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Anomalous control: When 'free-will' is not conscious

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Abstract

The conscious feeling of exercising 'free-will' is fundamental to our sense of self. However, in some psychopathological conditions actions may be experienced as involuntary or unwilled. We have used suggestion in hypnosis to create the experience of involuntariness (anomalous control) in normal participants. We compared a voluntary finger movement, a passive movement and a voluntary movement suggested by hypnosis to be 'involuntary.' Hypnosis itself had no effect on the subjective experience of voluntariness associated with willed movements and passive movements or on time estimations of their occurrence. However, subjective time estimates of a hypnotically-suggested, 'involuntary' finger movement were more similar to those for passive movements than for voluntary movements. The experience of anomalous control is qualitatively and quantitatively different from the normal conscious experience of a similar act produced intentionally. The experience of anomalous control may be produced either by pathology, or, in our case, by suggestion.

Voluntary action is a characteristic human behaviour, involving both specific brain processes and specific conscious experiences. Brain imaging studies in humans and animals show activity in a network of brain areas including the basal ganglia and frontal cortex prior to voluntary actions, but not prior to actions elicited by external stimuli (Jenkins, Jahanshahi, Jueptner, Passingham, & Brooks, 2000). Psychological studies of the experience of action show that people experience their own voluntary actions quite differently from similar physical events generated by other causes (Blakemore, Wolpert, & Frith, 2000; Haggard, Clark, & Kalogeras, 2002).

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The intention to perform an action leads the brain to construct a coherent sensory experience of the intended body movement, and of its consequences (Blakemore, Oakley, & Frith, 2003; Haggard et al., 2002). However, the relation between neural events preceding action and the conscious experiences they produce remains unclear. Understanding the neural and psychological processes of voluntary action has been a key challenge for the cognitive neuroscience of consciousness (Dennett, 1993). It also has considerable applied importance. Many legal systems invoke the concept of conscious free will in attributing moral responsibility for actions. Only if a criminal act is performed with conscious intention (*mens rea*) can a person be liable in law (Morawetz, 1980). Conversely, an understanding of anomalous control of movement is relevant to both neurological psychopathological conditions such as schizophrenia and conversion disorder. In those conditions, experiences appear as part of the symptomatology and are described as examples of 'alien (or anarchic) control' (Bundick & Spinella, 2000; Frith, Blakemore, & Wolpert, 2000; Marchetti & Della Salla, 1998; Mellors, 1970; Oakley, 1999a).

Appropriate suggestions following hypnotic induction may dissociate physical movement from normal conscious volition (Heap & Aravind, 2002; Kirsch & Lynn, 1997; Weitzenhoffer, 2000). In this context such actions are commonly referred to as "ideomotor responses." For example, in the classic hypnotic phenomenon of arm levitation suggestions are typically given that the arm is becoming lighter, or is attached to a helium-filled balloon. In hypnotically responsive individuals the arm will then rise upwards whilst the participant experiences the movement as occurring 'all by itself'—that is without any awareness of conscious intention to move the arm.

We have used hypnosis as a cognitive tool to produce an involuntary finger movement in normal participants as an experimental analogue of the clinical condition of alien/anarchic control of motor action. We use an experimental procedure described by Libet, Gleason, Wright, and Pearl (1983) which enables the accurate measurement of the time at which an individual experiences the occurrence of their own motor action. Previous work has shown that when motor acts are produced voluntarily the individual anticipates the time of their occurrence compared to the case when a physically comparable movement is is produced involuntarily, such as by transcranial magnetic stimulation (Haggard et al., 2002). More generally, movements which are highly intentional, and involve substantial deliberate preplanning, show more anticipatory awareness than movements which lack such preparation (Haggard, Newman, & Magno, 1999). We therefore hypothesised that an ideomotor response produced by suggestion would be *generated* via normal voluntary motor control systems but would be *experienced* as involuntary, resulting in a conscious experience close to that of a passive movement.

1. Method

1.1. Participants

Twelve university students aged between 18 and 21 years (Mean 20 years 1 month; SD 10.44 months) from three different academic departments (Psychology 6, Medicine 5, Law 1) took part in the study. There were 9 females and 3 males—all were right-handed. They had been previously selected for high hypnotizability (scoring at least 9 out of 12) using the Harvard Group Scale of Hypnotic Susceptibility (HGSHS—Shor & Orne, 1962) then individually screened for their ability

to produce an involuntary finger movement in response to suggestion in hypnosis (ideomotor response). Their HGSHS scores ranged from 9 to 11 with a mean of 10.00 (SD 0.95).

