the number of suggestions passed, between 0 and 12.

2.2.2. Dissociation

The Dissociative Experiences Scale (DES-C, Wright & Loftus, 1999) is a minor adaptation of the Bernstein and Putnam (1986) scale, and the first validated measure of dissociation designed for a non-clinical population. Wright and Loftus found Cronbach's alpha to be .93 for this measure. The DES-C asks participants to rate how often disruptions in attention, thought, and memory processes in everyday activities, and to do so in relation to their perception of the frequency with which these disruptions occur to others. The scale consists of 28 items. For each item the participant selects one of 11 possible graded responses labelled as 'much less than others' at one end, as 'much more than others' at the other, and in the middle with 'about the same as others'. For scoring, the responses to each item were numbered 0–10. The scores from each of the 28 items were averaged and multiplied by 10 to obtain a score between 0 and 100.

2.2.3. Cognitive inhibition

Cognitive inhibition was measured using three tasks: the memory priming task used by David and Brown (2002); the spatial negative priming task, which we adapted from Kathmann, Bogdahn, and Endrass (2006); and a variant of the latent inhibition task introduced by Lubow and Kaplan (1997).

(1) *Memory priming.* The David and Brown (2002) task consisted of two phases, the first attend/ignore phase and then the test phase. For the first phase words appeared individually on the computer screen with the instructions 'attend' or 'ignore' presented directly above each word. In order to attend to words, participants were to mentally image them. Conversely, in order to ignore words, participants were to keep looking at the word 'ignore' whilst repeatedly saying 'coca-cola' in their head. Each word was displayed on a computer monitor for 5 s. The stimuli consisted of 10 words from the category of fruit and vegetables (apple, radish, banana, lemon, pear, orange, lime, tomato, onion, and potato) and 10 words from the category of animals (duck, sheep, eagle, mouse, spider, monkey, rabbit, lion, snake, and toad), each word presented once in random order. Subjects were randomly assigned to the category that they would attend or ignore with half of the subjects cued to attend to the animal words whilst the other half were cued to attend to the fruit and vegetable words. In the test phase, the task was to categorise each of the 20 words as either an animal or a fruit and vegetable word as quickly as possible using a response box. Each word was presented for a total of 5 s before the next word was shown. The task took only a few minutes. Priming was measured by the difference between reaction times to categorise the words that the subjects were instructed to ignore and to attend. The control group performed only the classification phase; their reaction times provide a baseline for assessing the amount of both negative and positive priming

(2) *Spatial negative priming.* The spatial negative priming task was adapted from that used by Kathman et al. (2006). Each trial contained an 'O' (the target) and an 'X' (the distractor) each in one of four possible locations. Participants responded to the location of the target and ignored the location of the distractor. Four buttons on the response box corresponded to the four possible locations of the target. The trials were made up of either control trials or negative priming trials in equal proportion. For the control trials the target appeared in any location other than the location the distractor was in on the immediately preceding trial. For the negative priming trials the target appeared in the location where the distracter was presented in the immediately preceding trial. Each trial was randomly assigned as a control or a negative priming trial for each of the four blocks of 51 trials. The task took 10 min to complete. Negative priming was measured by the difference between reaction times on the negative priming and control trials.

(3) *Latent inhibition.* We adapted the procedure used by Lubow et al. (2001) whereby participants had to visually search and then report whether a unique shape (the target) was located on the left or right of the screen when surrounded by a field of homogeneous shapes (distractors). All figures were constructed from five randomly connected straight lines generated from a 3×3 matrix measuring 1.5 cm $\times$ 1.5 cm. On each trial one target was presented randomly on the left or right of the screen amongst 19 identical distractors. The positions of the 20 figures were pseudo-randomly determined for each trial, with 4, 5, or 6 stimuli in each quadrant, and with the target appearing in a different position on each trial, such that it appeared equally often in each of the quadrants. Participants pressed buttons labelled 'Left' or 'Right' on a response box depending on whether the shape was on the left or right hand side of the imaginary midline of the screen. The response stimulus interval was 1.5 s. There were 12 practise trials followed by two blocks of 96 trials. The first block of 96 trials was the *pre-exposure* block and the second the *test* block. In the pre-exposure block the target and the distracters were the same throughout. In the test block there were four equally probable trial types presented in pseudo-random order. In *reminder* trials, the target and distractor were the same as in the pre-exposure block. In *novel* trials both targets and distractors were novel. In *reversal* trials, the target was the distractor in the pre-exposure block, and the distractors were the target from the pre-exposure block. In *novel target* trials, the target was novel, and the distractors were the target from the pre-exposure block. Notice the distractors were the same in reversal and novel target trials; only the targets differed. Lubow and colleagues measured latent inhibition by the difference between reaction times to reversal and novel target trials.

