Contemporary Hypnosis (2003)
Vol. 20, No. 1, 2003, pp. 16–24

PSYCHOGENIC PAIN: A STUDY USING MULTIDIMENSIONAL SCALING

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Abstract

Hypnotic suggestions designed to induce a sensation of pain were given to 11 highly hypnotizable participants and produced the intended effect in six of them. Subjective aspects of the pain experiences were investigated using conventional pain questionnaires and a multidimensional scaling technique. The implications are discussed in terms of a model of consciousness and the etiology of chronic pain.

Key words: hypnosis, psychogenic pain, multidimensional scaling

Introduction

Chronic pain is a major problem in our society, with estimates of its prevalence reaching 46% of the general population (Elliot, Smith, Penny, Smith and Chambers, 1999). However, contemporary treatments for chronic pain do not match the efficacy of treatments for acute pain conditions. One reason that has been postulated for this is that chronic pain is supported more pervasively by psychological factors (Turk, 1999). It is commonly reported that there seems to be a much greater psychological component to chronic pain – there is a real sensation of pain, but in many cases no apparent tissue damage. It is important, of course, that extensive checks are made to ensure that pain with an organic cause is not misdiagnosed or inappropriately labelled as 'psychogenic' (Covington, 2000). Nevertheless the fact that there are cases where tissue damage cannot be shown to be a factor in generating the pain experience raises the possibility that psychological factors could in some instances be attributed as the primary or even the sole source. In most clinical cases it is not possible in practice to exclude the possibility of a somatic (or organic) component. However, we are concerned here with the experimental production of an hypnotically induced pain, in which a somatic component can be assumed to be absent. We refer to this pain experience, which has a purely psychological origin, as 'psychogenic' in the original sense of that term.

Linking hypnosis to pain is not new. Hypnotic analgesia has long been used to treat a wide variety of pain conditions and has repeatedly been confirmed as an effective analgesic for both acute and chronic pain in experimental and clinical settings (Montgomery, DuHamel, Redd, 2000). Hypnosis has also been linked to theoretical accounts of pain and its origins. Crawford, Knebel, Kaplan and Vendemia (1998), for example, have identified a link between high hypnotic suggestibility and chronic pain. Wickramasekera, Pope and Kolm (1996) and Wickramasekera (1998) cite high or low hypnotic susceptibility in conjunction with high social desirability scores as a risk factor for chronic pain within his high-risk model of threat perception. Investigating the nature of this relationship presents an intriguing challenge for researchers in the fields of both pain and hypnosis.

The aim of the present investigation is to explore the use of hypnosis as a cognitive tool to create a virtual experience of pain – a pain experience not initiated by a physical stimulus. We have identified three previous experiments that attempted to induce a sensation of pain using hypnosis (Barber and Hahn, 1964; Dudley, Holmes, Martin and Ripley, 1966; Hilgard, Morgan, Lange, Lenox, Macdonald, Marshall and Sachs 1974). The primary goal of these experiments was to correlate physiological changes with the pain sensation. The authors did report accurate reproductions of 'real' pain experiences and of some of the accompanying physiological measures but the reproduction of a pain experience under hypnosis was not found to be exactly the same as the corresponding physically induced pain experience. However, these previous studies are limited in their analysis of the subjective experiences of pain. Only Dudley reports subjective data but this is restricted to statements such as 'I was fighting the head pain and was angry with you' (Dudley et al., 1966).

An important aspect of the analysis of pain is that it is intrinsically a subjective experience so it is logical and would be valuable, despite the methodological difficulties, to investigate this aspect of the experience. Relationships have been shown to exist between physiological measures and the subjective intensity of pain. Unfortunately pain is a complex phenomenon and, as yet, physiological measures are not a good correlate of the unpleasantness of a pain, reports of which are themselves difficult to elicit reliably via introspective means. Chapman, Nakamura, Donaldson, Jacobson, Bradshaw, Flores, and Chapman (2001) report that psychophysiological measures such as skin conductance or pupil dilation did not help them to verify the separability of pain dimensions. They argue that a relationship should exist between autonomic arousal and negative affect, however no sensitive measure has been developed to distinguish between them. It therefore appears to be worthwhile also to attempt to tackle the problem from a different perspective; obtaining a more detailed assessment of the subjective experience of pain.

Despite a strong tendency among pain experimenters to use visual analogue scales to measure the sensory and affective dimensions of pain, and experimental evidence supporting this use (Price, McGrath, Rafii and Buckingham, 1983), recent work suggests that the results of these measures must be treated with caution. Chapman, Nakamura, Donaldson et al. (2001) argue that for laboratory experiments (but, importantly, not for pain patients or for participants trained in pain discrimination) the sensory and affective dimensions of pain are not differentially open to introspection. In light of this evidence other measures of pain were also taken in the present study to allow for a multidimensional scaling analysis of the experiences.