1.2. Materials

The participant's wrist and lower arm rested on a support so that the arm and hand could remain relaxed and their right index finger was held against the top of a response button by an adjustable loop of fabric in all testing conditions. The response button could be operated by the participant with a brief downward movement of their finger or could be operated covertly from below by the experimenter invisibly pulling a string. In the latter case the participant's finger would be moved passively downwards. Participants were seated in front of a computer screen that had an clock display (Libet et al., 1983). This consisted of a clock face 4 cm in diameter and marked around its perimeter with numbers incrementing from 0 to 60 in units of 5. The clock had a single hand (radius 1.2 cm) that completed a revolution in 2.56 s. Voluntariness ratings of finger movements were taken throughout the study using 100 mm visual analogue scales with the end boundaries marked 'Completely voluntary (I moved it deliberately)' and 'Completely involuntary (it felt like it was moved by the button).'

2. Procedure

2.1. Experimental procedures

The participants used the clock display to report verbally as precisely as they could when their right index finger moved downward in contact with the response button. These time estimations were taken under three movement conditions: Voluntary, Passive, and 'Involuntary.' In the Voluntary condition the participant was asked to allow the clock hand to make at least one rotation and to then depress the response button of their own free will, at any time they chose. After a brief random interval, the clock hand stopped, and subjects reported the time that the finger movement occurred. The participant was also asked to think carefully about making each movement, to avoid responding in a stereotyped way, and to avoid deciding in advance to respond at a particular clock position. In the Passive condition, the participant was told that the response button would be depressed mechanically from below at similar time intervals, thereby moving their finger passively, and that they were to report when that finger movement occurred. This method of producing a passive movement gave no external cues to the subject. Participants first performed these two conditions in separate blocks of 40 trials (AB) in counterbalanced order. The participant was then taken through a hypnosis induction and deepening procedure (see below). Within the hypnosis phase of the experiment, an independent ABC/CBA design was used with all three conditions in counterbalanced order again in 40 trial blocks. The three conditions studied under hypnosis were Voluntary and Passive conditions (as before), and an 'Involuntary' movement condition. The 'Involuntary' condition involved the participant making ideomotor button presses at similar time intervals as their own voluntary movements. These were in fact voluntary actions made by the participant, but were suggested to be involuntary movements. In all three conditions participants again used the clock display to report the time of the movement.

Following reversal of the hypnosis instructions participants were again tested in the Voluntary and Passive conditions this time in the reverse of the order they had encountered them before hypnosis. This completed an overall ABBA design in the no-hypnosis condition for each participant. The participant sat back from the apparatus and took a short break with their arms resting in their laps between each of the 40 trial blocks at all stages of the study. The same experimenter gave the relevant standardized instructions to the participants before each block of trials throughout.

The judgement error—the time difference between the actual finger movement and participant's report of it—was averaged across the 40 repetitions in each block. Negative judgement errors indicate anticipatory awareness, in which the participant thought the finger movement occurred before it actually did so. Positive judgement errors indicate a delayed awareness of finger movement.

2.2. Hypnosis procedures

An eyes-closed relaxation induction was used for all participants followed by descent imagery (steps or lift) as a deepening and then a 'special place' procedure (Heap & Aravind, 2002). These hypnosis procedures were carried out by a second experimenter. Once the induction and deepening were complete a short trial run of the Involuntary condition was carried out. The suggestion was given to the subject that after at least one revolution of the clock on each trial the index finger on their right hand would 'make a clear, distinct downward movement at about the same time intervals that it does when you move it yourself... but on these trials it will move all by itself. You will not know when it is going to move but you will be clearly aware of the movement when it occurs and you can report it in the usual way by calling out the number from the clock.' The participant was asked to open their eyes, to place their finger on the button and the clock display was activated for two or three test trials. If clear finger movements of the same intensity, form and speed as those on Voluntary trials were seen the suggestion was reversed and the experimental procedures continued. If the finger movements were not the same as those seen on Voluntary trials the suggestions were repeated. No participant required more than one repetition of the suggestions before producing responses of the required form during these preliminary test trials. The second experimenter introduced and removed the unwilled movement suggestion as appropriate before each block of trials, checked that the participant was still in the hypnosis condition (continuation of the special place experience) between test blocks and gave the suggestion that they would 'remain as hypnotized as you are now' during eye-open testing. No participant reported that they had felt a lessening of the hypnosis experience during testing. In this phase of the study participants closed their eyes when not being tested and opened them just before the test block commenced.

