HYPNOTIC TIME PERCEPTION: BUSY BEAVER OR TARDY TIMEKEEPER?

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Abstract

Experimental participants were asked to make prospective and retrospective time judgements, for both brief and longer periods of time. It was found that when these tasks were performed in hypnosis, prospective estimates became longer than the actual time period, whereas retrospective judgements became shorter than actual. The effects were the same, whether the periods involved were brief or long. It is proposed that this pattern of results is not satisfactorily explained by the ‘Busy Beaver’ hypothesis (St Jean, McInnes, Campbell-Mayne and Swainson, 1994). These results are better accounted for by assuming that time judgements are derived from an internal clock, which runs slow during hypnosis. An absence of any effect of hypnosis upon critical flicker fusion (CFF) frequency is taken to rule out a simple physiological explanation for the slow clock. Instead, a tentative account is offered that links the timing effects with recent research in the areas of brain mapping, hallucinations and reality monitoring.

Key words: consciousness, critical flicker fusion (CFF), hypnosis, reality testing, time judgement

Introduction

After experiencing a period of hypnosis, the majority of participants will underestmate the duration of the experience. This is a robust effect, and one of considerable magnitude, with judged times sometimes being as much as 50% shorter than the actual duration. In some ways, these characteristics are reminiscent of the Stroop Effect (Stroop, 1935), since both are observed across a variety of test situations, with magnitudes a good deal larger than many effects studied by psychologists. There the similarity ends, for although the Stroop Effect has generated a considerable literature, the hypnotic time distortion effect has received relatively little attention during the two decades since first being reported (Bowers, 1979; Bowers and Brenneman, 1979).

The rather low level of interest in the role of hypnosis in time underestimation is surprising, since the effect has relevance to the state/non-state debate. Over recent years, researchers have made a strong case for describing hypnosis as a socially driven phenomenon, with some cognitive elements that enable participants to believe in and enact the various suggestions made by the hypnotist (Barber, 1969; Spanos, 1986; Wagstaff, 1991). This view has been referred to as ‘non-state’, distinguishing it from
the earlier belief that hypnosis represented an altered state of consciousness (Hilgard, 1965). Recently, Barber (1999) has adopted a far more state-like approach in describing hypnosis, and Naish (1999) has linked this description to current brain-mapping studies that appear to demonstrate something rather special (if not a unique state) about hypnosis. The state/non-state debate is thus still very much alive, and either approach, if viable, should be able to accommodate the time distortion effects.

The non-state descriptions of hypnosis emphasize the fact that participants do only what they expect they should do in hypnosis. The position is supported by the observation that participants asked to simulate being hypnotized generally produce very similar behaviour to those who are supposed genuinely to be hypnotized (Orne, 1979). This seems to demonstrate that participants’ beliefs about what should happen in hypnosis, together with their recognition of the experimenter’s specific expectations, all serve to guide their behaviour, whether real or simulated. From this conclusion, it is a small step to claim that so-called ‘real’ hypnotic responses are, in effect, simulated behaviour. However, although most expectations about hypnotic performance may be obvious, even to naïve participants, it is far from clear what they should believe about the perception of time. There seems to be no special reason why a person undergoing hypnosis should expect time to pass any differently from its passage outside hypnosis. Consistent with this view, Mozenter and Kurtz (1992) found no time judgement changes in simulators, in a situation where highly-susceptible hypnotized participants did produce timing distortions. Thus, the non-state approach appears to have difficulty in accounting for the timing effects.

If hypnosis did produce changes in some internal state then it might be plausible to attribute timing effects to these state changes. However, there is an observation which somewhat undermines this suggestion. Although people vary in hypnotic susceptibility, and hence presumably in the degree to which they enter the hypnotic state (if there is one), there seems to be no correlation between susceptibility and magnitude of time distortion. There were early reports of such a correlation (Bowers, 1979), but the majority of studies show no such relationship (St Jean et al., 1994). The apparent absence of a clear link between the timing effect and ‘depth’ of hypnosis throws into doubt any suggestion that the timing changes result from state changes. Indeed, as St Jean (1988) pointed out, ‘It has not been established that underestimation is due to the employment of hypnotic procedures.’ (p. 83).

