Original Experimental

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"Big girls don't cry": the effect of the experimenter's sex and pain catastrophising on pain

https://doi.org/10.1515/sjpain-2020-0157
Received October 8, 2020; accepted January 12, 2021;
published online February 10, 2021

Abstract

Objectives: The expression of pain in males and females involves complex socio-psychological mechanisms. Males may report lower pain to a female experimenter to appear strong, whereas females may report higher pain to a male experimenter to appear weak and to seek protection. However, evidence to support these stereotypes is inconclusive. Individuals who catastrophise about pain rate higher pain than those who do not. How pain catastrophising interacts with the effect of the experimenter's sex on pain reports is yet to be explored. Thus, the aim of this study was to determine whether pain catastrophising moderated the effect of the experimenter's sex on pain reports in healthy males and females.

Methods: Participants (n=60, 30 males) were assigned to one of four experimental conditions: males tested by male experimenters, males tested by female experimenters, females tested by male experimenters, and females tested by female experimenters. Participants completed the Pain Catastrophising Scale, and then sensitivity to heat and to blunt (pressure-pain threshold) and sharp stimuli was assessed on both forearms, and to high frequency electrical stimulation (HFS) administered to one forearm.

Results: Females reported lower pressure-pain thresholds than males irrespective of the experimenters' sex. Females reported lower sharpness ratings to male than female experimenters only when the test stimuli were moderately or intensely sharp. Higher pain catastrophising scores were associated with higher sharpness ratings in females but not males. Additionally, higher pain catastrophising scores were associated with greater temporal summation of pain to HFS, and with lower pressure-pain thresholds in females who were tested by male experimenters.

Conclusions: These findings indicate that the experimenters' sex and the participant's pain catastrophising score influence pain reports, particularly in females. Awareness of these psychosocial factors is important in order to interpret pain responses in a meaningful way, especially when females are tested by male experimenters. A greater awareness of sex/gender role biases and their potential interaction with pain catastrophising may help researchers and clinicians to interpret pain reports in meaningful ways. In turn, this may help to improve delivery of treatments for patients with chronic pain.

Keywords: experimenter sex; high frequency electrical stimulation; pain catastrophising; pain sensitivity; social modulation of pain; temporal summation.

Introduction

The sex of the experimenter may influence how individuals report pain. In several studies, males tolerated pain longer and reported lower pain intensity to a female experimenter than to a male experimenter [1–4]. Encouragement of stoicism as part of the stereotypical male role in Western Society may contribute to this effect, as males typically want to appear strong in the presence of a female by demonstrating the capacity to withstand pain [2, 3, 5]. If stereotypes of traditional gender roles are true, then one would expect that females would report more pain to a male than female experimenter, ostensibly to appear helpless and to seek protection or attention [3]. Interestingly, however, females tolerated pain longer when tested by a male than female experimenter [4]. In other studies, participants, irrespective of their sex, reported higher pain intensity when tested by an experimenter of the opposite sex [6].

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A limitation of most studies that have examined the effects of experimenter sex on pain is that sensitivity primarily to heat or cold pain was assessed [7]. The International Association for the Study of Pain recommends the use of various stimulus modalities and intensities, as this is more likely to reveal sex/gender differences in pain responses than single modalities or intensities [8]. Thus, in the present study, we assessed pain responses to a wide range of stimulus modalities. These included heat, pressure-pain, pain and sharpness sensitivity to mechanical and electrical stimuli, and unpleasantness to high frequency electrical stimulation. High frequency electrical stimulation was chosen for its intense and unpleasant effect [9–14].

A psychological attribute that has helped to explain sex differences in pain perception is pain catastrophising [15, 16]. Females catastrophise more about pain, and have a lower pain tolerance and higher pain sensitivity than males [15–17]. Nevertheless, whether pain catastrophising influences the effect of the experimenter's sex on pain reports is yet to be explored. Therefore, we wanted to determine whether pain catastrophising would moderate the effect of the experimenter's sex on pain responses. Specifically, we hypothesised that pain catastrophising would moderate the effect of the sex of the experimenter in female but not male participants due to heightened pain catastrophising in females.

To recap, the literature review thus far suggests an involvement of complex socio-psychological mechanisms underlying the expression of pain. In particular, sex/gender roles could interact with pain catastrophising to moderate pain reports. This warrants further investigation, as a clearer understanding of how males and females report pain could be important for quantifying and treating chronic pain.

Methods

Participants

The sample consisted of 30 male and 30 female healthy and pain-free university students and volunteers from the general population, who were recruited through the Participant Research Portal at Murdoch University, campus advertisements, and snowball sampling. Participants were Caucasians (n=48), Asians (n=8) and Africans (n=4) aged between 18 and 50 years (M=24, SD=7.74). Participants were excluded if they suffered from any chronic pain condition, or if they were taking medication for pain. Other exclusion criteria included pregnancy, breastfeeding, and suffering from any other chronic medical or psychiatric condition. Participants gave informed consent for the procedures, which were approved by Murdoch University's Human Research Ethics Committee.