The Lubow et al. (2001) measure may not reflect purely inhibition: it may also reflect novel pop out, the tendency to attend quickly to a novel item amongst a familiar background. Novel pop out can be measured by the difference between the novel target trials (novel target against familiar background, so novel pop out possible) and the novel trials (novel target against novel background so no novel pop out). Lubow and colleagues uniformly obtained a latent inhibition effect; by contrast, they sometimes obtained a novel pop out effect (e.g. Lubow, Kaplan, Abramovich, Rudnick, & Laor, 2000) and some times did not (Lubow et al., 2001). A measure of *attentional rigidity,* free from novel pop out effects, is to compare reversal trials with reminder trials, which reflects the joint tendency of the trained distractors to be difficult to attend to (latent inhibition) and the trained targets to draw attention to themselves.

2.3. Procedure

Hypnosis screening always occurred first, but the remaining tasks were run in a random order separately for each participant in one further session. In the second session participants were run individually. Participants were not fully debriefed until all participants had been run.

3. Results

First we will consider the relation of hypnotisability to the measure of dissociation in everyday life (DES-C); then each cognitive task in itself, and the relation of these tasks to hypnotic suggestibility. Finally we consider gender differences in the correlations. Table 1 shows the means and standard deviations (in parentheses) for the measures.

Table 1
Means and standard deviation (in parentheses) for the measures.

WSGC	4.9 (2.2)
DES-C	37.0 (13.1)
Memory priming, RT to classify ignored words (ms)	697 (186)
Memory priming, RT to classify attended words (ms)	666 (161)
Memory priming, control reaction time (ms)	757 (200)
Spatial negative priming, RT to negative priming trials (ms)	646 (74)
Spatial negative priming, RT to control trials (ms)	635 (75)
Latent inhibition task, RT to reversal trials (ms)	2546 (578)
Latent inhibition task, RT to novel target trials (ms)	2133 (584)
Latent inhibition task, RT to reminder trials	2109 (420)
Latent inhibition task, RT to novel trials	2827 (739)

3.1. Dissociation

The Pearson correlation between hypnotisability and DES-C was .08 and was not significant (shown in Fig. 1 together with its confidence interval). Thus, the zero to small relationship typically found between hypnotisability and the DES was replicated with the DES-C.

3.2. Cognitive tasks

The cognitive tasks all showed priming effects. For the memory priming task of David and Brown (2002), the priming effect, the difference in reaction time to classify to-be-ignored and to-be-attended words, was significant, $t(179) = 3.14$, $p = .002$, $d = .23$. However, these data alone do not tell us whether the effect is due to inhibition of the to-be-ignored words or to greater activation (positive priming) of the to-be-attended words. To establish which of these possibilities was more likely, we compared participants' response latencies to those of control participants who had received no prior training on the task. The mean reaction time for to-be-ignored words was actually faster than the baseline reaction provided by control participants, $t(228) = 1.99$, $p = .048$, $d = .31$, thus indicating a small but significant positive priming effect, rather than a