A case could be made for attributing time underestimation to an hypnotic state, if the effect were presumed to have an all-or-nothing characteristic. The proposition would be that a certain minimum level of hypnosis would trigger the time misperception, but that thereafter increasing responsiveness to hypnosis would not have any further effect on the timing. The actual magnitude of the time discrepancy would depend upon the individual, but have little or no relationship to the individual’s hypnotic susceptibility. If this were the situation, it would still be desirable to be able to identify a mechanism which linked hypnosis and time estimation. Some superficially plausible mechanisms are rendered less likely, because they are linked to effects known to correlate with susceptibility (which, as explained, does not correlate with timing effects). Not surprisingly, therefore, direct tests of the proposed mechanisms have failed to show a link with time judgement. Thus, Bowers (1979) proposed that the failure accurately to note the passage of time resulted from the increased absorption associated with hypnosis. St Jean and McCutcheon (1989) manipulated level of absorption, but failed to observe any resultant changes in time misperception, so
concluded that absorption was not the causal process. Similarly, the work of Ornstein (1969) suggested that time judgements were influenced by amnesia; the inability of participants to recall many events from a hypnosis session would lead to the false impression that little time had passed. St Jean, MacLeod, Coe and Howard (1982) weakened this proposal by showing that varying levels of amnesia did not modulate the extent of participants’ time underestimation.

Over many years of research in the field, St Jean has developed an account of time misperception linked to task demands and attention. The theory has been most fully expressed as the ‘Busy Beaver’ hypothesis (St Jean et al., 1994). This is effectively the hypnotic counterpart of the common observation that time ‘flies’ when one is busy. The hypothesis builds upon a resource allocation account of time perception (Zakay, 1989), which sees time monitoring as a resource-demanding process. If other cognitively demanding tasks are taking place, fewer resources are available for time checking, hence time estimates become inaccurate. St Jean et al. (1994) showed that participants overloaded with secondary tasks did, indeed, make larger time underestimates. The theory proposes that hypnosis itself is cognitively demanding, since the participant has to attend closely to the experimenter and endeavour to achieve the required effects. In other words, a person undergoing hypnosis is a ‘busy beaver’, so consequently has fewer resources available for time checking, and makes poor time estimates.

Although St Jean et al. (1994) seem not to have made the point, the hypothesis neatly explains the lack of a consistent relationship between hypnotic susceptibility and size of time discrepancy. It is the effort involved which leads to the time shortening, irrespective of whether the effort is successful in achieving a high degree of hypnosis. Unfortunately, there appears to be an incompatibility between this account and the entirety of the data of St Jean et al. (1994). These data show, as predicted, that additional tasks in the waking state lead to shorter time estimates. However, these same additional tasks produced a statistically similar (actually less marked) shortening when administered during hypnosis. If it is to be claimed that hypnosis is so demanding that, by itself, it produces timing errors, then adding further tasks should produce a greater, not lesser, discrepancy than in the waking state. The result does not fit easily within a resource allocation account, and suggests that the hypnotized beaver may be less busy than presumed.

The study to be reported here considers an alternative explanation for hypnotic time misperception: that it results from the slowing of an internal clock. There is evidence for the existence of some form of internal timing oscillator, the frequency of which can be shifted in some circumstances (for example, by temperature (Fox, Bradbury, Hampton and Legg, 1967) or by rhythmic sound (Treisman, Faulkner and Naish, 1992)). If hypnosis, perhaps through relaxation or focused attention, provided the right circumstances to slow the temporal mechanism then this would lead to the observed effects, that is, a slow-running internal clock would cause time to seem shorter. However, this shortening would apply only to retrospective judgements; a person using a sluggish clock to set up a defined period of time (as when boiling an egg) would make the period too long. Thus, retrospective and prospective time estimates would, respectively, produce shortening and lengthening when compared to the true time. As St Jean et al. (1994) point out, most investigations of hypnotic time distortion have considered retrospective judgements, but Mozenter and Kurtz (1992) did investigate prospective errors. Their results were not entirely clear, but where significant effects emerged they were in the direction predicted by the slow clock hypothesis, that
is, the periods were lengthened. There is a need to confirm this effect, and ideally to evaluate it together with retrospective tests, using the same individuals. If there really is a change of ‘tick rate’ in an internal mechanism, common to both prospective and retrospective timing, then the greater the overestimation in prospective judgements the larger should be the underestimation in retrospective timing.

