Pain 124 (2006) 134–139

PAIN

www.elsevier.com/locate/pain

Decreased sensitivity to self-inflicted pain

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Received 8 December 2005; received in revised form 8 March 2006; accepted 3 April 2006

Abstract

There is anecdotal and incidental research evidence suggesting that self-inflicted injury is experienced as less painful than when the same injury is applied by another person. We tested the hypothesis that the sensitivity and the ability to tolerate pain differs depending on the person applying the painful stimulus. Self-selected healthy undergraduate students were obtained from the University of Stirling participant panel. None were suffering chronic pain or taking any form of analgesic drug. The participants applied a pressure algometer to themselves and to other participants. Depending on the type of trial, each was terminated when the participant experienced the algometer as either "painful" (for threshold reading) or "unbearable" (for tolerance reading). Both measures of pain, threshold and tolerance, were significantly higher when the algometer had been self-applied compared with when it was applied by another person. The mean difference for pain thresholds was 0.27 MPa (95% confidence interval 0.10–0.44, $P = 0.002$), and the mean difference for pain tolerance readings was 0.25 MPa (95% confidence interval 0.03–0.48, $P = 0.028$). An unexpected finding was that the mean tolerance score was less when females applied the algometer ($P < 0.01$). When a painful stimulus was self-inflicted this resulted in significantly less pain and a greater ability to tolerate the pain compared with when the same stimulus was applied by another person. If the findings generalized to a clinical context, certain painful or discomforting procedures, such as mammography, removal of wound dressings and lancet withdrawal of blood, should be adapted for self-application by patients.

Keywords: Self-inflicted pain; Self-injury; Mechanonociception; Algometer; Pain threshold; Pain tolerance; Mammography

1. Introduction

The circumstances in which an injury is sustained strongly influence how pain is experienced in relation to its intensity and toleration (Beecher, 1946; Hardy et al., 1952; Melzack and Wall, 1996). Often our experience of pain arises from events beyond our immediate control. For example, the pain that results from a pathology such as a toothache. Sometimes pain arises through the deliberate actions of another person – for example, a hard rugby tackle. Pain may also arise from the deliberate actions of another person who has specifically been given our consent: as occurs in a medical setting, e.g., receiving an injection, or when an afflicted body region is manipulated by a doctor. Furthermore, the gender of the person administering the noxious stimulus, in relation to the gender of the recipient, may influence reports of pain (Levine and De Simone, 1991; Kallai et al., 2004; Weisse et al., 2005).

Alternatively, pain may be intentionally self-inflicted, for example, the diabetic's self-therapy by injection of insulin. There are many other circumstances in which pain is self-inflicted, sometimes incidental to the purpose of gaining some other benefit, for example, improving physical appearance by eyebrow hair plucking (Hardy et al., 1952). Sometimes pain results more explicitly by self-mutilation (Stengel, 1965) or is actually sought out, as in masochism (Hardy et al., 1952).

Introspective, anecdotal evidence (e.g., from self-injecting diabetics) and evidence from those who habitually self-injure would suggest that self-inflicted injury is

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0304-3959/$32.00
doi:10.1016/j.pain.2006.04.006

not as painful as the same injury inflicted by another person. In the same way that it is difficult to tickle one self (Weiskrantz et al., 1971), it may be more difficult to evoke pain when it is self-inflicted (Stengel, 1965). Surprisingly, no study appears to have specifically addressed this issue.

Using a pressure algometer to apply a mechanical noxious stimulus to the sternum we aimed to compare self- versus other person-applied stimuli. Our principal experimental hypothesis was that both pain threshold and pain tolerance measures would be elevated for self-applied compared with other person-applied stimuli. Subsidiary experimental hypotheses involved the gender of the person receiving and applying the algometer. First, that females receiving the algometer would have lower pain thresholds and tolerances. Second, that those receiving the algometer from females, particularly males, would have elevated pain thresholds and tolerances.