Materials and apparatus

The pain catastrophising scale (PCS; [16]): The PCS is a 13-item scale that measures negative thoughts and feelings about pain. It assesses three related dimensions: rumination, magnification, and helplessness associated with pain [16]. Participants were asked to reflect on their past painful situations, and to rate the extent to which they experienced each of 13 thoughts or feelings when experiencing pain, on 5-point scales ranging between (0) not at all and (4) all the time. PCS yields high internal consistency of 0.87 [16].

Psychophysical tests

Participants reported pain and sharpness intensity using a verbal rating scale ranging from 0 to 10. For pain, 0 indicated "no pain" and 10 indicated "extreme pain". For sharpness intensity, 0 implied "not sharp" and 10 implied "extremely sharp". To assess heat sensitivity, a 1.5 cm diameter metal probe heated to 44 ± 0.2 °C was placed on the skin for 7 s. To investigate sensitivity to mild sharpness, a 10 g von Frey monofilament (Neuropen, Owen Mumford, Woodstock, Oxfordshire, UK) was applied at a 90° angle to the skin surface with sufficient force to bend the filament for 1 s. To assess sensitivity to more intense sharpness, a sharp tip with a calibrated spring mechanism exerting a force of 40 g (Neuropen, Owen Mumford) was applied for 2 s. Stimuli were applied in runs alternating between sites on the ventral forearms. To measure pressure-pain sensitivity, an algometer (FDX, Wagner Instruments, Greenwich, CT, USA) with a modified 8 mm diameter hemispheric rubber tip was applied at each forearm site at 100 g/s until the participant reported pain. Participants were trained until pain ratings and pressure-pain thresholds stabilized. During training, the psychophysical stimuli were administered in the wrist area. To minimise sensitivity at the test area due to repeated testing, the psychophysical tests were administered at the test area once only.

High frequency electrical stimulation (HFS)

One ventral forearm area was assigned as the test site (Figure 1). The laterality of the test arm was counterbalanced across participants. The electrical detection threshold (EDT) was determined at the test site using the method of limits for two ascending and two descending sets of single pulses at 2 ms pulse width. The stimulus intensity, starting at 0.1 mA, increased in steps of 0.1 mA until the participant perceived the stimulus, and then decreased in steps of 0.05 mA until the stimulus was no longer perceived. This procedure was then repeated. The EDT was defined as the geometric mean of the four stimulus intensity levels. After 5 min rest, HFS conditioning was applied at the test site. This consisted of five 1-s bursts of electrical stimulation (100 Hz, 2 ms pulse width, at 10 times EDT up to a maximum of 8 mA) with a 9-s rest between bursts [9–12, 14, 18]. Participants provided pain, sharpness, and unpleasantness ratings after each HFS burst.

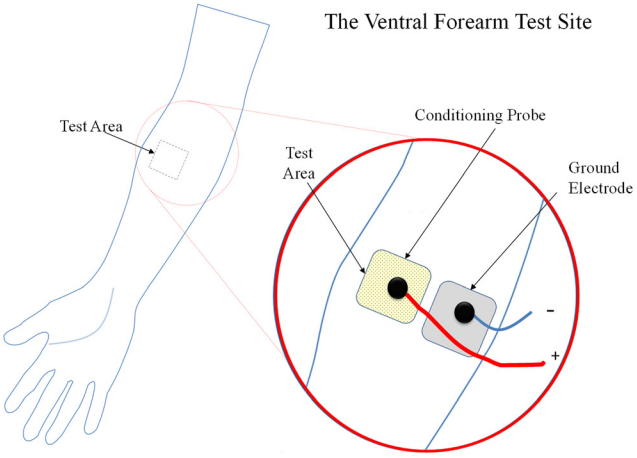

Figure 1: Adapted from Vo and Drummond (2013). Sensitivity to von Frey's monofilament, pinprick and pressure-pain was assessed at the test area in the ventral forearm and at a mirror-image site in the contralateral forearm. High frequency electrical stimulation was also administered at the test area.

Procedure

Participants were tested individually in a laboratory maintained at around 21 °C. Upon arrival, participants were informed that the purpose of the experiment was to explore human pain mechanisms. Participants sat in a comfortable armchair throughout. The testing procedure is illustrated in Figure 2. First, participants completed the Pain Catastrophising Scale [16] and then were allocated randomly to being tested by male or female experimenters. Six research students (four females) aged 22 or 23 years collected data for the study. Two experimenters of the same sex were involved in each test session.

To minimise skin electrical resistance to subsequent electrical stimulation, the ventral forearm areas were cleaned with pumice stone, rinsed with water and dried. Psychophysical tests were carried out at the cleaned sites, followed by the high frequency electrical stimulation procedure.

Data reduction and statistical analyses

The effect of the experimenter sex on pain indices: The effect of experimenter sex (male, female) and participant sex (male, female) on each psychophysical measure, and pain, sharpness, and unpleasantness ratings to HFS was assessed in univariate analyses of variance. The mean value of each psychophysical measure was the average of the measures taken across both forearms before HFS.

The association between PCS and pain indices: A univariate analysis of variance was used to assess the effect of experimenter sex (male, female) and participant sex (male, female) on PCS scores. Pearson's correlation was also used to assess the association between PCS scores and each of the pain indices.