It is possible that these different kinds of judgement actually have separate underpinning mechanisms; certainly it is likely that participants would use different strategies, depending upon the nature of the task. Thus, when asked to time events lasting a few seconds, counting is a likely strategy. Alternatively, if the period is relatively long, and particularly if it is filled with other demanding activities, then counting becomes infeasible, and participants must resort to other methods. The two kinds of strategy may lead to different patterns of misjudgement, so it is important to test with both brief and longer periods. If the patterns were similar, this would lend support for the claim that the various kinds of timing shared a common, underlying oscillator, which was itself affected by hypnosis. If that oscillator had a simple neurological substrate, it is possible that aspects of hypnosis, such as relaxation, might lower neural reactivity and slow the oscillator. A potential means of assessing any such change would be via the critical flicker fusion (CFF) frequency. This is the frequency at which the flashing of a light just seems to become a continuous illumination, that is, the off periods can no longer be detected. The frequency falls with fatigue and rises with stimulants such as coffee; it is presumed to reflect neural reactivity (Naish, 2000).

The foregoing considerations directed the design of the present experiment, that is, both brief and longer periods would be used, in prospective and retrospective time judgements. Additionally, CFF data would be collected to determine whether hypnosis influenced that measure.

**Method**

This was a within-subjects study design, with two conditions: pre-hypnosis and within hypnosis. In each phase a series of time-judgement tasks was administered, these being made as similar as possible in the two conditions.

Participants were tested individually, and a timer was started as they entered the test room. They were given a consent form to read and sign, which gave a brief ‘demystifying’ account of hypnosis and offered the opportunity to decline to take part in all or part of the proceedings, in particular drawing attention to a pain-producing procedure which would be used. The opportunity was being taken in this experiment to evaluate a controlled pain-inducing technique, which appeared to be simpler to administer than the traditional cold-pressor method. It was based on the methodology reported by Johnson, Breakwell, Douglas and Humphries (1998), involving iontophoresis of potassium ions. Details on the participants’ consent forms explained the procedure, and no participant declined to take part. Other than serving as a ‘time filler’, and giving participants one more task, the pain procedure has no relevance to the timing study and results will not be reported here.

When they had agreed to continue, participants were told that the experimenter was interested in, among other things, various ways in which people judge time. They were informed that, as part of that strand of the research, the experimenter wanted them to interrupt the proceedings to tell him as soon as they believed a two-minute period was complete, starting timing from that moment. The procedures then continued with the
collection of autobiographical data, followed by a measurement of the CFF, using the apparatus and procedures detailed in Naish (2000).

The next phase of testing involved a series of brief time estimates, both retrospective and prospective. Participants were played a tone burst and asked to say, in seconds, how long they believed it to have been. In all, four tone bursts were used, one each with durations of two, four, six and eight seconds. Order of presentation was randomized. After each tone burst, participants were asked to depress a computer mouse button for a period that they estimated to be five seconds. The computer logged the actual time for each of the four attempts.

After the brief time judgements the pain tolerance assessment was made. This procedure took approximately four minutes.

Finally, in this pre-hypnosis testing, participants were asked how long they believed it was since they had entered the room. The actual time was approximately 20 minutes.

There followed an hypnotic induction, using progressive relaxation and guided visual imagery. At the end of this, participants were again asked to interrupt the experimenter, as soon as they believed that two minutes had passed. Following this request, a number of items from the Stanford Hypnotic Susceptibility Scale, Form C (SHSS-C) (Weitzenhoffer and Hilgard, 1962) were administered, as detailed below.