2. Methods

2.1. Participants

Participants were self-selected for participation in a study titled "Perception of Pain" from the University of Stirling participant panel. The study received prior approval by the Department of Psychology Ethics Committee. Forty-eight healthy university students (24 men and 24 women) aged at last birthday between 17 and 29 years old (mean = 20.3 years) were participants. All were aware that the study would involve painful stimuli and signed a consent form. According to their answers on a questionnaire, none of the participants were currently taking any kind of analgesic drugs nor suffering from chronic pain.

2.2. Apparatus

A pressure algometer was used that closely resembled the instruments previously described and illustrated (Head and Holmes, 1911; Keele, 1954; Merskey and Spear, 1964). It consisted of a metal cylinder containing a spring attached to a plunger. The tip of the plunger was cylindrical with a flat end, diameter 0.5 cm made of firm cork, which was pressed onto the body area to be tested. When held and pushed towards the tested body area the spring applied an increasing pressure. A scale on the metal cylinder was calibrated for a range from 0 to 8.5 kg. The kilogram readings were converted to pressure expressed as megapascals ($Pa = g_n \times$ kilograms per m^2). The reliability of the pressure algometer, as a test for both pain threshold and pain tolerance, has been well established (Merskey and Spear, 1964). In the present study the mechanical threshold and tolerance readings obtained by the algometer applied by another person to the participant are directly comparable with those previously reported using the same kind of device. The mean threshold was 1.45 MPa and the mean tolerance was 2.82 MPa, which compares with 1.62 and 2.59 MPa, respectively, obtained from male and female medical students by application of the algometer to the forehead (Merskey and Spear, 1964), where the latter reading represented the point "when it hurt a lot". A study using pupillomotor responses found that 1.5 MPa caused reliable pupil dilation, and this correlated with the increase in subjective pain ratings (Ellermeier and Westphal, 1995). The present data also encompass the mean mechanical escape threshold of 1.76 MPa measured in freely moving male rats (Cahusac et al., 1990). Therefore, the results from the algometer in the present study are consistent with earlier reports of mechanical threshold and tolerance measures, and support the use of this instrument as a reliable and valid means of examining pain experience.

2.3. Questionnaire materials

A short questionnaire was used asking for their age, gender and whether they were taking any analgesic drugs. In the same questionnaire they gave a rating in response to the question: "How afraid are you of receiving an injection? Please rate your fear on a scale of 1 being the lowest, and 5 being the highest", below which were the numerals 1–5 (labeled 1: "not afraid at all", 2: "quite nervous", 3: "nervous", 4: "afraid", 5: "extremely afraid"). This question was adapted from three items from the Fear of Pain Questionnaire (McNeil and Rainwater, 1998) in which fear was assessed for receiving injections in the mouth, the arm, and the buttocks/hip. In our study the question aimed to assess specifically the fear of pain inflicted by another person. The distributions of responses by gender were approximately normal, with no evidence for floor or ceiling effects.

2.4. Procedure

Testing was carried out between 10 a.m. and 3.30 p.m. on two different days. The whole procedure lasted approximately 20 min for each participant. Testing was performed on groups of four participants, two men and two women, at a time.

On entry into the test room participants completed a consent form and filled in the questionnaire. The participants were then shown how to use the algometer, and the investigator demonstrated its operation on herself. They were told to increase the pressure smoothly by 1 kg/s on the scale (Merskey and Spear, 1964) and were shown the exact position on the sternum where the algometer's tip was to be placed: at the slight depression found at the centre of the first piece or manubrium (Keele, 1954). The algometer was moved perpendicular to the body surface. Participants were told not to look at the scale of the algometer, and compliance was monitored by the investigator. The participant was given a threshold test followed by a tolerance test followed by a threshold test, or vice versa, depending on sequence order to which the participant had been assigned (see below). The algometer was applied to the participant by his/her self, by another male participant and by another female participant, in an order that depended upon the administration order to which the participant was assigned (see below).