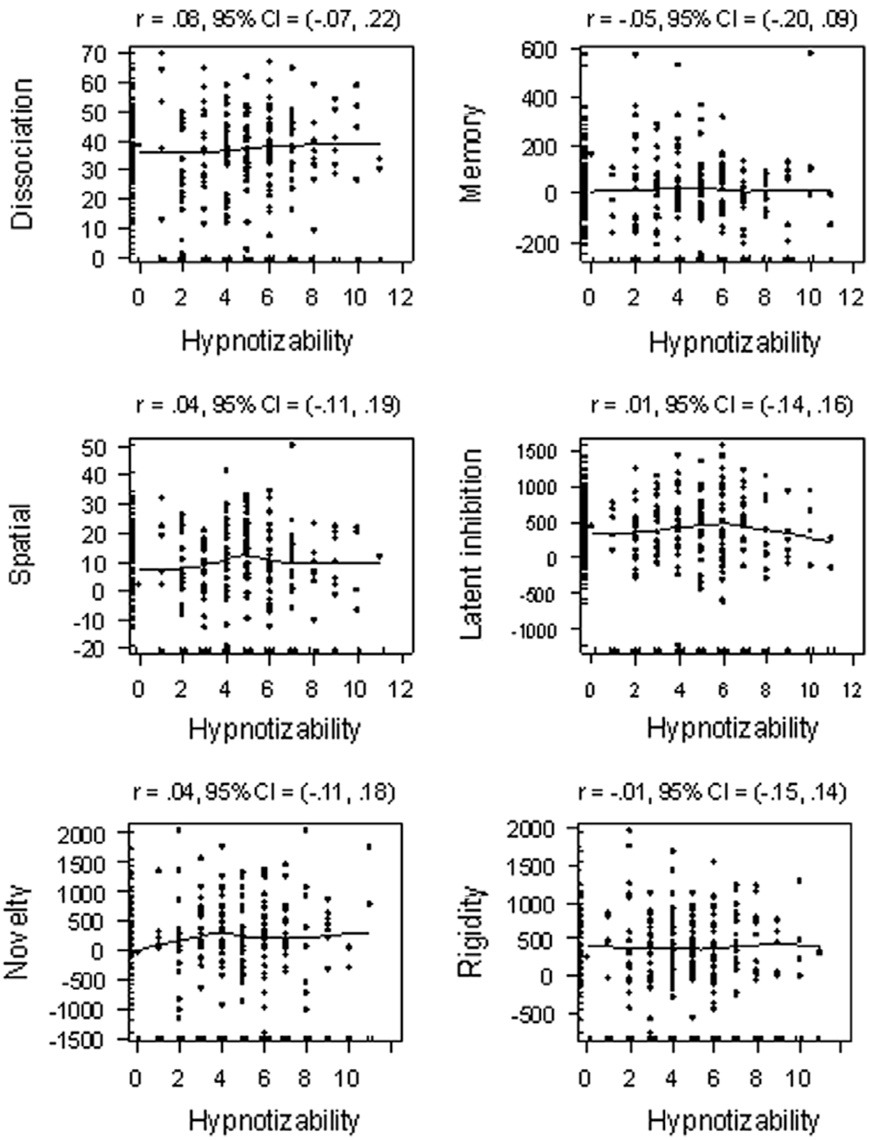

Fig. 1. Scatterplot, showing the relationship between each measure and hypnotizability, and rugplots, showing the univariate distributions. Pearson's correlations show no linear relationships exist and lowest curves are shown to investigate if any non-linear relationships may be present (which there are not).

negative priming effect. That is, exposure to the words, even in the context of being instructed to ignore them, led to some positive priming. Reaction time for to-be-attended words was considerably faster than the baseline reaction time of controls, $t(67.5) = 2.98$, $p = .004$, $d = .50$. Thus, the David and Brown paradigm illustrates how attending to words can lead to greater conceptual priming. Although the priming effect for this task is an attentional measure, it is a measure of positive priming in addition to or rather than inhibition.

For the spatial negative priming task, negative priming (the difference in reaction time between negative priming and control trials) was significant, $t(179) = 12.45$, $p < .0005$, $d = .93$, presumably reflecting the ability of people to inhibit irrelevant stimuli (Tipper, 2001).

Finally, for the latent inhibition task, the difference in reaction time between reversal and novel target trials was also significant, $t(179) = 12.18$, $p < .0005$, $d = .91$. The latter result may reflect inhibition and/or novel pop out. To measure novel pop out, the RT for the novel target trials was tested against the RT to the novel trials. We found that RTs for novel target trials were significantly shorter than RTs for novel trials, $t(179) = 16.07$, $p < .0005$, $d = .45$, indicating novel pop out. Attentional rigidity, the difference between reversal and reminder trials, was significant $t(179) = 13.41$, $p < .0005$, $d = 1.00$, indicating participants acquired the habit of attending and disattending in a somewhat fixed way.