First, items 1 (hand lowering), 2 (hands moving apart), 4 (taste), 5 (rigid arm) and 7 (age regression) were given. Participants were then told that they could open their eyes for a short time without losing their sense of deep relaxation. The flicker fusion measure was then taken, following which participants were instructed to close their eyes again, and to be deeply relaxed. Items 8 and 9 (arm immobilization and anosmia) of the SHSS-C were then given, followed by the sequence of brief time judgements. For the five-second measure, participants were handed the computer mouse and instructed to depress the button without opening their eyes.

The final SHSS-C test used was item 11 (negative hallucination), following which the pain test was administered, with suggestions that the affected area was remaining cool and comfortable. At the conclusion of the test, participants were given suggestions of well-being, followed by alerting instructions. They were then asked how long had passed since the relaxation procedures, at the start of the hypnosis, had begun. The actual time was approximately 30 minutes.

Participants
Fifteen participants (mean age 32.8 years) volunteered to take part in the experiment. They were Open University students, attending a summer school as part of a psychology course. The course does not include information about hypnosis.

Results
Susceptibility scores, derived from the subset of the SHSS-C scale, ranged from one to seven, with a mean of 4.7. To facilitate comparison with other studies, which have used the complete scale, a simple transformation was carried out. Adopting the usual assumption (described in the SHSS instructions) that passing later items of the SHSS implies that earlier items would have been pased, these values correspond with full-scale scores between one and nine, with a mean of 6.3.

Since some periods (time since entered room and duration of hypnosis) differed somewhat between participants, it was convenient to express all time estimates as percentages of the actual times involved. Scores greater than 100 indicate that the
judgement was longer than the true or requested duration; thus, waiting for three minutes before signalling that two minutes had elapsed would be scored as 150%. Table 1 shows the means for all the percentage measures, both pre-hypnosis and during the hypnotic procedure.

An analysis of variance (ANOVA) was carried out on the time judgement scores. This was in the form of phase (pre-hypnosis versus hypnosis) × judgement (prospective versus retrospective) × required duration (seconds versus minutes), that is, a 2 × 2 × 2, within-subjects ANOVA. There were no statistically significant main effects, but there was a highly significant interaction between phase (pre-hypnosis versus hypnosis) and judgement (prospective versus retrospective) ($F(1,14) = 34.7; p<0.0001$). Figure 1 shows the nature of the interaction.

Changes in judgements between the two phases of testing were computed by expressing each within-hypnosis estimate as a percentage of the corresponding estimate made before hypnosis. Scores greater than 100 indicate that the subject produced a longer estimate during the hypnosis phase. Means of these values are listed in Table 2, with an indication of the implications of the change for the speed of a putative internal clock.

All measures (except CFF) supported the notion of a slow-running clock. Almost all participants in the hypnosis phase produced longer responses in the conditions predicted to take longer, and shorter responses in those conditions expected to be shorter (chi-square test = 11.0; $p<0.001$).

No significant correlations were found between any of the measures, including between susceptibility scores and judged duration of the hypnosis phase ($\rho = -0.28; p>0.1$). There was a somewhat higher (but still non-significant) correlation between susceptibility and the change in duration judgement ($\rho = -0.33; p>0.1$).

Scores were collapsed across the duration parameter, to produce means for prospective and retrospective judgements. Thus, the two-minute interruption and the five-second button press scores were combined (as percentages) to give a measure of prospective accuracy; the session duration and the two-, four-, six- and eight-second judgements were combined to represent retrospective accuracy. There was a relatively large, although non-significant correlation between these values in the pre-hypnosis phase ($\rho = -0.43; p>0.1$).

