ARTICLE

High time

Ruth Ogden and **Catharine Montgomery** on the effect of drugs on the perception of time

Time rarely feels like it is passing at a constant rate; instead it expands and contracts from one activity to the next. Never is this more true than when under the influence of drugs or alcohol. Drugs such as cocaine, methamphetamine and alcohol appear to make time speed up, whereas haloperidol and marijuana appear to slow time down. Drugs alter perceived time by affecting the speed of our internal clock and the amount of attention that we pay to time. Whilst such time-altering effects are generally perceived as pleasant and harmless, there is some evidence to suggest that the effects may be long-lasting.

questions

How do different drugs affect the perceived duration of events?

Do the effects of drugs and alcohol on timing change depending on the tasks that we perform?

resources

Ogden R.S., Wearden. J.H., Gallagher, D.T. & Montgomery, C. (2011). The effect of alcohol administration on human timing. *Acta Psychologica, 138*, 254–262.

Wittmann, M., Leland, D., Churan, J. & Paulus, M.P. (2007). Impaired time perception and motor timing in stimulant-dependent subjects. *Drug and Alcohol Dependence, 90*, 183–192.

Do you ever feel like time is flashing past you, or perhaps that it is crawling by so slowly that it may have stopped? Perhaps you find yourself amazed that it's already last orders in the pub, or disappointed when you realise there are still 40 minutes to go in a lecture. If so, fear not, you are not alone: experiences of distortions to the passage of time are a common occurrence.

Although real 'clock measured' time is passing at a constant rate, experience tells us that our subjective sense of the amount of time that has occurred, or the speed at which time is passing, can vary, leading to distortions in the passage of time. When we feel like less time has occurred than actually has, time feels like it has speeded up. When we feel like more has occurred than actually has, time feels like it has slowed down.

Despite being commonly experienced, the mechanisms behind distortions of the passage of time are underresearched and, as a result, poorly understood. Anecdotal accounts imply that our experience of time is influenced by our emotions and the activities we engage in: 'time flies when you're having fun', but not when an car is hurtling towards you.

It is not only enjoyment and fear that affect how quickly time appears to be passing: other alterations in subjective consciousness have similar effects. The consumption of drugs and alcohol has long been known to warp time experiences. In his much-quoted book *Confessions of an English Opium Eater*, Thomas De Quincey (1821/1971) noted that opium intoxication resulted in distortions to the passage of time to the extent that he 'Sometimes seemed to have lived for 70 or 100 years in one night; nay, sometimes had feelings representative of a millennium passed in that time'. Similar experiences were also reported by Aldous Huxley (1954) in *Doors of Perception* after consuming mescaline and LSD. Drug-induced distortions to time are not only experienced by renowned literary figures: a quick search of an internet drug forum will reveal that many drug users report similar experiences to De Quincey and Huxley following marijuana, cocaine and alcohol use. The frequency of such reports has led to a recent revival of interest in the way in which recreational drug and alcohol use affect time perception.

A recent study at Liverpool John Moores University explored the prevalence of drug- and alcohol-induced distortions of the passage of time in a student population (Wearden et al., in press). Students reported occasions in which time seemed to have been distorted during everyday life, and they were encouraged to discuss an occasion in which drugs or alcohol had been consumed. They then rated how frequently they experienced time distortions and the extent to which the distortions were troublesome. The results confirmed that distortions are commonly experienced during, but also in the absence of, drug and alcohol use. Distortions were more common amongst people who took drugs than those who did not, and, of those who took drugs, 66 per cent agreed that distortions occurred more frequently when they were under the influence of drugs than when they were not. There were no reports of distortions to time causing distress; indeed, many people said they were pleasurable. However, it seemed that the nature of distortions varied greatly under the influence of different drugs and during different social situations.

