ABSTRACT

Objective. Recent research suggests that higher scores on measures of empathy correlate with a stronger response to observed pain, as well as higher estimates of pain intensity. Little work to date has examined the impact of empathy on evaluations of different levels of expressed pain, or how empathy may alter the accuracy of interpreting these painful facial expressions. This study examines the role of empathy in rating the intensity of facial expressions of pain, and the accuracy of these ratings relative to self-reported pain. The potential mediating role of available pain cues or the moderating role of gender on this relationship are also examined.

Methods. Undergraduate participants (observers, N = 130) were shown video clips of facial expressions of individuals from a cold presser pain task (senders), and then asked to estimate that pain experience. This estimate was compared with the video sender’s actual pain ratings.

Results. Higher empathy was associated with an overall increase in estimates of senders’ pain, which was not mediated by video subject or participant gender or the duration of painful facial expressions. Further analyses revealed that high empathy was associated with greater accuracy in inferring pain on only one of three inferential accuracy indices.

Conclusions. While observers with greater empathy may infer greater pain in senders, resulting in a smaller underestimation bias overall, they are not necessarily more accurate in estimating pain on any given stimuli. The importance of these potential differences in perceived pain for clinical assessment and interpersonal relationships are discussed.

Key Words. Facial Cues; Pain Communication; Empathy; Observed Pain; Accuracy
component of empathy involves imagining the person’s internal affective state, which may include the direct simulation (i.e., sharing) of the same internal emotional experience [5,10].

Preston and de Waal [11] proposed a perception-action model to clarify the process of empathy. According to their theory, the fundamental basis of empathy lies in “emotional linkage” where there is a direct mapping of the sender’s affective/physical experience onto the same circuits within the observer [5,10]. This bottom-up association appears supported by recent functional magnetic resonance imaging (fMRI) evidence, which suggests that observing disgust [12], touch [13], or pain [14–16] activates some of the same brain regions in the observer. Further, muscle cell firing may be suppressed in body regions where a video shows a needle being injected [17].

Recent research has focused on the role of empathy in understanding and interpreting a sender’s pain [18]. Along with the initial bottom-up sharing of an experience, empathy also involves a number of top-down processes involving cognitive appraisal of the subject and the context [19]. As pain is a highly complex and contextual experience, it is likely that contextual and cognitive processes such as empathy could be crucial to our understanding of someone else’s pain [20]. Interestingly, from the pain and neuroscience literature, higher levels of neural activation (i.e., “sharing” in the same brain regions as experienced pain) in response to observed pain correlate with higher pain ratings of the sender’s experience [15,21], as well as higher scores on empathy questionnaires [6,16,22,23]. Together, these results suggest that empathy may be associated with a better internal representation of another’s experience, and thus allow for better recognition and understanding of their pain.

Despite recent interest into how empathy may alter pain perception, little work outside of the fMRI literature has directly examined this relationship between empathy and observed pain [18], with the recent exception of a study of parents of adolescents with chronic fatigue syndrome [24]. This is likely the case because empathy is a complex cognitive process, which may be influenced by a number of contextual and internal appraisal factors [18]. To complement existing studies, research examining factors that underlie or moderate the pain and empathy association are essential. Gender, for example, has been shown to influence how videos of other’s pain are rated [25], and may also be correlated with the degree of affective empathy [26]. Thus, in this study, we first examined the relationship between empathy and estimates of pain, as well as the mediation of this relationship by available bottom-up information (i.e., facial pain cues expressed and the gender of the person in pain), or moderation by the observer’s gender.

Notably, while higher levels of empathy appear to be related to more intense ratings of observed pain, no study to date has examined the “accuracy” of these higher intensity ratings. That is, if empathic individuals are observing higher levels of pain, are they actually better at inferring the pain the person has reported, or are they just inferring higher levels of pain regardless of what the sender is actually feeling? While people demonstrate an aptitude for recognizing the presence of pain from early childhood [27], large individual differences exist, and suffering is often significantly underestimated by observers [28–31]. Thus, our second goal was to investigate if more empathic individuals give more “accurate” estimates of observed pain. We hypothesized that higher levels of pain would not only be associated with higher estimates of observed pain, but that these estimates would be significantly “better”/closer to the amount of pain reported by the sender. Better estimates (i.e., greater “accuracy”) were characterized using three different indices of judgement accuracy; difference scores, as an index of average estimation error, a covariation index, looking at sensitivity to changes between videos, and a within-stimulus change index, looking at the observer’s sensitivity to changes in an individual sender’s pain across different videos.

