

Social modulation of facial pain display in high catastrophizing children: an observational study in schoolchildren and their parents

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ABSTRACT

The present study examined existing communal and operant accounts of children's pain behaviour by looking at the impact of parental presence and parental attention upon children's pain expression as a function of child pain catastrophizing. Participants were 38 school children and one of their parents. Children completed a cold pressor pain task (CPT) twice, first when instructed that no-one was observing (alone condition) and subsequently when told they were being observed by their parent (parent present condition). A 3-minute parent-child interaction occurred between the two CPT immersions, allowing measurement of parental attention to their child's pain (i.e. parental pain-attending talk vs. non-pain attending talk). Findings showed that child pain catastrophizing moderated the impact of *parental presence* upon facial displays of pain. Specifically, low catastrophizing children expressed more pain in presence of their parent whereas high catastrophizing children showed equally pronounced pain expression when alone or in parental presence. Further, children's catastrophizing moderated the impact of *parental attention* upon facial displays and self-reports of pain ; higher levels of parental non-pain talk were associated with increased facial expression and self-reports of pain among high catastrophizing children; for low catastrophizing children, facial and self-report of pain was independent of parental attention to pain. The findings are discussed in terms of possible mechanisms that may drive and maintain pain expression in high catastrophizing children as well as potential limitations of traditional theories in explaining pediatric pain expression.

1. INTRODUCTION

Interest regarding the concept of catastrophizing in the context of pain has increased over the past years and resulted in a growing literature pointing to its importance in understanding deleterious pain outcomes, including increased disability, distress and pain [30;37;38;58;64]. Accumulating evidence indicating heightened associations between pain catastrophizing and observable pain behaviours [39;58;59] has emphasized the importance of considering catastrophizing within an *interpersonal* context. [58]. Sullivan et al. [58;59] have argued that catastrophizing relates to a communal or emotionally expressive orientation toward managing pain. From this communal coping perspective, catastrophizers' heightened pain expression may function primarily as social communication aimed at maximizing the probability that others will maintain proximity or offer support. Accordingly, the presence of others might provide a discriminative cue for increased pain expression in high catastrophizing individuals [56;58]. Offering an operant perspective, various authors further suggest that the presence of others, particularly those who are likely to respond solicitously (e.g., with positive attention to pain behaviour) may in turn reinforce and further strengthen these heightened expressions of pain [6;22;23;58].

Such potential interpersonal processes are particularly salient in pediatric populations. Children are highly dependent upon others and (facial) pain expressions may, particularly in this population, serve as especially strong signals of the need for attention or care [12;16;18;72]. The communicative nature of pain catastrophizing in children is supported by a consistent relationship between catastrophizing and increased pain expression [43;62;66].

However, a number of questions remain about processes underlying children's interpersonal expression of pain in the context of child catastrophizing. First, it is unclear whether increased expression of pain in high catastrophizing children is driven primarily or solely by communication goals. Recent evidence suggests that, among high catastrophizing

children, pain expression may similarly reflect a decreased ability to modulate displays of pain. To this end, Vervoort and colleagues [65] found that low catastrophizing children displayed greater pain in presence of their parent than in presence of a stranger. In contrast, high catastrophizing children's facial pain display was equally high in presence of either audience. To extend these findings, it is worthwhile to investigate whether high catastrophizing children show increased pain in the absence of direct communicative function -- i.e., when instructed that no one is watching. Additionally, operant conceptualizations of children's pain would further benefit from research examining whether high catastrophizers' pain displays vary with type of social response. Current findings link children's catastrophizing with both positive and negative parental attention to their child's pain [30;63;67], suggesting that an operant account (framing these parental responses as reinforcement and punishment, respectively) may be insufficient.

The present study aimed to further elucidate existing communal and operant accounts of children's pain expression in the context of child pain catastrophizing. We explored the communal coping account of catastrophizing by investigating whether high catastrophizing children show increased levels of pain expression not only in presence of their parent but also when alone. We explored operant conceptualizations of catastrophizers' pain expression by investigating the relationship between children's pain behaviour and parental responses to their child's pain as a function of the children's catastrophic thinking about pain.

2. METHOD

2.1 Participants

The present study is part of a larger study that investigated the effects of distraction. Children included in this larger study were either assigned to a distraction condition or control condition. The present study only reports on children assigned to the control condition. Participants were recruited from a larger sample of school children from grades 5 through 12

and their parents (n=2681) who were approached for a questionnaire study that took place approximately 1 year prior [67]. Only children and parents who had given consent to be re-contacted (n=1015) were approached. Children and their parents were eligible to participate if (1) the child and parent were able to speak and write Dutch, and if the child did not suffer from (2) any chronic illness including recurrent or chronic pain, (3) a developmental disorder, or (4) colour blindness. A weighted random sampling procedure was used [31], ensuring an equal proportion of boys and girls and an equal age distribution. From the total of 1015 parent child dyads who consented, 122 parent-child dyads were randomly selected and contacted. Of those contacted, 95.1% (n=116) met the inclusion criteria and 77.6% (n=90) agreed to participate. Three parent-child dyads later withdrew because of illness or other family responsibilities (response rate=75%). The final sample entering the present study (i.e. children assigned to the control condition) consisted of 44 children.