Spatial negative priming did not correlate with latent inhibition, novel pop out, attentional rigidity, nor with memory priming; similarly, memory priming did not correlate with latent inhibition, novel pop out, nor attentional rigidity (all $|r|$'s < .10). DES-C correlated with latent inhibition, $r(180) = .17$, $p = .021$ (people with more dissociative experiences showed more inhibition), but with none of the remaining four priming measures ($|r|$'s < .10).

3.3. Correlates of hypnotic suggestibility

Now we consider the relation of each task to hypnotic suggestibility, as shown in Fig. 1. The inhibition measures are the relevant difference scores in mean reaction times. The priming measure for the David and Brown (2002) task was the difference between to-be-ignored and to-be-attended words. None of the correlations were significant, and the confidence intervals allow us to reject any population correlations above about .20.

It is possible that the dissociation and attentional measures are related to the performance of some hypnotic suggestions more than others. For example, maintaining selected amnesia might require inhibition of the to-be-forgotten material, whereas the generation of a positive hallucination may be more dependent on attentional focus. To evaluate this possibility, we examined the correlations between each of the priming measures whether or not each of the 12 hypnotic suggestions was passed. Out of the 60 correlations only one reached significance at the .05 level (uncorrected): memory priming with arm rigidity, point-biserial $r = -.15$. In sum, measured inhibition was not related to the performance of any particular suggestion.

The analyses were repeated taking sub-sets of WSGC items to code individual differences in direct motor, motor challenge, direct cognitive and cognitive challenge suggestions (cf. Woody & Barnier, 2008). None of these sub-types correlated significantly with the cognitive inhibition measures or the DES-C, all p's > .21.

3.4. Gender differences

Our sample consisted of 149 females and 31 males. Hypnotic suggestibility did not differ between males (5.2, SD = 2.4) and females (5.0, SD = 2.2), $t(178) = .41$, $p = .69$, $d = .07$. There were no detectable gender differences on any of the measures of cognitive inhibition, all p's > .75. On the DES-C males (33.4, SD = 13.1) and females (37.7, SD = 13.1) also scored similarly, $t(178) = 1.67$, $p = .097$, $d = .33$.

Correlations between hypnotic suggestibility on the one hand and DES-C and the cognitive inhibition variables on the other were computed separately for each gender. No correlations were significant, p's > .13, except for the correlation of hypnotic suggestibility with priming from the David and Brown (2002) task. For males the correlation was .48, $p = .006$, and for females the correlation was -.18, $p = .027$. Note the correlation for males survives a Bonferroni correction for conducting eight tests, although the correlation for females does not. Multiple regression indicated gender and hypnotic suggestibility interacted in predicting priming on the David and Brown task, $p = .001$. Our sample contained a majority of females; however in the studies conducted by David and Brown the gender ratio was very close to one. Thus, gender differences may explain the different overall results between our study and theirs.

Our priming measure on the David and Brown task was mean RT for the ignored stimuli minus mean RT for the attended stimuli. Mean RT for attended stimuli did not correlate with hypnotic suggestibility for either males ($r = .32$, $p = .081$) or females ($r = .03$, $p = .077$). However, mean RT for ignored stimuli did correlate with hypnotic suggestibility for males ($r = .54$, $p = .002$) though not females ($r = -.12$, $p = .15$). Thus, gender differences relate mainly to processing of ignored stimuli.

With all males and females together, the correlation of RT for ignored stimuli with hypnotic suggestibility was not significant, $r(180) = .04$. In contrast, Brown and David found in two studies that hypnotic suggestibility correlated (about .40) with reaction time for to-be-ignored words in their memory priming task. We do replicate their correlation for males, and overall their gender ratio, unlike ours, was close to unity so their overall results would have been more influenced by the male data than ours.

4. Discussion

The study found no evidence for a relation overall between hypnotic suggestibility and cognitive inhibition, as measured by a spatial negative priming task and latent inhibition task. Overall there was no detectable relation between hypnotic suggestibility and the increase in positive priming produced by attentional focus as indexed by the David and Brown task. Nor was there a relation between hypnotic suggestibility and novel pop out nor with attentional rigidity. Further, there was no relation between hypnotic suggestibility and dissociation as measured by Wright and Loftus's (1999) DES-C. Given the sensitivity of the study, we can rule out correlations stronger than about .20 in all these cases. These are compelling null results, with one exception: there was a substantial gender difference in the correlation between priming on the David and Brown task and hypnotic suggestibility.