Methods
Participants
One hundred and thirty students were recruited from the Introductory Psychology participant pool at Queen’s University after clearance from the research ethics board. Participants were compensated with course credit or $5. Participants included 58 men and 72 women, ranging in age from 17 to 26 years ($M = 18.93$ years, $SD = 1.59$). The majority of the participants identified themselves as Caucasian (69%), 31% identified themselves as being of or partially of partial Asian descent, and 2% indicated other ethnic affiliations.

Stimuli and Measures
Stimuli: Video Depictions of Painful Facial Expressions
A series of 54 five-second clips were sampled from 1-minute videos of individual senders during a
cold-pressor test. Videos were filmed during a previous study analyzing facial expressions of pain with permission granted from the participants to use the clips in future research [32]. Eighteen clips were randomly selected for sampling, split by gender (nine men, nine women). Each 5-second clip of the sender’s facial expressions was sampled from one of three time points in the video; 1–5 seconds, 25–30 seconds, and 55–60 seconds after the arm was initially immersed in cold water. These different time points were selected to allow for a greater degree of variance in the amount of pain expression exhibited by the participants. Each clip corresponded with a time frame prior to a sender’s rating of self-reported pain. Sampled clips were presented in a PowerPoint slideshow with stimuli alternated by gender (clip of a male followed by a clip of a female).

**Stimuli: Ratings of Sender Facial Expressions**

Judges blind to the actual reported pain levels, as well as to observers’ pain ratings, viewed and coded the painful facial expressions of the senders in the cold-pressor clips. The facial action coding system (FACS) procedure was used as the coding method. The two primary judges were trained in using a video capture program and on how to differentiate facial action units (AU) by the lead judge who is a certified FACS coder. The AUs of painful facial expressions were AU4 (brow lowering), AU6 (temple pull), AU7 (lid tightening), AU9 (nose wrinkle), AU10 (lip raise), and AU12 (smile/lip tightening). The total amount of time in each video clip that these painful facial expressions were present was recorded and totalled. Percentage agreement for the classification of the different AUs ranged from 83% to 88%. Discrepancies were resolved through discussion. For the present study, the time of all AUs scored were totalled and used as an index of facial pain expression in seconds.

**Davis Empathic Concern Scale**

The Davis empathic concern scale (DECS) is a seven-item subscale of the Davis interpersonal reactivity index (IRI) [33]. The DECS evaluates empathetic concern by examining an individual’s tendency to take another person’s perspective in times of stress and to show compassion and concern for mistreatment of another person [33]. The measure contains seven statements gauging a person’s empathy for others (e.g., “When I see someone being taken advantage of, I feel kind of protective toward them”). Items appear on a five-point scale ranging from 0 (does not describe me at all) to 4 (describes me well), and scores on the DECS can range from 0 to 28. In an undergraduate sample, the reported mean range of the DECS was 17–21 [34,35]. The DECS has adequate internal consistency (alpha = 0.78), with test-retest correlations from 0.62 to 0.81 [33]. In the present study, internal consistency for the DECS was 0.76. The present study assessed empathy using the DECS because it has been previously shown to correlate with higher neural “sharing” of observed pain [16].

**Procedure**

Participants were scheduled in groups of 20–30. All participants (observers) completed the DECS, as well as a series of demographic questions that assessed their age, gender, and ethnic identity. Observers were told they would be watching videos where people were experiencing different levels of pain. Observers were then told to rate the level of pain being experienced by the sender in every video clip, using the 11-point numeric pain rating scale (0 = no pain; 10 = worst possible pain).

**Data Computation and Analyses**

**Factors Affecting the Relationship between Observed Pain and Empathy**

**Pain Estimates and Empathy**

Estimates of the perceived pain of senders in the video sequences were compiled using the observers inferences on the 11-point rating scale. A simple linear regression was first performed to determine if the average pain estimated by the observer across all the video clips varied by their level of empathy.