Within the present study, children were requested to perform a 1 minute cold water task (CPT) twice; once when instructed no-one was observing (first CPT immersion) and once when told their parent was observing them (second CPT immersion). The order of CPT performance was consistent across participants. A 3-minute parent-child interaction took place between the two cold pressor tasks. One participant was excluded because accompanied by a brother instead of a parent. Additionally, participants were excluded from data analysis if they withdrew participation before the pain task (i.e. 1 minute duration) was completed. This was the case for 5 children (3 withdrew participation during the first CPT and 2 during the second CPT). Drop-out analyses showed no significant differences in level of pain catastrophizing between those children who dropped out and those who did not ($t(42)=-.56$, ns). The final sample considered for analyses included 38 children (22 boys, 16 girls) aged 10-18 years ($M=14.5$ years, $SD= 2.52$) and one of their parents (28 mothers, 10 fathers). Approximately 10.5% of the children (n=4) were recruited from the fifth grade, 5.3% (n=2)

from the sixth grade, 10.5 % (n=4) from the seventh grade, 7.9% (n=3) from the eighth grade, 13.2% (n=5) from the ninth grade, 15.8% (n=6) from the tenth grade, 18.4% (n=7) from the eleventh grade, and 18.4% (n=7) from the twelfth grade. Parents ranged in age from 34 to 57 years ($M = 45.71$ years, $SD = 4.84$). The majority of parents were married or co-habiting (92.1%) and had further education (beyond the age of 18 years; 81.6%). Children and their parents were compensated 35€ for participating in this study. The study was approved by the Ethics Committee of the Faculty of Psychology and Educational Sciences of Ghent University, Belgium.

2.2 Apparatus

A cold pressor apparatus was used as an experimental technique to induce pain in the children. The cold pressor device consisted of a metallic water container (type Techne B-26 with TE-10D, size 53x32x17cm). Children were instructed to immerse their left hand (first immersion: alone condition) or right hand (second immersion: parent present condition) up to just above the wrist in the tank with cooled water for a fixed immersion time of 1 minute. They were also instructed not to form a fist and not to move their fingers [68]. Temperature of the water was kept constant at 12°C and was circulated continuously by a water pump (type Techne Dip Cooler RU-200) to prevent local warming around the immersed hand [68]. Previous research has revealed that this temperature and 1 minute immersion interval creates a painful stimulus of moderate pain intensity [61]. The cold pressor procedure is considered to be well suited for use with children and the pain experienced is considered to be an analog for various naturally occurring acute pains [68]. The cold pressor apparatus was placed upon a trolley adjustable in height to provide comfortable access to the water tank for children of different stature. Another container filled with water at room temperature of 21°C (type Julabo TW20, size 56x35x32cm) was used to standardize hand temperature before the immersion in the cold water [68].

2.3 Measures

2.3.1 Child Measures

2.3.1.1 Pain catastrophizing

Catastrophic thinking about pain was assessed with the Dutch version of the *Pain Catastrophizing Scale for Children (PCS-C)* [19]. This instrument is an adaptation of the adult Pain Catastrophizing Scale [57]. The PCS-C consists of 13 items describing different thoughts and feelings that children may experience when they are in pain. Children rate how frequently they experience each of the thoughts and feelings when they are in pain using a 5-point scale (0 = 'not at all', 4 = 'extremely'). The PCS-C yields a total score that can range from 0 to 52, and three subscale scores for rumination, magnification and helplessness. The PCS-C has shown to be a reliable and valid instrument in children from 9 to 15 years [19]. Cronbach's alpha for the present study was .80.

2.3.1.2 Pain intensity

The child's experienced pain intensity was assessed using a 100 mm VAS scale. After completion of each cold pressor task, children were prompted to provide written ratings of their current pain and worst pain they had experienced during the one-minute immersion on a 100 mm VAS-scale, labeled at 0mm ("no pain"), 25mm ("low pain"), 50mm ("moderate pain"), 75mm ("most intense pain") and 100 mm ("enormous pain"). The mean of the two pain intensity ratings was taken as an index of experienced pain. This measure is a valid indicator of the pain experience during the CPT [36].

2.3.1.3 Facial pain expression

Children's facial activity was recorded with a video camera. Pain behaviour was then assessed using the Child Facial Coding System [CFCS; 5;13;24]. The CFCS is an observational rating system of 13 discrete facial actions (brow lowering, squint, eye squeeze, nose wrinkle, nasolabial furrow, cheek raiser, upper lip raise, lip corner pull, vertical mouth

stretch, horizontal mouth stretch, blink, flared nostril and open lips). The CFCS has shown good reliability and validity in coding children's facial pain expressions [24]. Facial actions were coded by two trained raters who were blind to the children's pain and catastrophizing ratings as well as parental behaviours. From videotape, the first coder rated pain behaviour for all participants. A random sample of 20% of the participants was coded by the second coder to determine inter-rater reliability. Raters were trained to competency by studying the original CFCS manual and coding 5 practice tapes of previous studies [13]. Competent coding was achieved when coders achieved minimum reliability of .70 for each of the 13 facial pain expressions. Interrater reliability was calculated according to the formula given by Ekman and Friesen [21] which assesses the proportion of agreement on actions recorded by two coders relative to the total number of actions coded as occurring by each coder. Ten facial actions were coded for intensity (no action (0), slight action (1), distinct/maximal action (2)), and three facial actions (blink, flared nostril, open lips) were coded as absent or present (0 or 1). Each second of the child's 1 minute CPT immersion was coded for these 13 facial actions using software that enabled raters to view and re-view each second at a normal rate and at a rate of 1/10 of a second [see 65]. For each 10-second interval of the child's CPT immersion, a mean score per second was calculated for each facial action. For each facial action, the mean score derived from each of the six 10 second intervals (comprising the 1-minute immersion) were subsequently summed to yield a total CFCS score. As 10 of the 13 facial actions were coded on frequency and intensity (0,1 or 2) and 3 were coded on frequency alone (0 or 1), the total CFCS scores for each cold water immersion ranged between 0 and 138. Within the present study, acceptable interrater reliability was achieved for overall frequency (.78 range .70-.94) and intensity (.71; range .54-.94) [5;24]

