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Effects of hypnotic induction and hypnotic depth on phonemic fluency: A test of the frontal inhibition account of hypnosis

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Abstract

According to the frontal inhibition account of hypnosis, many of the phenomena traditionally associated with hypnosis, such as the suspension of reality testing and loss of planning functions, come about because hypnosis produces decrements in frontal lobe performance. In line with this view, previous studies investigating the frontal inhibition account of hypnosis have found that phonemic fluency performance declines with hypnotic induction, but only for high hypnotizables. However, these studies were limited by their use of small restricted samples and suggestion based measures of hypnotizability. The aim of the present study was to attempt to investigate this effect using a sample which included a full range of hypnotizability, and dividing the phonemic fluency task into its frontal (switches) and temporal (cluster size) components. In addition, depth reports were used to assess the influence of hypnotic induction instead of suggestion based measures of hypnotizability. Results showed that overall, hypnosis had a negative effect on frontal aspects of the fluency task, and a positive effect on temporal aspects of the task; however, whilst the resulting changes partly differentiated those of medium depth from the other groups, they did not differentiate between subjects of high and low hypnotic depth. High hypnotic depth, however, was related to better phonemic fluency performance in the non-hypnotic condition. An explanation in terms of divided attention is proposed, the importance of adequate sampling in neuropsychological studies of hypnosis emphasized, and problems for the frontal inhibition account of hypnosis are identified.
Key words: Hypnosis, Hypnotizability, Frontal lobes, Verbal fluency, Divided attention

Resumen

De acuerdo con teoría de la inhibición frontal de la hipnosis, muchos de los fenómenos tradicionalmente asociados aeste fenómeno, como la prueba de la suspensión de la realidad y la pérdida de las funciones de planificación, se relacionan porque la hipnosis produce decrementos en funcionamiento del lóbulo frontal. En esta dirección, estudios previos que investigaban la teoría de la inhibición frontal de la hipnosis han encontrado que la fluidez fonémica disminuye con con la inducción hipnótica, pero solamente en los altos sugestionables. Sin embargo, estos estudios son limitados por el uso restrictivo de muestras pequeñas y sugestiones basadas en la medida de sugestionabilidad. El propósito del presente estudio fue procurar investigar este efecto usando una muestra que incluyó un amplio rango de sugestionabilidad, y dividiendo la tarea de la fluidez fonémica en sus

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componentes frontales y temporales. Además, para determinar la influencia de la inducción hipnótica fueron utilizados informes de profundidad en vez de medidas de sugestionabilidad. Los resultados demostraron en general que la hipnosis tenía un efecto negativo en los aspectos frontales de la tarea de fluidez, y un efecto positivo sobre los aspectos temporales de la tarea; sin embargo, mientras que los cambios que resultaban distinguieron en parte los de profundidad media de los otros grupos, no distinguieron entre los participantes de profundidad hipnótica alta y baja. La alta profundidad hipnótica, sin embargo, fue relacionada con un funcionamiento mejor en a fluidez fonémica en las condiciones no-hipnóticas. Se propone una explicación en términos de la atención dividida, se enfatiza la importancia del muestreo adecuado en los estudios neuropsicológicos de la hipnosis y se identifican las dificultades de la teoría de la inhibición frontal en la hipnosis.
Palabras Clave: hypnosis, sugestionabilidad, lóbulos frontales, fluidez verbal, atención dividida.

With the increasing application of the technologies of cognitive neuroscience, changes in brain activity following the induction of hypnosis have become an important focus of attention (Crawford, 1996; Gruzelier, 1998, 2000, 2006; Horton & Crawford, 2003; Wagstaff, 1998, 2000). In this context, one of the most important and influential theoretical perspectives is that of frontal inhibition.