**Moderation by Gender**

Next, the relationship between empathy and observer pain inferences was examined in both men and women, to determine if gender moderated the effect of empathy on pain estimates. This was accomplished using a moderated multiple regression (MMR), as described in Aiken and West [36]. MMR involves a hierarchical regression that tests first the relationship between the predictors (in this case DECS scores and gender) and our criterion variable (pain estimates), as well as testing an “interaction term” that contains information about both predictors. Gender was dummy coded (male = 0 and female = 1), and centered scores (altered so that the mean of the group is 0) on the DESC were entered into a simultaneous multiple regression equation with the interaction term of the two variables.
Mediation by Pain Behaviors

The “bottom-up” incoming stimuli from the senders may potentially influence the relationship between empathy and observed pain estimates (i.e., people with different levels of empathy may be more or less likely to observe and utilize, available distress cues in the video clips). For each observer, the correlation between the estimated pain rating provided and the time spent by the video sender exhibiting painful facial expressions was analyzed for each of the 54 video clips. Higher correlations for a given participant would reflect that they relied more heavily on the presence of these facial cues in order to rate the pain levels of the sender. The role of a reliance on these cues in mediating differences in perceived pain was examined using a multiple regression model of mediation, as described by Kenny and la Voie [37]. To investigate a potential mediator using this method, four computational “steps” are required. Step 1 confirms that there is a relationship between the predictor of interest (DECS empathy scores) and estimated pain levels (as analyzed in the simple regression). Step 2 analyses the relationship between the predictor variable (DECS scores) and the potential mediator (the correlation index described above). If a significant correlation is found, step 3 is to perform a simultaneous regression using both the existing predictor (DECS) and the mediator (the correlation) to determine if a significant relationship exists between the mediator and the criterion (estimated pain levels). If a significant relationship between the mediator and the criterion variable is found, step 4 is to then reanalyze the relationship in step 1 (DECS and estimated pain levels) while controlling for the mediator variable (correlation index) to determine how much of the initial step 1 relationship is the result of this “other” variable.

B. “Accuracy” of Pain Estimates and Their Relation to Empathy

Observers’ pain estimates were compared with senders’ actual self-reported pain, to determine the level of concordance between observers and the self-reported “feelings” of pain, in order to determine how accurate observers were in their “sense of knowing” [18], a sender’s emotional state. Estimated levels of pain for each video clip were compared with the pain ratings self-reported by the sender. “Accuracy” was defined based on how closely estimates of pain corresponded to actual pain reports, as well as the observers’ sensitivity to changes between senders and across time points as in associated research [38]. “Accuracy” was calculated for each observer, across the stimuli, using three indices. 1) Difference scores were computed based on the overall average of estimation error by subtracting observer pain inferences from actual cold-pressor pain ratings, and averaging their absolute values, providing an “overall” measure of error variance. Here, higher numbers suggest a greater estimation error (i.e., lower accuracy); 2) covariation of actual-estimated pain was analyzed by computing a within-observer correlation between estimated pain levels and actual sender pain ratings, across all 54 video clips. Higher values designate a greater covariation, and subsequently, an increased sensitivity to differences in the levels of pain expressed across all stimuli; and 3) within-sender change in pain ratings were also computed for each observer. The within-sender difference score was calculated using the difference between the actual sender pain ratings on the video clips corresponding to the first (i.e., 5 seconds) and last (i.e., 60 seconds) time points of the initial cold-pressor experiment. Differences of less than or equal to +1 or −1 point were classified as “no change,” differences of +2 points or more were designated as “increased pain rating,” and those of −2 points or more were designated as “decreased pain rating.” The same classification system was used to assign values to the observer’s pain estimates at these time points. The number of matches across stimuli was counted, with a higher number of matches indicating greater sensitivity to changes in a sender’s pain across time.

Correlation and regression analyses were conducted to examine the impact of the observers’ empathy scores on pain estimation, over and above the individual demographic variables of participant age, gender and ethnicity. For analysis of variance (ANOVA) statistics, empathy was divided into low and high categories (low ≤ 17, high ≥ 18) by a median split. The potential influences of the observers’ gender, as well as the video participant’s gender, on accuracy were analyzed using a 2 × 2 ANOVA.

These multiple statistical evaluations of the participant pain estimations are necessary to reduce the ambiguity associated with calculating multiple estimation indices. For example, a systematic over- or under-estimation bias may affect the average estimation error index. Participants with high levels of estimation accuracy may also display a low average estimation error, a high covariation of actual-estimated pain, and a high number of matches in sensitivity to within-stimulus changes in pain.
<table>
<thead>
<tr>
<th>Sex of sender</th>
<th>Mean pain ratings</th>
<th>Mean pain behaviors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>Mean pain ratings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 seconds</td>
<td>4.1  (1.8)</td>
<td>4.3   (2.1)</td>
</tr>
<tr>
<td>30 seconds</td>
<td>6.1  (2.0)</td>
<td>6.3   (2.4)</td>
</tr>
<tr>
<td>60 seconds</td>
<td>7.4  (1.8)</td>
<td>6.9   (2.1)</td>
</tr>
</tbody>
</table>

Pain ratings were made on a 0–10 scale. Pain behaviors were computed by calculating the total duration of the clip in which any painful facial expression was observed. Values in parentheses are standard deviations.