2.3.1.4 Parent –child interaction

Videotapes of the 3- minute interaction between parents and children were transcribed and divided into independent child and parent utterances. The coding system used in the present study was based upon the coding procedure developed by Walker et al. [70]. This coding system is a modification of the Child Adult Medical Procedure Interaction Scale-Revised (CAMPIS-R) [3] and comprises codes for parents' utterances including (1) *Attending or pain-related talk*, defined as any talk by the parent that focuses upon the child's pain experience (e.g. 'Did it hurt a lot?', 'Are you still in pain now?'), (2) *Non-pain related talk*, defined as parent utterances that did not focus upon the child's pain experience or CPT procedure (e.g. 'Are you seeing your friends this evening?', 'I am wondering what we will have for dinner tonight') and (3) *Other*, which included parent's inaudible utterances and statements about technical aspects of the experimental procedure. Within the present study, one refinement was made to the original coding procedure. In particular, previous findings have indicated that parental attention to the child's pain can be considered either positive (e.g. 'are you feeling OK now?') or negative (e.g. 'I cannot believe it is that painful', 'don't exaggerate') [see e.g. 14;30;35]. Therefore, parental attending talk was coded as either positive or negative.

In line with Walker et al. [70], codes for children's utterances included (1) *Child pain talk*, defined as statements about the pain experience (e.g. 'My hand feels numb'; 'It was painful) and (2) *Other*, defined as all other child utterances. Mutually exclusive codes (either '*Positive attending talk*' '*Negative attending talk*', '*Non-pain attending talk*' or '*other*' for parent utterances and '*child pain talk*' or '*other*' for child utterances) were assigned to each utterance. A primary coder assigned codes to all utterances. Reliability was assessed by having a second independent coder completing the same coding process for 25% of the transcripts. Coders were trained by studying and discussing the training manual based upon the procedure used by Walker et al. [70]. Raters were also familiar with the CAMPIS-R

manual, from which the current coding procedure was derived. Training consisted of practice coding 5 videotapes from a previous study. Adequate reliability was demonstrated when coders achieved minimum reliability of .70 for each of the coding categories. In line with Walker et al. [70], reliability calculations were computed using intra-class correlations [2]. Reliability coefficients within the present study indicated excellent reliability (ranging from .90 to .94) for all coding categories, except for parental negative attending talk. However, negative pain attending talk by parents occurred infrequently (approximately 0.3% of all utterances) during the 3-minute parent-child interaction. Therefore it was decided not to include this category in further analyses.

Three proportion scores were created for data analysis: (1) *Parental positive pain attending talk* (number of parent utterances coded as positive pain attending talk divided by the total number of parent utterances), (2) *Parental non-pain talk* (number of parent utterances coded as non-pain attending talk divided by the total number of parent utterances) and (3) *Child pain talk* (number of child utterances coded as pain talk divided by the total number of child utterances).

2.4 Procedure

2.4.1 Introduction phase

All participants were invited by phone and received standardized information about the experiment. The pain procedure was described and they were informed that their child would be asked to perform a cold water task, in which the hand will be immersed in a box of cold water for one minute. Parent and children were not informed beforehand about the second CPT performance or the interval 3-minute parent-child interaction. Families showing interest in participating were asked whether the child could be accompanied by either their mother or father. When parents and children provided consent, they were invited to the

laboratory at Ghent University where the study was conducted. A letter confirming their appointment was sent to them.

Upon arrival at the lab, one of two experimenters accompanied the parent and child to the test-room. Participants were explained that we were interested in “how children think and feel about the pain that they experience”. The pain procedure was described, and the cold water box was shown. They were reminded of the option to withdraw participation at any time, and written parental consent and child assent were obtained. Experimenter 1 stayed with the child in the test-room while experimenter 2 accompanied the parent to an adjacent room. The second experimenter explained that we were also interested in how parents think and feel when their child experiences pain and asked the parent whether the parent would be willing to observe their child during the pain procedure. Parents filled in a socio-demographic questionnaire, while their child completed the measure on pain catastrophizing.

2.4.2 Experiment phase

The experimental procedure consisted of several parts; i.e. (1) the child performing the cold pressor task when instructed that no-one is observing (2) a 3-minute interaction phase between parent and child, and (3) the child performing the cold pressor task when instructed that they were being observed by their parent. In reality, parents observed their child during both CPT immersions; however, children could not see their parent during either CPT immersion and were only instructed about their parent observing them prior to performing the second CPT. Prior to the first immersion, the child was told that their parent was seated in the waiting room, and hence, not instructed about being observed during performance of the first CPT. Thus, during the first CPT children were *unaware* of parental presence, whereas they were *aware* of their parent observing them during the second CPT. Throughout the remainder of the text, we will refer to the first CPT as the ‘alone condition’ and to the second CPT as the ‘parent present condition’.