The most widely reported sensation was that of time passing more quickly than normal after the consumption of alcohol: 'when drinking on a night out… enjoying myself, time passed a lot quicker'. The

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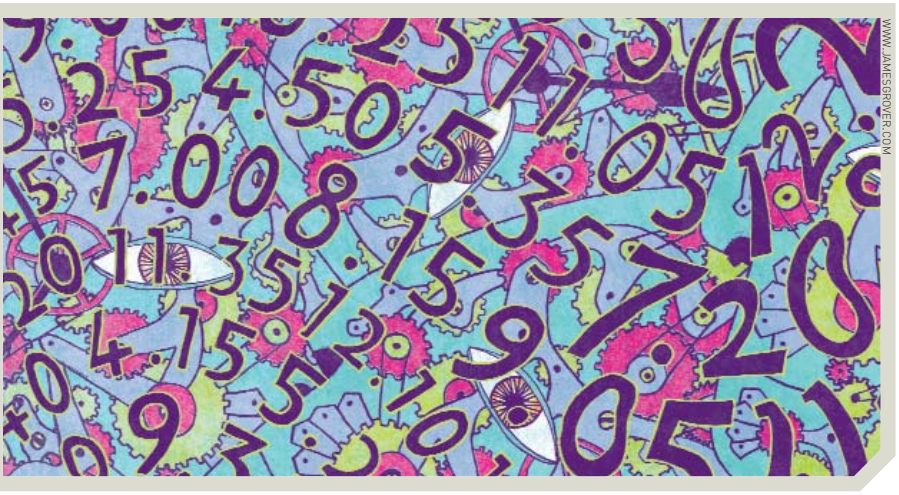
same was also true of cocaine use: 'When taking cocaine time always goes very very quickly. It seems you start taking the drug and then all of a sudden several hours have passed and it is about 7am'. Cannabis, on the other hand, appeared to have different effects on people's perceptions of time depending on the circumstances in which it was consumed. When consumed in stimulating environments or with other drugs or alcohol, cannabis consumption led to the feeling that time was passing more quickly than normal: '…after a night out and alcohol consumption coming back to my flat sitting down watching TV with my friends and drinking more alcohol, smoking cigarettes and cannabis, when this happens times seems to pass much quicker.' On the other hand, when consumed alone, cannabis was associated with a slowing of the passage of time: 'On cannabis, time goes slow, you think that an hour has passed when it was only 10 minutes.'

So, *how* do drugs and alcohol affect our perception of time? One possibility is that the drugs themselves affect the way in which the brain monitors time, possibly by altering the speed of some 'internal clock' (Meck, 1983). Another possibility is that the activities that we perform whilst intoxicated influence how we perceive time, perhaps by distracting our attention away from time. One way to tease apart these influences is to examine whether drugs still affect temporal perception when they are consumed outside of their normal social surroundings in the laboratory.

Early studies into the effects of drugs on timing were conducted on animals. In the 1980s, Warren Meck published a seminal study in which he explored the effects of methamphetamine and haloperidol on animal timing (Meck, 1983). Meck trained rats to respond to a signal after a set duration of 12 seconds, by pressing on a lever that released a pellet of food. Instances in which the lever was pressed too early or too late were not rewarded. When the rats received methamphetamine (which increased dopamine levels) after training, they pressed the lever too soon, suggesting that they thought that more time had occurred than actually had. The opposite happened when haloperidol (which decreases dopamine levels) was administered: the rats responded too late indicating that they thought less time had occurred than actually had. Meck suggested the rats' perception of time was altered because the administration of methamphetamine and haloperidol led to dopamine-modulated increases and decreases in internal clock speed. Similar effects to those induced by methamphetamine have been reported following cocaine administration, but not ketamine (Cheng, Ali et al., 2007; Cheng, MacDonald et al., 2006). It seems then that, in some animals at least, some drugs that affect dopamine levels influence temporal perception.

The effect of recreational drug use on human timing is less well understood, in part because of ethical constraints on giving people illegal drugs. A number of studies have, however, looked at the effects of alcohol and marijuana on timing. These studies have typically employed prospective timing tasks in which people are asked to estimate the duration of auditory and visual stimuli. Because prospective timing is thought to be accomplished by means of an internal clock, these studies may provide information about the way in which drugs affect our timing system. Alcohol and marijuana are two of the most commonly consumed recreational drugs in the UK (Smith & Flatley 2011) and their pharmacological and cognitive effects are well documented (see Stahl, 2008). Both alcohol (Schweizer & Vogel-Sprott, 2008) and cannabis (Solowij & Battisti, 2008) are known to impair memory function and attentional processing. In addition, consumption both of alcohol and of marijuana leads to indirect increases in dopamine levels (Bossong et al., 2009; Stahl, 2008). It seems likely, then, that both substances may affect the way in which we perceive time.