Predictors of pain reports: To determine if PCS scores moderated the effect of the sex of the experimenter on pain reports, stepwise regression analyses were performed on bootstrapped samples of n=1,000 separately for female and male participants on any psychophysical test that yielded significant interactions between the sex of the experimenter and the sex of the participant. PCS scores were centred before creating interaction terms to minimise possible multicollinearity. In Model 1, we wanted to determine if the main effects of the sex of the experimenters and the Pain Catastrophising Score individually predicted the pain reports. In addition to these main effects, we also wanted to determine if the interaction between the sex of the experimenters and Pain Catastrophising Score further explained the pain reports (Model 2).

Temporal summation: Repeated-measures analyses of variance were used to assess changes in pain and sharpness ratings over the five HFS bursts. Pearson's correlation was also used to investigate the relationship between temporal summation for pain and sharpness ratings to HFS and the PCS score. The temporal summation values were derived by subtracting pain and sharpness ratings to the first HFS burst from that to the final HFS burst (burst 5).

Statistical Package for the Social Sciences (SPSS) Version 21 was used to run all statistical analyses with an alpha level of 0.05.

Results

During the preliminary training, two male participants, one being tested by male experimenters, achieved stabilised pain ratings to von Frey's monofilament after three applications. The remaining participants reported stabilised

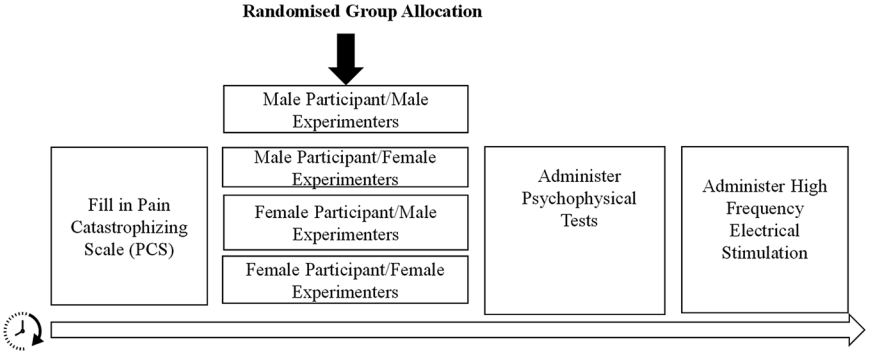

Figure 2: Schematic diagram of the testing procedure.

pain ratings and pressure-pain thresholds after two applications of each stimulus.

The effect of experimenter sex on pain indices

Pressure-pain threshold (PPT)

Females (M=1.67, SD=0.67 kg, 95% CI [1.43–1.91]) had lower PPT than male participants (M=2.18, SD=1.11 kg, 95% CI [1.78–2.58]) (main effect of participant sex (F (1, 56) =4.50, p=0.038, partial η^2=0.074, 95% CI [0–0.22]) irrespective of the experimenter's sex.

Electrical detection threshold (EDT)

Females had a lower EDT than male participants (mean difference=–0.17 ± 0.049 mA, 95% CI [–0.27 to –0.07]) (main effect of Participant Sex, F (1, 56)=11.31, p<0.01, partial η^2=0.168, 95% CI [0.03–0.34]) irrespective of the experimenter's sex.

Heat rating

Neither the experimenter's nor the participant's sex influenced heat ratings (all effects were not significant).

Sharpness rating to von Frey's monofilament

Neither the experimenters' nor the participant's sex influenced sharpness ratings to von Frey's monofilament (all effects were not significant).

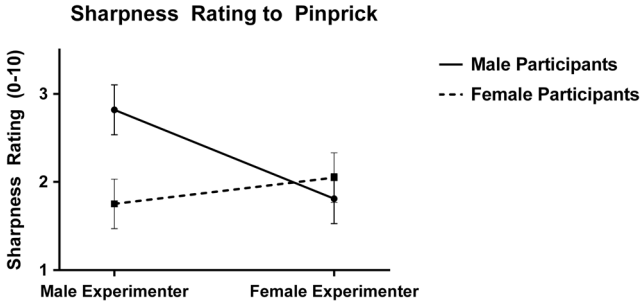

Figure 3: Mean sharpness rating ± S.E. to pinprick. Male participants reported lower sharpness ratings to pinprick to female experimenters than to male experimenters (p=0.014). To male experimenters, female participants reported lower sharpness than male participants to pinprick (p=0.024).

Sharpness rating to pinprick

There was a significant interaction between the experimenter sex and participant sex (F (1, 56)=4.85, p=0.032, partial η^2=0.080, 95% CI [0–0.23]) for sharpness to pinprick (Figure 3). Pairwise comparisons indicated that male participants reported lower sharpness to pinprick when tested by female experimenters rather than male experimenters (Mean Difference=–1.07 ± 0.39, 95% CI [–1.85 to –0.29], p=0.010). Additionally, female participants reported lower sharpness to pinprick than male participants when tested by male experimenters (Mean Difference=–0.98 ± 0.38, 95% CI [–1.74 to –0.22], p=0.014).

