

Children's selective attention to pain and avoidance behaviour: The role of child and parental catastrophizing about pain

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ABSTRACT

The present study investigated selective attention to pain in children, its implications for child avoidance behaviour and the moderating role of dimensions comprising child and parental catastrophizing about pain (i.e., rumination, magnification and helplessness). Participants were 59 children (31 boys) aged 10-16 years and one of their parents (41 mothers). Children performed a dot-probe task in which child facial pain displays of varying pain expressiveness were presented. Child avoidance behaviour was indexed by child pain tolerance during a cold pressor task. Children and parents completed measures of child and parent pain catastrophizing respectively. Findings indicated that both the nature of child selective attention to pain as well as the impact of selective attention upon child avoidance behaviour were differentially sensitive to specific dimensions of child and parental catastrophizing. Specifically, findings showed greater tendency to shift attention away from pain faces (i.e., attentional avoidance) among children reporting greater pain magnification. A similar pattern was observed in terms of parental characteristics, such that children increasingly shifted attention away from pain with increasing levels of parental rumination and helplessness. Furthermore, child attentional avoidance was associated with greater avoidance behaviour (i.e., lower pain tolerance) among children reporting high levels of pain magnification and those whose parents reported greater rumination about pain. The current findings corroborate catastrophizing as a multidimensional construct that may differentially impact outcomes and attest to the importance of assessing both child and parental characteristics in relation to child pain-related attention and avoidance behaviour. Further research directions are discussed.

1. INTRODUCTION

Contemporary cognitive-affective models propose that pain imposes an overriding attentional priority that motivates avoidance behaviour [3;20;61;70], particularly in the context of excessive elaboration/rumination regarding pain, as is the case in high pain catastrophizing [57;60;63]. To date, most studies in this domain have been conducted with adult samples. In contrast to the growing adult literature, only two studies have addressed children's selective attention to pain-related information [5;9]. However, neither study assessed the impact of child selective attention on child avoidance behaviour, or the role of catastrophizing. This is surprising given the significant number of children suffering from pain [37], the hypothesized pivotal role of attention and avoidance in development and maintenance of pain problems [3;20;61;70], and the importance of pain catastrophizing in understanding deleterious pain outcomes (e.g., increased pain /disability) among both clinical and non-clinical pediatric samples [15;29;42;67].

While several adult studies find that attentional capture and behavioral avoidance are amplified with greater pain-related catastrophizing [35;60;63], this evidence is not unequivocal. Some studies fail to identify expected relationships between attention, avoidance, and catastrophizing [32;49;62], or find evidence counter to expectations [8;65;66]. The limited pediatric literature is likewise marked by inconclusiveness. Selective attention toward pain (words) was observed among children with functional abdominal pain [5], but the reverse pattern (attentional avoidance) was observed among children with recurrent abdominal pain [9].

The apparent discrepancies in adult and child literatures may owe to methodological and conceptual limitations. A central methodological limitation may be reliance on word stimuli [8;19;36;41;51 but see 44;50;65]; linguistic stimuli are criticized as having low ecological validity and only indirectly relating to pain [16;17]. More ecologically valid

stimuli, such as facial pain expressions may represent a significant advance in the study of attention to pain, particularly when these facial stimuli relate to personally relevant impending pain [16;17].

From a conceptual standpoint, discrepant findings may owe to investigation of catastrophizing as a unidimensional construct. Research has supported a *multidimensional* conceptualization of catastrophizing, comprising elements of rumination, magnification and helplessness [54;57], which may differentially impact outcomes [47;55;57]. Moreover, while attention to pain is primarily linked to excessive rumination processes [2;20;57], research has yet to examine the specific dimensions of catastrophizing associated with attention to pain.

Accordingly, the objective of the present study was twofold. First, child selective attention to visual pain stimuli (faces) and the moderating role of pain catastrophizing were examined using dot-probe methodology. As child responses to pain are likely influenced by parental pain coping [13;23;25;27;39;48], both child and parental catastrophizing about personal pain experience were examined as potential moderators. Second, we examined the impact of children's selective attention to pain and child/parental catastrophizing upon child avoidance behaviour (indexed by cold pressor pain tolerance). Based upon current cognitive-affective models of attention to pain [3;20;61;70], we hypothesized that (1) children would selectively attend to pain, particularly when child and parental catastrophizing were high, and (2) increased selective attention to pain, particularly in the context of high child and parental catastrophizing, would contribute to greater child avoidance behaviour. Importantly, for each hypothesis, we examined the differential predictive value of the distinct dimensions comprising child and parental catastrophizing (i.e., rumination, magnification, and helplessness).

2. METHODS

2.1 Participants

The present study is part of a larger investigation consisting of two parts. The first part aimed at examining the relationship between child's selective attention to pain and avoidance behaviour and the moderating role of child and parental catastrophizing about personal pain. The second part aimed at examining the relationship between parental attention and parental emotion regulatory processes in response to child pain. The present manuscript reports findings pertaining to the first part of this larger investigation. Except for the questionnaire assessment (see below), additional procedures relevant to the second part of the larger investigation occurred *following* the currently described methodology and are thus not expected to interfere with current results. Participants were recruited from a sample of school children from grades 5 through 11 and their parents ($N= 660$ children) who participated in a questionnaire study that took place approximately 1.5 years prior [see 10]. Only children and parents who had provided informed consent to be re-contacted and who had not already been invited for participation in another study were approached ($N = 164$). Exclusion criteria for this study included: (1) child recurrent or chronic pain, (2) developmental delay, and (3) having insufficient knowledge of the Dutch language. A weighted random sampling procedure was used [30] with an equal proportion of boys and girls. From the total of 164 parent-child dyads, 88 parent-child dyads were randomly selected and contacted. Of those contacted, 95.5% ($N =84$) met the inclusion criteria and 77.4% ($N=65$) agreed to participate. The main reason for refusal to participate was lack of time. Two parent-child dyads later withdrew participation because of child illness ($N = 1$) or other family responsibilities ($N = 1$) (final response rate = 71.6%). One parent-child dyad was further excluded because the child withdrew participation at an early phase of the pain task (i.e., refusal to perform the cold pressor task). Additionally, data of three participants was excluded since avoidance behaviour, which was strictly operationalized as pain tolerance during CPT performance with water temperature at $10^{\circ}\text{C} \pm 1^{\circ}\text{C}$ and with the hand immersed up to the wrist, was not