The design of the present study consisted of a repeated measures design where the order of CPT performance was the same for each child; all children first performed the cold pressor task when told that no-one was observing (i.e., ‘alone condition’), followed by performing the cold pressor task when told of being observed by their parent (i.e. ‘parent present condition’, with a 3-minute parent-child interaction in between the two cold pressor tasks. Order of CPT performance was not counterbalanced as the reverse order would have precluded investigation of the impact of parental responses upon *subsequent* child pain behavior in *presence* of their parent, and hence, would not allow investigation of whether catastrophizers’ pain displays are amenable to reinforcement by parents.

In the test-room a video camera recorded the child’s facial pain behaviour during the pain procedure. The camera was connected with a television screen in the observer-room where the parent was able to observe their child. In addition, to prevent any contact with the child, experimenter 1 was seated behind a screen during performance of both cold pressor tasks.

(1) First Cold pressor task – alone condition

Prior to immersion in the cold water box, the child was requested to immerse their left hand for one minute in the room temperature tank to standardize hand temperature [68]. Then, participants immersed their left hand in the cold water container for one minute. Immediately following the one minute cold water immersion, they rated their experienced pain. The cold pressor procedure ended with a submersion for one minute in the room temperature tank to recover [68].

(2) Parent- child interaction

After completion of the first CPT, the child and parent were reunited in the observer-room, debriefed about parental observation and informed about performing the CPT for a second time. After additional written parental consent and child assent were obtained for performance of the second cold pressor task, parent and child were left alone in the observer

room for a fixed time interval of 3 minutes. During this 3-minute interval, parent-child interaction was videotaped. Parent and child were not informed about video recording their interactions in order to capture spontaneous behaviours.

(3) Second Cold pressor task – parent present condition

Prior to performance of the second CPT, experimenter 1 accompanied the child to the test-room and the child was explicitly told that their parent would be observing them during performance of the second CPT. The second cold pressor procedure was similar to the first immersion, except for using the other (right) hand during the second immersion. After completion of the second cold pressor test, the parent and child were reunited in the test-room, fully debriefed and additional written parental consent and child assent were obtained for the use of the video data.

2.5 Statistical plan

For the current study, the primary outcome measure was the child's facial pain expression. To investigate the impact of parental presence, we used a repeated measures analysis of variance (ANOVA), with parental presence (alone versus parent present) as a within group factor and the child's pain catastrophizing as a covariate (moderator). Greenhouse-Geisser corrections (with adjusted degrees of freedom) were performed and stated whenever the sphericity assumption was violated (Mauchly's Test of Sphericity; $p < .05$).

To test for the impact of parental attention to their child's pain, hierarchical linear regression analyses were performed with parental pain talk or non-pain talk, respectively, as predictor variables, the child's pain catastrophizing as a moderator variable, and the child's facial display of pain in presence of their parent (i.e., during the 2nd CPT) as the dependent variable. Moderation analyses followed the procedures outlined by Aiken and West [1] and Holmbeck et al [33;34] -- i.e., (1) continuous predictor variables were centered and (2)

significant interactions were investigated by plotting and testing the significance of the regression lines for high (+1 SD above the mean) and low (-1 SD below the mean) values of the continuous moderator variable (i.e., child catastrophizing) [33;34].

To partial out the impact of demographic variables upon pain expression, we controlled for the child's age and sex (boys coded 0, girls coded 1) in each repeated measures/regression analysis. In addition, for moderation analyses investigating the impact of parental attention, we controlled for the impact of the child's pain talk as this was closely associated with parental behaviour (i.e., parental pain or non-pain talk). Furthermore, to investigate whether patterns associated with the child's catastrophizing and parental presence/parental attention were unique to facial display of pain, similar analyses as described above were run with child-reported pain intensity as the dependent variable.

3. RESULTS

3.1 Descriptives

Mean scores, standard deviations and correlations between measures are reported in Table 1. Scores on pain catastrophizing ranged from 1 to 24 with a mean score of 12.08; (SD = 5.49). The mean level of catastrophizing in the present sample is comparable with those obtained in other samples of school children [see e.g. 64]. Children reported moderate levels of pain intensity for both immersions. However, the child's reported pain intensity for the first immersion (alone condition; M= 43.09; SD=24.42; (range 1-100)) was significantly higher than the child's mean pain intensity for the second immersion (parent present; M=36.04; SD=21.12; (range .5-89); $t(37)=3.73$, $p < .01$). Interestingly, the reduction in experienced pain intensity was not reflected by the child's facial pain displays. In fact, the inverse pattern emerged for the child's facial pain expression; i.e., facial display of pain was significantly higher when they were aware of parent observation ($M_{\text{second immersion}}=10.11$; SD=8.02; (range 1.3-46.4)) as compared to when they believed they were alone ($M_{\text{first immersion}}=6.85$; SD=9.85;

(range .8-60.7); $t(37)=3.04$, $p<.01$). For the 3-minute parent-child interaction, an equal proportion of parents' utterances were coded as pain talk (M= 34%, SD= 21%) and non-pain talk (M= 36%, SD= 21%). Approximately a quarter of the child's utterances were coded as pain talk (M= 28%, SD= 19%). Kolmogorov-Smirnoff (KS) tests of normality indicated that all variables were normally distributed (All KS Z-scores $<.95$, ns), except the score on child facial pain expression (CFCS score) for the first immersion (KS Z-score = 1.66, $p < .01$). Root mean square transformation resulted in normal distribution of this score. However, analyses with transformed or non-transformed CFCS score for the first immersion revealed similar findings. Therefore non-transformed CFCS score was retained in analyses.