Sharpness and unpleasantness ratings to HFS

Neither the experimenters' nor the participant's sex influenced HFS pain intensity ratings (all effects were not significant). However, the interaction between Experimenter Sex and Participant Sex approached statistical significance for sharpness (F (1, 53)=3.42, p=0.069, partial η^2=0.060, 95% CI [0–0.21]) and was significant for unpleasantness ratings (F (1, 53)=5.32, p=0.025, partial η^2=0.090, 95% CI [0–0.25]). Pairwise comparisons showed that females rated both sharpness (Mean Difference=–1.75 ± 0.76, 95% CI [–3.27 to –0.23], p=0.009) and unpleasantness (Mean Difference=–1.97 ± 0.74, 95% CI [–3.45 to –0.49], p=0.014) to HFS lower to male than female experimenters. Additionally, male participants rated HFS unpleasantness lower to female experimenters than did female participants (Mean Difference=–1.96 ± 0.78, 95% CI [–3.52 to –0.40], p=0.016,) (Figure 4A and B).

Pain catastrophising score and its correlation with pain indices

Neither the experimenters' nor the participant's sex influenced PCS scores (Mean (males tested by male experimenters)=13.80, SD=7.27, 95% CI [9.70–17.06], Mean (males tested by female experimenters)=12.47, SD=8.46, 95% CI [8.19–16.75], Mean (females tested by male experimenters)=15.93, SD=7.50, 95% CI [12.13–19.73], Mean (females tested by female experimenters)=14.67, SD=11.19, 95% CI [9.01–20.33]) (all effects were not significant). The PCS score was not associated with any psychophysical measure in any condition involving male participants (Table 1). However, PCS scores were positively and

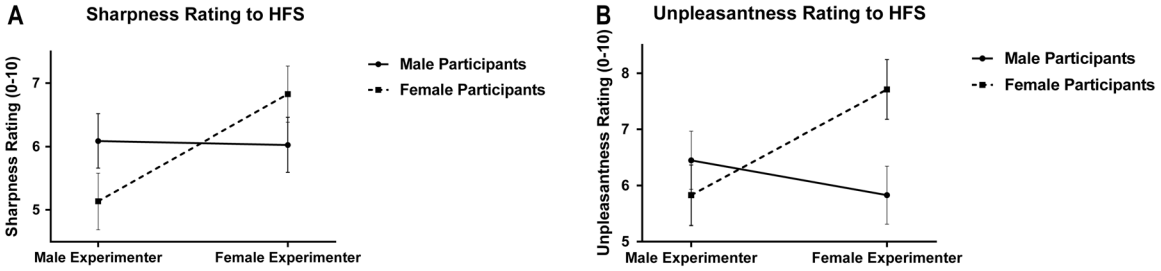

Figure 4: (A) Mean sharpness ratings ± S.E. to HFS. Females reported lower sharpness ratings to male experimenters than to female experimenters (p=0.009). (B) Mean unpleasantness ratings ± S.E. to HFS. Females reported lower unpleasantness ratings to male experimenters than female experimenters (p=0.014). To female experimenters, male participants reported lower unpleasantness ratings than female participants (p=0.016).

Table 1: Correlations between the pain catastrophising score and psychophysical measures, and pain, sharpness, and unpleasantness ratings to HFS in each of the experimenter sex (male, female) by participant sex (male, female) conditions with 95% confidence intervals.

	Male experimenters testing		Female experimenters testing	
Pain measure	**Male participants**	**Female participants**	**Male participants**	**Female participants**
EDT	0.14 [−0.40 to 0.61]	−0.02 [−0.53, 0.50]	−0.22 [−0.66, 0.33]	0.09 [−0.44, 0.58]
PPT	−0.21 [−0.65 to 0.34]	−0.56* [−0.83, −0.07]	−0.30 [−0.70, 0.25]	0.06 [−0.47, 0.56]
Heat sensitivity	0.29 [−0.26 to 0.70]	0.43 [−0.11 to 0.77]	0.17 [−0.37 to 0.63]	−0.16 [−0.62 to 0.38]
Sharpness to monofilament	0.35 [−0.20 to 0.73]	0.50* [−0.02 to 0.81]	0.21 [−0.34 to 0.65]	0.55* [0.05 to 0.83]
Sharpness to pinprick	−0.10 [−0.58 to 0.43]	0.57* [0.08 to 0.84]	−0.04 [−0.54 to 0.48]	0.63* [0.17 to 0.86]
HFS sharpness	0.40 [−0.14 to 0.76]	0.50* [−0.02 to 0.81]	−0.03 [−0.53 to 0.49]	0.61* [0.14 to 0.86]
HFS pain	0.30 [−0.25 to 0.70]	0.60* [0.13 to 0.85]	0.19 [−0.36 to 0.64]	0.70** [0.29 to 0.89]
HFS unpleasantness	0.34 [−0.21 to 0.73]	0.53* [0.02 to 0.82]	−0.10 [−0.58 to 0.43]	0.48 [−0.04 to 0.80]
Temporal summation of HFS pain	0.08 [−0.45 to 0.43]	0.54* [0.04 to 0.82]	0.09 [−0.44 to 0.58]	−0.08 [−0.57 to 0.45]
Temporal summation of HFS sharpness	−0.11 [−0.59 to 0.43]	0.33 [−0.22 to 0.72]	−0.28 [−0.69 to 0.27]	−0.09 [−0.58 to 0.44]

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).

moderately correlated with various measures in female participants, predominantly sharpness perception. A moderate and negative association between the PCS score and pressure-pain threshold was detected only in females who were tested by male experimenters (Table 1).

