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Gender differences in attention to pain body postures in a social context: a novel use of the bodies in the crowd task

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Abstract

Pain signals the presence of potential harm, captures attention, and can inhibit performance on concurrent tasks. What is less well known, however, is whether such attentional capture also occurs in a wider social context, such as when observing people in pain. To explore this possibility, we adopted a novel social-cue detection methodology: the bodies-in-the-crowd task. Two experiments are reported that consider whether nonverbal cues of pain, happiness, and anger as expressed through body postures would capture and hold attention. Both experiments recruited 40 (20 male and 20 female) pain-free individuals. Overall, results show that pain postures do not capture attention any more than happiness or anger postures, but disengagement from pain postures was significantly slower across both studies. Gender differences were also found, and were more likely to be found when crowds comprised both men and women. Male pain postures were more likely to capture attention. However, female observers had faster target detection speed, and were quicker to disengage from distractors. They also showed slower disengagement from female expressions overall. Male observers showed no variation based on target or distractor gender. Implications and potential directions for future research are discussed.

Keywords: Pain, Communication, Body posture, Nonverbal behaviour, Attention

1. Introduction

Pain is the archetypal perceptual defence, warning us of the presence of threat and driving us towards protective response behaviours.[8] Not only does pain interrupt and demand attention,[6,23] but even the anticipation of pain[16,37] draws our attentional focus towards pain-related cues. [38] Although selective attentional biases have typically been examined within individuals in pain, appreciation that pain operates in a social context means that we are starting to consider vigilance towards pain cues in those we interact with. For example, nonverbal signals of pain in others, including facial expressions[5,31,36] and body postures,[2,41] can cue us towards the presence of a potential threat in the environment, as well as be used for promoting caring behaviours. Evidence for this includes studies showing selective attentional capture from facial expressions of pain,[21] and where parents selectively attend to child pain displays.[39]

Pain does not just occur in one-to-one social interactions, but in a group and a crowd, where there is a wider range of competing cues. Although it is assumed that attentional capture from pain cues also occurs in groups, few studies have directly explored this—most investigations into pain are limited to individual expressions, or contrast pain to one other competing expression. However, attention to affective expressions in group contexts has been explored outside of pain.[10] For example, when presented with crowds of faces, it has been shown that fearful and angry expressions pop-out and capture attention, especially in those prone to anxiety. Such an approach has not been used for pain, and is explored here.

Most pain vigilance studies focus on facial expressions. However, faces usually require an observer to be in close physical proximity, and other cues, such as body postures, are easier to detect if viewed from a distance or within a crowd of people. In addition, there is evidence that body expressions are processed earlier than facial expressions in perception, thus potentially superseding facial expressions in recognition.[7] Although few studies have considered this within pain, representations of anger and fear have been shown to engage and hold attention when presented in a field of distractors in body posture.[10,15,22]

The first aim of this study was therefore to examine whether pain body postures engage and hold attention when presented within a crowd of distractor stimuli. To achieve this, we conducted 2 experiments that made use of the bodies in the crowd task.[10] It was predicted that pain postures would engage and hold attention more than neutral postures. A second aim was to explore whether gender plays a role in attentional capture. This is because gender differences have been found for the decoding of, and attention towards, negative expressions including pain.[40,42] Based on findings that threatening expressions displayed by men are more likely to capture attention,[18,27,43] it was predicted that male expressions of pain would be detected more than female expressions when presented in a crowd.

2. Experiment 1

2.1. Methods

2.1.1. Development of static images for crowd task

The Body Emotion and Pain Posture Stimuli (BEAPPS)[41] was used in the current study, which comprises dynamic stimuli presenting body postures that communicate 1 of 7 expression types (pain, anger, fear, disgust, surprise, happiness, and sadness), as well as neutral postures. In the original BEAPPS stimulus set, 2 types of pain stimulus are available—directed, meaning uniform in pose, and undirected, which are more varied. For this study, only directed postures were used as these present a uniform pain posture, meaning similarity was ensured across the stimulus set. The BEAPPS was initially validated across 2 recognition studies, showing consistent recognition rates for expressions of pain and other emotions, and has also been used successfully in other studies, although with dynamic stimuli.[42]

Static stimuli were required to conduct an investigation using the crowd paradigm. This is because the human visual system detects motion over nearly all other stimulus properties,[13,29] and so must be controlled to ensure that attention orientation can be attributed to the expression rather than differences in motion. To this end, the first phase was to create a static version of the BEAPPS. This was achieved by converting all 144 stimuli from the original clips to static images using Microsoft Adobe Premiere Elements. Resolution was kept constant (900 x 900). For each stimulus, the final frame of the video (which represented the peak intensity of the dynamic version of the video) was taken to create a static version.

The new static stimuli were then presented to a group of 10 participants (5 male, mean age 28.3 years, SD 8.55), who were recruited opportunistically from the University of Bath. All had normal or corrected to normal vision, and no previous formal training of diagnosing pain conditions. Participants completed a forced choice discrimination task, designed and implemented using eprime 2.0.[35] Participants were initially presented with a fixation cross (+), followed by a static stimulus which was presented for 2000 ms. This was followed by a forced choice discrimination task in which participants identified which expression was being communicated from a field of 8 options (pain, anger, fear, happiness, sadness, disgust, surprise, and no emotion) using the computer keyboard. This was repeated for 144 trials, split evenly between 2 blocks with a short break in the middle to guard against fatigue. Once the study was completed, participants were debriefed and given the opportunity to ask any questions relating to the study. Participation took 15 to 20 minutes in total.

Recognition accuracy was calculated for each expression, and a 50% recognition accuracy threshold was used to establish whether stimuli could be included in the static postures set, following previous examples.[36,41] All stimuli met these inclusion criteria. Recognition accuracy rates are presented in Table 1. Results showed consistent recognition accuracy rates to those previously observed when validating the stimuli.[42] Although the recognition figures for pain are above 0.70, they are lower than we previously found for the dynamic versions, especially when compared to happiness and sadness. This point is returned to in the discussion.

