TIME TO EXPLAIN THE NATURE OF HYPNOSIS?

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Abstract

Time distortion is a well known phenomenon of hypnosis. Perhaps less well known are the distortions to temporal judgement that are exhibited by patients with Parkinson’s disease or schizophrenia. Both these classes of patient also suffer from hallucinations, which of course can be induced in hypnosis. It is argued that these are not chance parallels; they can all be accommodated by Gray’s (1995) account of the neurophysiology underpinning consciousness. Recognizing that patients with hallucinations have their consciousness altered, it is concluded that hypnosis too represents an altered state of consciousness. The degree of alteration is shown to be correlated with the magnitude of time distortion experienced. In contrast with many studies, it is also reported that distortion is significantly greater in those who are highly susceptible to hypnosis. Copyright © 2006 British Society of Experimental & Clinical Hypnosis. Published by John Wiley & Sons, Ltd.

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Introduction

For the last few years I have been advocating the study of hypnotic time distortion (Naish, 2001; 2003; 2005a). Clearly this rather striking phenomenon is deserving of investigation in its own right, but I have suggested that it might also offer an insight into the nature of hypnosis itself. In this paper I shall give an overview of the data that have prompted my position, and set the findings in context with other relevant material on time perception and consciousness.

The significant underestimation of the duration of a period of hypnosis, when judged retrospectively, seems first to have been reported formally by Bowers and Brenneman (1979). They described their subjects’ underestimation of the time taken to receive the Harvard Group Scale of Hypnotic Susceptibility (Shor and Orne, 1962). However, the size of this error of judgement (commonly as much as 50% of the true time), and its almost ubiquitous occurrence, make it seem likely that many others had observed the effect. One knows of clinical colleagues who use the misjudgement to ‘prove’ to clients that ‘things were working’. Indeed, some use the extent of the underestimation as a rough indicator of the susceptibility of the client. As will be shown, whether they are correct to do so has been a matter for debate.

If an effect is associated with hypnosis, then it is reasonable to suppose that it will be exhibited more strongly by those who are more responsive, in other words that there will be a correlation with hypnotic susceptibility. Surprisingly, neither the original
Bowers and Brenneman study, nor many subsequently (see St. Jean, McInnis, Campbell-Mayne and Swainson, 1994, for a review) have found such a relationship. This is extremely puzzling. It is far from clear how an effect so strongly linked with hypnosis can fail to be influenced by responsiveness to hypnosis. Possible explanations can, in broad terms, seek a reason for the lack of correlation in the hypnosis domain or the time domain. Thus, an extreme explanation related to hypnosis would be that susceptibility scales do not measure anything related to the ‘true’ responsiveness to hypnosis. In effect, one would be claiming that time distortion is a better measure of susceptibility than the standard scales: a difficult position to defend. A less extreme version of this account would suggest that, whereas traditional scales incorporate a range of dimensions, perhaps the timing effects are linked to only one. If this were true, a subject might score highly on the other dimensions, and hence gain an overall high susceptibility score, but crucially be deficient in the measure that correlates with time distortion.

A similar pair of explanations can be constructed from the timing perspective. The extreme version is that the effect is linked to something that often accompanies hypnosis, but has nothing to do with hypnosis itself. Certainly, two decades ago this would have been a reasonable position to adopt, and St. Jean (1988) pointed out, ‘It has not been established that underestimation is due to the employment of hypnotic procedures’ (p. 83). Nevertheless, a less extreme explanation can preserve the hypnosis–timing link. It is that the timing effect is partly brought about by hypnosis, but is also influenced by other factors. These would increase the variance in the timing data and reduce the correlation with susceptibility.

Studies of hypnotic time distortion, many of them conducted by St. Jean and his colleagues, can be characterized as searching in the two domains outlined above. Some research has attempted to find the elements of hypnosis that might influence time perception; other studies have taken known influences upon time judgement, and looked for them in hypnosis. As will be explained, the searches did not meet with great success.

Amnesia and absorption

Following hypnosis, subjects may be amnesic for some of the test items that have been administered (particularly if given suggestions for amnesia). It has been proposed (Ornstein, 1969) that one of the factors that influence our judgement of how long a period lasted is the number of activities that took place within it. Someone who, through amnesia, could remember only a few activities might conclude that the period had been rather brief. However, St. Jean, MacLeod, Coe and Howard (1982) failed to find any correlation between the extent of hypnotic amnesia and the degree of time distortion. Amnesia appears not to be the element of hypnosis that accounts for the effect.