Predictors of pain reports

Significant interactions between the sex of the experimenter and the sex of the participant were identified for sharpness ratings to pinprick, and sharpness and unpleasantness ratings to HFS. To determine possible predictors for these pain measures, bootstrapped regression analyses were performed separately for males and females. The Maximum Mahalanobis Distances were between 9.8 and 10.5, which did not exceed the critical Chi-squared value (χ^2) for df=3 (number of predictor variables) (at α=0.001) of 16.27, indicating that multivariate outliers were not of concern. Tolerance levels were between 0.32 and 0.99, and the variance inflation factors were between 1.20 and 3.31 for all predictor variables, indicating that multicollinearity was not present in the regression analyses and thus would not interfere with our ability to interpret the outcome of the regression analyses.

As shown in Table 2, in females, the PCS score and the experimenters' sex were significant predictors of sharpness ratings to pinprick (Model 1: F (2, 26)=8.45, p=0.001, Model 2: F (2, 26)=5.58, p=0.005), and sharpness (Model 1: F (2, 26)=8.93, p=0.001, Model 2: F (2, 26)=5.77, p=0.004) and unpleasantness ratings to HFS (Model 1: F (2, 26)=6.83, p=0.004; Model 2: F (2, 26)=5.00, p=0.008). The Cohen's f^2 values ranged from 0.52 to 0.69, indicating that the combined magnitude of the effect observed in both models was "large". However, in males, the PCS score and the experimenters' sex accounted for a significant proportion of sharpness ratings to pinprick only (Model 1: F (2, 27)=3.70, p=0.038; Model 2: F (2, 27)=2.38, p=0.093). The Cohen's f^2 value of 0.28 suggests a 'medium' effect size in males. The interaction between the experimenters' sex and the PCS score was not a significant predictor for any of these pain indices in either males or females. Full results of the stepwise regression models are shown in Appendix A.

Table 2: Unstandardised (*B*) with bias-corrected and accelerated (BCa) 95% confidence interval (CI), bias, standard errors (S.E.), standardised (β) regression coefficients, R, R^2, standard error (S.E.), and squared semi-partial correlations (sr^2) for each predictor in bootstrapped regression models predicting sharpness ratings to pinprick, and sharpness and unpleasantness rating to HFS.

Predictor variables									
	***B* (95% BCa CI)**	**Bias**	**S.E.**	**β**	**R**	**R^2**	**Adjusted R^2**	**sr^2**	**p-Value**
Dependent variable: sharpness rating to pinprick									
Male participants									
Model 1					0.46	0.22	0.16		
Gender of the experimenter	−0.11 (−1.83 to −0.38)	0.00	0.41	−0.47				0.215	0.017
Model 2					0.46	0.22	0.13		
Gender of the experimenter	−1.08 (−1.85 to 0.40)	−0.05	0.42	−0.47				0.215	0.024
Female participants									
Model 1					0.62	0.39	0.34		
PCS	−0.08 (−0.13 to −0.03)	0.00	0.02	−0.61				0.37	0.002
Model 2					0.62	0.39	0.32		
PCS	−0.07 (−0.14 to 0.01)	0.00	0.04	−0.57				0.096	0.019
Dependent variable: Sharpness Rating to HFS									
Female participants									
Model 1					0.64	0.41	0.36		
PCS	−0.11 (−0.18 to −0.05)	0.00	−0.03	−0.52				0.260	0.007
Gender of the experimenter	1.75 (0.40–2.84)	−0.04	0.63	0.44				0.194	0.014
Model 2					0.64	0.41	0.34		
PCS	−0.13 (−0.25 to −0.02)	0.00	0.06	−0.58				0.109	0.049
Gender of the experimenter	1.75 (0.40–2.84)	−0.04	0.65	0.44				0.194	0.019
Dependent variable: Unpleasantness Rating to HFS									
Female participants									
Model 1					0.59	0.34	0.29		
Gender of the experimenter	1.84 (0.35–3.31)	0.04	0.69					0.184	0.018
Model 2					0.61	0.38	0.30		
Gender of the experimenter	1.84 (0.42–3.17)	0.00	0.68					0.184	0.027

Column Headings for nine Predictor variables.

Table 3: Mean, SD, and 95% confidence intervals for pain and sharpness ratings to HFS bursts.