Emotion	Recognition accuracy (as %)	SD
Directed pain	71.80	1.52
Undirected pain	95.31	2.12
Anger	97.66	1.52
Disgust	57.81	4.96
Fear	86.72	3.41
Happiness	95.53	2.22
Sadness	98.44	1.25
Surprise	69.53	4.62

Table 1. Recognition accuracy results for the validation task of the static versions of the BEAPPS.

2.1.2. Bodies in the crowd task

2.1.2.1. Stimuli

For the bodies in the crowd task, a set of crowd images needed to be created from the static body expression stimulus set. The approach used was based the task described by Gilbert et al.,[10] but adapted to include pain. Briefly, the task concurrently presents 9 images of individuals of the same gender displaying expressions of various types in a 3 x 3 grid. An example, using stimuli of a field of static body postures presented in a 3 x 3 grid, is illustrated in Figure 1. These are referred to as “crowds.”

In the original study, each crowd consisted of 9 different actors. Because we were looking at differences between male and female actors, we were limited by the fact that our stimulus set contained 8 male and 8 female actors. We had a number of options, such as presenting the same actor within the crowd, thus controlling for actor identity. However, given that crowds typically comprise different individuals, we allowed one actor to appear twice within each crowd. The actor repeated was selected at random for each stimulus, and changed identity and location for each crowd. The repeated image was never the target. This repetition was necessary to facilitate a large enough crowd to make target detection appropriately difficult, and to ensure that methodological approach mirrored those used in other studies.[10,34]

Previous studies have used repeated actor identities within crowds and some have used only one actor throughout a crowd.[34,43] Accordingly, the repetition of a single actor was not considered a confounding factor here.

Crowd images were presented at a 900 x 900-pixel resolution, with each image being 250 x 250 megapixels in size. A 40-megapixel gap was present between each stimulus in the grid, with a 35-megapixel gap around the outer edge of the stimulus. Each actor occupied the same screen space and was accordingly presented at equal heights, although the width of each varied depending on the expression presented.

Each crowd could be categorised according to 1 of 2 types: congruent, where all bodies in the crowd presented the same affective state, or incongruent, where one body within the crowd presented a different emotion from the other eight. Thus, 4 types of congruent crowd were created (neutral, pain, happy, and angry), and 12 types of incongruent crowd created: (1) neutral crowds with incongruent happy, angry, or pain target; (2) happy crowds with either neutral, angry, or pain targets; (3) angry crowds with either neutral, pain, or happy targets; (4) pain crowds with either neutral, happy, or angry targets. Each of the 8 available actors were presented as the target within each of the 12 different incongruent types, for both male and female crowds, creating a total of 192 incongruent crowds (12 incongruent crowd types x 8 actors as targets x 2 crowd gender). Target gender and crowd gender always matched. The same number of trials was presented for congruent and incongruent trials (192), resulting in a total of 384 trials.