This suggests that participants who produced greater overestimation in prospective judgements tended to produce greater underestimates in the retrospective condition. The relationship was far weaker for the hypnosis phase ($\rho = -0.18$), although there were significant correlations for each individual measure, between

<table>
<thead>
<tr>
<th>Measure</th>
<th>Pre-hypnosis</th>
<th>Within hypnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two minute prospective</td>
<td>79.9 (32.5)</td>
<td>120.6 (65.6)</td>
</tr>
<tr>
<td>Five second prospective</td>
<td>92.9 (36.3)</td>
<td>104.8 (36.0)</td>
</tr>
<tr>
<td>Seconds retrospective</td>
<td>117.0 (51.2)</td>
<td>92.9 (35.6)</td>
</tr>
<tr>
<td>Long period retrospective</td>
<td>97.0 (27.0)</td>
<td>64.2 (29.5)</td>
</tr>
</tbody>
</table>

SD = Standard deviation.

Table 1. Mean (SD) timing estimates, made before and during hypnosis, expressed as percentages of actual time.
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Table 2. Mean timing values obtained in hypnosis, expressed as percentages of the corresponding pre-hypnosis measures (the third column shows the type of change required in a clock, to produce the timing changes)

<table>
<thead>
<tr>
<th>Measure</th>
<th>Effect of hypnosis</th>
<th>Implications for clock rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two minute prospective</td>
<td>160</td>
<td>Slower</td>
</tr>
<tr>
<td>Five second prospective</td>
<td>117</td>
<td>Slower</td>
</tr>
<tr>
<td>Seconds retrospective</td>
<td>81</td>
<td>Slower</td>
</tr>
<tr>
<td>Long period retrospective</td>
<td>68</td>
<td>Slower</td>
</tr>
<tr>
<td>Flicker fusion frequency</td>
<td>103</td>
<td>(Just) faster</td>
</tr>
</tbody>
</table>

Figure 1. Mean prospective and retrospective time estimates made before and during hypnosis.

The results indicate that participants’ tendencies to over- or underestimate durations outside hypnosis persist within the hypnosis situation.
Discussion

Methodology

As explained in the Introduction, there is little evidence that hypnotic time judgement effects are correlated with susceptibility; consequently, no attempt was made to select participants with extreme scores on the susceptibility scale. With the modest number of participants tested, it was considered inappropriate to attempt a retrospective division into high- and low-susceptible groups.

Since it was intended to look for correlations between the different conditions, it was necessary to employ a within-subjects study design. Thus, there was no control group, and neither were simulators used. It was pointed out earlier that there was no reason to suppose that participants could guess the expected outcomes, and that another study (Mozenter and Kurtz, 1992) had shown simulators not to produce the timing changes. Similar considerations led to a design that did not need to counterbalance for order; it is certainly plausible that this may have influenced scores on the unreported pain measure, but not on the timing measures described here.

The timing measures were not identical in the corresponding prospective and retrospective conditions, and this deserves comment. For the short time estimates the prospective judgement was fixed at five seconds, whereas for the retrospective, the intervals were two, four, six and eight seconds. It was necessary to use a variety of intervals in the latter condition, so that although participants expected a whole number of seconds, they would not be sure of which interval they had heard. Had a repeated, fixed-length tone burst been used, participants would have tended to select a duration and keep to it, in all probability using the same figure in the hypnosis phase as in their pre-hypnosis estimates. For participant-generated time production (as when holding down a button) there is no requirement for a variety of time periods. Although there would be an attempt to generate a whole number of seconds, the actual time produced could be of any duration, so was able to reflect any changes in counting rate. To have requested very short intervals in this condition would have been inappropriate, as they would have been contaminated with a relatively large proportion of ‘noise’, such as from the precise times of button press and release. A five-second period was selected as being adequately long, and being the mean of the retrospective intervals used.

The long intervals were very different in the prospective and retrospective conditions, being two minutes for the former, and of the order of 20–30 minutes for the latter. Retrospective judgements were sought for the entire phase, since that is the norm when reporting hypnotic time distortion. The reason for requesting a rather short prospective interval was to ensure that, although long enough to rule out a counting strategy, the time was not so long that participants would forget the instruction to interrupt the experimenter. A pilot study had shown that, for longer periods, this was a real risk. By expressing all responses as percentages of the true intervals, the actual durations used for the various conditions had no effect upon the subsequent comparisons.