Marijuana consumption has been shown to affect timing when people estimate the duration of events (Chait & Pierri, 1992),



Do drugs alter the speed of some 'internal clock'?

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produce durations (Tinklenberg et al., 1976) and compare durations with one another (Lieving et al., 2006). Generally speaking, taking marijuana makes people overestimate the amount of time that has passed. This pattern of behaviour is consistent with an increase in internal clock speed. Laboratory studies exploring the effect of alcohol on timing have produced more mixed results. When participants have been asked to produce durations after the consumption of alcohol (e.g. hold down this button for 30 seconds) some studies have reported that durations were overproduced (Tinklenberg et al., 1976), whereas others find that durations were underproduced (Lapp et al., 1994), and some find no effect of alcohol on timing at all (Heishman et al., 1997). The disparity in findings is, perhaps, due to the differing doses of alcohol and the differing duration ranges employed in the different experiments.

To try to clarify the effect of alcohol on human temporal perception and to bridge the gap between the distortions that people report in the real world and the findings from the laboratory, we recently explored how alcohol consumption affected a range of timing judgements (Ogden et al., 2011). In particular, we wanted to see whether we could replicate the alcohol induced sensation of time 'flying,' that people reported in Wearden et al. (in press), even when the social interactions usually surrounding alcohol consumption were removed. We wanted to create a laboratory-based task that reflected the way in which people make judgements about time in the real world. In the laboratory, we usually tell people that their ability to judge time is being tested and this, presumably, motivates them to concentrate on time: 'prospective' timing. In the real world, however, people often make judgements about the duration of previous events, even when they are not concentrating on their duration. We replicated this type of judgement by asking people to complete a short word-classification task, without telling them that they would later be asked how long the task lasted. Because participants were unaware that timing was the focus of interest, they would be unlikely to consciously monitor time. Once the word-classification task was complete the participants estimated how long they thought it lasted (a 'retrospective timing' judgement) and also indicated whether they thought that time was passing at the same speed as normal, or faster or slower than normal during the task (a 'passage of time' judgement). They then performed a series of prospective timing tasks in which they made judgements about the duration of short tones.

People's ability to estimate the duration of the word-classification task in minutes and seconds was unaffected by alcohol consumption, but a high dose of alcohol did result in the sensation of time passing more quickly than normal. The fact that people said that time sped up after alcohol consumption even in the laboratory suggests that the psychopharmacological effects of alcohol consumption alone are sufficient to affect our perception of time. It is of course likely, however, that when these effects are coupled with pleasurable activities that distract our attention away from time, any speeding effect would be more pronounced. Alcohol also made people overestimate the duration of short tones in one of the prospective timing tasks used, and this overestimation is consistent with a dopamine-induced increase in internal clock speed.

Having experienced distortions in the passage of time whilst under the influence of drugs and alcohol, there is some concern amongst users about whether any effects could be permanent. Heavy drug and alcohol use can result in long-term neurological damage (Harper, 2009) and impaired cognitive function (Fisk & Montgomery, 2009), both of which may alter timing ability even when drug use has ceased. Chronic cocaine and amphetamine use reduces dopamine D2 receptor availability (Volkow et al., 2001), and, because animal studies have demonstrated that dopamine levels influence duration perception, it is possible that chronic users of cocaine or methamphetamine may show impaired timing even after drug use has stopped. Wittmann et al. (2007) compared the timing abilities of currently abstinent cocaine and/or methamphetamine users with control participants, and found that timing was impaired in the abstinent drug user group relative to the controls on most measures. Typically, the abstinent users were less able to discriminate between different durations and appeared to overestimate the duration of longer events. Wittmann et al. (2007) also suggested that the tendency to overestimate the duration of long delays may lead to increased drug taking amongst users as the time elapsed since the last drug administration appears longer.

In the real world and the laboratory alike, it would seem that drug and alcohol use has the ability to affect our perception of duration. Reassuringly for those of us who may be affected by such distortions, research tells us that they are commonly experienced and that most people find them to be harmless. Having said this, there is some preliminary evidence that some negative effects appear to be long-lasting in chronic drug users. Further research in this area is clearly warranted; not only to enable better understanding of how drugs and alcohol may affect our ability to time, but also to explore whether impairments to timing may influence our ability to perform time-dependent tasks such as driving, and affect drug-seeking and drug-taking behaviours.

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