The idea that frontal lobe inhibition is a fundamental feature of hypnosis was very much pioneered by the work of Gruzelier (1988), but gained particular prominence in the early 1990s through its connection with the theory of dissociated control (Bowers, 1992; Woody & Bowers, 1994). Dissociated control theory posits, like modern cognitive theories of working memory, the existence of a number of specific information-processing sub-systems governed by a supervisory mechanism or executive system involved in controlling their on-line operation (see, for example, Baddeley, 1993, 1996; Norman & Shallice, l986). The theory further assumes that the induction of hypnosis results in an altered state of consciousness in which there is a release of 'lower level functions from the integration that is normally imposed on them', with the result that 'subsystems of control can be directly and automatically activated, instead of being governed by high level executive control' (Bowers, 1992, pp.57 and 267). In terms of brain anatomy and function, proponents of this approach have argued that these effects are achieved primarily through inhibition of the frontal lobes of the brain (Bowers, 1992; Gruzelier & Warren, 1993; Kallio, Revonsuo, Hamalainen, Markela & Gruzelier, 2001). Hence, Gruzelier and Warren (1993) argue that frontal functions become inhibited during hypnotic induction procedures, and that this underpins 'the suspension of reality testing, abdication of planning functions, and reduced attentional monitoring of external cues which characterise hypnosis' (p. 205). Moreover, the inhibitory processes associated with hypnosis are alleged to occur with active-alert hypnotic induction procedures as well as traditional relaxation induction procedures (Cikural and Gruzelier, 1990).

An examination of neurophysiological and neuropsychological studies on the function of the frontal lobes in nonhypnotic contexts shows why the link between hypnosis and frontal lobe inhibition has been made. For example, it has been demonstrated that willed generation of motor acts are associated with bilateral blood flow increases in dorsolateral prefrontal cortex while instruction guided acts are not (Frith, 1996; Jahanshahi & Frith, 1998). And importantly, some patients with lesions of the prefrontal cortex appear to show specific disruptions of the executive processes assumed in cognitive models of executive functioning (Shallice & Burgess, l993; Leclereq *et al*, 2000). Typical deficits attributed to patients with damage to the prefrontal cortex of the brain include deficits in initiation, cessation and control of action; impairments in abstract and conceptual thinking; and deficits in goal-directed behaviour (Banich, 1996; Shallice & Burgess, l993). These features fit well with the traditional view of hypnosis as a condition in which reality testing is reduced and hypnotized subjects lose initiative to control and plan their actions, thus enabling the hypnotist to take over at least some of this role such that suggestions given by the hypnotist are experienced as involuntary.

Nevertheless, despite the appeal of frontal inhibition as a defining feature of hypnosis, behavioural evidence for frontal inhibition has been inconsistent. For example, Kallio *et al* (2001) tested the effects of hypnotic induction on a range of psychological indicators of frontal performance including the stroop task, simple and choice reaction time, vigilance, and phonemic and semantic verbal fluency. Significant differences between hypnosis and waking conditions were found on only one measure, phonemic or letter fluency; i.e. a task in which subjects are required to generate words beginning with specific letters within a time limit. In this respect, they replicated the results of Gruzelier & Warren (1993) who also found a significant reduction in phonemic fluency for high hypnotizables (those susceptible or most responsive to hypnosis procedures) following hypnotic induction. However, this may be significant in that, of the measures used by Kallio *et al* (2001) phonemic fluency is the one that has been most reliably related to the left dorsolateral frontal region; hence, phonemic fluency performance tends to be impaired in patients with left dorsolateral frontal lesions, and is accompanied by increases in blood flow to the left prefrontal cortex in normal individuals (Elfgren and Risberg, 1998; Troyer, Moscovitch, Winocur, Alexander & Stuss, 1998). Moreover, the particular area tapped by phonemic fluency is assumed to be involved most in the generation of willed or internally driven responses (Elfgren & Risberg, 1998; Morris, Ahmed, Syed & Toone, 1993).