The pain threshold was determined as the point at which the participant first stated that they perceived the pressure stimulus as "painful", and the participant was told to say "Now", upon which the algometer was removed and the reading noted down by the investigator. The pain tolerance was determined as the point at which the participant said "Stop" when the participant perceived the pain to be "unbearable", upon which the algometer was removed and the reading noted down by the investigator. The threshold endpoint corresponds to that previously described (Keele, 1954), and the tolerance endpoint corresponds to the measure described by Melzack and Wall (1996) (between (c) and (d), respectively, p. 17). Trials were separated by approximately 1 min.

At the end of the study participants were debriefed and told about the nature of the investigation. None of the participants had guessed the main motive of the investigation, viz. to determine whether pain threshold and tolerance were influenced by who was applying the stimulus.

2.5. Design

To control for order effects the application of the algometer by the self, by another male participant, and by another female participant, participants were randomly assigned to one of six possible administration order groups (self–male–female, self–female–male, female–self–male, male–self–female, male–female–self and female–male–self). For the same reason participants were randomly assigned to one of two sequence order groups: threshold–tolerance–threshold–tolerance–threshold–tolerance and tolerance–threshold–tolerance–threshold–tolerance–threshold. On the first day of testing, each participant received three applications of the algometer according to the participant's administration order and sequence order group. On the second day the same instructions were issued and each participant received three further applications of the algometer according to the same administration order and sequence order group assignment. The testing was split over 2 days to avoid excessive pain testing in a single session (which might have produced hyperalgesia or other complications). When administration and sequence orders were entered as between-participant factors in separate analyses of threshold and tolerance data, there was a significant effect of administration order for threshold but not tolerance data: $F(5,24) = 4.53$, $P = .005$ and $F(5,24) = .97$, $P = .456$, respectively. For both threshold and tolerance data there were significant interactions between administration order and sequence order: $F(1,24) = 5.19$, $P = .002$ and $F(1,24) = 3.30$, $P = .021$, respectively. While there were significant order effects, these were independent of and did not involve the other variables of a priori interest (the type of person applying the algometer, and the gender of the recipient). In addition, the impact of order effects was minimized due to the counterbalanced design. Multiple t-tests showed that there were no significant differences between pain measures obtained across the two days of testing ($.06 \leqslant P \geqslant .567$).

2.6. Statistical analyses

A repeated-measures ANOVA was performed for each type of pain measurement (threshold and tolerance), where the person applying the algometer was the within-participants factor (three levels), and where gender, administration order and sequence order were between-participants factors ($2 \times 6 \times 2$, respectively). Although order effects were analysed (see above), the main analysis excluded these variables. Where appropriate the Greenhouse–Geisser adjustment was used. Multiple t-tests were used to examine specific group and condition effects within the data set. Correlations were performed between the fear of injection ratings and the pain measurements.

3. Results

3.1. Effect of the person (self, male, and female) applying the algometer

The algometer, when self-applied, resulted in the highest mean pain threshold and tolerance readings compared with when the algometer was applied by another person (male or female), see Fig. 1. Repeated-measures ANOVAs performed for each type of pain measurement, threshold and tolerance, produced highly significant main effects for the person applying the algometer, $F(1.8, 81.5) = 7.0$, $P = 0.002$ (mean pressures: self = 1.72, male = 1.45, female = 1.44 MPa) and $F(1.7, 76.5) = 7.94$, $P = 0.001$ (mean pressures: self = 3.08, male = 2.99, female = 2.65 MPa), respectively. Estimates for effect size (η^2) for the person applying the algometer gave .13 (threshold) and .15 (tolerance). For the threshold readings, those for self-applied were significantly higher than those for male applied ($t(47) = 3.18$, $P = .003$) and female applied ($t(47) = 2.88$, $P = .006$), and male and female applied were not different ($P = .904$), see asterisks in Fig. 1. A slightly different profile of results was seen for the tolerance readings: those for self-applied were significantly higher than those for female applied ($t(47) = 3.18$, $P = .003$) but not