Multidimensional scaling (MDS) is a mathematical technique that allows the similarities between items to be represented spatially. Items that are judged to be similar are located close to one another whereas items that are judged to be dissimilar are located further apart. It allows experimenters to explore patterns of interrelations in data where underlying dimensions are unclear (Shepard, Romney and Nerlove, 1972; Schiffman, Reynolds and Young, 1981). Another potential benefit of MDS is that it only requires participants to make judgements about the similarity between items – it does not require them to articulate any of the properties of the items. This overcomes a frequent criticism of other commonly used measures such as the McGill pain questionnaire – that it requires participants or patients to verbalize their pain experience, often using unfamiliar language. Multidimensional scaling is typically used as an exploratory analysis. With a low danger of experimenter contamination it can guide the investigator towards a description of the dimensions underlying the data.

Our hypothesis was that it would be possible to induce a subjectively real experience of pain (as measured by questionnaire and psychometric data) by the use of

hypnosis, and that the experience of hypnotically induced pain would closely match that of a physically induced pain sensation on which the hypnotic suggestion would be modelled.

Method

Participants

Participants were 11 students (six female, five male) recruited from University College London. The mean age was 22 (range 20–25). Participants were recruited from a database of highly hypnotizable individuals (scoring >8 on the Harvard Scale of Hypnotic Susceptibility (Shor and Orne, 1962)). Mean Harvard score was 10.6. This study was approved by the Joint UCL/UCLH Committees on the Ethics of Human Research and informed consent was obtained from all participants. Participants were tested individually. The experiment took about one hour, and participants were paid £6 for their time.

Hypnotic induction

Participants were seated in a chair in front of the apparatus and the hypnotic induction and suggestions were presented from a compact-disc player via a loudspeaker. This procedure was adopted to allow for the standardization of the instructions.

The hypnotic induction began with instructions for participants to close their eyes and continued with instructions to imagine a colour representing tension, and imagine breathing out air tinted with that colour, then to replace this tense breath with air tinged with a calming colour. This was followed by progressive muscle relaxation and then a deepening procedure involving participants in imagery of descending steps within a garden. The induction finished with instructions to go to a 'special place' of their own choosing where participants would be relaxed and comfortable.

Pain induction techniques

Subjects received two pain experiences, one to each hand, in the course of the experiment. They remained hypnotized and had their eyes closed throughout the procedure. In both instances of pain they were instructed that when their hand became painful they should return it to their lap, at which point the pain would be removed. The order of presentation of the pain induction technique was randomized, as was the instruction for which hand to use first.

Physically induced pain

In the physically induced pain condition subjects were asked to place their hand palm-down on to a table surface in front of them. A 100 W infra-red lamp was shone on to the back of the hand from a distance of 12 cm.

Hypnotically induced pain

In the hypnotically induced pain condition participants were instructed to place their hand on a table in front of them and to focus their attention on that hand. Suggestions were given that a powerful lamp was shining on to it, and that their hand was becoming increasingly hot until it became painful. These suggestions were repeated for a maximum of three minutes.

Measures

A simple questionnaire was initially used to assess whether the participant had felt (i) a sensation of heat and (ii) a sensation of pain. Descriptions of these aspects of the experience were also elicited whenever they were reported.

Visual analogue scales were used to assess (i) the similarity of the hypnotically induced (HI) to the physically induced (PI) pain, (ii) the intensity of the HI and PI pains, and (iii) the unpleasantness of the HI and PI pains. (The intensity scale was bounded by the terms 'no pain at all' and 'most intense pain imaginable', and the unpleasantness scale 'not at all unpleasant' and 'most unpleasant pain imaginable'). These measures were designed to investigate the dimensions of pain mentioned most often in the pain literature, namely the sensory and affective dimensions.

A rank-ordering task was given to produce similarity data for a multidimensional scaling analysis. Twelve cards, each representing a different pain experience (for example pinprick, toothache, sore throat) and including the PI and HI pain experiences, were presented to the participant. One of these cards, termed the 'reference card' was placed on the participants' left-hand side. Their task was to rank the pain experiences identified on the remaining 11 cards in order of similarity to the one on the reference card. This task was repeated until each of the 12 cards had been used as a reference card. The result of this reference ranking procedure is a matrix of similarity data that, unlike many other forms of data collection, is 'extremely low in terms of experimenter contamination' (Schiffman et al., 1981).

Analysis

Similarity data collected from the participants was transformed into a square asymmetric dissimilarity matrix. This was analysed using an INDSCAL model within SPSS 10 (SPSS INC, 2000). Intensity and unpleasantness data from the visual analogue scales was analysed using a Wilcoxon test.