With this in mind, the present study aimed to extend the studies of Kallio *et al* (2001) and Gruzelier and Warren (1993) on phonemic fluency in a number of respects. Most important, in the previous studies, the investigators tested small samples of subjects categorized as high and low hypnotizables on the basis of their responses to standard suggestion based scales of hypnotic susceptibility. However, they did not sample the sizable section of the population who would be classed as ‘medium hypnotizables’. This is important for a frontal inhibition theory of hypnosis; for example, if medium hypnotizables were to show more frontal inhibition than high hypnotizables, or no evidence at all of frontal inhibition, this would at least complicate the relationship between frontal inhibition and hypnotic responding.

Another possible limitation relates to the use of suggestion based measures of hypnotizability in studies of this kind. According to some, determining hypnotizability on the basis of responses to suggestions following hypnotic induction potentially confounds hypnotizability with suggestibility per se (Council, 1999; Braffman & Kirsch, 1999; Kirsch & Braffman, 1999; Weitzenhoffer, 1980). Typically, suggestion based scales employ a sleep/relaxation based hypnotic induction procedure followed by a set of suggestions, such as suggesting one's arm feels heavy, or one cannot separate one's hands. However, when we administer a conventional suggestion based test of hypnotic susceptibility, we have no estimate of the extent to which we are measuring baseline 'waking suggestibility' (suggestibility without hypnosis), as distinct from the ability to enter the hypnotic state or condition per se (regardless of whether the latter is construed is an altered brain state, state of imaginative involvement, a role-enactment, etc.). Indeed, according to Bowers (1976), it may be possible for some highly hypnotizable subjects to enter such a profound state of hypnosis that they may become less responsive to suggestions. Consequently, when measuring the ability to 'enter hypnosis', as distinct from the ability to perform suggestions whilst in this condition, there may be merit in using self-report measures of hypnotic depth that assess the experience of hypnotic induction per se (Bowers, 1976; Hilgard & Tart, 1966; Laurance & Nadon, 1986; Tart, 1970; Wagstaff, Cole & Brunas-Wagstaff, 2006).

It can also be noted that the measure of phonemic fluency used by Gruzelier and Warren (1993) and Kallio *et al* (2000), i.e. total word scores, is only one measure of frontal function that can be derived from phonemic fluency tasks. It has commonly been assumed that phonemic fluency, in terms of words generated to phonemic categories, is related to frontal and executive processing, as fluency taps aspects such as keeping rules in mind, following rules, and self-monitoring. However, Troyer *et al* (1997, 1998) have argued that verbal fluency is a multifactorial task which involves both intact semantic storage and effective search processes; hence optimal fluency requires the production of phonemically related words, and once a category is exhausted switching to another. Thus two important components of fluency are a) clustering, i.e. the production of words within phonemic categories and b) switching, the ability to shift efficiently to a new subcategory. A variety of evidence supports the view that switching between phonemic categories is specifically related to frontal lobe and executive functioning; whereas other aspects, i.e. the production of phonemic clusters is more related to non-executive temporal functioning (Baddeley *et al*, 1998; Martin, Wiggs, Lalonde, & Mack, 1994; Troyer, 2000; Troyer, Moscovitch, & Winocur, 1997; Troyer *et al*, 1998).

Given, these considerations the main aim of the present study was to assess the effects of the induction of hypnosis on phonemic fluency on a sample sufficiently large to include medium hypnotizables as well as highs and lows, and using hypnotic depth scores as the measure of hypnotizability. In addition, the phonemic fluency task was broken down into the components identified by Troyer *et al* (1997, 1998). On the basis of the frontal inhibition hypothesis it was predicted that the higher the degree of hypnotic depth reported by subjects, the lower their switching scores would be following hypnotic induction. Also, as total words tend to be more highly correlated with switches than clusters (Troyer *et al*, 1997, 1998), total words following induction should also be lower in those of high hypnotic depth, but perhaps to a lesser extent. Clusters, however, being related to temporal rather than frontal processes, should be unaffected by hypnosis or hypnotizability.

Method

Subjects

The subjects were 80 undergraduate students (41 females and 39 males) from the University of Liverpool from various disciplines. Subjects were told they were participating in a study of hypnosis and memory and were briefed about the procedures to be used. All gave their informed consent.