Absorption is seen as another element of hypnotic responding; it can be measured, and is known to correlate with hypnotic susceptibility (Tellegen and Atkinson, 1974). Since susceptibility has seldom been shown to correlate with time judgements, it might have been expected that those judgements would also fail to correlate with absorption. Nevertheless, it is tempting to propose that becoming ‘lost in one’s thoughts’ might be a distraction from detecting the passage of time. St. Jean and MacLeod (1983) tested this proposal, by reading subjects absorbing stories, following which the subjects judged the story’s duration. Substantial underestimation was found only in high-susceptible subjects, when they were hypnotized. In other words, this study showed hypnosis producing its traditional timing effect, but in particular with those who scored high on susceptibility. The effect was not found if the material listened to was not involving, suggesting
that the absorption component of hypnosis was indeed the dimension associated with the timing effects.

This study had aspects in common with some of my own, which will be discussed later, but St. Jean soon rejected the absorption account (St. Jean and Robertson, 1986). It was shown in this latter study that the key determinant of the degree of time underestimation. Outside the hypnosis context, it is known that high attentional demand leads to time underestimation (e.g. Brown and Boltz, 2002). It is assumed that attention is a finite resource, and that an increase in mental workload, such as occurs when a task is difficult, makes more demands upon the resource, so leaving less to monitor the passage of time (e.g. Zakay, 1989). This observation is pertinent to two possibilities raised in the introduction. First, it suggests a plausible non-hypnotic influence upon time judgements, which might dilute any hypnotic effects. Second, mental workload may actually be a varying element of hypnosis itself, and thus be the component that gives rise to the timing effects. This will now be considered.

**Hypnosis and mental workload**

St. Jean et al. (1994) reasoned similarly to the above, and set about demonstrating the effects of workload upon time estimation in hypnosis. In their first experiment, hypnotized subjects took part in one of two conditions; both included listening to a story, and at the end they were asked to estimate how long the story had lasted. Listening was all that was required in the low workload condition, but the high workload group had simultaneously to solve word puzzles and count the number of occurrences of a particular name in the story. The two groups each comprised 50% high susceptibility (‘highs’) and 50% low susceptibility (‘lows’) subjects.

St. Jean et al. found that time estimates were shortened for both workload groups. People in the low workload condition averaged 63% of the true time, but the high workload subjects reduced their estimates to 43% of the actual duration of the story. Interestingly, the results hint at an apparently non-significant interaction (the statistics are not quoted). Whereas there was no difference between the estimates of hypnotic ‘highs’ and ‘lows’ in the low workload condition, under high workload the ‘highs’ and ‘lows’ gave estimates of 38% and 48% (of true time) respectively. This suggests that ‘highs’ might be more vulnerable to the time-shortening effect, when subjected to higher workload. This theme will be revisited later.

The basic finding of an effect of workload upon time judgement is not of great interest, since it merely confirms an effect known outside hypnosis. There was no reason to suppose that hypnosis would eliminate the effect. However, St. Jean et al. went on to a further experiment, comparing the magnitudes of the effect obtained in and out of hypnosis. Unfortunately, in this experiment there seems not to have been a separation into ‘highs’ and ‘lows’, so the effects are averaged across subjects with a range of susceptibilities. Moreover, the tasks had been modified somewhat, so it is not possible to make meaningful comparisons with the first experiment. The results obtained were hard to explain.