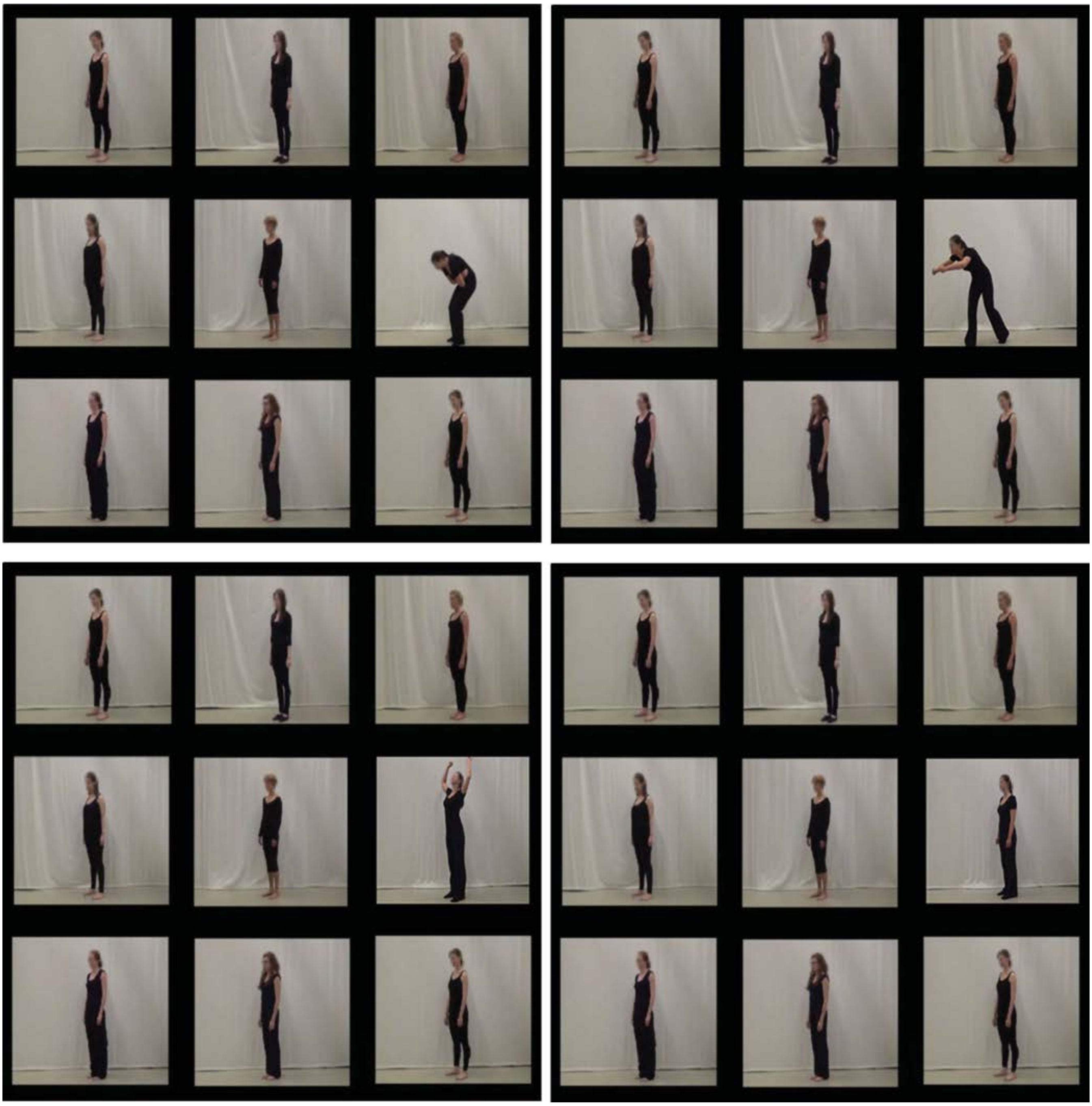

Figure 1. An example of a female neutral crowd with an incongruent pain (top left), anger (top right), and happy (bottom left) body posture target (all targets centre right), alongside a neutral crowd with no target (bottom right).

2.1.2.2. Task

The computer task was controlled using a programme written in eprime 2.0.[35] For each trial, participants were first presented with a fixation cross (+) at the centre of the screen, which was displayed for 500 ms. This fixation cross was then replaced with a crowd stimulus, selected at random. Stimuli remained on the screen until the participant responded. Participants were required to identify whether the display of body postures were all presenting the same expression, or if one body posture was different. Responses were performed using a response box, with participants using their left index finger to indicate a congruent trial (same), and their right index finger for the incongruent trials (different). Once a response had been made, the crowd stimulus was replaced by a black screen for 1000 ms, before the fixation cross was presented again for the next trial. Participants were encouraged to respond as quickly and accurately as possible. Although there was no limit imposed on the time participants had to respond to stimuli, response times longer than 3000 ms were later removed from the analysis. The 384 trials were split evenly between 4 blocks, in between which a short break could be taken.

2.1.3. Participants

Forty participants (20 male and 20 female, mean age 24.74 years, range 19-53) were recruited opportunistically from the University of Bath student and staff population. All provided fully informed consent and were compensated with £5 for their time. All had normal or corrected to normal vision, were free of any current pain, had no history of persistent pain, and had no formal training in pain diagnosis. It should be noted that the required sample size was determined based on previous evidence, and not through a priori power calculation as is now standard in experimental work. At the time of data collection, this was not a widespread practice, but in subsequent work, we recognise the need to calculate sample sizes based on calculations as well as being informed by previous work.

2.1.4. Procedure

Ethical approval was granted by the research ethics committees of the University of Bath's Department for Health and the Department of Psychology. After recruitment and written consent, participants were informed that they would be taking part in a task aimed at examining how good people are at identifying emotional expressions in crowds. No mention of specific affective states was made. They were first presented with written task instructions, and asked to direct any further questions regarding the task to the researcher. Participants were afforded regular breaks throughout testing, which took approximately 30 minutes. Once testing was complete, participants were given a debrief form and offered the opportunity to ask any further questions.

2.1.5. Design and analysis

The independent variables were crowd gender (2 levels, male and female), participant gender (2 levels, male and female), and crowd type (congruent/incongruent; note: levels outlined below). The dependent variable was the time taken to correctly classify the crowd type, and was measured in milliseconds (ms). Following Gilbert et al.[10] analyses examined 2 distinct attentional processes—disengagement from distractor postures, and engagement towards target expression.

Disengagement from distractors refers to the speed with which observers are able to either make the correct judgement that no target is present or detect a target expression in a field of distractors. Accordingly, disengagement was subdivided into 2 separate analyses, depending on the type of crowd.[10] The first analysis explored *disengagement from distractors where crowds are presented with no targets*, that is, is correct identification of a no-target crowd different for all-pain crowds, compared to all-neutral, happy, or angry crowds. For this analysis, we examined the speed with which observers were able to complete a search of the crowd of postures, where there was no target, and correctly conclude that no target was present. Longer response times are again taken to indicate a slower disengagement from each distractor.[10] For *affective crowds with a neutral target expression present*, disengagement was defined as the speed with which participants were able to identify that a neutral target was presented—for example, identifying that a neutral target was presented in a field of distractors presenting pain expressions when compared to crowds containing happy or angry distractors. Longer response times for these stimuli are taken to demonstrate slower disengagement from distractors.

The final analysis examined *engagement*, which is the extent to which attention captures an affective target when presented in a field of neutral distractors. Here, engagement is defined as faster detection of the target posture in a neutral crowd, that is, if a painful target posture is detected more rapidly in a neutral crowd than an angry or happy target in a neutral crowd.

This experiment was not preregistered and sample size was based in previous similar studies, rather than an a priori power analysis as is now standard within the laboratory group.

2.2. Results

2.2.1. Data screening

Incorrect classifications were excluded, as were response times below 200 ms and above 3000 ms (109 responses, representing 0.01% of total number of responses). This was the same procedure as described by Gilbert et al.[10] All variables were examined for normality, and found to be normally distributed (Kolmogorov–Smirnov test $P >. 0.05$). Means for experiment 1 are presented in Table 2.

Crowd expression type	Participant gender	RT to male actors (SD)	RT to female actors (SD)
Pain	Male	2074 (1384)	2035 (1340)
	Female	2057 (1185)	1953 (1141)
Anger	Male	1446 (925)	2013 (1529)
	Female	1559 (777)	1987 (1086)
Happiness	Male	1073 (574)	1516.15 (915)
	Female	1117 (476)	1518.33 (707)
Neutral	Male	1068 (517)	1087.89 (523)
	Female	1160 (549)	1172 (572)

Table 2 Descriptive statistics for male and female actors and participants reaction times (RTs), for stimuli presenting single-expression crowds, with no target present.