### Results

**Stimuli: Sender Video Clip Characteristics**

The mean self-reported pain ratings and the total time senders expressed painful facial cues (i.e., duration of the AUs) are presented in Table 1. Pain ratings self-reported by the senders increased significantly at later time points of video sampling, \( F(2, 32) = 69.19, P < 0.05 \), and did not differ between the sexes. This indicates that both male and female senders reported similar overall pain experiences during their cold water immersion (i.e., a time 2 pain rated higher than time 1, a time 3 pain rated higher than time 2). A linear regression analysis revealed a significant association between a sender’s pain ratings and the duration of facial pain exhibited \( F(2, 32) = 6.50, P < 0.05 \). This suggests that video clips where senders reported more pain they were also showing greater facial cues of distress—and that facial expressions could be a compelling cue for observers attempting to judge the degree of a sender’s pain. Lastly, there were no significant differences in the duration of facial expressions (coded by the facial action units) \( F(2, 32) = 1.54, P > 0.05 \) in video clips taken from different time points and no apparent interaction effect of gender on these facial cues.

**Observer Characteristics**

Study participants scored within the published range on the DECS (\( M = 17.7, SD = 3.50 \)). Women, on average, appeared to have higher levels of reported empathy than men, \( t(128) = -4.66, P < 0.01 \). Observers estimated the pain ratings in the video clips, on the 0–10 scale, at a mean of 3.60 \( (SD = 1.30) \), which underestimated the average self-reported pain across all video clips by 2.20 points \( (SD = 1.50) \). Pearson correlations among measures are shown in Table 2. Empathy scores were highly correlated with gender \( (r = 0.37, P < 0.01) \).

**Observer Empathy and Pain Inferences**

A simple linear regression analysis reveals that higher scores on the DECS predict higher ratings of others pain, \( R^2 = 0.04, Adj R^2 = 0.03, F(1, 128) = 5.27, P < 0.05 \). This suggests that observers with greater empathy were judging senders to be in more pain than those with low empathy when looking at the same individual, to a small but significant degree.

**Gender as a Moderator of Empathy**

Gender was analyzed as a potential moderator of the above relationship between empathy and estimates ofsenders’ pain. As described in the data analysis section, a moderated multiple regression was performed, using a dummy coded gender variable, a centered score on the DECS, and an interaction term made up of the product of the two variables, entered into a simultaneous multiple regression equation. Overall, the equation was nonsignificant, \( R^2 = 0.06, Adj R^2 = 0.04, F(2, 127) = 2.57, P < 0.05 \). Neither gender itself, \( \beta = -0.09, t(127) = -0.98, P > 0.05 \), nor the interaction between gender and empathy scores, \( \beta = -0.08, t(127) = -1.52, P > 0.05 \), were significant predictors of higher pain ratings, but empathy alone remained a significant predictor in this relationship, \( \beta = 0.34, t(127) = 2.67, P < 0.01 \). This suggests that gender was not a significant factor in the ratings of others pain, nor does the sex of the observer influence the impact of empathy on their perceptions of others pain.

**Pain Behaviors as a Mediator of Empathy**

As previously mentioned, incoming stimuli (e.g., pain behaviors) may be an important “bottom-up” influence on empathy. As such, a mediational model was created to analyze whether or not the use of incoming facial cues from stimuli accounted for the relationship between empathy and pain.

Table 2  Pearson correlations among observer measures

<table>
<thead>
<tr>
<th>Age</th>
<th>Gender</th>
<th>Ethnicity</th>
<th>DECS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>-0.09</td>
<td>-0.03</td>
<td>-0.08</td>
</tr>
<tr>
<td>Gender</td>
<td>0.07</td>
<td>0.38**</td>
<td>0.08</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DECS</td>
<td></td>
<td></td>
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</tbody>
</table>