HFS burst	Pain	SD	95% CI	Sharpness	SD	95% CI
1	4.50	1.88	[4.29–4.71]	5.33	2.10	[5.13–5.53]
2	5.09	1.97	[4.89–5.29]	5.84	2.06	[5.64–6.04]
3	5.59	1.97	[5.39–5.79]	6.26	1.94	[6.05–6.47]
4	5.86	2.00	[5.66–6.06]	6.38	2.11	[6.18–6.58]
5	5.95	2.05	[5.75–6.15]	6.71	2.03	[6.51–6.91]

Temporal summation

Pain and sharpness ratings after each successive burst of HFS were significantly higher compared to the first burst (all p's<0.01, partial η^2 values range from 0.31 to 0.61), indicating temporal summation of pain and sharpness (Table 3). Pearson's correlation revealed a moderate and positive association between temporal summation of HFS pain ratings and PCS scores only in females who were tested by male experimenters (Table 1).

Discussion

The key findings of this study were (1): that females reported lower sharpness ratings to male than female experimenters only when the test stimuli were moderately or intensely sharp; (2) higher pain catastrophising scores were associated with higher sharpness ratings in females, but not in males; and (3) greater temporal summation of pain to HFS and lower pressure-pain thresholds were associated with higher pain catastrophising scores in females who were tested by male experimenters. Together, these findings suggest that the sex of the experimenter and pain catastrophising influenced pain reports primarily in females.

Pressure-pain and electrical detection thresholds

Consistent with past literature, our results showed that females had lower pressure-pain and electrical detection

thresholds than males [19–23]. This sex difference might have masked an experimenter sex effect on these measures. Evidence of an influence of experimenter sex effects on pressure-pain thresholds is sparse and inconclusive. For example, Otto and Dougher [24] reported no sex difference on pressure-pain thresholds. In contrast, Gijsbers and Nicholson [25] demonstrated that men reported higher pressure-pain thresholds to a female than male investigator. However, in Gijsbers and Nicholson's [25] study both male and female investigators dressed in a manner that emphasised their sex stereotype whereas we did not follow this dress convention in our study. Pressure applied at a faster rate yields a higher PPT because of the extent of the overshoot before participants are able to report pain [26–29]. PPT may also depend on the topography of the tested area (e.g., flat, broad and bony vs. soft tissue surface) [28]. When assessing pressure-pain thresholds, Gijsbers and Nicholson [25] applied pressure at 1 kg/s to the sternum compared with 0.1 kg/s to the forearm in our study. Despite training, male and female experimenters may apply pressure at different rates. Instrumental differences (manual vs. digital algometer) may also influence PPTs. These methodological differences might explain differences between our findings and Gijsbers and Nicholson [25], and other studies.

Heat sensitivity

Literature on the experimenter sex effect on heat sensitivity is inconclusive. Bush et al. [30] reported that participants reported lower heat pain to an experimenter of the opposite sex, while Aslaksen et al. [2] showed that men rated heat pain lower only when tested by a female experimenter. In other studies, participants, irrespective of sex, reported lower heat pain when tested by a female experimenter [31]. Notably, most studies did not detect any sex difference or experimenter sex effect on heat perception [32]. Different types of heat stimuli, temperature settings and stimulus duration might have contributed to these divergent findings. For example, Aslaksen et al. [2] applied 15 heat stimuli with the temperature above 48 °C up to 12 s, while we applied a single, mild heat (44 °C) stimulus for 7 s.

Sharpness and unpleasantness ratings

The experimenters' sex did not influence sharpness ratings to weak stimulation with von Frey's monofilament. However, we detected significant interactions between the experimenters' and participant's sex for moderately sharp stimuli (pinprick) and intense sharpness elicited by HFS. Together, our findings suggest that both males and females reported lower sharpness and unpleasantness to experimenters of the opposite sex, when the test stimuli were moderately or intensely sharp.

The relationship between pain catastrophising and the effect of experimenter sex on pain

Females generally report higher pain catastrophising than males [16]. However, in this study, pain catastrophising scores did not differ between males and females. Interestingly, the total PCS score in our female student population (N=30, M=15.30, SD=9.39) was lower than in a significantly larger female student population in Sullivan, Bishop and Pivik's study [33] (N=302, M=19.5, SD=8.50). Whether females with chronic pain were excluded from Sullivan, Bishop, and Pivik's study is unknown. The difference in the PCS score suggests that our female sample catastrophised less about pain than the general female population. Even so, pain catastrophising scores were associated with higher sharpness ratings to von Frey's monofilament, to pinprick and to HFS in females but not males. Together, these findings suggest that females have a heightened attentional bias towards sharp stimuli, particularly electrically-evoked pain. This is supported by females reporting lower electrical detection thresholds in our investigation and in past studies [21, 22].

Interestingly, higher pain catastrophising scores were associated with greater temporal summation of HFS pain and lower pressure-pain thresholds only when females were tested by male experimenters. Literature on the effect of pain catastrophising on temporal summation is sparse. However, being female and being anxious together predicted temporal summation of heat pain [34, 35]. Importantly, higher pain-related catastrophising was associated with greater temporal summation of heat pain in females who were tested by a male experimenter [36], thus resembling the present findings.