Materials and Procedure

Subjects were randomly assigned to two conditions, Order 1 and Order 2. Each subject was tested under two conditions, waking (no hypnotic induction) and hypnosis (with hypnotic induction). Those in the Order 1 group received the hypnosis condition first, whilst those in the Order 2 condition received the waking condition first. In the waking condition, subjects were asked to generate words beginning with the letters F, A and S, or C, L, and M; they were given one minute for each. They were told not to use any proper names (such as a person's name or a place name), or variations of the same word, i.e. repetitions of the same word with different endings (like teach and teaches) (see Troyer *et al*, 1997; Troyer, 2000). Within each Order condition, half of the subjects received the FAS letters in the waking condition, and the CLM letters in the hypnotic condition, and vice versa for the other half. To investigate the possibility that the effects of hypnotic induction may be influenced by group size, within the Order and Stimulus Type conditions, half of the subjects were tested individually, and half in groups of five.

The procedure was identical for the hypnosis condition except that, before the phonemic fluency test, subjects were presented with 10 minute standard relaxation based hypnotic induction procedure slightly modified from Barber (1969), and hypnotic depth was then measured using the Long Stanford Scale of Hypnotic Depth (LSS) (Tart, 1970), which requires subjects to rate their degree of experienced depth on a scale from 0 'awake and alert, as you normally are', through 1 'borderline state, between sleeping and waking', 2 'lightly hypnotized', 5 'quite strongly and deeply hypnotized', 8-9 'very hypnotized' to 10 'very deeply hypnotized'[1]. After the administration of the phonemic fluency test, all subjects in the hypnosis group were given the hypnosis termination instruction. It can be noted that the use of what could be construed as a 'neutral hypnosis' paradigm (Edmonston, 1977); i.e. a standard induction procedure followed by the LSS, rather than a more conventional procedure involving an induction plus a number of test suggestions, was preferred to prevent the confounding of the effects of the induction of hypnosis with the effects of responsiveness to test suggestions *per se* (for discussions of this issue see Bowers, 1983; Council, 1999; Braffman and Kirsch, 1998; Kirsch and Braffman, 1999; Wagstaff, 1998; Wagstaff *et al*, in press; Weitzenhoffer, 1980).

Results

The responses for each subject were scored for total words generated, switches and mean cluster size according to the criteria described by Troyer (2000) and Troyer *et al* (1997). On the basis of their scores on the LSS (*M*= 2.21; *SE*= 0.24; range= 0-10), subjects were divided into four groups, low depth (0, *N*= 19), low-medium depth (1-2, *N*= 30), high-medium depth (3-4, *N*= 22), and high depth (5-10, *N*= 9). The nature of this distribution, with the largest number of cases in the 1-2 category (borderline) and the smallest in the 5+ category (very hypnotized) accords with normative data for self-reported depth scales (Hilgard & Tart, 1966; Wagstaff, Brunas-Wagstaff & Cole, 2006).