For Gender data: Male = 0, Female = 1. For Ethnicity data—Caucasian = 0, all others = 1. DECS = Davis empathic concern scale.
ratings. Correlation coefficients were first computed to compare an observer’s pain estimates for each video to the duration of painful facial expressions in that video clip. This resulted in a mean correlation coefficient being created for each observer that assessed the covariance between a sender’s duration of facial pain expression and the observer’s pain estimates. In this case, the mean correlation for observers was small ($r = 0.14$, range $= -0.26$–$0.40$), suggesting that slightly less than 2% of the variance in observer estimates was related to the amount of time facial pain cues pain were present in the video clip. In accordance with Kenny and la Voie’s model [37], described previously in the methods section, this correlation coefficient was examined as a potential mediator of the empathy pain relationship. In step 1, a significant relationship between empathy and observer pain estimates was presented (as previous analyses indicated), $R^2 = 0.04$, $Adj \ R^2 = 0.03$, $F(1,128) = 5.27$, $P < 0.05$, satisfying the Kenny and la Voie criterion that a relationship exists that can be mediated by other factors. However, at step 2, no significant correlation existed between an observer’s empathy scores and the correlation index created for pain estimates and facial expressions, $R^2 = 0.00$, $Adj \ R^2 = -0.01$, $F(128) = 0.00$, $P > 0.05$, suggesting no correlation between the initial variable (empathy) and the potential mediator (use of facial expressions). Thus, empathy did not appear to affect the degree to which observers utilize cues from painful facial expressions to draw inferences about a sender’s pain state.

**Empathy and Accuracy in Estimating Other’s Pain**

As described previously, three indices were calculated to describe “accuracy” of estimates relative to the sender’s self-reported pain.

**Difference Scores**

Difference scores were calculated by subtracting the observers’ estimated ratings of pain from the self-reported pain rating, and taking the absolute value of this relationship. This provided a measure where 0 indicated perfect agreement, and higher numbers indicated greater differences between observer estimates and sender self reports. To examine the relationship between the average estimation error (difference scores) committed by the observer and DECS scores, a simple regression analysis was employed. This relationship was found to be significant, $R^2 = 0.03$, $Adj \ R^2 = 0.03$, $F(1, 128) = 4.45$, $P < 0.05$. Empathy was a significant predictor of smaller difference scores (less error), with higher DECS empathy scores resulting in more accurate pain estimates, $\beta = -0.18$, $t(128) = -2.11$.

**Actual/Estimated Pain Covariation**

A simultaneous multiple regression analysis examined the relationship between gender and empathy and the correlations resulting from a within-observer covariation of pain estimates and a sender’s self-reported pain. The two predictors of gender and empathy were not significantly correlated with covariation accuracy, $R^2 = 0.02$, $Adj \ R^2 = 0.00$, $F(2,127) = 1.09$, $P = 0.34$, and did not predict differences in cross-stimuli sensitivity. This suggests that an observer’s gender and/or empathy levels had no effect on their ability to detect variability in the pain levels expressed across video clips of cold water immersion.

**Within-Sender Perception of Changes in Pain**

The relationship among gender, empathy and the number of matches on a within-sender perception of change index was examined using a simultaneous multiple regression. The two variables did not significantly predict sensitivity to within-sender changes in pain rating over time, $R^2 = 0.01$, $Adj \ R^2 = -0.01$, $F(2,127) = 0.59$, $P = 0.55$. Thus, neither observer gender nor empathy scores influenced their ability to detect changes in a sender’s pain levels across times of the cold-water immersion footage (at 5, 30, or 60 seconds).

Together, the analysis of these three indices suggested that only one potential indicator of “accuracy” had any significant relationship with DECS empathy scores. As difference scores provide only a somewhat broad “average” of estimation error/variance, we next investigated some of the potential underlying “biases” or cues that may have contributed to this mean decrease in error in higher empathy individuals.

**Observer Empathy and the Presence of Painful Facial Expressions**

The role of facial expressions of pain in determining average estimation error was analyzed by computing correlations between an observer’s pain estimates and the duration of facial expressions in each video clip. This resulted in a correlation coefficient created for each observer that assessed the covariance between the amount of facial pain expressed and the observer’s pain estimates. The average correlation for the sample was moderate ($r = 0.30$, range $= -0.18$–$0.57$), suggesting that approximately 9% of the variance in observer pain ratings could be accounted for by the duration of
Facial pain expressions exhibited during each video clip, which indicates that facial pain expression could be a viable cue for determining pain levels. Similar correlation coefficients were created to compare observer estimation error (difference scores) and the presence of painful facial expressions. In this case, the mean correlation for participants was small ($r = 0.14$, range $-0.26$ to $0.40$), suggesting that slightly less than 2% of the variance in observer error was related to the amount of facial pain expression in the video clip. No significant correlation exists between observer DECS scores and the rating index for pain estimates, $r(128) = 0.00$, $P > 0.05$, or difference scores $r(128) = 0.08$, $P > 0.05$. Thus, empathy did not appear to affect the degree to which observers used painful facial expressions as cues to estimate sender pain state.