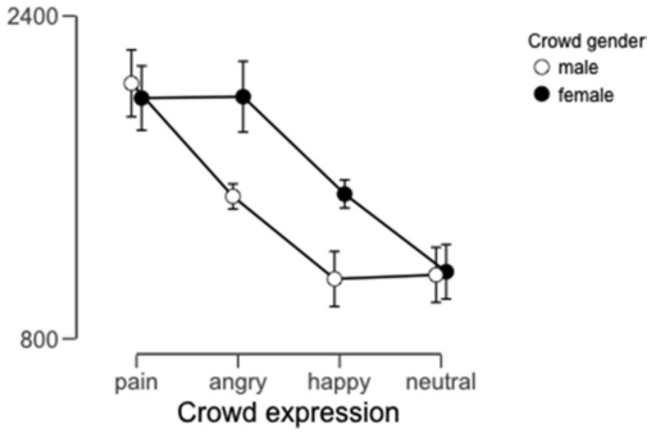

Figure 2. An illustration of the expression x actor sex interaction for no target trials (experiment 1). Error bars represent standard error of mean.

2.2.2. Disengagement from crowds with no target present

Response time data from trials in which no target was presented (all pain, angry happy, or neutral crowds, with no target) were analysed using a 4 (crowd expression type with no target; painful, neutral, angry and happy) x 2 (crowd gender) x 2 (participant gender) mixed-groups analysis of variance (ANOVA). Slower response times indicate longer decisions (for means, see Table 2).

For individual main effects, no significant main effect of participant gender was found ($F(1,40) = 0.10$, $P = 0.92$). However, the main effect of crowd gender was significant (female = 1660 ms; male = 1444 ms; $F(1,40) = 27.12$, $P < 0.001$, $\eta^2 = 0.40$), as was the main effect of crowd expression type ($F = 3120) = 43.32$, $P < 0.001$, $\eta^2 = 0.52$). However, these should be interpreted in light of a significant interaction between crowd expression type x crowd gender ($F(2.16,120) = 23.41$, $P < 0.001$, $\eta^2 = 0.37$; Figure 2). Post hoc Bonferroni corrected (0.05/4 = 0.0125) t-tests were conducted, comparing reaction times for male and female crowds within each crowd expression category. Responses were slower for female crowds compared to male crowds when they displayed happiness ($t(41) = 6.71$, $P < 0.001$, $d = 0.08$) and anger ($t(41) = 5.77$, $P < 0.001$, $d = 0.13$) expressions. No crowd gender difference was found for pain ($t(41) = 1.03$, $P = 0.31$) or neutral ($t(41) = 0.58$, $P = 0.56$) crowds. A second set of analyses were conducted within male and female crowds. Here again, a corrected alpha level of $P < 0.0125$ was used. When viewing female crowds, responses to pain were similar to anger, but slower then when compared to neutral ($t(41) = 6.81$, $P < 0.001$, $d = 0.90$) and happy expressions ($t(41) = 5.81$, $P < 0.001$, $d = 0.46$). When viewing male crowds, responses were slower for painful crowds compared to angry ($t(41) = 6.15$, $P <0.001$, $d = 0.52$), happy ($t(41) = 7.42$, $P <0.001$, $d = 0.91$), and neutral expressions ($t(41) = 7.24$, $P <0.001$, $d = 0.90$). No other significant interactions were found (smallest $F = 0.28$).

2.2.3. Disengagement from affective crowds with a neutral target

The second analysis compared reaction times for trials where a neutral target is present in a crowd of distractors, which comprised either pain, anger, or happy expressions. Again, longer response times are taken to be indicative of slower disengagement from distractors to make a decision as to whether a target was present (for means, see Table 3). Analysis did not use pure neutral crowds as a comparison point because these did not contain a discrepant target; thus, analysis was conducted using a 3 (discrepant neutral posture in a pain, anger or happiness crowd) x 2 (crowd gender) x 2 (participant gender) mixed- groups ANOVA.

A significant main effect of crowd expression type was also found ($F(2,80) = 3.51$, $P = 0.03$, $\eta^2 = 0.08$). Post hoc simple effects tests (corrected alpha of $P <0.0.012$) showed no significant differences after Bonferroni correction. However, means suggest that responses were slower for crowds with pain distractors (mean reaction time [RT] = 1280 ms) and the fastest when containing happy distractors (mean RT = 1188 ms), although this did not reach an acceptable level of significance ($P = 0.07$). No significant main effects of participant gender ($F(1,40) = 0.39$, $P = 0.54$) or crowd gender ($F(1,40) = 2.74$, $P = 0.11$) were found; however, results were interpreted in light of a significant interaction between crowd expression x crowd gender ($F(2,80) = 9.10$, $P <0.001$, $\eta^2 = 0.18$), which is illustrated in Figure 3 and showed that for pain-expressing crowds, reaction times were again significantly slower for female targets (1352 ms) than male targets (mean RT = 1205.5 ms), as in the previous analysis.

Expression	Participant gender	RT to male actors (SD	RT to female actors (SD
Pain	Male	1146 (396)	1261 (579)
	Female	1266 (409	1443 (628)
Anger	Male	1131 (389)	1264 (480)
	Female	1168 (396)	1397 (518)
Happiness	Male	1161 (344)	1213 (483)
	Female	1099 (352)	1277 (507)
Neutral	Male	1068 (517)	1087 (523)
	Female	1160 (549)	1172 (572)

Table 3 Response time (RT) descriptive statistics for male and female actors and presenting postures communicating the target expression given in column 1, with a neutral target stimulus.