These results pose a challenge for various theories of hypnosis. According to dissociation theories of hypnosis, hypnotic suggestibility should correlate with a tendency to experience dissociation in everyday life. The challenge for dissociation theorists is to explain in a non-ad hoc way why the relation is non-existent or, at best, trivial, even when the measure of dissociation in everyday life is normally distributed. If the tendency to dissociate in everyday life is not related to hypnotic suggestibility, maybe for people high in hypnotic suggestibility, dissociative experiences reliably occur only after an induction? However, the empirically determined flexibility of what can count as an induction (for example, a sugar pill labelled 'induces hypnotic state' is an effective induction, Baker & Kirsch, 1993), and the very small effect induction has on responsiveness to suggestion (Kirsch, 1997), suggest the occurrence of dissociative experiences cannot depend on a very rigid set of triggering circumstances. In any case, if dissociative experiences reliably occur only after the induction of hypnosis, then individual differences in hypnotic suggestibility remain unexplained by dissociation theories.

Various theories see hypnotic suggestibility as a peculiar ability to focus attention and inhibit to-be-ignored information. We found no evidence for this conjecture overall. Our data do not support the notion that highs have a general ability to engage in cognitive inhibition or focus attention. The results are problematic for theories that postulate hypnotic suggestibility involves a special ability to focus attention and disattend stimuli (e.g. Crawford & Gruzelier, 1992; Gruzelier, 1998). Conversely, Farvolden and Woody (2004) thought highs might be highs because of lowered executive functioning and hence a poor ability to inhibit. Our results do not support this conjecture either. Metzler and Parkin (2000), for example, found patients with frontal damage are impaired on negative priming; yet, in the current study, people high in hypnotic suggestibility showed the same level of negative priming as lows. Our data are not consistent with the claim that highs have poorer frontal function than lows.

The failure of the spatial negative priming to correlate with latent inhibition suggests that (to the extent the latent inhibition measure was measuring inhibition) cognitive inhibition cannot be usefully regarded as a single construct, at least not at the level of individual differences. Thus, one might wonder whether our tasks tapped the right sort of cognitive inhibition or attentional ability. The challenge though is to specify theoretically which inhibitory or attentional tasks should relate to hypnotic suggestibility and which should not (see Jamieson & Woody, 2007, for a start at developing dissociated control theory in the light of the neuroscience of the frontal lobes). Possible parallels between schizophrenia and hypnosis may also help isolate relevant tasks (cf. Baruch et al. ,1988; but see Williams et al., 1998).

Our results seem to contradict earlier evidence that there may be a relation between hypnotic suggestibility and inhibitory ability. Strategy differences may account for the way highs respond to visual illusions differently from lows, which has been cited as evidence for different attentional abilities between highs and lows. For example, highs report seeing more reversals of a Necker cube, more cases of autokinetic movement (illusory movement of a light in a dark environment), and a stronger Ponzo illusion (e.g. Crawford et al., 1993; Miller, 1975; Wallace, 1979; contrast Jamieson & Sheehan, 2002). While Miller, Wallace and Crawford et al. interpreted these findings as indicating highs have greater attentional or executive skills than lows, the findings are difficult to interpret without knowing what participants were trying to do. If highs do have good inhibitory skills, they should, for example, be able to maintain one perspective of the Necker cube for a long time if that is what they are trying to do. Conversely they should be able to make the perspective change frequently if that is what they are trying to do. To settle the issue instructions need to be explicitly manipulated in future research.

Highly suggestible individuals can dramatically reduce the Stroop effect both in and out of hypnosis, when given a suggestion that the words would appear meaningless (Raz, Kirsch, Pollard, & Nitkin-Kaner; 2006; Raz et al., 2002). Low suggestible participants are not able to do this during hypnosis, but we do not know if they might be able to achieve this reduction when outside of hypnosis. Although a substantial body of data indicate a high correlation between responsiveness to suggestion with and without the induction of hypnosis (e.g. Braffman & Kirsch, 1999; Hilgard & Tart, 1966), as evidence for a special inhibitory ability of highs, these studies are inconclusive until research has compared highs and lows outside of the hypnotic context.