**The Relationship between Pain Ratings and Difference Scores**

The potential impact of a sender’s actual level of (self-reported) pain on the relationship between observer empathy and estimation error (difference scores) was examined to determine if levels of pain (high/low) impacted how pain was interpreted by high or low empathy observers. For each observer, mean difference scores were computed separately for video stimuli classified by the sender as low pain (i.e., self-report rating less than 5) and high pain (i.e., a self-report rating from 6 to 10). A $2 \times 2$ ANOVA examined the impact of high and low observer empathy scores on their mean estimation error (difference scores) for low and high pain situations. In this case, the original difference score values, not the converted absolute values, were used to allow an examination of the direction of error as well as the amount of variance. The mean values for each category of this analysis are displayed in Table 3. When senders were reporting low pain, all observers tended to overestimate their pain levels (Table 3). However, more empathic observers tended to overestimate senders’ pain to a significantly greater degree, $F(1,128) = 7.30$, $P < 0.01$. When observers viewed videos where the coldpressor pain was rated as high, most observers underestimated the sender’s actual self-reported pain (Table 3), but more empathic observers showed less underestimation (less “error”) relative to the actual pain report, $F(1,128) = 4.60$, $P < 0.05$.

**Discussion**

This study suggests that individuals reporting higher empathic concern perceive higher pain in others. This finding was not moderated by gender, nor mediated by incoming facial cues, and “accuracy” analyses revealed that empathic concern did not correlate with a consistently improved ability to predict pain. On average, more empathic participants made less (i.e., smaller) errors when estimating pain relative to the sender’s self-report, but they were no better at detecting differences between video clips or changes within a sender across stimuli. This suggested that the significant decrease in average error (difference scores) may not have been the result of higher “accuracy” in perceiving pain. Indeed, secondary analyses examining low vs. high pain videos revealed that more empathic individuals showed smaller difference scores only in high pain situations, indicating less underestimation in high pain situations. Thus, the finding of improved difference scores should not be interpreted as reflecting greater “accuracy” at inferring self-reported pain, but perhaps a bias to perceive more pain regardless of the sender’s actual reported pain levels.

In a review of potential roles for empathy in pain-related social interactions [18], painful facial expressions were suggested as one of the most salient bottom-up factors involved in the empathic response to a sender’s pain. In our study, the relationship between facial cues and pain ratings was not influenced by levels of empathic concern. Thus, empathic individuals were no better at noticing these facial cues, or inferring more “accurate” pain ratings from them, than less empathic individuals.

Interestingly, despite a moderate correlation between estimated pain levels and sender facial cues (with more facial cues correlating with higher levels of estimated pain), this did not appear to improve estimation accuracy. A similar finding was reported

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Mean accuracy ratings of low and high pain stimuli based on empathy</th>
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<tbody>
<tr>
<td></td>
<td>Low pain</td>
</tr>
<tr>
<td></td>
<td>DECS</td>
</tr>
<tr>
<td>Mean</td>
<td>-0.83</td>
</tr>
<tr>
<td>SD</td>
<td>1.83</td>
</tr>
<tr>
<td>Min</td>
<td>-5.25</td>
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<tr>
<td>Max</td>
<td>1.88</td>
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</tbody>
</table>

N = 130. Groups are divided into high and low pain by actual pain levels reported for the video (low is 0–5, high is 6–10). Participants are divided into high and low pain by their position relative to the mean score in the sample ($M = 17.7$), where high is all scores greater than the mean. Mean accuracy is the average accuracy of the pain ratings given by participants when compared with the video’s actual reported pain levels, with higher values indicating greater underestimation. SD is the standard deviation, Min is the minimum score, and Max is the maximum score. DECS = Davis empathic concern scale.
by Sullivan et al. [38], where pain catastrophizers displaying more facial cues received higher (but no more accurate) pain ratings from observers. Thus, while observers are making use of the available facial cues, they may be accessing a number of other heuristics (gender, previous experience, etc.) when making their final judgments on the “level” of pain being experienced by the sender [39]. This idea of “filtering” the importance of a sender’s cues was proposed by Prkachin and Craig [40]. Behavioral cues of pain correlate with experienced distress, but they are also an important social cue to communicate that distress, not simply a measure of the amount of pain, and can be influenced by the context and sender’s intentions [38]. Thus, observers likely need to use their own judgments on intent or context to “filter” the relative importance of these cues. As our findings indicate, empathic concern may be one such heuristic.