Session underestimation

Consistent with many other studies in the literature, participants produced a significant underestimation of the length of the hypnosis phase, the mean judgement being 64% of the actual duration. Again, as with other studies, there was no significant
correlation between susceptibility and underestimation. Although the duration judgement of the pre-hypnosis phase was largely accurate (mean 97% of actual duration), there was wide variability (standard deviation (SD) 27%). Expressing the hypnotic judgement as a percentage of the pre-hypnosis score reduced the size of underestimation somewhat, to a mean value of 68% of actual. Use of these adjusted scores produced a slightly larger (–0.33) correlation with susceptibility. Although the effect did not reach significance, it is possible that other, larger studies would have found significant correlations, had their time measures been expressed in terms of pre-hypnosis judgements.

The internal clock
These data are strongly supportive of the slow-running internal clock hypothesis. The highly significant phase \(\times\) judgement interaction shows that hypnosis produces marked shifts in timing estimates. Outside hypnosis, participants tend to overestimate periods judged retrospectively, but to make self-generated periods too short. This pattern reverses in hypnosis, with durations of events that have passed being underestimated, whereas attempts at prospective time judgement become too long. The complementary shifts are entirely consistent with the suggestion that hypnosis causes an internal timing reference to run more slowly.

A participant who is busy taking part in a variety of tests cannot adopt a counting strategy to decide when two minutes has passed, or to estimate the duration of the session. On the other hand, when trying to depress a button for five seconds, or when estimating the length of a short ‘beep’, it is highly likely that some form of counting method would be employed. In spite of this difference, the effects of hypnosis on the two lengths of timing were very similar. Treisman and colleagues (Treisman, Faulkener, Naish and Brognan, 1990; Treisman et al., 1992; Treisman, Cook, Naish and MacCrone, 1994) have suggested that there is a common neural substrate for a variety of timing tasks; certainly, the absence of a three-way interaction, or a main effect of duration (that is, brief or longer estimates) suggests that the same underlying timing mechanism influences judgements of both short and long periods.

Although the Busy Beaver hypothesis (or, indeed, the absorption or amnesia hypotheses) can account for effects in long duration judgements, the explanation is less convincing when applied to the brief timing effects. A participant concentrating on timing a period of a few seconds cannot plausibly have significant resources occupied elsewhere, be otherwise absorbed, or be forgetting passing events. The statistically significant correlations between the before-hypnosis and within-hypnosis timing scores suggest another explanation: that participants attempted to use the same timing mechanism in the two phases of the experiment, but that their clocks ‘ticked’ more slowly during hypnosis.

Speculation on the nature of the clock
The negligible changes observed in CFF make it clear that the timing changes were not the result of a reduction in arousal, or in general neural transmission rates. For this reason it seems unlikely that the putative inner clock runs slowly as a result of its building blocks becoming more sluggish. It is more likely that there is a change in the way that the clock is used. What follows is a speculative attempt to link the timing process to a theory of consciousness, and to recent observations of the neural correlates of hypnosis.
Gray (1995) has proposed that the contents of consciousness are derived from a repeated monitoring cycle. The monitoring is of outside and inner events, giving rise to a succession of ‘snapshots’. He suggests that the contents of each data capture are used to compute predictions as to what will be registered in the succeeding snapshot. Where there are discrepancies between prediction and observation, attention is devoted, and that portion of the ‘picture’ becomes at the centre of consciousness. This repeating function, Gray (1995) suggests, is implemented in circuitry which includes the septohippocampal system and the Papez loop. He proposes that the cycle time is of the order of 100 ms, and it is of interest that Treisman et al. (1994) have determined an internal timing oscillator period to be approximately 80 ms.

Gray’s (1995) account is intended to explain some of the phenomena of schizophrenia, in particular the extreme distractibility of individuals with schizophrenia. This, it is suggested, results from a problem at the matching stage, where predictions are compared with the latest information. For those with schizophrenia, there are numerous, erroneous mismatches, which consequently place intolerable attentional demands on the sufferer. The matching failure is presumed to occur for inner events as well as perceptions of the outside world. Thus, self-generated, inner speech may be registered as ‘unexpected’, and hence be attributed to an external agent; as a result, an auditory hallucination is experienced.