Insert Table 1 about here

3.2 Correlations

Pearson correlation analyses (see Table 1) revealed that the child's catastrophizing was significantly positively correlated with child reported pain intensity for both immersions. The child's catastrophizing was positively, though not significantly, associated with facial display of pain during the first CPT and with parental non-pain talk¹. Interestingly, the child's facial pain expression during the first immersion was significantly positively correlated with parental non-pain talk, indicating that higher levels of child facial pain expression were followed by higher levels of parental talk not attending to pain. Furthermore, there was a significant positive correlation between the child's facial pain display and child-reported pain intensity during the first immersion (alone condition) only. Correlations between pain intensity and facial display of pain were no longer significant for the second immersion (in presence of parent). Complementing other findings [68], parent pain talk and child pain talk

¹ Additional correlational analyses performed on the sample of children who completed the first CPT but withdraw participation during the second CPT ($n = 40$) indicated that the child's catastrophizing was significantly positively correlated with facial display of pain during the first CPT immersion ($r = .35$, $p < .05$). It is therefore likely that correlational analyses on the restricted sample of children who completed both CPT immersions ($n=38$) resulted in a decrease in power, and hence, failure to reach significance.

were positively correlated, whereas parent non pain talk was inversely correlated with child pain talk.

3.3 The impact of parental presence and child catastrophizing

3.3.1 Facial pain expression

A repeated measures ANOVA with parental presence (alone versus parent present) entered as within-subject variable, child sex as between subject factor, and the child's age and pain catastrophizing as covariates revealed no significant effects of the child's pain catastrophizing ($F(1,34)=.14$; ns) and child's sex ($F(1,34)=1.07$, ns). There was a significant main effect of the child's age ($F(1,34) = 5.69$, $p < .05$), indicating decreased facial pain expression among older children. Further, there was also a significant main effect of parental presence ($F(1,34) = 8.81$, $p < .01$), indicating that children expressed more pain when they were aware of being observed by their parent (parent condition) than when they were unaware of parent observation (alone condition). However, there was a significant interaction between the child's pain catastrophizing and parental presence ($F(1,34) = 4.38$; $p < .05$), indicating that the effect of parental presence upon facial pain expression was conditional on levels of the child's pain catastrophizing. To illustrate the pattern reflected in this statistically significant interaction term, we plotted regression lines for high (+1 SD above the mean -- high catastrophizing) and low (-1 SD below the mean -- low catastrophizing) values of the moderator variable [see 33;34]. These regression lines are shown in Figure 1. Results of 2 additional repeated measures ANOVAs with parental presence x low child catastrophizing and parental presence x high child catastrophizing respectively, indicated that only the analysis with low catastrophizing reached significance; low catastrophizing children displayed more pain expression in the presence of their parent compared to when alone ($F(1,36) = 15.90$, $p < .0001$). In contrast, facial pain expression of high catastrophizing children did not vary as a function of parental presence ($F(1,36)=.24$, ns); i.e., high catastrophizing

children expressed equally increased levels of facial pain expression regardless of whether they believed to be alone or whether they were aware their parent was observing them.

Insert Figure 1 about here

3.3.2 Pain intensity

The repeated measures ANOVA with parental presence as within subject factor and child age, sex and pain catastrophizing as covariates revealed a significant main effect for the child's pain catastrophizing ($F(1,33) = 4.83, p < .05$), indicating that higher levels of pain catastrophizing are associated with higher pain intensity. Further there was also a significant main effect of child-reported pain intensity ($F(1,33) = 12.90, p < .01$). Interestingly, though contrary to the child's facial display of pain, child self-reported pain was lower when being aware of parental observation than when they believed to be alone. There were no other significant main or interaction effects (all $F(1,33) \leq 1.15, ns$).

3.4 The impact of parental attention to the child's pain and child catastrophizing

3.4.1 Facial pain expression

Two regression analyses were performed to investigate the relationship between parental attention (parental positive pain talk and parental non-pain talk, respectively) and the child's facial display of pain. Within each regression, the moderating role of the child's pain catastrophizing was investigated. Four blocks of independent variables were entered in each regression in the following order; (1) the child's age and sex, (2) the child's pain talk, (3) the child's catastrophizing and either parental pain talk or non-pain talk and (4) the cross-product terms of the respective type of parental responses and pain catastrophizing. The variance-inflation factors of the moderation analyses were acceptable (range 1.07-3.32), suggesting that there was no problem of multicollinearity.

The regression analysis using *parental pain talk* revealed a significant effect for the child's sex ($t=-2.04, \beta=-.32, p<.05$) and a trend for the child's age ($t=-1.75, \beta=-.29, p=.09$)

indicating that girls and older children tend to express lower levels of pain as compared to boys and younger children. There were no other significant main or interaction effects (all $t \leq |1.51|$, ns).

The regression analysis with *parental non-pain talk* entered as an independent variable revealed similar effects for the child's sex ($t=-2.23$, $\beta=-.35$, $p<.05$) and age ($t=-1.91$, $\beta=-.30$, $p=.07$), indicating lower pain expression for girls and younger children. In addition, there were also no significant effects of the child's catastrophizing ($t=-.34$, $\beta=-.05$, ns) or parental non-pain talk ($t=1.23$, $\beta=.22$, ns) upon the child's facial pain expression. In contrast to above findings, however, a significant interaction emerged between the child's pain catastrophizing and parental non-pain talk ($t=2.12$, $\beta=.35$, $p<.05$; $\Delta R^2=.10$), indicating that the effect of parental non-pain talk upon child facial expression of pain was conditional on the level of child catastrophizing. To illustrate the pattern reflected in this statistically significant interaction term, we plotted regression lines for high (+1 SD above the mean) and low (-1 SD below the mean) values of the moderator variable (see Figure 2). Significance tests for both slopes revealed that the regression line for low catastrophizing children was not significant ($t=.53$, $\beta=.11$, ns), indicating that parental non-attending talk had no impact upon the child's pain expression when the child reported low levels of pain catastrophizing. For high catastrophizing children, however, findings indicated that higher levels of parental non-pain talk were significantly associated with higher expression of pain ($t=1.98$, $\beta=.51$, $p<.05$).