We hypothesised that pain catastrophising would moderate the experimenter sex effect in females. However, this hypothesis was not supported as the interaction between the experimenters' sex and pain catastrophising did not predict sharpness or unpleasantness to HFS in females. To our knowledge, the influence of pain catastrophising on the experimenter sex effect on pain reports has not been examined before. Aslaksen et al. [2] reported

that stress significantly predicted heat pain but did not moderate the experimenter sex effect in males, who reported lower heat pain to a female than male experimenter. Our findings suggest that experimenter sex effects masked an effect of pain catastrophising on moderate and intense sharpness and unpleasantness ratings in our female sample.

Gender role expectation of pain

Lower pain reported by males to female experimenters in our study aligns with past literature, which demonstrates that males tolerate pain longer and report lower pain sensitivity to different stimulus modalities when tested by a female experimenter [1–4]. This conforms to the pain behaviour expected of a typical male in Western culture, who presumably under-reports pain to impress females by his capacity to withstand pain [3].

However, patterns of pain reporting in females are less predictable. On one hand, Tashani et al. (6) observed that females reported higher pain to a cold pressor task when tested by a male experimenter, and Bush et al. [30] noted that individuals rated higher heat pain when tested by an experimenter of the opposite sex. In contrast, Kallai et al. [4] reported a higher pain tolerance to a cold pressor task in females when tested by a male experimenter, which aligns with lower pain reports in females when tested by male experimenters in our study. This pattern of pain reports opposes the stereotype of high pain sensitivity associated with traditional female norms [3]. Possibly, young females no longer perceive themselves as the 'weaker sex' but equal to males who are of similar age and status. Like males, our females might have under-reported pain in the presence of the opposite sex to avoid appearing weak despite catastrophising about pain.

Importantly, only moderate and intensely sharp stimuli yielded these experimenter sex/gender effects, suggesting that a floor effect limited ratings to weak stimuli. Alternatively, embarrassment might have inhibited vocalising or overt acknowledgement of a high level of pain to someone of the opposite sex as it is inconsistent with the self-perceived gender role and stereotypical views on pain. Indeed, both males and females endorse gender stereotypical views on pain, which affect their pain responses [7, 37–39]. For example, both males and females believed that a typical man should tolerate more pain than a typical woman [40], but only males who identified themselves with male gender norms demonstrated a higher electrical tolerance. One's expectation of oneself as being less sensitive to pain compared to the opposite sex was associated with higher heat pain thresholds [38]. Additionally, individuals with higher self-evaluated masculinity demonstrated higher pain thresholds and tolerances to cold, pressure and electrical stimulation compared to those with higher femininity scores [7, 41]. Further examination of the influence of individual psychosocial factors on pain reports, specifically gender role expectations of pain, may help to further clarify the mechanisms that modulate the experimenter sex/gender effects observed in this study.

Methodological considerations and conclusion

Female and male experimenters might have exerted different force when administering the psychophysical stimuli. However, we anticipated minimal variation as all experimenters were trained by one researcher (LV); in addition, inter-rater reliability was established for pain ratings and PPT. Repeated testing may also enhance sensitivity; however, we minimised this by administering each stimulus only once at the test site.

We did not control for sex and individual differences that might affect pain responses (e.g., age, mood, attention, distraction, expectancy, coping behaviours, self-efficacy, past chronic pain history, familiarity and experience with similar pain studies, physical or hormonal factors such as blood pressure, body fat, female reproductive stage, or menstrual cycle) [8]. Experimenter characteristics (e.g., friendliness, attractiveness, and professional status) may influence social interactions with participants and consequently their pain reports, as might cultural awareness, mutual attraction, likeableness and familiarity [8]. Verbal (e.g., warm/cold tone of voice) and non-verbal cues (e.g., eye contact, nodding, smiling, interpersonal distance) may also alter expectancy about pain and thus influence pain reports [42].

Our experimenters were not blinded to participants' pain ratings; in addition, self-reported pain may be a potential confound. Our sample was small and consisted mostly of young and healthy Caucasian males and females. Thus, our findings may not generalise to older populations or different ethnicities. In spite of these limitations, both males and females reported lower sharpness and unpleasantness when tested by experimenters of the opposite sex, although the effect was stronger in females. Importantly, this effect was only detected for stimulus modalities that evoked moderate to intense sharpness, and unpleasantness. The links between pain catastrophising scores and various sharpness ratings and unpleasantness in females, and the lack thereof in males, support

existing literature that pain catastrophising influences how females report pain. Despite this, females appeared to under-report their pain responses when the experimenters were males, indicating that gender role biases may sometimes overshadow catastrophic attitudes about pain.

An influence of gender role biases on pain has also been noted in clinical settings. For example, both male and female patients reported higher pain to a female clinician [43]. Interestingly, male and female clinicians rated pain of female patients either lower or higher than that of male patients, contingent on whether the cause of pain was or was not obvious [44]. Higher pain catastrophizing is associated with more intense pain and poorer pain-related outcomes in chronic pain [16, 33, 45]. Together with our findings, this suggests that the influence of the clinician's sex on patients' pain catastrophising and on pain-related outcomes warrants further investigation. This is important as a greater awareness of the sex/gender role biases and their potential interaction with pain catastrophising may help researchers and clinicians to interpret pain reports in meaningful ways. In turn, this may help to improve delivery of chronic pain treatments.