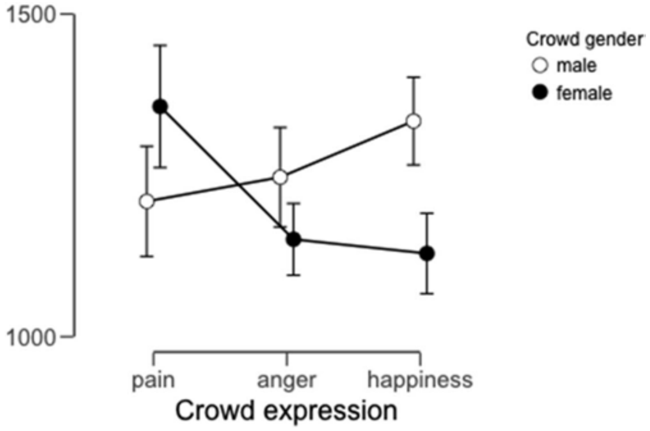

Figure 3. An illustration of the expression x crowd gender interaction for trials presenting a neutral target in an effective crowd (experiment 1). Errors bars represent standard error of mean.

2.2.4. Engagement towards targets in a neutral crowd

Engagement was examined using responses for the target expressions presented in a neutral crowd stimuli within a 3 (incongruent painful in a neutral crowd, angry in neutral crowd, and happy in a neutral crowd) x 2 (crowd gender) x 2 (participant gender) mixed-groups ANOVA. Faster detection of targets suggests greater engagement. For example, if a painful target posture is detected more rapidly in a neutral crowd than a happy target, this would indicate greater engagement towards pain postures.

No main effect of target expression ($F(2,80) = 0.37$, $P = 0.55$), crowd gender ($F(1,40) = 1.18$, $P = 0.28$), or participant gender ($F(1,40) = 0.11$, $P = 0.74$) was found. No significant interactions were found (smallest $F = 0.22$).

2.3. Summary of findings from experiment 1

Findings from experiment 1 suggest that observers take longer to disengage attention when searching for targets among crowds of people expressing pain through body postures, and that this is effect stronger when the target is absent. Although this effect was similar among male and female observers, a greater general disengagement effect was also found when searching for targets within female crowds, compared to all male crowds. This is contrary to our predictions, and previous evidence concerning attentional engagement to threatening postures.[4] This suggests that when searching for targets in a crowd, observers are generally slower to disengage attention when the crowd is female. We failed to find any evidence to suggest that attention is engaged towards painful targets in crowds, or indeed that attention was engaged towards angry or happy targets in neutral crowds. This is also contrary to previous evidence, which suggests attentional capture towards affective targets, in particular negative affective targets, in crowd-type tasks.[14,15]

One potential reason for the lack of apparent gender effect in experiment 1 is that the experiment used crowds and targets that were exclusively male or female. This means that direct comparison of male and female posture recognition was not possible. To asses this, with a more direct comparison, experiment 2 presented mixed male–female crowds. We predicted that the slower disengagement from female crowds observed in experiment 1 would persist when viewing mixed gender crowds, and that slower disengagement from pain postures would also persist regardless of crowd and target gender. Based on the findings in experiment 1, we did not expect pain targets to preferentially engage attention. We did predict that there would be a gender effect in attentional engagement and disengagement when male and female postures are presented together, such that disengagement from female postures is slower than for male postures, as observed in experiment 1.

3. Experiment 2

3.1. Methods

3.1.1. Participants

A new sample of 40 participants (20 male and 20 female, mean age 25.68 years, SD 5.43) were recruited in the same way as for experiment 1 from the staff and student body at the University of Bath, and compensated £5 for their time.

3.1.2. Materials

Experiment 2 used mixed male and female crowd stimuli. Accordingly, each crowd expression type (congruent/incongruent) was presented in either a male-majority crowd (where 5 bodies within the crowd were male and 4 were female) or a female majority-crowd (where 5 bodies were female and 4 were male). In total, 10 actors were used (5 male and 5 female) for this study, selected at random from the BEAPPS stimulus set. Actors once again changed location at random between each stimulus, as in experiment 1, although within the constraint that no 2 actors of the same gender could appear horizontally or vertically adjacent. Male and female actors were presented an equal number of times across the different crowds. An example of both male and female majority crowds is presented in Figure 4.

3.1.3. Design

The design for experiment 2 was similar to that for experiment 1, but with the additional variable of match–mismatch between target gender and gender majority of the crowd. This meant that when targets were present, they were either the same gender as the majority of the crowd (ie, female target in a female majority crowd), or different (ie, male target in a female majority crowd). The dependent variable was the response time, recorded in milliseconds (ms).

3.1.4. Task, procedure, and analyses

The independent variables were participant gender (2 levels, male and female), crowd type (congruent and incongruent), crowd majority gender (2 levels, male and female), target gender (2 levels, male and female), and expression (4 levels, painful, angry, happy, and neutral). The dependent variable was the time taken to correctly identify the presence of a target, and was measured in milliseconds (ms). As in experiment 1, 2 processes were examined: disengagement from distractor postures, and engagement towards target expression.

The task followed the same structure as experiment 1. The main difference was the crowd gender, which either comprised a majority of males or females. Participants were presented a total of 432 trials; 108 no target male majority crowds, 108 no target female majority crowds (total 216 no-target trials, 50% of total trials), and 54 crowds with a target for each of the 4 expression types (54 for painful, angry, happy, and neutral targets, for a total of 216). Again, each set of 54 was split evenly between majority male and female. Trials were presented in a random order, and split evenly into 4 blocks with a break between each block.

Ethical approval was granted by the University of Bath Department of Psychology and Department for Health. The procedure was the same as that described in experiment 1. The analyses were also similar to those in experiment 1, with the addition of crowd majority gender as a within-groups factor.

Figure 4. An example of incongruent crowds in the majority-male (left) and majority-female (right) configurations.

3.2. Results

3.2.1. Data screening

Incorrect responses were removed from analyses (174 trials, 1.1% of total data collected), as were responses below 200 ms and above 3000 ms (0.04% of total data). Normal distributions were found for responses times across all variables, and so no transformation was necessary. Mean responses (and SDs) are presented in Table 4.