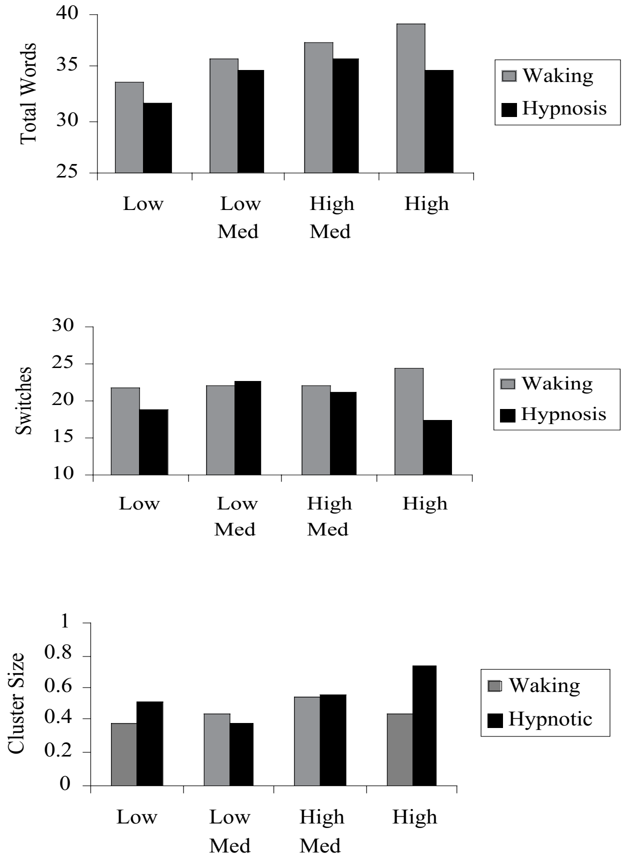

Figure1. Experiment 1: Mean total words, switches and cluster sizes, under waking and hypnosis conditions, for subjects of Low, Low Medium (Low Med), High Medium (High Med) and High hypnotic depth.

The original plan was to conduct a series of Depth X Individual/Group X Waking/Hypnosis ANCOVAs with Stimulus Type (FAS or CLM), Condition Order (hypnosis first or second), and Gender as control covariates. However, the Stimulus Type control violated the ANCOVA parallel linearity assumption and had an undue effect on the outcome of the main analysis. As an alternative, therefore, Stimulus Type was entered as a control in the main analysis with Individual/Group added as a covariate; i.e. the data for total words, switches and mean cluster scores were analysed using three 4 X 2 X 2 ANCOVAs (Depth X Waking/Hypnosis X Stimulus Type) with repeated measures on the Waking/Hypnosis factor, and with Group, Condition Order, and Gender as covariates. The Depth X Waking/Hypnosis means are shown in Figure 1.

The results for total words showed only one significant effect; total word scores were significantly higher in the waking condition (*M* = 36.39; *SE*= 1.19) than in the hypnosis condition (*M*= 34.17; *SE*= 1.11), *F*(1,72)= 4.52, *p*< .04, h^2 = .06; i.e. hypnotic induction, or at least the kind of induction used here, inhibited total word verbal fluency performance. Neither the main effect for Depth, nor the Depth by Waking/Hypnosis interaction approached significance (Figure 1).

Switching scores were also significantly higher in the waking condition (*M*= 22.57; *SE*= .98) than in the hypnosis condition (*M*= 19.98; *SE*= .93), *F*(1,72)= 12.10, *p*< .002, h^2 = .15. However, the Depth by Waking/Hypnosis interaction was also significant, *F*(1,72)= 3.22, *p*< .03, h^2 = .12 (Figure 1). Post hoc *F* tests showed a significant tendency for the low depth subjects to score fewer switches in the hypnosis than the waking conditions (*p*< .01, h^2 = .32), and a near significant trend (because of less power), but with a similar effect size, for highs to perform similarly (*p*< .08, h^2 = .34). *F* tests on the waking versus hypnosis comparisons for the other two groups did not approach significance. Moreover, further *F* tests showed that lows and highs did not differ in the hypnosis condition. Thus, although, overall, there was a decrease in switches with the induction of hypnosis, this was most apparent for low and high depth subjects; indeed, the low-mediums showed a slight non-significant increase in switches.

The ANCOVA on the mean cluster scores showed that, overall, cluster sizes were higher in the hypnosis condition than in the waking condition, *F*(1,72) = 10.35, *p*< .003, h^2 = .13. Although the Depth X Waking/Hypnosis interaction just failed to reach significance, *F*(3.69)= 2.53, *p*<.065, h^2 =.10, it is clear from the means (Figure 1) that the increase in cluster size was only evident for the lows and highs.

In addition, a series of partial correlations were performed between the full LSS scores and the waking and hypnotic scores for total words, switches and clusters, controlling for stimulus type, order, group presence and gender. Only two correlations approached significance; LSS depth scores correlated positively with waking total word scores (.28, *p*< .015), and waking switches scores (.21, *p*< .07); i.e. in the waking condition the higher the degree of reported depth, the better the frontal performance.