Parallels between schizophrenia and hypnotically induced hallucinations have been drawn for some time (Naish, 1986), and recently Szechtman, Woody, Bowers and Nahmias (1998) have used hypnosis as a means of researching auditory hallucinations. Using ‘brain mapping’ positron emission tomography (PET) techniques, Szechtman et al. (1998) demonstrated that the right anterior cingulate cortex was crucially involved in the formation of hallucinations. Discussing this finding in the context of hypnosis, the researchers (Woody and Scheztman, 2000) point out that many recent investigations of the neurophysiology of hypnosis have implicated the cingulate region. Moreover, these workers cite an early study (Whitty and Lewin, 1957) showing that lesions to the area produce failures of reality monitoring. Hypnotic effects have, of course, long been ascribed to an abandonment of normal reality checking (Naish, 1986).

Reality monitoring is, in effect, equivalent to the predict-and-compare process described by Gray (1995), and it is significant that the cingulate region forms part of the circuitry he suggests is involved. It is not infeasible that the reality checking cycle is intimately linked with the internal clock, and that changes in reality testing, as produced by hypnosis, affect its tick rate. The reality changes discussed above are rather extreme, leading to hallucinations, and only a small proportion of hypnotized people are able to produce such dramatic effects. In contrast, the large majority of people taken through an induction procedure will experience the timing misperceptions reported here. Clearly, extreme changes in perceived reality are not required to produce the timing effects. The explanation may perhaps be found in the impact of the induction procedure, which generally leads participants to close their eyes, and focus the attention on internal sensations. Thus, external, potentially changing stimulation is reduced, and attention is shifted to the rather static inner experiences. In these circumstances, when each snapshot of the reality cycle is much like the last, it would be reasonable for the cycle time to be increased, so increasing the probability that a change would be registered. In other words, it is proposed that the sampling rate is determined in part by the rate at which the monitored information is changing; slow
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changes give rise to a slow clock, which in turn implies that retrospective time judgements will be shortened. Incidentally, this situation may be contrasted with the experience of events taking place in slow motion, during a period of greatly heightened arousal, such as in an accident. In such circumstances it is suggested that the sampling rate is considerably increased, with snapshots being taken so frequently that the changes from one to the next are relatively small. As a result, an oncoming car, for example, appears to be approaching remarkably slowly; put another way, the very fast clock makes a few seconds 'seem like an age'.

In summary, there is evidence for an inner clock, and it is known that external events can influence its period (Treisman et al., 1990, 1992, 1994). The suggested tick rate of the clock is of the same order as the sample rate suggested by Gray (1995), for his theory of reality monitoring and consciousness. Parts of the neural circuitry identified by Gray (1995) as taking part in the sampling process have also been shown (Crawford, Horton, Hirsch, Harrington, Plantec, Vendemia, Shamro, McClain-Furmanski and Downs, 1998) to be important in producing hypnotic experiences. The hypnotic induction procedure that gives rise to the experiences affects the reality monitoring loop by reducing the rate at which incoming information changes. In response, the loop cycle time lengthens, so as to increase the chance of finding change from one sample to the next. This slowing of the sampling rate is equivalent to a slowing of the inner clock, and leads to underestimates of retrospective periods, but overestimates in prospective judgements.

Conclusions

It has been demonstrated that, during hypnosis, both short and long time periods are underestimated when judged retrospectively, but overestimated when they are self-generated, prospective judgements. In part, the observations may be explained by the Busy Beaver hypothesis (St Jean et al., 1994), but this does not account well for the discrepancies observed in the judgements of brief periods of time. The effects are more consistent with the concept of an internal clock, which is used for timing judgements, and which runs slow during hypnosis. It is proposed, tentatively, that the seat of the slow-running clock lies in circuitry involving the cingulate region, which is part of a reality monitoring system. The explanation is considered to be more consistent with state, rather than non-state views of hypnosis.

References


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