Insert Figure 2 about here

3.4.2 Pain intensity

Similar regression analyses looking at parental attention to the child's pain (i.e. parental pain talk, parental non-pain talk) and child catastrophizing were performed for child-reported pain intensity. VIF were acceptable (range 1.07 – 3.14). The analysis examining the impact of *parental pain talk* upon the child's pain intensity revealed a positive trend for the

child's pain catastrophizing ($t=1.94$, $\beta=.33$, $p=.06$), indicating that higher levels of pain catastrophizing were associated with higher pain intensity. There were no other significant main or interaction effects (all $\beta < |.15|$, ns).

The analysis using *parental non-pain talk* revealed a significant positive effect of the child's pain catastrophizing ($t=2.34$, $\beta=.38$, $p<.05$). There were no other main effects (all $\beta < |.21|$, ns). Interestingly, however, there was a significant interaction effect ($t=2.17$, $\beta=.37$, $p<.05$; $\Delta R^2=.11$), indicating that the association between parental non-pain talk and child-reported pain intensity differed for high vs. low catastrophizing children. Significance tests of the regression lines for high and low catastrophizing children (see Figure 3) indicated that neither reached significance. Nevertheless, the slope for high catastrophizing children ($t=1.67$, $\beta=.40$, $p = .10$) was much more pronounced than the slope for low catastrophizing children ($t=-.83$, $\beta=-.17$, ns), suggesting that the impact of parental non-pain talk may be most influential for high catastrophizing children. Indeed, additional analyses (see also Figure 3) revealed that higher levels of the child's pain catastrophizing were associated with higher levels of pain intensity reports, but only when non-pain talk by parents was high ($t= 2.78$; $\beta = .66$, $p < .01$) and not when parental non-pain talk was low ($t=.45$, $\beta = .09$, ns).

Insert Figure 3 about here

4. DISCUSSION

The present study investigated the impact of parental presence, parental attention to their child's pain, and child pain catastrophizing upon children's pain expression during a cold pressor task (CPT). Children completed the CPT twice, first unaware that their parent was observing them (alone condition) and subsequently when told they were being observed by their parents (parent present condition). A 3-minute parent-child interaction occurred between the two CPT immersions. Results indicated that children's pain catastrophizing

significantly moderated the impact of *parental presence* upon facial displays of pain. Low catastrophizing children expressed more pain believing to be in presence of their parent than when alone; in contrast, high catastrophizing children showed equally pronounced facial pain expression when alone or in parental presence. This pattern of findings was not observed for children's self-reported pain; independent of catastrophizing, self-reported pain was significantly lower in presence of a parent than when children thought they were alone. Further, children's catastrophizing significantly moderated the impact of *parental attention* to their child's pain upon facial pain displays and self-reports of pain. Specifically, higher levels of parental non-attending pain talk were associated with increased facial expression and self-reports of pain among high catastrophizing children; for low catastrophizing children, facial display and self-reports of pain were independent of parental attention to pain. Our results are in line with previous findings that (particularly facial) expressions of pain are sensitive to audience presence [40;51;74], the threat value of pain [43;62;666], and the interaction between these variables [56;65].

While our findings are in line with evidence linking pain catastrophizing with an expressive orientation toward coping with pain [39;43;58;59;62;66], they extend prevailing theoretical frameworks characterizing research with adult populations. Among adult samples, communal coping and operant conceptualisations of pain behaviour suggest that catastrophizers' heightened pain expression primarily reflects communication goals and is subsequently maintained by operant reinforcement [22;23;58]. Accordingly, adults who catastrophize about pain show greater duration of pain behaviour when an observer is present [56] and the association between catastrophizing and pain report is stronger for individuals residing with a solicitous spouse or partner [23].

Our findings suggest that pain behaviour in high catastrophizing children reflects more than can be explained by communication intent or reinforcement history. Increased pain

expression serves communicative functions to the extent that it can capture others' (e.g., parents') attention, who might in turn react with help and care [16;72]. High catastrophizing children's comparable displays of pain in presence of a parent as when alone suggests that children's facial pain expressions *may not always or solely be driven by communication goals*. Although well known to occur when alone [40;72], pain displays have limited communicative value (and hence protective social function) in absence of others. Moreover, solitary pain displays are not amenable to reinforcement by others.