Results

The numbers of participants who experienced heat and pain in the two conditions are given in Table 1. Scores from the visual analogue scales of intensity and unpleasantness from the six participants who felt both types of pain are given in Table 2. Pain intensity and unpleasantness scores were analysed by (PI or HI) condition but no significant differences were found (Wilcoxon test).

Of the nine participants who felt pain in the PI condition the mean time until they moved their hand was 42.29 s (range: 14.7–73 s). The remaining two participants who did not feel pain due to the heat lamp also moved their hands but did not report the experience as painful.

Of the six participants who felt pain in the HI condition, the mean time-to-move was 143.72 s (range: 78–165 s). The total length of the suggestion was 165 s and two of the participants who felt pain waited until the end of the suggestion before they moved their hands. The reason they gave for not moving their hands previously was that they were interested in the sensation. The remaining five participants who did not feel pain in response to the suggestion all felt a sensation of heat, but this must not be seen as an essential prerequisite for the pain experience as one participant experienced a suggested pain in the absence of a sensation of heat.

Table 1. Percentages (and numbers) of participants who felt heat and pain due to the heat lamp or hypnosis

	Heat lamp	Hypnosis
Felt heat	100% (11)	91% (10)
Felt pain	82% (9)	55% (6)

Table 2. Average VAS rating (standard deviation in brackets) for pain unpleasantness and intensity due to heat lamp or hypnosis

	Heat lamp	Hypnosis
Pain intensity	46.4 (26.0)	44.9 (35.2)
Pain unpleasantness	36.0 (24.2)	46.4 (31.6)

Participants were asked to rate on a visual analogue scale the similarity between the PI and HI experience on which it was modelled. On a scale of '0 = not at all similar' to '100 = completely the same', the average score was 56 (range 4.7 – 83.5).

A multidimensional scaling analysis was carried out on the data from the six of the 11 participants who felt both the HI and the PI pains. An INDSCAL analysis yielded a two-dimensional solution, which is presented in Figure 1. The stress of this solution, which is an inverse measure of the correspondence between the input data and the distances among points on the MDS map, was 0.319 and the root square value was 0.548.

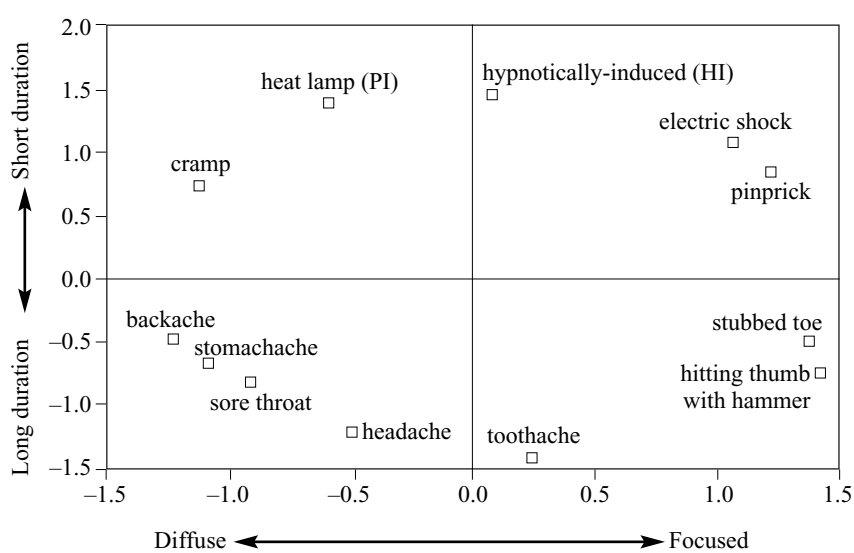

Figure 1: Multidimensional scaling solution.

Dimensions were chosen on the basis of their fit with the data. The widely cited sensory and affective dimensions of pain do not account well for the pattern of data in the MDS solution: there is no clear dimension of intensity despite some participants reporting that they used it as a factor in their decisions about the similarity of the stimuli. The preferred dimensions of duration and diffusion/focus were both reported by some participants as factors that played a role in their decision making.

There are indications that factors particularly salient to the individual may influence the nature of the hypnotic pain experience. One of the participants in this study, a theatre technician, visualized a '2,500 Watt spot lamp burning my hand', others described very focused pain experiences such as laser beams directed at the hand.

Discussion

The times that it took participants to feel the HI pain were not necessarily reflective of the amount of pain felt and were simply used as a guide for the experimenter to see if pain was felt. Debriefing reports indicate that some participants felt a pain in the HI condition but did not move their hand because they were interested by the sensation. Conversely, some participants did feel a sensory change in the HI condition but did not feel a pain, and moved their hand nonetheless. Their reports indicate that this may have been because they were apprehensive and/or did not want to experience a painful sensation despite their initial willingness to take part in the study. The maximum length of the pain suggestion was 165 s. Of the six participants that felt pain in the HI condition the average length of time it took was 143 s. It is possible that if the suggestions had continued for longer then a higher proportion of the participants would have felt pain in response to suggestion.