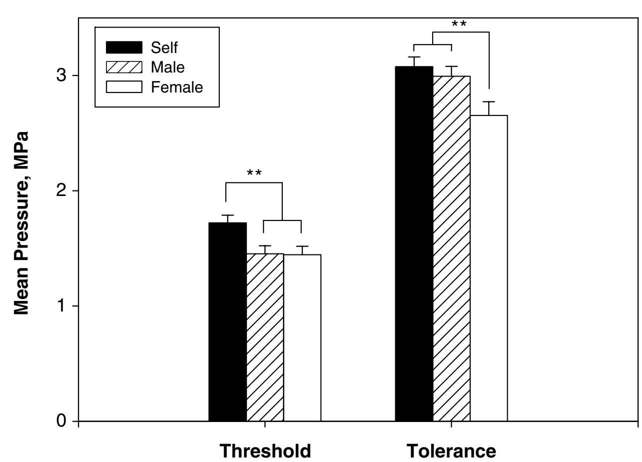

Fig. 1. Bar diagram showing the mean pain Threshold and pain Tolerance algometer pressure readings (in MPa) according to the person applying the algometer. The mean threshold reading, when self-applied, was significantly higher than when applied by others (male or female). The mean tolerance reading, when self-applied, was significantly higher than when applied by other females, but was not significantly different for when applied by males (see asterisks). The mean tolerance reading, when applied by males, was not different from the tolerance for self-applied but both of these were significantly different from when applied by females. The bars represent means with standard errors. Filled bars represent self-applied, hatched represent applied by males, and white bars represent applied by females. The double asterisks indicate statistical significance $P < 0.01$ for the specific comparisons illustrated. Error bars represent the standard error of the mean.

those for male applied ($t(47) = .786$, $P = .436$), and male applied was significantly higher than female applied ($t(47) = 3.69$, $P = .001$), see Fig. 1 where the summaries of these tests are indicated by asterisks.

When readings obtained from another person applying the algometer (male and female) were combined and then compared with self-applied, the differences for threshold and tolerance means were statistically significant: 0.27 MPa (95% confidence interval 0.10–0.44, $P = 0.002$) and 0.25 MPa (95% confidence interval 0.03–0.48, $P = 0.028$), respectively.

3.2. Effect of receiving participant's gender

There was a significant main effect of gender for threshold: 1.30 MPa for women versus 1.77 MPa for men, $F(1, 46) = 11.13$, $P = 0.002$, which was even more significant for tolerance: 2.41 MPa for women versus 3.40 MPa for men, $F(1, 46) = 32.78$, $P < 0.000001$. There was no interaction between gender and the person applying the algometer for either threshold or tolerance readings, both $P = .528$, indicating that there was no differential effect of same sex versus different sex of the recipients in relation to their administrators, see Table 1.

3.3. Fear of injection ratings

The mean fear of injection rating for men was 2.58 ± 1.21 (SD), and for women was 2.62 ± 1.05 (comparison of means was not statistically significant: $t(46) = 0.127$, $P = 0.9$). None of the correlations between the fear of injection rating and self-other differences approached significance ($r < |\pm 0.195|$, $N = 48$, $P > 0.18$). There was also no significant correlation between each of the original pain measures and the fear of injection rating ($r < |\pm 0.16|$, $N = 48$, $P > 0.28$).