Under low workload, the time estimates were 92% outside hypnosis and 80% in hypnosis. Thus, hypnosis appeared to be having the usual effect of reducing the perceived duration. However, under high workload the situation was different: with ‘waking’ 45% and ‘hypnosis’ 64%. In other words, in hypnosis the time distortion was actually less pronounced. This puzzling interaction just missed statistical significance (p = 0.08), and
the only significant main effect was of workload. That is, increased workload caused a
time period to seem shorter, but whether or not a subject was hypnotized had no effect.
Since it is effectively a universal finding that hypnosis does have an effect on time
estimation, we must conclude that some very unusual factors were influencing these
results.
A partial explanation might be that the high workload condition was so demanding
that subjects were unable to maintain a significant degree of hypnosis. However, the
subjects in the corresponding non-hypnosis condition (who clearly were not attempting
hypnosis) suffered an even greater time distortion. This was a ‘between subjects’ study,
with only 15, non-selected subjects per group, so perhaps the best explanation for this
strange reversal is that it was brought about by inadequate randomization of subjects.
Before moving on to other explanations for hypnotic timing effects, it is worth con-
sidering how St. Jean et al. accounted for their results. They concluded that the traditional
time reduction was indeed due to the demands (i.e. workload) of being hypnotized. This
was encapsulated in what they called their ‘busy beaver’ hypothesis:

The processing resources of the hypnotic subject are so fully occupied by the demands of
the hypnotic task that the residual capacity available for the processing of time-related
[. . .] cues is minimal. [Hypnotic time underestimation] may simply be a by-product of the
attentional demands of the hypnotic task. (St. Jean et al. 1994: 568)

This position does not seem to be justified by the data. Their first experiment showed
that, although the hypnotized ‘beaver’ may well be busy, there was still capacity to take
on another task and thus increase the time distortion. The second experiment was even
more problematic for the busy beaver hypothesis. If hypnosis is demanding, then adding
it to a task that is already causing time distortion should lead to even greater timing
effects. The experiment showed that there was no such increase (if anything a decrease),
so the hypothesis is completely unsupported.

Hypnosis and the internal clock

Researchers in the field of time perception assume that the impact of increasing workload
comes about through the reduction in resources available to count some kind of ‘clock
tick’ (e.g. Brown and Boltz, 2002). If a proportion of ‘ticks’ were missed, then the accumu-
lated score at the end of a timed period would be less than normal, hence leading to
the perception that less time had passed. The exact nature of the clock has been unclear,
but Treisman and colleagues (e.g. Treisman, Faulkner and Naish, 1992; Treisman, Cook,
Naish and MacCrone, 1994) have proposed that it is neurologically based. We were even
able to suggest the rate at which it appeared to tick: approximately 12 Hz (Treisman,
Faulkner, Naish and Brognan, 1990).

Although the timing effects associated with manipulations of workload and attention
are plausibly related to the number of timing units counted or missed, there is another
possible candidate for bringing about changes: the tick rate itself. If this was to change
speed, then the number of ticks counted in a given period would also change, giving rise
to changed estimates of duration. Whether the effects of increased workload should be
conceptualized as a distraction from counting, or a slowing of the clock to ‘fit everything
in’ is an issue not relevant to this paper; it is concerned only with the possibility that
hypnosis might slow the clock.

What would be the observed effects, if hypnosis caused an inner clock to run more
slowly? With fewer ticks being counted per unit of real time, the overall number
accumulated over a session of hypnosis would be relatively small, leading the subject to conclude that a shorter length of time had passed. That of course is the usual observation. A further prediction can be made. If it is true that the clock ticks slowly, a subject waiting for a period of time to pass will wait too long. Suppose, for example, that they try to wait two minutes, before carrying out some action. From previous experience, they will have in mind what two minutes feels like, presumably based upon some conscious representation of the tick-accumulation value for this duration. If the clock begins to tick more slowly than usual, then inevitably the person has to wait longer for the appropriate tick value to accumulate.

I tested the ‘waiting two minutes’ idea (Naish, 2001), asking hypnotized subjects to interrupt me when they believed two minutes to have passed. They did indeed ‘over-shoot’, producing an average duration 21% longer than a true two minutes. In contrast, at the end of the hypnosis session their estimate of the overall time taken was only 64% of the actual 35 minutes or so that had passed.

These two timing tests can be described as prospective and retrospective. The usual test in hypnosis, asking how much time has passed, seeks a retrospective estimate. Requesting the subject to keep track of time, for a specified interval, is a prospective task. Outside the hypnosis field it is well known that prospective estimates are generally longer (and as a result more accurate) than retrospective (e.g. Zakay, 1989) and the observation is commented upon by St. Jean et al. (1994). These authors claimed that the principal difference between the two tasks was that the retrospective measure was unexpected by the subject, hence leading to a reduced level of attention to the timing task. Prospective timing, by definition, requires that the subject knows what is required, and presumably deploys the necessary resources to carry out the task.