The results given in Table 1 indicate that only nine of the participants reported the sensation due to the heat lamp as painful. There are a number of possible explanations for the behaviour of the two who moved their hands away like the others but did not report pain. One is that they were anxious about experiencing the pain and removed their hands to avoid it – another is that they found the PI pain stimulus aversive but not painful; one of them offered the observation that the heat stimulus had been an unpleasant sensation but that he did not wish to label it as 'pain'.

Table 2 indicates large inter-individual variability in pain intensity and unpleasantness scores. However, modest participant numbers prevent any significant differences from being found from the VAS data and we will have to wait for information from a larger study to draw conclusions about these aspects of the pain experience.

The results of the MDS analysis (Figure 1) are interpreted in terms of duration and focus/diffusion as these appear to us to offer the best fit to the data. These dimensions differ from the conventionally assumed sensory and affective dimensions of pain, but provide valuable insight into how participants describe experimental pain stimuli – the dimensions of duration and localized/generalized were reported by some participants as being important in the decision making process. The presence of these dimensions does not discount the possibility of further dimensions, but these seemed to be the dimensions most salient to the participants in this study when asked to judge the similarity of the pain experiences. The results presented here go some way to explaining the difficulty that Chapman, Nakamura, Donaldson et al. (2001) found when participants were asked to make judgements about the intensity and unpleasantness aspects of experimental pain. Sensory and affective dimensions of the pain experience may not be the most important ones for the participants. The fact that the HI and PI heat pain experiences are closely

located on the MDS plot in Figure 1 suggests that they are perceived as being more similar to each other than they are to other types of pain despite the wide range of similarity ratings produced by the VAS measure. In particular the HI and PI heat pains were rated as being very similar in the duration dimension with the HI heat pain being experienced on balance as a little more focused than the PI heat pain.

Similar configurations of pain similarity judgements were found in the plots from individual participants and in the grouped data plot shown in Figure 1. As 10 out of the 12 items in the test (for example, headache, stubbed toe) required the participant to imagine a past pain experience the presence of a stable configuration indicates that it is possible for participants to reliably imagine different pain experiences. This preliminary empirical validation opens the possibility for conducting neuroimaging studies to analyse the differences between a 'real' pain experience, a hallucinated pain experience and an imagined pain experience. Similar real/hallucinated/imagined paradigms using hypnosis as a cognitive tool as part of a neuroimaging study have already proved insightful for other modalities (for example, Kosslyn, Thompson, Constantini-Ferrandon, Alpert, and Spiegel, 2000) and indicate that the hallucinated experience is more similar to an actual event than is the imagined experience (Sczechtman, Woody, Bowers and Nahimas, 1998).

High hypnotizability has been associated with conversion disorder and it has been suggested that hypnosis and conversion hysteria share common neuropsychological mechanisms (Oakley, 1999a, 2001; Halligan, Athwal, Oakley and Frackowiak, 2000). In many respects truly psychogenic pain of the sort described in this study could be conceived as being similar to conversion disorder: the experience is internally generated yet knowledge of this internal generation is not accessible to self-awareness. In terms of the model of consciousness proposed by Oakley (1999a,b), suggestions that produce the experience of pain or paralysis in hypnosis act at the level of a central executive system and affect lower-order processes without involving higher-order systems that mediate 'self-awareness'. In conversion hysteria, and possibly with psychogenic pain, the suggestion is internally generated and produces symptoms by processes that are not available to self-awareness. It must be recognized that there are differences between hypnotically induced pain demonstrated in this study and forms of psychogenic pain that might be seen in clinical settings. The former is a very short-term experience, for instance, whereas the latter is more likely to be a chronic condition.

Studies are planned to further examine the individual variation in the nature of hypnotically induced pain using larger sample sizes. Multidimensional scaling will be used to assess the between-group effects of manipulation of the hypnotic suggestion for pain, and will also be used to assess the dimensions salient to some chronic pain patients.

Hypnosis is a potentially valuable tool in neuroscience research in general and for investigating pain in particular. Ground-breaking studies have already used hypnosis to manipulate the sensory and affective dimensions of physically induced pain (Rainville, Duncan, Price, Carrier and Bushnell, 1997; Rainville, Carrier, Hofbauer, Bushnell and Duncan, 1999). We feel it has equal potential in understanding the mechanisms and phenomenology of psychogenic pain and in some of the chronic pain conditions seen in the clinic.

Acknowledgement

The work reported here was supported by a scholarship from the Department for Work and Pensions to MW.

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