Discussion

Overall, the results for total words and switches lend general support for the view that a standard sleep/relaxation style hypnotic induction procedure can induce a decline in frontal performance. However, unexpectedly, there was no evidence that the frontal performance of those reporting a high degree of hypnotic depth was any worse under hypnosis than those reporting no influence of hypnosis. Indeed, particularly with regard to switches, the trend was for both lows and highs show greater performance decrements than the two medium groups (Figure 1).

The corresponding rise in cluster sizes our low and high groups (Figure 1), indicating temporal lobe activation, was also an unanticipated finding. However, one might perhaps expect an increase in non-executive processing in situations in which executive processing is compromised, or working at full capacity, yet subjects are especially motivated to perform a task. The motivating properties of hypnosis are well documented (Sheehan & Perry, 1976); accordingly, if hypnosis simultaneously disrupts performance on the frontal aspects of the phonemic fluency tasks, whilst maintaining or even increasing the motivation to do well on the task (produce as many words as possible), this might give rise to an increase in cluster sizes to compensate.

However, the reason why, in general, the low hypnotizables produced similar results to the highs, obviously requires explanation. It could be argued perhaps that those who felt they were in their normal waking state of awareness were misguided in some way; i.e. they were 'hypnotized' without realizing it. If so, this in itself would be very interesting, but, apart from conceptual difficulties with the idea of 'hypnosis without awareness' (Wagstaff, 1998), it seems unlikely on empirical grounds. In general, self-report depth scales are not only reliable but also possess good criterion related validity as predictors of hypnotic performance (for reviews see Bowers, 1976, Wagstaff et al., 2006, Tart, 1970, 1979). Hence, typically, those who report zero depth on self-report scales also score very low on suggestion based scales of hypnotic susceptibility (Hilgard and Tart, 1966)[1,2]. Thus, whilst it is important to establish whether the effects found here for subjects of low depth also emerge with subjects who score extremely low on standard suggestion based scales, it seems unlikely that the present effects resulted from a misclassification of high hypnotizables as 'lows'.

It may be possible to derive a more plausible explanation, however, by looking at the present results in the context of neuroimaging studies on the effects of hypnotic induction and hypnotic suggestions. Somewhat paradoxically in terms of the frontal inhibition hypothesis, studies of cerebral blood flow consistently indicate increased involvement of regions within the frontal cortex during hypnotic induction and suggestion, and particularly the left frontal context (see for example, Crawford, 1996; Jamieson, Dwivedi & Gruzelier, 2005; Rainville *et al*, 1999). In other words, induction instructions typically result in increased left frontal activation for those who respond to them. An implication of this is that, when required to perform a frontal executive task, such as phonemic fluency, subjects who simultaneously engage with the instructions in the induction (those of high depth) may be in a state of divided attention; i.e. the task of trying to relax, concentrating on their limbs etc. might compete with that of generating words. This might manifest itself a deterioration in performance on the phonemic task. For example, in a study that did not involve hypnosis, Troyer, Moscovitch and Winocur (1997) found that requiring subjects to perform an executive finger tapping task at the same time as a phonemic fluency test resulted in a highly significant reduction in performance on the latter. This might go some way towards explaining the relative difference in the performance of highs and low-mediums; i.e. if we assume that low-mediums do not engage in the induction instructions to the same extent as highs, they would be less affected by divided attention. But why should low depth subjects, who are presumed not to respond to the induction at all, show a divided attention effect?