Voluntariness ratings were taken for each of the 40-trial blocks in the no-hypnosis Voluntary and Passive conditions immediately after the first two trial blocks had been completed and after the final two. For the hypnosis condition separate ratings of all six trial blocks were taken immediately after the termination of hypnosis. Participants were also asked at the termination of hypnosis to estimate the time elapsed in minutes since they first closed their eyes as part of the induction procedure.

3. Results

All participants under-estimated the time elapsed during hypnosis. The mean actual time elapsed was 69.08 min (SD 7.55 min) and the mean estimated time elapsed was 37.08 min (SD 14.05 min).

Repeated blocks in each condition were pooled to negate learning and order effects. Mean voluntariness ratings are shown in Table 1 for all conditions, both with and without hypnosis. We first compared the perceived voluntariness of movements in the Voluntary and Passive conditions, with and without hypnosis, in a factorial ANOVA. This showed only an expected effect of movement type, with voluntary movements being rated as significantly more voluntary than passive movements ($F(1, 11) = 443.94,\ p < .001$). Importantly, comparison of the Voluntary and Passive conditions outside hypnosis with the same conditions in hypnosis revealed no main effect of hypnosis ($F(1, 11) = 0.014$, NS). Hypnosis by itself did not therefore produce feelings of passivity.

In addition, we performed planned comparisons of the voluntariness ratings involving the 'Involuntary' (ideomotor) condition in hypnosis. 'Involuntary' ideomotor movements were perceived as significantly less voluntary than truly voluntary movements ($t(11) = 23.889,\ p < .001$). They were also perceived as slightly, but significantly, more voluntary than truly passive movements ($t(11) = 4.129,\ p < .01$). Ideomotor suggestion thus evoked movements that felt much less voluntary than normal voluntary movements, without feeling completely involuntary.

The mean judgement errors in each condition are shown in Table 2. Comparing the perceived times of Voluntary and Passive finger movements in the hypnosis and no-hypnosis conditions, we found that the mean judgement error was significantly more anticipatory for Voluntary movements (ANOVA $F(1, 11) = 4.836,\ p = .05$). There was no main effect of hypnosis ($p = .39$) or

Table 1
Mean (SD across subjects) subjective voluntariness rating

Hypnotic state	Movement type	Mean voluntariness rating
Not hypnotised	Voluntary action	9 (17)
	Passive movement	97 (5)
Hypnotised	Voluntary action	9 (10)
	Passive movement	97 (5)
	'Involuntary' ideomotor	87 (8)

Zero corresponds to a completely voluntary movement, and 100 to a completely passive/involuntary movement.

Table 2
Mean (SD across subjects) judgement errors, relative to actual time of finger movement (ms)

Hypnotic state	Movement type	Mean judgement error (ms)
Not hypnotised	Voluntary action	−73 (53)
	Passive movement	−50 (51)
Hypnotised	Voluntary action	−86 (67)
	Passive movement	−48 (53)
	"Involuntary hypnotic"	−61 (67)

interaction with movement type ($p = .12$). Planned comparisons within the hypnosis condition showed that judgement errors for 'Involuntary' ideomotor movements were significantly delayed relative to judgement errors for Voluntary movements ($t(11) = 3.172,\ p = .009$), but did not differ significantly from judgement errors for Passive movements ($t(11) = 0.837$, NS).

4. Discussion

First, the induction of hypnosis did not affect the subjective experience of voluntariness of intended movements or of the experience of passively produced movements. There was a very clear difference in perceived voluntariness between active and passive movements irrespective of the hypnotic state. The suggestion for non-voluntary (ideomotor) finger movement given in hypnosis however did produce a profound, though perhaps not total, experience of the movements being non-volitional. Since these ideomotor movements were, in fact, entirely generated by the participant, we take this to reflect a change in conscious experience without any corresponding physical change in the actions themselves. This finding may also be taken as supporting evidence for the effectiveness of the hypnosis induction procedures and the persistence of the hypnosis condition during the testing procedures. Similarly, the underestimation of the duration of the hypnosis condition by approximately 50% by participants in this study is typical of time distortion effects previously reported in hypnosis (Naish, 2003).