Target expression	Participant sex	Male crowds		Female crowds	
		RT to male actors (SD)	RT to female actors (SD)	RT to male actors (SD)	RT to female actors (SD)
Pain	Male	849 (169)	993 (162)	802 (95)	823 (137)
	Female	731 (148)	754 (173)	723 (202)	785 (219)
Anger	Male	829 (196)	835 (260)	751 (108)	745 (143)
	Female	785 (179)	828 (244)	750 (148)	797 (207)
Happiness	Male	837 (120)	737 (122)	738 (76)	767 (105)
	Female	743 (270)	725 (184)	766 (197)	652 (107)

Table 4. Mean reaction time (RT) and SD data for happy, angry, and painful target postures presented in a neutral crowd that is either male or female dominated.

3.2.2. Disengagement from mixed-gender crowds when no target was present

A 4 (crowd expression type; pain, neutral, anger or happiness) x 2 (crowd majority gender; majority male or majority female) x 2 (participant gender; male or female) mixed-groups ANOVA was conducted to examine responses when searching crowds where no target was present.

There was no significant main effect of mixed-gender crowd type ($F(1,38) = 0.16, P = 0.70$); however, a significant main effect of crowd expression type was found (pain = 1224 ms, angry = 1121 ms, happy = 1114 ms, neutral = 952 ms; $F(3,114) = 21.74, P < 0.001, \eta^2 = 0.36$), as well as a significant main effect of participant gender ($F(1,38) = 8.20, P = 0.007, \eta^2 = 0.18$), with means showing slower overall responses amongst men (1302 ms) compared to women (903 ms). Both main effects are interpreted in light of a significant interaction between participant gender x crowd expression type ($F(3,114) = 2.86$, $P = 0.04$, $\eta^2 = 0.07$; Figure 5). Post hoc tests indicated that female observers were faster than males when searching among painful (males = 1398 ms; females = 1050 ms; $P = 0.04$), angry (males = 1284 ms; females = 958; $P = 0.03$), happy (males = 1368 ms; females = 860, $P = 0.002$), and neutral (males = 1159 ms; females = 744 ms, $P = 0.001$) crowds. This suggests a consistent female superiority in disengagement across all emotion categories. Within genders, female participant responses were slower for painful crowds (mean RT = 1050 ms) than for angry (mean RT = 958, $P < 0.001$), happy (mean RT = 860, $P < 0.001$), and neutral (mean RT = 744.16, $P < 0.001$)

crowds. Male participant reaction times were slower for painful (mean RT = 1398 ms) than for angry (mean RT = 1284, $P < 0.001$) and neutral (mean RT = 1159, $P < 0.001$), but there was no significant difference between painful and happy reaction times (mean RT = 1369, $P = 0.31$).

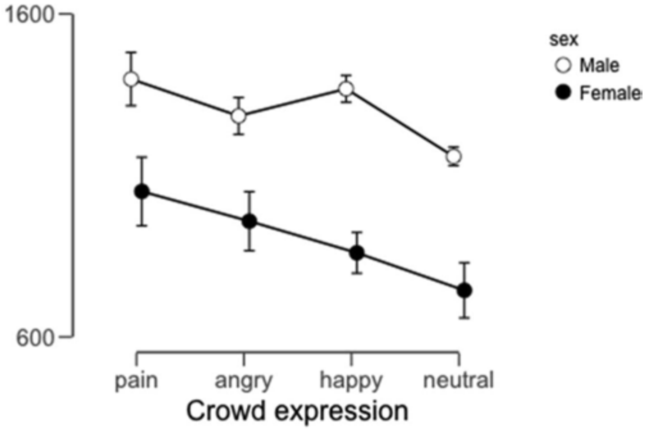

Figure 5. An illustration of the participant gender x target expression interaction in experiment 2. Error bars represent standard error of mean.

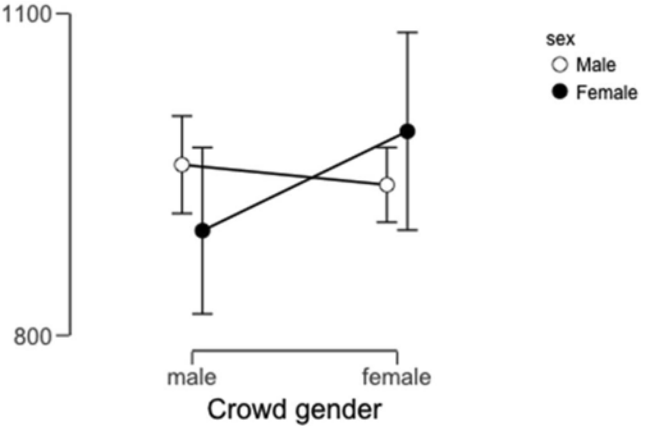

Figure 6. An illustration of the crowd gender x participant gender interaction in experiment 2. Error bars represent standard error of mean.

3.2.3. Disengagement from affective mixed-gender crowds with a neutral target

Responses to neutral targets when presented in affective crowds was explored in a 3 (crowd expression: discrepant neutral posture target within a pain, anger, or happiness crowd) x 2 (mixed gender crowd type; majority male or majority female) x 2 (target gender; male or female) x 2 (participant gender; male or female) mixed-design ANOVA.

No individual significant main effects were found for crowd expression ($F(2,76) = 1.44, P = 0.24$), mixed gender crowd ($F(1,38) = 2.74$, $P = 0.11$), target gender ($F(1,38) = 1.92$, $P = 0.17$), or participant gender ($F(1,38) = 0.01, P = 0.92$). However, a significant interaction was found between crowd gender x participant gender ($F(1,38) = 6.22, P = 0.02, \eta^2 = 0.14$; Figure 6). Follow-up analysis indicated that women were slower when searching for female targets (990 ms) than for male targets (898 ms, $P = 0.02$, $d = 0.21$). No difference was found among men, indicating that the effect seen in experiment 1 with single-gender crowds was replicated for female participants, but not for males.