The possibility that the prospective/retrospective difference I found was merely due to some shift of expectation or attention needs to be addressed. An effective way of looking at the impact of hypnosis itself (and incidentally removing other individual differences) is to compare the timing estimates made in hypnosis with those made outside hypnosis, when carrying out similar tasks. Importantly, an individual’s hypnosis results should be expressed as a fraction of their ‘waking’ results. In this way, any tendency for an individual to over- or underestimate time intervals is eliminated from the result; only the impact of hypnosis upon the timing is recorded. It was possible to recalculate my data in this way.

When I compared subjects’ ability to interrupt me in what they felt was two minutes, both during and before hypnosis, I found that the time they waited within hypnosis was 60% longer than the time delay during ‘waking’. Corresponding calculations of the retrospective effect showed that the estimate in hypnosis was 32% shorter than the estimate made out of hypnosis. It was clear that hypnosis was having an impact upon both measures of time estimation, and the directions of the changes were consistent with the slow clock hypothesis.

Hypnosis and brief interval assessment

The time estimates investigated in hypnosis have tended to be for periods in the range of several minutes, whereas most experiments reported in the time perception literature consider intervals of a few seconds or less (e.g. Fortin and Couture, 2002). There would be merit in using brief periods in hypnosis. One advantage is that this would eliminate some of the variability introduced by activities associated with other tasks. Thus, St. Jean et al. (1994, Experiment I) showed that higher workload tasks within hypnosis produced greater distortion. Most retrospective estimates published have been for periods...
during which subjects were involved in a variety of tasks, of unknown attentional demand; these may have contributed to the variability in the magnitude of the effects reported. In a brief time-estimation study it is not possible for subjects to be engaged in any other activity. Another advantage of using brief periods is that, appropriately administered, there can be no claim that the subject had not expected the task, and in consequence had paid insufficient attention to it.

The tasks I used (Naish, 2001) were button-pressing and tone-duration judgement. For the prospective task subjects were required to depress a push-button for an estimated 5 seconds. In the retrospective task they listened to computer-generated ‘beeps’, of duration ranging from 2 to 8 seconds (mean 5 seconds), and had to judge how long each beep had lasted. Clearly, subjects were warned that they were required to make this judgement, so this form of retrospective estimate was in no sense unexpected. It should be noted that, if the internal clock were running slowly, then the prospective task would result in the button being depressed for too long, while the retrospective task would have beeps judged as being of shorter duration than they would be at a normal clock speed. I found that the button pressing was indeed 17% longer in hypnosis, while the beeps were judged to be 19% shorter in hypnosis (both being compared with the corresponding ‘waking’ estimates).

The four sets of results I have described show that, whether making a prospective or retrospective judgement, and whether it is for a long or short interval, the resultant timing shifts are consistent with the proposal that hypnosis causes the inner clock to tick more slowly. The short interval results are unlikely to be attributable to the subject in some sense ‘attending away from’, or forgetting the task; all appeared to be as focused upon what was required of them as they seemed to be when performing the task outside hypnosis. It is possible that, as St. Jean et al. (1994) suggested, the hypnosis acted as an additional task and that, as in many other timing studies, this produced the familiar ‘workload’ effect. However, while this might be plausible in some phases of hypnosis, when for example a subject could be engaged in trying to enact the suggested experiences (Spanos, 1986; 1991), it seems less likely when no experience is being demanded. These subjects were already hypnotized (without prejudging what that term might mean), and were merely being asked to focus upon simple timing tasks. The resulting effects seem more reasonably attributable to the slowing of an internal clock than to an increase in workload. If this conclusion is reasonable, it invites the question: why does hypnosis slow the clock?