Acknowledgments: The authors wish to thank Cameron Bateman, Beth L. Coughlin, Alexander G. Drane, Abby Fredericks, Praise Ojo, Jessica K. Powell and Jamaica Sams for their assistance in collecting data for this study.

Appendix A

Predictor variables									
	B **(95% BCa CI)**	**Bias**	**S.E.**	***β***	**R**	**R^2**	**Adjusted R^2**	**sr^2**	**p-Value**
Dependent variable: Sharpness Rating to Pinprick									
Male participants									
Model 1					0.46	0.22	0.16		
PCS	0.00 (−0.04 to 0.06)	0.00	0.03	0.05				0.003	0.787
Gender of the experimenter	−0.11 (−1.83 to −0.38)	0.00	0.41	−0.47				0.215	0.017
Model 2					0.46	0.22	0.13		
PCS	0.01 (−0.09 to 0.13)	0.00	0.05	0.07				0.003	0.864
Gender of the experimenter	−1.08 (−1.85 to 0.40)	−0.05	0.42	−0.47				0.215	0.024
Gender of the experimenter × PCS	−0.01(−0.12 to 0.10)	0.00	0.06	−0.05				0.003	0.926
Female participants									
Model 1					0.62	0.39	0.34		
PCS	−0.08 (−0.13 to −0.03)	0.00	0.02	−0.61				0.37	0.002
Gender of the experimenter	0.35 (−0.39 to 1.02)	−0.01	0.37	0.14				0.020	0.357
Model 2					0.62	0.39	0.32		
PCS	−0.07 (−0.14 to 0.01)	0.00	0.04	−0.57				0.096	0.019
Gender of the experimenter	0.34 (−0.44 to 1.18)	0.01	0.39	0.14				0.020	0.374
Gender of the experimenter × PCS	0.00 (−0.11 to 0.08)	0.00	0.05	−0.06				0.001	0.822
Dependent variable: Sharpness Rating to HFS									
Male participants									
Model 1					0.21	0.05	−0.03		
PCS	−0.04 (−0.14 to 0.04)	0.00	0.05	1.04				0.002	0.350
Gender of the experimenter	−0.14 (−1.30 to 0.94)	−0.06	0.62	−0.20				0.040	0.822
Model 2					0.29	0.08	−0.03		
PCS	−0.09 (−0.21 to 0.04)	0.00	0.07	−0.45				0.078	0.219
Gender of the experimenter	−0.16 (−1.40 to 0.92)	−0.10	0.65	−0.05				0.003	0.786
Gender of the experimenter ×PCS	0.08 (−0.09, 0.27)	0.00	0.10	0.10				0.036	0.418
Female participants									
Model 1					0.64	0.41	0.36		
PCS	−0.11 (−0.18 to −0.05)	0.00	−0.03	−0.52				0.260	0.007
Gender of the experimenter	1.75 (0.40 to 2.84)	−0.04	0.63	0.44				0.194	0.014
Model 2					0.64	0.41	0.34		
PCS	−0.13 (−0.25 to −0.02)	0.00	0.06	−0.58				0.109	0.049
Gender of the experimenter	1.75 (0.40 to 2.84)	−0.04	0.65	0.44				0.194	0.019
Gender of the experimenter X PCS	0.02 (−0.14 to 0.19)	0.00	0.08	0.07				0.002	0.788

(continued)

Predictor variables									
	B **(95% BCa CI)**	**Bias**	**S.E.**	***β***	**R**	**R^2**	**Adjusted R^2**	**sr^2**	**p-Value**
Dependent variable: Unpleasantness Rating to HFS									
Male participants									
Model 1					0.21	0.05	−0.03		
PCS	−0.02 (−0.12 to 0.10)	0.00	0.06					0.006	0.724
Gender of the experimenter	−0.73 (−2.42 to 0.66)	−0.05	0.79					0.035	0.365
Model 2					0.29	0.08	−0.03		
PCS	−0.07 (−0.20 to 0.06)	0.00	0.07					0.038	0.310
Gender of the experimenter	−0.75 (−2.39 to 0.39)	−0.13	0.83					0.037	0.360
Gender of the experimenter × PCS	0.10 (−0.11 to 0.37)	0.00	0.12					0.038	0.370
Female participants									
Model 1					0.59	0.34	0.29		
PCS	−0.10 (−0.18 to −0.04)	0.00	0.04					0.198	0.066
Gender of the experimenter	1.84 (0.35 to 3.31)	0.04	0.69					0.184	0.018
Model 2					0.61	0.38	0.30		
PCS	−0.16 (−0.33 to −0.03)	0.00	0.09					0.160	0.095
Gender of the experimenter	1.84 (0.42 to 3.17)	0.00	0.68					0.184	0.027
Gender of the experimenter × PCS	0.09 (−0.11 to 0.32)	0.01	0.10					0.030	0.370

Research funding: None declared.

Author contributions: All authors have accepted responsibility for the entire content of this manuscript and approved its submission.

Competing interests: Authors state no conflict of interest.

Informed consent: All participants gave consent to the test procedures in the study.

Ethical approval: The study has been approved by the Murdoch University's Human Research Ethics Committee.

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