The pattern of judgement errors in our participants indicated that awareness of Voluntary actions was more anticipatory than that of Passive movements, as expected from previous results (Haggard et al., 2002). In general, anticipatory awareness of action seems to be a hallmark of intention and preparation (Haggard et al., 1999). Moreover, the judgement error scores were not significantly different in the hypnosis condition compared to the no-hypnosis condition. This shows that the induction of hypnosis did not in itself interfere with the motor or temporal judgement aspects of the task, and also corroborates the effects seen in subjective voluntariness ratings. The key condition for our present purpose, however, is the Involuntary condition. Here, subjects are given the ideomotor suggestion that their own actions are occurring involuntarily, whereas in fact they occur by the participant's own agency, just as in the Voluntary condition. Judgement errors for 'involuntary' (ideomotor) movements were significantly delayed relative to those for truly voluntary actions performed in hypnosis but did not differ significantly from passive movements performed in hypnosis. That is, the hypnotic involuntariness suggestion shifted the time of awareness of these essentially voluntary actions towards that for passive movements.

Both subjective ratings and time judgements indicate that our involuntariness suggestion had altered the awareness of voluntary actions in our subjects. Normally, people have no difficulty in distinguishing between their own voluntary actions, and physically comparable passive displacements of their body parts produced by an external cause. Moreover, the conscious experience of these is quite different (Ach, 1905; Dennett, 1993). Also, the extensive frontal brain networks associated with voluntary action are not activated in passive conditions (Weiller et al., 1996). However, our results suggest it is possible to "will" an action, presumably using these 'volitional' areas of the brain, yet without producing the subjective experiences associated with volition, as long as the suggestion is given to the participant in hypnosis that that their movement is involuntary.

Recent neuroimaging work has shown that voluntary movements in hypnotized individuals are accompanied by normal patterns of activation in motor and premotor areas (Halligan, Athwal, Oakley, & Frackowiak, 2000). Both voluntary movements and hypnotic involuntary movements are associated with significant activation of contralateral sensorimotor cortex, premotor cortex, supplementary motor area and insula, bilateral basal ganglia and parietal operculum, and ipsilateral cerebellum (Blakemore et al., 2003). It seems reasonable to conclude therefore that the neural processes producing action in the Involuntary condition in the present study were in fact identical to those in true voluntary actions, but were decoupled from subjective experience by the hypnotic suggestion. Hypnosis by itself does not alter either the mechanisms of action control, the conscious experience of action, or the ability to make temporal judgements about actions.

Instead, we suggest that specific ideomotor suggestion seems to interfere with the conscious experience of action without altering the brain mechanisms that control action. Clearly, however, the conscious experience of volition must have some corresponding neural counterpart. Our experiment shows that the neural activity associated with this conscious experience can clearly be separated from the neural activity that drives the action itself. For example, the conscious experience of volition could arise via parallel circuits monitoring the premovement processing in the frontal areas of the brain. Consistent with this view, a recent neuroimaging study has indicated that the attribution of self-generated actions to an external source is associated with elevated activity in the parietal cortex, insula and cerebellum compared to identical active movements correctly attributed to the self and consequently experienced as 'willed' (Blakemore et al., 2003).

Since our temporal measures were neither generally affected by the hypnotic state, nor required direct report of the phenomenon of willing, our timing error results cannot reflect either a non-specific effect of hypnosis on conscious judgement, or the subjects' general views of what hypnosis, voluntariness or ideomotor suggestion might involve. It seems unlikely that the observed pattern of changes in perceived timing resulted from participants' trying to produce what they thought was a 'desired' behaviour. Thus, our results offer strong support for the view that these 'involuntary' (ideomotor) actions represent a true dissociation between voluntary action and conscious experience. These findings may have important implications for the notion of conscious intention in moral and legal situations. The results also relate to recent cognitive models of the human mind (Shallice, 1988). In such models routine processing normally operates unconsciously, while a central executive selects and transfers only immediately critical information to a more developed level of processing, at which point the information reaches consciousness (Halligan & Oakley, 2000; Oakley, 1999a; Jack & Shallice, 2001). Purely psychological factors such as hypnotic suggestion do not alter the role of the central executive in voluntary action, but interfere with normal conscious experience of the executive system's output (Oakley, 1999b). The paradigm we have described also provides a convenient experimental model for some effects of neurological damage and for psychopathological conditions such as conversion disorder and schizophrenia in which a similar decoupling is seen between the execution of actions using voluntary motor systems and the subjective experience of voluntary control over those actions.

In conclusion, we have shown that the conscious experience of voluntary action can be altered by purely psychological means. Participants who made voluntary actions following the hypnotic suggestion that the actions were occurring involuntarily experienced the timing of these actions in the same way as purely passive movements, and quite differently from truly voluntary actions made in or out of hypnosis. Thus, we show that agency, the experience of willing our own actions,

can be manipulated and even excluded from conscious awareness. These observations have potential implications for psychopathological conditions in which the experience of alien control over movements occurs.