Table 1
Mean threshold and tolerance measures according to gender of participant in relation to the person administering the algometer test

Pain measurement	Participant receiving	Person administering	Mean pressure, MPa (SD)
Threshold	Men	Self	2.01 (.713)
		Male	1.67 (.485)
		Female	1.65 (.739)
	Women	Self	1.43 (.377)
		Male	1.24 (.544)
		Female	1.24 (.645)
Tolerance	Men	Self	3.53 (.688)
		Male	3.56 (.512)
		Female	3.12 (.907)
	Women	Self	2.63 (.733)
		Male	2.43 (.813)
		Female	2.19 (.777)

4. Discussion

This study demonstrated that a painful stimulus was perceived as significantly less painful, and could be tolerated more, when it was self-applied than if the same stimulus was applied by someone else. The relatively large effect sizes obtained for the type of person applying the algometer suggest that these findings are of practical importance. For the threshold readings, the self-applied means were consistently greater than those obtained when either males or females applied the algometer (Fig. 1), and this was seen in both men and women recipient participants (Table 1). For the tolerance readings, again self-applied means were generally higher than the others, but were not significantly different from means for when the algometer was applied by males (see Fig. 1). Rather, the differences here highlighted the finding that the algometer applied by females consistently gave the lowest tolerance readings.

When injury is self-inflicted in a religious or ceremonial setting there often appears to be minimal pain experienced by the participants (Hardy et al., 1952; Kosambi, 1967). Those with a propensity to self-injure generally report little or no discomfort during the self-inflicted injury (Stengel, 1965), although their normal pain thresholds (when tested by another person) are only slightly elevated compared with the non self-injuring population (Kemperman et al., 1997; Thurauf and Washeim, 2000).

Explanations for the effect may involve expectation, anxiety and trust of another person (Hollander, 1939; Kanfer and Goldfoot, 1966; Berkowitz and Thome, 1987). The rating provided here by participants on their fear of injection might represent some measure of trust that participants had of others in applying a painful stimulus to them. If so, those who least trusted others might be expected to show the largest difference between the pain measures (threshold and tolerance) when the algometer was applied to themselves compared with when it was applied by another person (male and female); however, none of these statistical analyses approached significance. Early studies have highlighted the importance of perceived control and locus of control as factors in the experience of pain (Bowers, 1968; Staub et al., 1971; Seligman, 1975). A more recent study, using a pressure algometer with healthy participants found that, under certain circumstances, the experience of pain was reduced when participants were given control over termination of the stimulus (Williams et al., 2004).

The effect of decreased pain sensitivity to the self-applied algometer was analogous to that obtained using tickle stimuli in which self-stimulation was perceived as less ticklish than when stimulation was applied by another person (Weiskrantz et al., 1971). One explanation involves the psychological phenomenon where a participant perceives the same stimulus differently when it is *actively sought* by the participant, compared with when it is *passively applied* to the participant (Gibson, 1968). It may be that afferent pain impulses arising from a person's actions are modulated by an "efference copy" of the motor command signals – and the pain sensation would represent a re-afferent input (von Holst, 1954). There is certainly evidence of such a gating mechanism for innocuous tactile stimuli (Coquery, 1978), and the descending controls of nociceptive pathways necessary for such a mechanism have been extensively studied (Willis, 1982). In the present study the pain experience may have been modulated by two neural processes: (a) the motor command signal efference copy and (b) the proprioceptive information from the muscles and joints of the arm. The study on tickle found that passive following of the experimenter-applied stimulus by the participant, i.e., without the motor signal, reduced the degree of tickle sensation but was more ticklish than when self-applied (Weiskrantz et al., 1971).