**Consciousness and its modification**

I shall temporarily leave the issue of the clock and, assuming for the time being that hypnosis is in some sense an altered state of consciousness, consider first how consciousness itself might be underpinned, and then in what ways it could be altered. The model of consciousness that I shall use was proposed by Gray (1995). Although the title of Gray’s paper indicated that his ideas were conjecture, they were nevertheless firmly based upon neurological evidence. Gray’s starting point can be viewed from an evolutionary perspective; as animals developed behaviours to interact with their environments, so they would need to develop monitoring systems, to ensure that the behaviour was progressing as required and that it continued to be appropriate for the environmental demands. Any mismatch detected by the monitoring system would be required to trigger corrective actions. In more advanced animals the mismatch could be described as capturing attention and, at least in humans, attention can be equated with consciousness (Naish, 2005b).
The behavioural and the monitoring components of Gray’s model comprise two interlocked loops. The motor element, he proposed, included the basal ganglia, thalamic nuclei and ascending dopaminergic pathways. The monitoring loop was claimed to be based on the septo-hippocampal system, and takes in regions of the prefrontal cortex, including the cingulate. These two systems, Gray suggested, operate together to carry out a test-and-predict cycle. The dopaminergic components are concerned with gathering data on the current state, while the monitoring system uses information such as goals, and memories of previous experiences, to predict what should be registered in the next cycle of data-gathering. As explained, mismatches detected between data and prediction are presumed to capture attention and become part of consciousness.

In a complex neural system there is inevitably the possibility of faults occurring, and in this system those might be expected to influence the content of consciousness. Indeed, much of Gray’s work was concerned with the neurological basis of the symptoms of schizophrenia, including the problems of attention and the generation of hallucinations. He proposed that, in schizophrenia, there is a problem with the system that compares the observed with the predicted, resulting in much of the normally predictable data being treated as ‘unpredicted’. Even the patient’s own ‘inner voice’, Gray suggests, can be treated as unexpected, and hence attributed to an external agent. This, of course, accounts for the classic symptom of auditory hallucination. It should be noted that there are some parallels between the hallucinations of schizophrenia, and those that can occur in hypnosis; Szechtman, Woody, Bowers and Nahmias (1998) went so far as to use hypnotically induced auditory hallucinations as an analogue for the schizophrenic form. Moreover, hypnotic susceptibility and schizotypy are positively correlated (Jamieson and Gruzelier, 2001; Gruzelier, De Pascalis, Jamieson, Laidlaw, Naito, Bennett and Dwivedi, 2004), and Gruzelier (2003) proposes that schizophrenia and hypnosis have common neurophysiological features.

Since Gray’s proposed circuitry includes significant dopaminergic pathways, it is not surprising to find that it can also account for some of the phenomena of Parkinson’s disease (PD), a condition resulting from dopamine deficiency. Here again, there is a link with consciousness, since patients can suffer from visual and auditory hallucinations; Fénelon, Mahieux, Huon and Ziegler (2000) report that hallucinations in PD patients are far more common than has been supposed in the past. The well known ‘freezing’ behaviour of PD sufferers appears to be a problem in trying to allow well-rehearsed motor ‘programmes’ (such as climbing stairs) to run without conscious monitoring. If the patient brings the activity into consciousness, by clearly imagining the intended goal, the actions can sometimes be recommenced. It will be proposed that imagination is an important element of consciousness, as will now be briefly explained. The topic will be revisited later.

Gray himself admitted that his model did not fully explain how the phenomenon of consciousness emerges from the circuits he describes. As he points out, consciousness seems not to be necessary to the processes of behaving and monitoring, yet we can all attest to a sense of ‘awareness of being aware’. A possible evolutionary driver for the sense of consciousness was the valuable skill of imagining, of being able to plan, and ask ‘What if?’ questions. This ability appears to use many of the same neural structures as would be active if external stimuli were really present, when in actual fact the neural activity is self-generated. The process is very much like using a computer ‘off-line’, as is sometimes done with the computers used to control complex systems. By disconnecting the computer’s sensors, and feeding it with dummy data, it can be used in training, or to test emergency scenarios. It is important that operators know the procedure is an
exercise, and similarly it is important that humans have the ability to recognize that imagination is not real. Whitty and Lewin (1957) showed that the region of brain apparently responsible for making the distinction is in the anterior cingulate cortex. Patients with damage to this area experienced great difficulty in differentiating between events that had actually occurred, and those that they had only imagined. Hypnosis is, of course, able to help some people to have very vivid (imagined) experiences, and it carries with it the danger of creating false memories. In view of this, it is particularly interesting to note that all hypnosis brain-scanning studies appear to show unusual activity in the anterior cingulate, irrespective of what other regions are active. This region, it will be recalled, is a component in Gray’s proposed circuitry.