A number of explanations can account for indiscriminate displays of pain among high catastrophizing children. Increased pain expression in high catastrophizing children may stem from accumulating individual failures to cope with pain experience. Previous findings show that effective coping may be severely compromised for high catastrophizers [32; 44;53;57]. While absence of a potential caregiver (e.g., parent) may cue mobilization of autonomous coping strategies [48], prior coping failures might explain why high catastrophizing children remain equally expressive when alone. In a similar vein, generally elevated pain displays may reflect decreased self-regulatory capabilities [25]. For high catastrophizing children, the high threat value of pain may impact motor regulation processes and thereby interfere with ability to (socially) modulate pain expression. This possibility is supported by findings that high catastrophizing adults show increased activation in brain areas related to motor activity [29;55]. However, increased pain expression may not necessarily reflect failure to cope or modulate motor output. Inhibition of pain expression is associated with negative consequences, such as increased pain and distress, particularly for high catastrophizing individuals [60]. Accordingly, increased pain expression among high catastrophizing children may represent an active attempt to handle pain experience. Importantly, these various explanations are not incompatible, nor imply suppression/absence of pain display among low catastrophizing children in the alone condition, but, in line with previous findings [65],

suggest that high catastrophizing children's pain displays are -- compared to low catastrophizing counterparts -- less sensitive to audience presence.

Irrespective of communicative intent, our findings indicate that displays of pain have impact upon others. In turn, others' responses likely impact sufferers' pain experience and expression. Our findings suggest that this may be particularly salient in the context of child catastrophizing. Specifically, among high catastrophizing children, higher levels of parental non-attending pain talk were associated with higher self-report and facial expression of pain. This was not observed for pain attending talk. At first sight, these findings stand in contrast to predictions drawn from operant conceptualisations of pain behaviour [10;22;50], yet corroborate recent evidence that parent-child interactions are not well accounted for by the ostensibly reinforcing vs. punishing quality of parental behaviours [50;52;69]. For instance, while parental non-pain talk can direct attention away from pain and hence imply distraction [3;70], adult and child literature suggests that distraction may not be an effective strategy, particularly for high catastrophizers [25;27;44]. In the context of our study, it is plausible that parental non-pain talk communicated *ignorance of and disregard* for the child's pain, thereby invalidating the child's pain experience [8;10]. Preliminary evidence that high catastrophizing adults feel highly entitled to support [9] suggests that high catastrophizers may be particularly prone to feeling invalidated in the absence of sufficient acknowledgment of their suffering, i.e., when non-pain talk is high. To the extent that parental non-pain talk invalidates high catastrophizers' pain, increased facial expression and self-reports of pain may reflect increased aversiveness of pain [10;45;54]. However, our findings do not entirely rule out operant explanations. It may be that high catastrophizing children's pain displays have previously but occasionally been reinforced. Through intermittent reinforcement, children may have learnt to persist (i.e. show increased pain) in order to obtain attention [4;20].

Interestingly, our findings suggest that increased pain displays are not necessarily successful in mobilizing parental attention to their child's pain. On the contrary, higher levels of child facial pain expression appear to mobilize parental non-pain talk -- behaviour that directs attention *away* from the child's pain. Although further research is needed, it is plausible that parents' emotional responses to their child's pain are salient in explaining parental behaviour. Studies indicate that observing pain not only elicits empathic concern and approach behaviour, but also an aversive state of personal distress with associated avoidance tendencies [7; 11;26; 73]. Viewing one's child in pain may primarily elicit feelings of distress, instigating an urge to avoid or escape the child's pain as an attempt to regulate personal distress. Such emotional response is one of various potential routes to parental behavior. For instance, parents are also likely to have expectations of consequences and related beliefs regarding the appropriateness of specific responses [42;49]. Parents' non-pain talk in response to pain displays may represent their active attempt to model well behavior (i.e. not to exaggerate or "fuss" about pain) [15;28;46]. Further research is needed to elucidate underlying mechanisms motivating parental behavior and account for the observed association between child pain displays and parental non-pain talk.

Several study limitations deserve consideration. First, we used experimental pain in a controlled environment. Extrapolation to clinical/naturally occurring pain should be done cautiously. Second, due to the small size of our sample, statistical power was limited and only large effects could be detected; our results may not fully represent the population from which the current sample was drawn. Third, for the majority of children in our sample, the participating parent was the mother (74%). Accordingly, our findings most represent mother-child interactions. Fourth, our findings may not characterize parent-child dyads who reunited after the child was unobserved while undergoing a painful procedure. Parental behaviour may have been different in case they did not observe their child during the first CPT. Similarly, as

children were, after completion of first immersion, informed about parental observation, this may have altered parent's discriminative cue value for increased expression and hence impact their subsequent pain expression in presence of their parent. Finally, the approach used for coding parent-child interactions may have limited ability to detect significant effects; finer-grained analyses may be necessary to elucidate distinct qualities of parental response to their child's pain and its impacts upon the child's pain experience and expression .

In spite of these limitations, the present study further attests to the expressive nature of pain catastrophizing in children [43;62;65;66] and suggests that various, not necessarily incompatible, processes likely drive and maintain child catastrophizers' pain expression. Importantly, our findings highlight limitations of traditional pain behaviour models in fully accounting for the complexities of interaction between parents and children. While communal and operant processes doubtless play a role in the parent-child dynamic, future research is encouraged to further explore alternative perspectives suggested by the current findings. Likewise, research is needed to elucidate our understanding regarding the origins of catastrophizers' pain expression and mechanisms contributing to its persistence. Given the significant role of catastrophizing within the interpersonal context, studies investigating how catastrophizing and related expressions are shaped by early relationships with caregivers and subsequently by significant partners in adolescence and adulthood, may be particularly informative [41;47;58;71].