The other notable and interesting finding from the present study is that the lowest tolerance (but not threshold) readings were obtained when females applied the algometer (Fig. 1), an effect seen for both men and women participants (Table 1). One possible explanation might be that females apply the algometer differently to males. For example, a slightly slower delivery of the algometer to the participant might result in lower readings. This seems unlikely for two reasons. First, if this were so then there would also be a similar difference across gender for thresholds, and this was not observed. The thresholds for men were virtually identical for when females and when males applied the algometer. The same was true for women (Table 1). Second, a difference in application method seems unlikely because when females applied the algometer to themselves they also obtained higher threshold and tolerance readings compared to when others do so, producing a similar pattern of results to those obtained by males (Table 1). Two other studies, one using radiant heat the other the cold pressor test, did not find an interaction between gender of recipient and administrator (Feine et al., 1991; Weisse et al., 2005). Our study also partly contradicts at least two other studies where the interactive effects of recipient and administrator gender were examined using the cold pressor test (Levine and De Simone, 1991; Kallai et al., 2004). One of these studies found that pain ratings were similar when recipient and administrator were of the same sex, but that more pain was reported by women when administered by males, and conversely, less pain reported by men when administered by females (Levine and De Simone, 1991). It is possible that these results arose because of their experimenters' exaggeration of gender stereotypes. In the present study the male and female administrators were fellow participants, and they were not given any instruction concerning the gender stereotyping of their dress or behaviour. The other study (Kallai et al., 2004) found that when the gender of the recipient was opposite to that of the administrator, there was an increase in pain tolerance. This contradicted the Levine and De Simone study with respect to the women participants, but was in partial agreement with the present study in finding that there was a main effect of administrator gender ($P < .05$) such that participants reported more pain when it was administered by a female. Various explanations for the differences between the studies may include: the nature of the pain stimuli (thermal, mechanical) used, the temporal flux of gender roles over the last 15 years or so, and cultural differences (European versus North American).

The finding that women were generally more sensitive and least tolerant to pain replicates closely reliability tests of the pressure algometer, albeit on different parts of the body (Merskey and Spear, 1964). The gender difference was also consistent with that seen in other studies using mechanically (Woodrow et al., 1972; Ellermeier and Westphal, 1995) and thermally (Feine et al., 1991; Keogh et al., 2005) produced pain. That a gender difference occurs for involuntary pupil reactions to the administration of mechanically produced pain (Ellermeier and Westphal, 1995) also suggests that the difference is related to the physiology of sensory pain transmission, rather than to attitudinal or emotional factors, or response bias.

Returning to the main finding, anecdotal and empirical evidence suggests that greater control by the patient reduces the anxiety and pain associated with hospital treatment, a fact that is appreciated by some hospital staff. For example, some clinicians when examining an anxious child hold the child's hand and use it together with their own to contact the area to be examined (e.g., the abdomen). There is already widespread use of patient-controlled analgesia producing a number of benefits (Lindley, 1994), such as reduced drug dosage, a more consistent level of analgesia, a saving of nursing time, earlier discharge from hospital and positive approval by patients. Of particular relevance to our results is one study where women were given control over the compression portion of a mammography examination (Kornguth et al., 1993). This resulted in a less painful experience and greater patient satisfaction. Moreover, the radiographic images so produced were as good as those obtained through technologist-controlled compression. Since patients identified the fear of pain as one of the barriers to regular screening (Stein et al., 1991), an important possible benefit of reduced pain would be improved compliance in mammography screening.

We specifically used normal healthy participants in this study to allow for the widest possible generalization of the results to diverse clinical situations. In fact, many painful clinical procedures are performed on normal healthy persons, e.g., screening mammography and finger lancet prior to blood donation. The results seem immediately applicable to acute rather than chronic pain, although further research is needed.

In conclusion, the results of the present study show that, in healthy young adult volunteers, pain applied to themselves produced an elevation in pain detection thresholds and tolerance, relative to pain applied by other people. Were this replicated in a clinical setting, it may have relevance to clinical procedures which produce pain (e.g., self-compression for mammography, self-removal of wound dressings), and would suggest that these procedures be adapted for patient control.

Acknowledgements

We are grateful to Dr. Karel Gijsbers of the University of Stirling, Dr. Solomon Senok of the Arabian Gulf University and Dr. V.M. Ramyil of the University of Jos for useful discussions. This research was funded by the University of Stirling.

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