**Consciousness and the clock**

The computer analogy is also apposite for Gray’s ‘consciousness loops’, since their effective intermeshing requires synchronization. This is achieved in a computer by means of a ‘clock’, an oscillator that ensures all the processes remain in step. Gray proposed that it was the septo-hippocampal system that maintained synchrony in the system that gives rise to consciousness, suggesting that its ‘tick rate’ was about 10 Hz. This frequency is remarkably close to the 12 Hz clock identified by Treisman et al. (1990); there is additional evidence to suggest that they may be driven by one and the same system.

If it is the case that the tick rate of the inner clock is determined by the rate of the test-and-predict loop proposed by Gray, then it is reasonable to suppose that a breakdown in the integrity of the loop might disrupt the timing. This effect is indeed observed, in the two classes of patient considered above. Thus, Elvevåg, Brown, McCormack, Vousden and Goldberg (2004) tested schizophrenic patients on a series of tasks, including time estimation, and concluded that schizophrenia is associated with a selective impairment in temporal processing ability. Similarly, Harrington, Haaland and Hermanowicz (1998) showed that PD patients have impaired time perception abilities, and concluded that the inner clock was most likely associated with the basal ganglia, a part of Gray’s circuit.

Extrapolating from the above, it seems to follow that the time distortions of hypnosis might also reflect some form of disruption to the smooth running of the ‘consciousness cycle’. If this were the case, then hypnosis could legitimately be called an *altered state* of consciousness. It has already been pointed out that hypnosis appears to impact the cingulate region, a component of the putative timing structure; how this might occur will now be considered.

**Hypnosis, self-generated consciousness and the clock**

As explained, the anterior cingulate appears to be involved in reality checking; it is a common description of hypnosis that it involves the abandonment of reality checking (e.g. Naish, 1986). In Gray’s terms, this would suggest that the ‘predict’ part of the test-and-predict cycle is running without meshing with the corresponding ‘test’ sub-component. In effect, this is another way of describing what happens when we engage in imagination, the difference with the latter being that we do not attempt the testing process, because we are aware that our experience is not being driven by external stimuli. Those susceptible to hypnosis also fail to test, but appear not to be *aware* that they are avoiding the process. If the anterior cingulate is conceptualized as a real/imagine indicator (a role supported by Szechtman et al.’s (1998) study of auditory
hallucinations), then in hypnosis it seems to be indicating ‘real’, when in fact the system is in ‘self-generate’ mode. There are circumstances in which the results of this self-deception can surprise the hypnotized person, in much the same way as schizophrenic patients (in Gray’s analysis) can be surprised by the ‘sound’ of their own inner voice. Thus, the failure properly to monitor the motor programmes that cause an arm to lift, leads the participant to believe that the arm lifted ‘all by itself’. Oakley (1999) has proposed a somewhat similar model to the one being developed here, although he did not link the suggested processes to any neural circuitry. His model also conceives of semi-autonomous processes, which may or may not be given access to conscious awareness, but the proposal does not include a component that could account for timing effects. More recently, Oakley and colleagues (Haggard, Cartledge, Dafydd and Oakley, 2004) reported a study in which hypnotized subjects were asked to indicate the moment in time (not a duration) when they moved a finger. When the movement was perceived as non-voluntary (i.e. like arm levitation) the indication that movement had occurred was made later, compared with the situation in which the movement was made consciously. In fact the ‘non-voluntary’ timing was very similar to that obtained when the movement was experimenter-initiated, i.e. truly involuntary. This finding supports the claim that, in hypnosis, the link between monitoring and self-generated behaviour can be in some way modified.

Clearly, hypnotized participants maintain a considerable link with reality; for one thing, without it they would be unable to follow the hypnotist’s suggestions. Moreover, to be aware of the results of a suggestion, such as for arm levitation, while failing to monitor their own enactment of the suggestion, implies that successful hypnosis requires a complex blend of attending and detaching. If this is an accurate account of hypnosis, then it is not surprising that relatively few have the skill to reach the level of hypnotic ‘highs’.