Our data do not address whether highs and lows might differ in inhibitory abilities when those abilities are tested in the context of hypnosis, i.e. following a hypnotic induction (see Lynn, Kirsch, Knox, Fassler, & Lilienfeld, 2007, and Oakley, 2008, for recent reviews of evidence relevant to the difference between hypnotic and non-hypnotic contexts). Also, highs but not lows are able to inhibit interfering stimuli when given suggestions to do so (Iani et al., 2006; Raz et al., 2002). Raz and colleagues subsequently found that highly suggestible participants could modulate the Stroop effect without the induction of hypnosis (Raz, Kirsch, Pollard, & Nitkin-Kaner, 2006). In contrast, Iani et al. (2006) reported that highs were able to inhibit an interfering flanking item only after hypnotic suggestion. However, in this study the suggestion given during hypnosis was different from the suggestion given out of hypnosis, making it impossible to determine whether the difference in outcome resulted from the induction of hypnosis or the difference in the suggestion.

Strategy differences may well underlie the gender differences we found. In a conceptual replication of David and Brown (2002), for males but not females there was a substantial positive correlation between hypnotic suggestibility and priming on their task. The null correlations for hypnotic suggestibility with the other tasks, even separated by gender, suggests these relations do not reflect relations between hypnotic suggestibility and cognitive inhibition abilities in general. Further, the genders did not differ overall in successful inhibition on any of the tasks. Thus, genders may differ in strategies in approaching the David and Brown task, strategies that are overall just as effective for the purposes of the task but bring to bear different processes that are differentially related to hypnotic suggestibility. One difference between the inhibition required in the David and Brown task and the other tasks is that on each trial participants were asked to actively ignore a stimulus over a sustained period of time (5 s), whereas the other tasks involved positively attending to target stimuli for briefer periods of time (RTs of about half a second for spatial negative priming and a couple of seconds for latent inhibition). Instructions to actively suppress may bring out different strategies in males and females.

There are known individual differences in thought control and suppression (Brown & Ryan, 2003; Wegner & Zanakos, 1994; Wells & Davies, 1994). Recently, Semmens-Wheeler and Erskine (submitted for publication) found that on self-report questionnaires, males self-reported greater mindfulness than females (using Brown & Ryan's, 2003, inventory), and females self-reported greater tendency to suppress thoughts and use thought control strategies than males (using Wegner & Zanakos', 1994, and Wells & Davies', 1994, inventories). Mindfulness is an open accepting awareness of the world and one's mental states without emotional reactions to one's mental states and without active attempts at control. Paradoxically, such an attitude may lead to effective mental control: there is evidence that mindfulness-based therapies can treat disorders involving ineffectual control , such as anxiety and obsessive–compulsive disorder (Ivanovski & Malhi, 2007). If males are more prone to being mindful than females and females more prone to active suppression than males, as Semmens-Wheeler and Erskine's results suggest, performance on the David and Brown task may have reflected ability to be mindful for males and ability to suppress for females. Thus, the positive correlation between priming on the David and Brown task for males may indicate a relationship between mindfulness and hypnotisability; and the small negative correlation for females may indicate that the tendency or ability to actively suppress is unrelated to hypnotic suggestibility. These suggestions remain purely speculative at the moment but are testable.

In general, the abilities of highs may relate not to abilities to deal with the world (for example, special abilities to attend or disattend stimuli in the world), but with abilities to deal with mental states. For example, Kirsch and Lynn (1997) regarded hypnotic responding as depending on setting up a generalised implementation intention to respond to suggestions. Spanos (1986) regarded it as self-deception as to whether one has responded to the task intentionally. Relatedly, Dienes and Perner (2007) regarded hypnotic responding as carrying out intentions without having higher order thoughts of having those intentions. In any of these cases, the processes do not strictly depend on abilities to attend or disattend to the world. Hopefully, the current research will stimulate further development of paradigms to pinpoint what the abilities of high suggestible individuals may be.

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