3.2.4. Engagement towards affective targets in neutral mixed-gender crowds

A 3 (target expression type: painful target in a neutral crowd, angry target in a neutral crowd, and happy targets in a neutral crowd) x 2 (mixed gender crowd type; majority male or majority female) x 2 (target gender) x 2 (participant gender) mixed- groups ANOVA was conducted.

A significant main effect of mixed gender crowd type was also found ($F(1,38) = 4.85, P = 0.03, \eta^2 = 0.11$) with faster responses for targets presented in within a majority female crowd (758 ms) than majority male crowd (804 ms) ($t = 3.89$, $P < 0.001$, $d = 0.62$). No significant main effects for target gender ($F(1,38) = 1.21$, $P = 0.28$) or target expression ($F(1,38) = 4.85$, $P = 0.07$) were found; however, 3 significant interactions were found, and the main effect was interpreted in light of these.

The first significant interaction was found between target expression type x crowd gender ($F(2,76) = 5.12, P < 0.01, \eta^2 = 0.12$; Figure 7). Post hoc analysis indicated that response times were faster when identifying pain targets in neutral female crowds (mean RT = 716 ms) than for neutral male crowds containing pain targets (mean RT = 853 ms) ($t(38) = 4.42, P < 0.001, d = 1.43$). A second significant interaction between target expression 3 target gender was also found ($F(2,76) = 16.65, P < 0.001, \eta^2 = 0.31$; Figure 8). Further examination of this interaction showed that for pain expressions, male targets were detected significantly more quickly (mean RT = 750) than female targets (mean RT = 818). No significant difference was found between male and female targets for anger or happiness (all $P > 0.05$).

A final significant interaction was found between target expression x participant sex ($F(2,76) = 9.80$, $P < 0.001$, $\eta^2 = 0.21$). Further examination of this interaction showed that female participants (mean RT = 715.78 ms) detected pain targets significantly more quickly than male participants (mean RT = 853.10, $t = 2.73$, $P = 0.02$, $d = 0.43$). No significant difference was found between males and females for either happy or angry expressions (all $P > 0.05$). This interaction is illustrated in Figure 9.

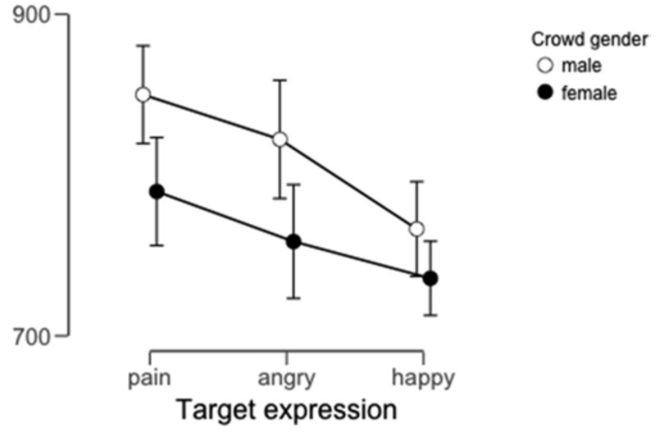

Figure 7. An illustration of the crowd sex x target expression interaction in experiment 2. Error bars represent standard error of mean.

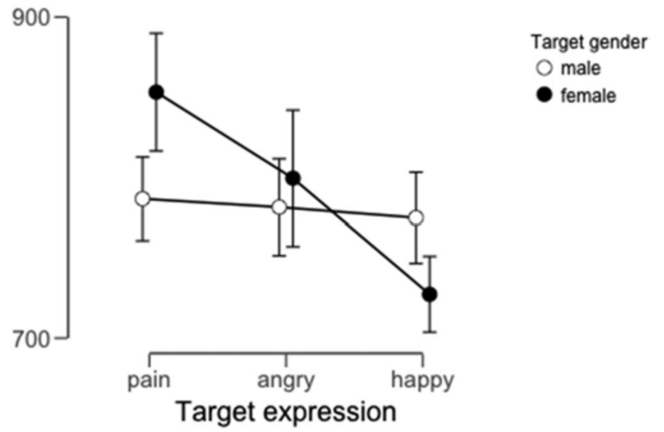

Figure 8. An illustration of the target sex x target expression interaction. Error bars represent standard error of mean.

Figure 9. An illustration of the participant sex 3 target expression interaction. Error bars represent standard error of mean.

3.3. Summary of findings from experiment 2

Experiment 2 demonstrates that when presented mixed male/female crowds with no targets present, attentional disengagement increases when crowds depict pain, compared to happiness and anger. This is similar to the pattern found experiment 1, when crowds contained all male or all female actors, and supports our initial hypothesis.

However, when presented with mixed-male/female neutral crowds, painful targets did not seem to stand out any more than other expressions, again consistent with findings in experiment 1. Furthermore, the disengagement effect found in experiment 1, where target detection was generally slower when targets were female, was only found to occur among women in experiment 2. Men did not show this crowd disengagement effect when the crowd was mixed gender.

Finally, in terms of engagement, women were faster at detecting pain targets in a neutral crowd, compared to men. In addition, male pain targets were detected more quickly than female pain targets in neutral crowds, regardless of the gender of the crowd.