If it is the abandonment of the reality-testing cycle that disrupts the clock and causes time distortion, then presumably those subjects who are better able to generate their own ‘reality’, while keeping the ‘real thing’ out of consciousness, will exhibit more distortion. However, as just pointed out, hypnosis requires some level of reality monitoring to be maintained; exactly how much may depend upon the particular circumstances. It is possible that even a ‘high’ may not always need to engage in a great deal of reality generating, and consequently the extent of the resultant time distortion may be less than the ‘high’ status would lead one to expect. This is another possible explanation for the rather weak timing-susceptibility correlations that have been reported. Nevertheless, if required to generate a ‘world of their own’, those participants who are most successful should produce the largest timing effects.

I carried out an experiment (Naish, 2003) that tested that prediction. Subjects were given the traditional task of imagining a beach scene, with the additional element that they were waiting on the beach for a friend, who was due in precisely five minutes. They were given stopwatches, which they were told to press at the moment they judged the friend to be due. While waiting for that moment, it was suggested that they should do whatever they liked on their beach; subsequently some reported sunbathing, others paddling and so on. The resulting times ranged from close to 2 minutes, to over 7.

After the participants had completed the timing task, they were asked to make two self-ratings, both on seven-point scales. The first was of the vividness and reality of the scene they had been trying to visualize, and the second asked for the extent to which the real world intruded (awareness of outside sounds, etc.). The intrusion score was subtracted from the vividness rating, to yield a measure of ‘detachment’. Thus, a subject
who rated the vividness as high and the intrusion as low would score high on detachment. This measure was taken to reflect the extent to which a subject was able to engage in generating a personal reality, while ceasing to monitor the real thing.

There was a highly significant ($p < 0.001$) correlation of $r = 0.75$ between the detachment scores and the time estimates. In terms of the clock, it was, as predicted, running more slowly for those who were able to detach more successfully. Neither of the individual seven-point instruments correlated with time judgements as strongly as the combined detachment measure.

**How does detachment slow the clock?**

In simple terms, it is proposed that failure to engage in reality testing disrupts the cycle that supports the clock function. However, this proposal does not, as it stands, predict a slowing of the clock; it could as well run fast. It is possible that the clock ‘free-wheels’ slowly when the two supporting components proposed by Gray become disengaged. Alternatively, their partial engagement (as explained above, to support a measure of contact with reality) may result in the detection of only some of the ‘ticks’. This second explanation is not dissimilar from the traditional account of high workload taking attention away from a ‘click counter’, except that hypnosis is not being described as a high workload condition.

If the ‘missing ticks’ account were correct, it might be expected that subjects who reported less awareness of outside reality would be those who cut themselves off most successfully from the source of the ticks. However, in the ‘detachment’ study the correlation between intrusion and timing scores was relatively low ($r = -0.62$, $p < 0.001$). Missing ticks may not be the reason for the clock seeming to run more slowly.

The experience of events unfolding as if in slow motion may offer a clue concerning the processes in hypnosis. People frequently report that at times of heightened arousal, such as in an accident situation, all the action appears to be slowed down. This may be the result of a speeding of the test-and-predict cycle (and with it the clock). To be sure of capturing timely data, the cycle might run more quickly, resulting in each captured scene differing only slightly from its predecessor. The person experiencing this phenomenon would be familiar with the usual extent of alteration between data captures; finding a smaller change would lead to perceptions such as an oncoming car appearing to be approaching unusually slowly.

The opposite situation may occur in hypnosis. If the content of consciousness is in large part self-generated, then there is little need to initiate another data capture cycle: the content would be much the same as for the current situation. As a result, the cycle rate would be reduced, and the ticks would be more widely spaced. This explanation might lead one to expect that people better able to generate a vivid inner experience would be the ones to suffer a greater time distortion effect. However, in the ‘detachment’ study this correlation was the lowest of all ($r = 0.57$, $p < 0.005$). Perhaps the ability to generate a vivid and convincing experience need not necessarily demand that a slower test-and-predict cycle be maintained.