In our study, the amount/duration of painful facial cues were used as a measure of pain behavior, rather than the intensity of those cues, which has been used by others [38]. Though recent research suggests both measures are correlated with changes in self-reported pain ratings [41], we cannot exclude the possibility that intensity may have somewhat different relationships with our empathy/accuracy measures. Further, previous research has suggested that although pain ratings increase over time, pain behaviors decrease with time in the painful situation [42]. In our study, we sampled pain behaviors from three time points within a 60-second cold-pressor task. Although we found no significant effects of the time of sampling on the amount of facial pain, the mean amount of facial pain in our study does appear to be following the same decreasing trend (Table 1), and this could have contributed to the lack of correlation between estimated ratings and facial cues. Within each video clip, however, facial cues were significantly correlated with levels of self-reported pain, and thus still provided an important piece of information for observers. Future studies investigating both intensity and duration of facial cues from a single time point may help to better clarify the importance of facial cues in empathic concern for pain.

Empathy requires not only the perception of a painful experience, but an emotional reaction to that perspective [1,15,18] and empathic participants did infer higher levels of pain from the stimuli on average. Greater empathic concern may promote a more intense internal simulation of observed pain [16] relating to reports of higher intensity for observed pain cues [15,21,43], which may result in disproportionate emotional responses to pain behavior, and an inability to discriminate lower levels of pain. This effect may be similar to the bias noted in depression, where increased attention and cognitive processing of negative stimuli is present, even with distraction [44]. Outside of this study, the role of empathy in responding to different levels of pain has not been examined, and further research is required to examine if such a distress-oriented bias is reliable in empathic individuals.

Several top-down processes likely interact with the bottom-up perception of pain behaviors in the pain perception of more empathic participants. Simulating another’s emotions requires incorporating direct observations with self beliefs, attributions, previous experience, and general logical reasoning [45]. Thus, empathy and pain ratings may be mediated by beliefs about, and previous experiences with pain, as well as the subject and context in which pain is being evaluated [25,46], which were not evaluated in this study. Catastrophizing, a cognitive process related to negative beliefs about pain and increased attention to painful stimuli, also correlates with higher levels of estimated pain and greater attention to pain behaviors, without the presence of greater inferential accuracy [38]. Although this study does not examine the relationship between catastrophizing and empathy, further studies could attempt to assess the importance of these different mechanisms in perceiving others pain. This would improve our understanding of the role of an individual’s beliefs, and the transference of these beliefs, to another’s presumed state.

Gender role beliefs are another top-down process affecting evaluations of other’s pain [25] along with the sex of the observer [46]. This study suggests no role of sex in either observer accuracy or in ratings of male and female stimuli. We did not directly measure stereotypical gender beliefs, so that analysis will await future research [25]. Alternatively, previous research may also have failed to control for the mediation effect of empathy on this relationship. Our analyses indicate a significant association between empathy and female gender. As higher empathy appears related to an overall increase in ratings, the previous results of higher pain ratings by women [46] might be mediated in part by this correlation.

It is possible that different aspects of the construct of “empathy” may contribute differently to the interpretation of, and response to, observed pain. The definition of empathy in this study is
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based on a broad construct containing both the cognitive and affective aspects of responding to a painful stimulus. Different aspects/processes of empathy (perspective taking, emotional response, etc.) might contribute differently to the interpretation of observed pain. For example the relative importance of “cognitive” perspective taking vs the affective “sympathetic” response are not yet well understood in the pain literature. While a parsing of these different constructs and definitions of empathy is beyond the scope of this article, pulling apart cognitive and affective aspects of empathy and sympathy are an important theoretical consideration for future studies. For example, an important cognitive process in empathy is the maintenance of a self/other differentiation, because presuming how another feels in a situation likely requires different perspective-taking than imagining oneself in the situation [43]. Interestingly, while imagining a person in a negative situation may evoke empathy by an other-oriented response, imagining yourself in the situation appears to evoke both empathy and distress, the self-oriented aversive response [3,43] and higher pain estimates [23]. Thus, without explicit instructions, perhaps highly empathic people are disposed to imagining themselves in the situation, evoking a more intense and distressing emotion to observed pain. Future studies of the relationship between pain ratings, empathy, and visualization instructions are needed to examine such relations.