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FIGURE LEGENDS

Figure 1: Regression lines for the relationship between parental presence and the child's facial display of pain as moderated by the child's pain catastrophizing

*** $p < .0001$

Figure 2: Regression lines for the relationship between parental non-pain attending talk and the child's facial display of pain as moderated by the child's pain catastrophizing

* $p < .05$

Figure 3: Regression lines for the relationship between parental non-pain attending talk and the child's self-reported pain intensity as moderated by the child's pain catastrophizing

** $p < .01$

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Table 1
Means (M), standard deviations (SD) and Pearson correlation coefficient for all parent and child measures

	M	SD	2	3	4	5	6	7	8
1. Child pain catastrophizing	12.08	5.49	.38*	.35*	.22	-.04	-.17	.21	-.13
2. Child pain intensity – CPT alone	43.09	24.42	--	.88**	.37*	.24	-.09	.21	-.05
3. Child pain intensity – CPT parent	36.04	21.12		--	.38*	.20	-.19	.14	-.13
4. Child facial expression – CPT alone	6.85	9.85			--	.75**	-.12	.37*	-.20
5. Child facial expression – CPT parent	10.11	8.02				--	-.05	.25	-.16
6. Pain talk parent	.34	.21					--	-.29 ^(*)	.79**
7. Non pain talk parent	.36	.21						--	-.41*
8. Pain talk child	.28	.19							--

^(*)p = .08; * p < .05; ** p < .0001; CPT = Cold Pressor Task

Figure 1: The moderating role of child pain catastrophizing for the relationship between parental presence and child facial expression pain

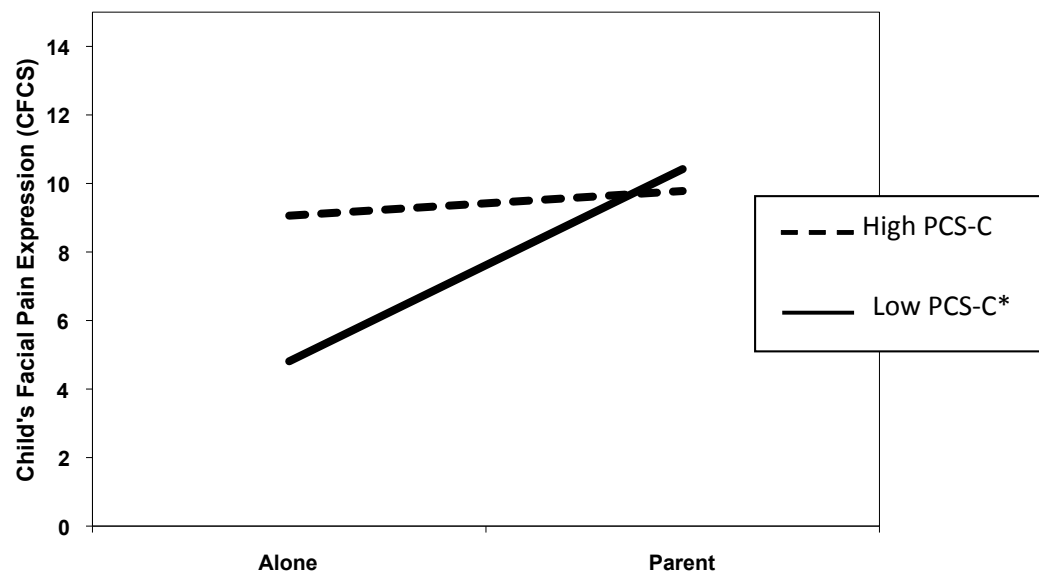


Figure 2: The moderating role of child pain catastrophizing for the relationship between parental non-pain talk and child facial expression pain

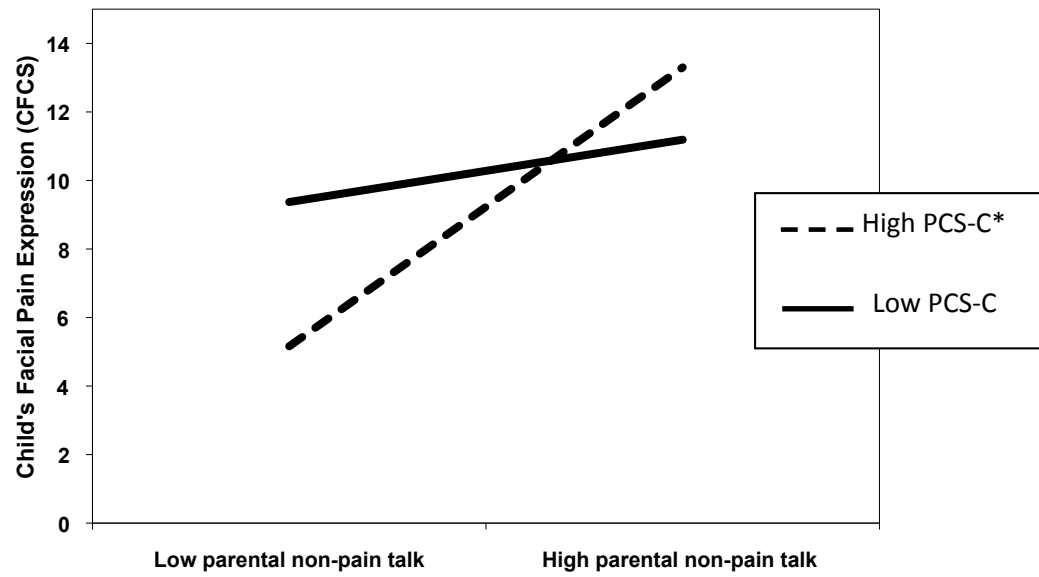


Figure 3: The moderating role of child pain catastrophizing for the relationship between parental non-pain talk and child-reported pain intensity