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References

Ach, N. (1905). *Uber die Willenstatigkeit und das Denken. Eine experimentelle Untersuchung mit einem Anhange: Uber das Hippsche Chronoskop. On volition and thinking. An experimental investigation with an appendix: On the Hipp chronoscope*. Gottingen: Vandenhoeck & Ruprecht.

Blakemore, S.-J., Oakley, D. A., & Frith, C. D. (2003). Delusions of alien control in the normal brain. *Neuropsychologia, 41*, 1058–1067.

Blakemore, S.-J., Wolpert, D., & Frith, C. (2000). Why can't you tickle yourself? *Neuroreport, 11*, R11–R16.

Bundick, T., & Spinella, M. (2000). Subjective experience, involuntary movement and posterior alien hand syndrome. *Journal of Neurology, Neurosurgery and Psychiatry, 68*, 83–85.

Dennett, D. C. (1993). *Consciousness explained*. London: Penguin.

Frith, C. D., Blakemore, S.-J., & Wolpert, D. M. (2000). Abnormalities in the perception and control of action. *Philosophical Transactions of the Royal Society of London: Biological Sciences, 355*, 1771–1788.

Halligan, P. W., Athwal, B. S., Oakley, D. A., & Frackowiak, R. S. J. (2000). Imaging hypnotic paralysis: Implications for conversion hysteria. *Lancet, 355*, 986–987.

Halligan, P. W., & Oakley, D. A. (2000). Greatest myth of all. *New Scientist, 168*(2265), 35–39.

Haggard, P., Clark, S., & Kalogeras, J. (2002). Voluntary action and conscious awareness. *Nature Neuroscience, 5*, 382–385.

Haggard, P., Newman, C., & Magno, E. (1999). On the perceived time of voluntary actions. *British Jounal of Psychology, 90*, 291–303.

Heap, M., & Aravind, K. K. (2002). *Hartland's medical and dental hypnosis* (4th ed.). Edinburgh: Churchill Livingstone.

Jack, A. I., & Shallice, T. (2001). Introspective physicalism as an approach to the science of consciousness. In S. Dehaene (Ed.), *The cognitive neuroscience of consciousness* (pp. 161–196). Cambridge, MA: MIT Press.

Jenkins, I. H., Jahanshahi, M., Jueptner, M., Passingham, R. E., & Brooks, D. J. (2000). Self-initiated versus externally triggered movements II. The effect of movement predictability on regional cerebral blood flow. *Brain, 123*, 1216–1228.

Kirsch, I., & Lynn, S. J. (1997). Hypnotic involuntariness and the automaticity of everyday life. *American Journal of Clinical Hypnosis, 40*, 329–348.

Libet, B., Gleason, C. A., Wright, E. W., & Pearl, D. K. (1983). Time of conscious intention to act in relation to onset of cerebral activity (readiness potential)—the unconscious initiation of a freely voluntary act. *Brain, 106*, 623–642.

Marchetti, C., & Della Salla, S. (1998). Disentangling the alien and anarchic hand. *Cognitive Neuropsychiatry, 3*, 191–208.

Mellors, C. S. (1970). First-rank symptoms of schizophrenia. *British Journal of Psychiatry, 117*, 15–23.

Morawetz, T. (1980). *The philosophy of law*. New York: MacMillan.

Naish, P. (2003). The production of hypnotic time-distortion: Determining the necessary conditions. *Contemporary Hypnosis, 20*, 3–15.

Oakley, D. A. (1999a). Hypnosis and conversion hysteria: A unifying model. *Cognitive Neuropsychiatry, 4*, 243–265.

Oakley, D. A. (1999b). Hypnosis and consciousness: A structural model. *Contemporary Hypnosis, 16*, 215–223.

Shallice, T. (1988). *From neuropsychology to mental structure*. Cambridge, UK: Cambridge University Press.

Shor, R. E., & Orne, E. C. (1962). *Harvard group scale of hypnotic susceptibility: Form A*. Palo Alto, CA, US: Consulting Psychologists Press.

Weiller, C., Juptner, M., Fellows, S., Rijntjes, M., Leonhardt, G., Kiebel, S., Muller, S., Diener, H. C., & Thilmann, A. F. (1996). Brain representation of active and passive movements. *Neuroimage, 4*, 105–110.

Weitzenhoffer, A. M. (2000). *The practice of hypnotism* (2nd ed.). New York: Wiley.