A variety of evidence suggests that subjects classed as low on measures of hypnotic susceptibility tend to have negative attitudes and expectancies towards hypnosis to the extent that they may actively resist suggestions in contexts defined as hypnosis (see, for example, Jones and Spanos, 1982; Spanos, 1986; Spanos, 1989; Lynn and Rhue, 1991). They may also fail to respond because they find the hypnotic situation more anxiety provoking (Gruzelier, 2006). Factors such as actively trying to resist instructions, and anxiety, might also induce interference and result in a decline in residual frontal capacity. Nevertheless, if lows remain particularly motivated to respond to the word generation task (for instance, to show they are 'unaffected' by hypnosis), this might produce a corresponding increase in clustering. In future research, therefore, it might be informative to integrate measures of attitudes, anxiety and strategy use with neuropsychological and neurophysiological data (see, for example, Elfgren & Risberg, 1998).

Notably, however, our results for lows appear to differ from those of Gruzelier and Warren (1993) who found a significant increase in total word performance for lows following hypnotic induction, whereas highs showed a decrease (see Figure 2). The former trend they put down to a practice effect as the waking condition always preceded the hypnosis condition. To control for practice, Kallio *et al* (2001) counterbalanced the order of the waking and hypnosis conditions; however, their results were broadly similar to those of Gruzelier and Warren; i.e. whilst the highs showed a significant decrease in total words in the hypnosis condition, lows showed a slight non-significant increase. Nevertheless, an examination of the sampling procedures for low susceptibles used by Gruzelier and Warren and Kallio *et al* may provide an explanation of this

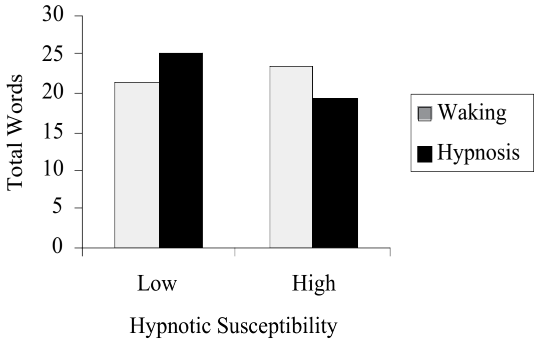

Figure 2. Gruzelier and Warren's (1993) study: Mean total words, under waking and hypnosis conditions, for subjects classified as Low and High hypnotic susceptibility.

discrepancy. As their sample of 'lows', both Gruzelier and Warren, and Kallio *et al*, used a sample of 10 subjects who scored a mean of 2.1, with a maximum score of 4, on the Barber Suggestibility Scale (BSS). In addition, Kallio *et al*'s sample scored a mean of 3.0, with a maximum score of 5, on the Harvard Group Scale of Hypnotic Susceptibility: Form A (HGSHS:A). However, according to Hilgard and Tart's (1966) normative data, subjects scoring zero on hypnotic depth score only 1.2 on the Stanford Hypnotic Susceptibility scale: Form C (SHSS:C); moreover, whereas a range of 0-5 on a standard suggestion based scale could represent up to 50% of the population, according to available norms, one would usually expect only around 15-17% of subjects to score zero on a self-report depth scale (Hilgard & Tart, 1966; Wagstaff *et al*, 2006). It thus seems possible that, in their samples of 'low susceptibles', Gruzelier and Warren and Kallio *et al* might have recruited a significant number of those who could have been classed as 'low-mediums' in the present experiment. If we make this assumption, then the similarity between the switching scores for low-mediums and highs shown in Figure 1, and the results of lows and highs for total words reported by Gruzelier and Warren and Kallio *et al*, are considerable; i.e. a slight increase for low-mediums, and a decrease for highs (Figure 2). Our findings for total words did not show an equivalent interaction, mainly because the slight increase in switches for the low mediums was offset by a small non-significant decrease in clusters (Figure 1); nevertheless, it can be noted that there was still a trend for the difference between the waking and hypnosis conditions to be larger for the highs than the low-mediums (Figure 1).