The discrepancy between estimated pain and self-reported pain across high/low pain stimuli, illustrates the importance of internal, top-down empathic appraisal factors. In stimuli where low pain was reported, high empathy observers overestimated pain compared with lower-empathy observers. Conversely, when senders reported higher pain, highly empathic observers underestimated to a significantly lesser degree. Thus, the overall decrease in empathic observers mean pain estimation error (difference scores) appears to be the result of an across the board increase in estimated pain estimates, which is more evident in low pain situations. As many people underestimate a sender’s pain [28,29,31], the general increases in perceived pain in more empathic observers may result in an overall mean increases in rating synchronicity.

This study suggests that greater empathetic concern for others is associated with inferences of higher pain. Increased perception of pain may have a number of clinical implications. It is possible that health care practitioners who present with greater empathetic concern may perceive more pain in patients and be inclined to provide greater attention to patients’ distress. If physicians generally underestimate patient pain [31,47,48], it is possible that more empathic physicians may be likely to interpret and record greater patient pain, particularly in high pain situations. Such synchronicity is important because untreated pain leads to many problematic outcomes including chronic pain and lengthier post-operative stays [49,50].

Any assertion that empathy is associated with better treatment must be critically considered. While higher empathy was positively associated with higher pain inferences, this was the result of generally higher estimations, even in low pain situations. Thus, one could hypothesize that empathic caregivers or spouses of pain patients could tend to overestimate a sender’s pain. If empathic caregivers or spouses perceived greater pain in partners with pain, they may respond by engaging in increased solicitous behavior. Importantly, these caregiver behaviors are associated with greater disability [51], and may have most deleterious effects in low pain situations by reinforcing sedentary behavior. Higher empathy in spouses may be associated with perceptions of greater pain more continuously, which may lead to resentment and negative or punishing responses to pain behaviors, similar to those reported in spouses of patients who manifest high levels of catastrophizing and help-seeking [52]. In review, empathy’s effects on care responses could be an important clinical consideration when evaluating family factors in chronic pain and is open to continued research.

Despite suggestions that empathy may be key to how one interprets pain [18], the effect size in this research is small ($R^2 = 0.03$). Empathy does not occur in an experimental vacuum, and diverse situational or individual factors impact the relative importance of empathic concern on perceptions of other’s pain [1,18,22]. For example, the observers in this study are primarily first year psychology students, and their young age and good general health likely limits their exposure to traumatic pain situations that could significantly alter their perceptions of observed pain, when contrasted with an older or healthcare professional sample. While recent fMRI research has demonstrated that even young children experience an empathic “mirroring” of the pain experience in the brain when observing others’ in painful situations [53], it is certainly likely that age, neurodevelopmental changes, and experience could alter this empathy pain relationship, as experience/exposure to trau-
matic pain is believed to alter observed pain ratings [31]. However, the present undergraduate sample did demonstrate a significant effect of empathic concern, even if it may be muted in this cohort. These limitations do impact the generalizability of this study to other populations, and further research using a broader sample base is required.

A further point to consider is that, from the perspectives of both the observer and the sender, experimentally induced pain may present an ecologically weak milieu due to a limited threat or uncertainty associated with the experimental setting when compared with clinical pain conditions (e.g., injury, illness, surgery) [21]. Ecologically relevant pain situations may provide a more emotionally salient pain experience, promoting stronger representations of the sender’s pain in high empathy observers, which could be manipulated in future studies testing such associations.

Despite limitations, the present study is the first to demonstrate an association between empathic concern and pain estimates outside of the accumulating fMRI research. Further, this study is the first to suggest that the increased pain ratings provided by more empathic observers are not the result of the available facial cues, and also describes a potential pathway for this relationship (i.e., a general overestimation of others pain). This study also confirms the presence of an empathic response to facial expressions in pain videos and highlights the importance of internal, cognitive, and emotional processes when studying the interpretation of pain, suggesting that empathy may be an important factor to examine in the mediation of top-down influences on pain perception [5, 14, 54]. Studying the empathy/pain relationship in these different contexts, and different samples, may provide important information about the mechanisms underlying the empathic response to other’s pain behavior. Several avenues of research are suggested by the present study, which may have relevance to clinical diagnostics, interpersonal therapies for caregivers, as well as the underlying theoretical models of pain communication and interpretation.

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