4. General discussion

In 2 experiments, we demonstrated that preferential attention towards pain-related body postures occurs when viewed in a wider multiperson social context. When searching for targets among crowds with pain postures, responses were slower than for happiness and anger postures in both experiment 1 and experiment 2. This suggests that in social settings, pain body postures hold attention more than postures communicating happiness and anger; this effect is probably due to the high salience afforded to pain information more generally in human attention.[23,38] Furthermore, this effect seems, to some extent, to depend on the gender context of the crowd. Experiment 1 found that participants disengage more slowly from pain when displayed within either all-male or all-female crowds. However, in experiment 2, when using mixed male–female crowds, male postures for pain engage attention faster than female signals. This latter finding is in keeping with previous evidence that has found that male nonverbal expressions. In particular, threatening signals such as anger are more readily detected than female signals.[28,43] However, this is at odds with experiment 1, where the gender of the crowd was not mixed. This difference may be because male pain expressions are more threatening when presented in mixed gender environments, or at least are treated as if they have a greater potential for harm. Alternatively, given that men are expected to behave more stoically,[9,17,19,20,40] nonverbal pain signals maybe viewed as more novel and thus more salient when presented alongside female expressions. From a predictive coding perspective, more attention may well be focused towards male postures if they are considered more unusual, and likely to increase the risk of errors in classification.

Although no participant gender effect was found in experiment 1, in experiment 2, women were faster at both detecting targets (especially pain) and judging that no target was present, when compared to men. Women were also found to take longer to disengage attention when searching for neutral targets within predominantly female affective crowds. This points to a greater ability to process and make judgements about visual social stimuli. Previous evidence has shown an overall female superiority in a range of emotion recognition-type tasks, including basic expression recognition,[12,25,26] and more complex multisensory integration tasks.[3] Here, we provide further evidence that female observers seem better able to process social information presented through nonverbal signals. Importantly, the current study indicates that these gender effects occur in modalities other than facial expression.

Although interesting, our methods limit our interpretations. Visual search type tasks such as the bodies in the crowd paradigm are abstractions for use in a controlled experimental environment and may not translate directly into complex real-world environments.[11,34] Where possible, we added complexity and avoided schematic stimuli,[24] but we recognise that tasks such as this lack ecological validity. Furthermore, although the BEAPPS stimuli used here are well validated and have been used previously to good effect, a larger sample for the revalidation of the static stimuli used here would have been advantageous. In real-world settings, other factors may influence the extent to which postures capture attention. For example, motion is among the most prominent attentional cues used by the human visual system.[13,29] Although the crowd task lends itself to the examination of attention engagement and disengagement by certain stimuli, further research could examine dynamic cues and more real-world incidences in which pain communicative postures capture attention. One potential avenue for future research would, therefore, be to consider the role of motion and movement intensity, and how this can modulate attention to expressions of pain. The human visual system is predisposed to engage attention towards movement, in particular high-intensity and high-speed motion.[1] Previous research into pain postures has shown that there are variations in these motion cues in pain postures,[41] and this variation is likely to be purposeful to either ensure attention capture (in the case of immediate injury, to encourage helping) or to avoid attentional engagement (as injury can increase vulnerability). The experiments presented here were only focused on the extent to which postural configurations associated with pain and other emotions engage attention. For this reason, we controlled for motion by using static crowds. However, future research should consider how movement changes attentional engagement towards and away from postures.

We chose to explore body postures, because faces are arguably more difficult to detect in crowds; body postures can be viewed from any angle, and from a distance. However, real-world examples of pain recognition not only involve body posture, but also facial and verbal expressions as well. Although evidence suggests body postures are a primary source of affective information, and even supersede facial expressions for recognition,[7] including multiple nonverbal channels would better reflect “real-world” recognition behaviour. Future studies could consider these alternative modalities, to see whether such effects are found consistently. Facial expressions are well documented in the pain literature,[5,21,30,36,39] yet no research has considered attentional engagement or disengagement in a crowd-based visual search paradigm. Similarly, no attempt has been made to develop a multichannel task designed to explore attentional engagement to pain.

The current research findings highlight that the gender context in which pain occurs affects how pain is communicated, and that this extends beyond one-to-one social exchanges. This is in line with previous findings that consistently show a female-superiority effect in emotion recognition.[3,25,42] However, this effect was limited to experiment 2, where the crowds comprised both men and women. One potential explanation is that mixed male/female environments increase task complexity, and so enable the detection of subtle gender-based differences in recognition. Indeed, it has been argued that where recognition is easier, then gender differences are less likely to be found.[42]

The current findings point to the need to explore the gender context of pain, and determine how pain is detected within multiperson environments, such as crowds. Although observer attention seemed more engaged towards male pain postures, reasons for this are less clear. Generally, early socialisation may be a core antecedent of gender differences in pain,[32,33,44] and so future investigations could explore whether similar effects are found in children. It would also be interesting to consider whether pain signals are differentially detected, and gender-based, in real-world environments, including emergency situations where choices need to be made around treatment priorities. For example, are men more or less likely than females to receive help for pain? Similarities between pain with threatening signals such as anger might suggest bystanders are more likely to select self-preservation response behaviours when presented with a male in pain. It would be interesting to consider whether these differences in communication translate to differences in clinical behaviours and treatment options taken by health care professionals.

A final, broader implication for future research is considering how our ability to detect pain in crowds, and gender differences in that detection, can impact on real-world situations where detection and response are key to providing appropriate support. In extreme cases, the speed with which responders are able to recognise and respond to patients and begin treatment is an important predictor of patient outcomes and mortality rates. Faster detection and treatment increases the likelihood of positive outcomes for patients, and is contingent on rapid recognition and response. We have shown in a laboratory setting that untrained observers are able to detect pain postures, and are slow to disengage from them, but is this different for individuals trained to work in these environments? If not, we can ask whether training would improve recognition. The research presented here is based in a laboratory, and future research needs to examine whether attentional biases to pain communications, and specifically male pain communications, carry over into real-world settings and have an impact on recognition and response behaviours.

In conclusion, the current study shows that the detection of pain expressions occurs in a wider social context. Body expressions of pain, displayed in a crowd, are selectively detected and seem to capture attention. Of interest, the gender context is also relevant and that pain expressions in men and women may capture attention in different ways.

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