All this points to the importance of representative sampling when considering neuropsychological correlates of hypnosis. Studies in this area are frequently based on very small samples with little if any information available concerning the parent sample from which they were derived. As the present results show, this may have crucial relevance to how findings are interpreted. For example, if we consider the switch scores of only the low-mediums and highs in Experiment 1 (Figure 1), this might give the impression that highs show a more profound frontal deficit than subjects less susceptible to hypnosis. Instead, the full data show that, although highs are affected by hypnosis, the resulting deficit does not take them to a level significantly below that shown by lows. This result is also reflected in the correlational evidence which did not support the prediction that phonemic fluency during hypnosis would be negatively related to hypnotic depth; instead the only trends to approach significance were for waking total words and switches to correlate positively with hypnotic depth. Interestingly, notwithstanding sampling issues, a similar baseline trend is evident in Gruzelier and Warren's (1993) data, such that, because of higher waking baseline levels of phonemic fluency performance for high susceptibles, the frontal performance of high susceptibles during hypnosis was not significantly different from that shown in the waking condition by subjects classed as lows (Figure 2).

The finding of a positive correlation between hypnotic depth and waking frontal performance is, of course, itself important, and fits with a variety of other evidence indicating that high hypnotizables may have greater waking attentional capacities (for example, Braffman & Kirsch, 2001; Evans & Graham, 1980; Gruzelier, 2006; Graham & Evans, 1977; Sigman, Philips & Clifford, 1985). However, if hypnotic phenomena are associated in a causal way with a decline in frontal performance, then one would still expect frontal decrements to be greater in high hypnotizables when 'hypnotized', than those less hypnotizable, whether 'hypnotized' or not. This does not consistently seem to be the case.

Perhaps, therefore, the main challenge for supporters of the frontal inhibition account of hypnosis is not so much to demonstrate that highs show a deficit in available frontal capacity between waking and hypnotic induction conditions, as to establish that the degree and nature of any resulting deficit is sufficient to have a fundamental effect on the production and experience of hypnotic suggestions. In other words, they need to establish that frontal inhibition with hypnosis is not simply an epiphenomenon. In this context, it is clearly important to establish the extent to which frontal performance and responsiveness to hypnotic suggestions vary in response to other types of procedures that might be expected to induce divided attention and frontal inhibition. As the present study was essentially a replication and extension of earlier work on verbal fluency by Kallio *et al* (2000) and Gruzelier and Warren (1993), no control groups were used. However, in future studies, control procedures might include, for example, other forms of hypnotic induction, such as active-alert inductions (Bányai and Hilgard, 1976); procedures that have been associated with hypnotic induction, such as relaxation and meditation (Barber, Spanos and Chaves, 1974; Benson and Klipper, 1976; Edmonston, 1977); and other distinctly non-hypnotic procedures such as finger tapping tasks (Troyer *et al*, 1997).

Notes

1. According to data presented by Tart (1970), the correlations between undeliberated LSS reports and the behavioural and experiential scores of the SHSS:C are .61 and .79 respectively. The latter is actually fractionally greater than the correlation found between the SHSS:C behavioural and experiential components, which is .77. When one further considers that typical correlations between the SHSS:C, and, for example, the SPS1 and 2, the HGSHS, and the BSS are .71, .72, .59 and .58, respectively, the LSS would appear to be at least as valid a measure of hypnotic susceptibility as many other suggestion based measures in common use (for reviews see Bowers, 1976; Tart, 1970, 1979; Wagstaff *et al*, in press).
2. Recent data from the present authors also show that LSS depth reports given immediately following induction actually predict the amnesia item of the Stanford Hypnotic Susceptibility Scale: Form A (SHSS:A), i.e. an item that has been especially associated with the presence of hypnosis, better than the total of the rest of the suggestions on the SHSS:A. In this study, 20 subjects were given the Barber (1969) induction scale, followed by the LSS and the SHSS:A. Multiple regression analysis with amnesia passing scores as the dependent variable, and LSS scores SHSS:A total suggestion scores (minus the amnesia item) as the predictors, showed that only LSS scores significantly predicted amnesia ($\beta = .45$, $p < .04$, and $\beta = .36$, $p > .09$, for the LSS and SHSS:A scores, respectively).

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