Clearly, there is as yet no complete explanation for the impact of hypnosis upon the inner clock. Nevertheless, three facts are clear: the anterior cingulate is involved in reality checking; that region is also involved in hypnosis; and ‘detaching’ to form one’s own reality slows the experienced passage of time. Moreover, the cingulate is a component of the circuits discussed by Gray, circuits for which there is evidence of a timing role.
A susceptibility/time distortion correlation

Throughout this paper, possible reasons have been offered for the weakness of the expected susceptibility/distortion correlation. Nevertheless, links have been proposed between hypnosis, modifications to conscious experience, and the clock. These links strongly imply that people better able to achieve the effects of hypnosis would normally experience more time distortion. It has been pointed out that the distortions are more apparent if the timing data collected in hypnosis are compared with the same subject’s data gathered during waking. In addition, for an initial evaluation with modest numbers of subjects, it is also more likely that differences would be found between ‘highs’ and ‘lows’, rather than seeking a correlation using subjects with a range of susceptibilities. I have been able to take this approach, in a small study, which formed part of a larger series of trials, being conducted by colleagues John Gruzelier and Tobias Egner (then both at Imperial College, London). They were engaged in research using ‘highs’ and ‘lows’, and it included periods of making EEG recordings, while the participants were in hypnosis. I was able to make use of both this period, and also the preceding time, during which participants were having the scalp electrodes attached (and were not hypnotized). A full account of this study will be reported elsewhere, but the salient details were as follows.

After both the electrode-fitting stage and the period of EEG testing, participants were asked how long they believed that phase had lasted. Additionally, during each phase they were required to carry out the beep estimation and five-second button press tests described earlier. With respect to the overall period judgement, the ‘highs’ and ‘lows’ did not differ significantly outside hypnosis: as a percentage of actual time they estimated the electrode fitting to have taken 86% and 80% respectively. Thus, both groups underestimated the time somewhat. However, in hypnosis the ‘highs’ decreased their estimation much further, reducing it to 65% of the true value. This change was significant \(p = 0.02\). In contrast, the ‘lows’ increased their assessment to 92% of the actual time: another significant shift \(p < 0.05\). The group (‘high’ or ‘low’) x condition (waking or hypnosis) interaction was also significant \(p < 0.01\).

When estimating beep duration, the ‘highs’ reduced their judgement by 12% in hypnosis. In this test the ‘lows’ also reduced their estimates, but by less than 2%. This interaction was again significant \(p < 0.05\). Consistent with the slow-running clock hypothesis, during hypnosis the ‘highs’ increased the duration of their button pressing by 6%. The lows, in contrast, actually reduced their button pressing time by 4%, producing yet another significant interaction \(p < 0.05\).

It can be seen that by every measure there was a ‘high’–‘low’ difference, with those scoring high on susceptibility producing the typical ‘slow clock’ effects, while the low scorers tended to produce little, or even a reverse effect. There seems to be no doubt that, at least with this method of testing, susceptibility modulates the hypnotic time distortion effect.

It will be recalled that in the St. Jean and MacLeod (1983) study the effects also appeared to be restricted to the highly hypnotizable. It is possible that, rather than exhibiting the quantitative differences of a behavioural continuum, the temporal effects of hypnosis in ‘highs’ and ‘lows’ are qualitatively different.

Summary

The key elements of this account were as follows:
• A plausible attempt to identify the neurological correlates of consciousness implicates circuitry that is also believed to be involved in time estimation, i.e. an inner clock.
• Patients with problems in aspects of the circuitry (PD and schizophrenia) show distortions of consciousness, i.e. experience hallucinations.
• Patients with those conditions also exhibit time distortion.
• Highly hypnotizable subjects are able to generate hallucinations.
• Scanning in hypnosis implicates the anterior cingulate in the alterations to consciousness.
• The anterior cingulate is known to be involved in reality testing, and is part of the proposed ‘consciousness-and-clock’ circuit.
• Hypnosis is associated with time distortion, the effects being equivalent to the slowing of an inner clock.
• The degree of time distortion is influenced by hypnotic susceptibility, probably because this determines the extent to which a subject is able to modify the contents of consciousness.

Conclusions

My title asked a question: ‘Time to explain the nature of hypnosis?’ Although not a primary aim of this evaluation of time distortion, the approach adopted leads inexorably to the conclusion that hypnosis, like PD or schizophrenia, can properly be described as an altered state of consciousness. In this respect, as my title suggests, time can indeed be seen as explaining something of the nature of hypnosis. Nevertheless, much remains to be explained, and whether or not research on time distortion will be able to contribute, only time will tell. It is clearly not yet time to deliver a complete account of the nature of the phenomenon.

References

Time to explain the nature of hypnosis?


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