assessed conform these criteria. Specifically, temperature exceeded the 10°C +/- 1°C range for two participants while one participant refused to fully submerge the hand.

The final sample entered in the analyses consisted of 59 children (31 boys) aged 10-16 years ($M= 12.64$ years, $SD = 1.58$) and one of their parents (41 mothers). Approximately 7% of the children were recruited from the fifth grade, 22% from the sixth grade, 22% from the seventh grade, 13.6% from the eighth grade, 23.7% from the ninth grade, 8.5% from the tenth grade, and 3.4% from the eleventh grade. Parents ranged in age from 34 to 55 years ($M= 43.59$ years, $SD= 4.55$). Most parents (89.8%) were married or co-habiting. The majority of parents (88.35%) had higher education (beyond the age of 18 years). Parent-child dyads were compensated 25€ 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 child participants. Children were instructed to lower their right hand in the cold water up to just above the wrist; children maintained their hand in the cold pressor box up to child pain tolerance level or an uninformed ceiling of 4 minutes. Temperature of the water was maintained at 10°C (+/-1°C) and was circulated continuously by a pump. The cold pressor apparatus is well suited for use with children and the pain experienced is considered to provide an analog for various naturally occurring acute pains [6;71]. A second tank was used where the water was maintained at room temperature (21°C; +/-1°C). To standardize skin temperature prior to cold pressor immersion, all children first immersed their hand in the room temperature water tank for a total of 2 minutes [see also 6].

2.3 Child Pain tolerance

Children's pain tolerance was defined as total time of immersion in the cold water (in seconds), measured by a stopwatch. Prior to the cold pressor task, children were provided with the following instructions '*Hold your hand in the cold water as long as you can endure the pain. When you think/feel 'I cannot endure the pain any longer – I cannot handle more', I want you to say 'STOP' and take your arm out of the cold water box*'. The maximum duration of exposure to the cold-pressor task was 4 minutes. However, the children were not informed of this ceiling so that there would be no risk that they mistakenly thought they were expected to leave their arm in the water for this length of time. The child's pain tolerance was taken as an index of child's avoidance behaviour [see e.g., 8].

2.4 Measures

Parents completed a battery of questionnaires including measures gauging socio-demographic characteristics and parental catastrophic thinking about pain. Children completed measures of child catastrophic thinking about pain and experienced pain intensity during the cold pressor task.

2.4.1 Parental measures

Parental catastrophic thinking about pain

Parental catastrophic thinking about pain was assessed with the Dutch version of the Pain Catastrophizing Scale (PCS) [54;59]. The PCS was developed for both non-clinical and clinical populations and consists of 13 items describing different thoughts and feelings that people may have during painful episodes. Parents were requested to rate how frequently they experienced specific thoughts and feelings when they experience pain using a 5-point scale (0 = 'not at all', 4 = 'all the time'). The PCS consists of three subscales (1) rumination (e.g., '... I keep thinking about how much it hurts'), (2) magnification (e.g., '... I wonder whether something serious might happen'), and (3) helplessness (e.g., '... there is nothing I can do to reduce the pain') and yields a total score that can range from 0 to 52 as well as three subscale

scores. The Dutch version has been shown to have good reliability and validity [59]. Cronbach's alpha in this study was $\alpha=.90$ for the total score and .89, .66, and .80 for rumination, magnification and helplessness, respectively.

2.4.2 Child measures

Child catastrophic thinking about pain

Children's catastrophic thinking about pain was assessed with the Dutch version of the Pain Catastrophizing Scale for Children (PCS-C) [15]. This instrument is adapted from the adult Pain Catastrophizing Scale [54;59]. The PCS-C also consists of 13 items, three subscale scores for rumination, magnification and helplessness and yields a total score that can range from 0 to 52 as well as three subscale scores. The PCS-C has been shown to be both reliable and valid for children aged 9 to 15 years [15]. Cronbach's alpha in this study was $\alpha=.85$ for the total score and .80, .48, and .73 for rumination, magnification and helplessness, respectively.

Experienced pain intensity

Children's experienced mean pain intensity during the cold pressor task was assessed using an 11-point 1-item scale with the anchors 'no pain' (0) and 'a lot of pain' (10). Children were requested to provide written ratings for this pain measure immediately after completion of the cold pressor task. For the current study, the child's self-reported pain intensity was considered as a secondary outcome measure (avoidance behaviour (i.e, pain tolerance) constituted the primary outcome of interest).

2.4 Stimulus Materials

Stimulus material for the dot-probe task consisted of a total of 40 pictures of 10 different children (5 boys and 5 girls; age range 9-16 years) displaying facial expressions of pain. These pictures were reliably coded for occurrence and intensity of facial pain display by means of the Child Facial Coding System (CFCS) [14] and were previously used in a similar

dot-probe study to assess parental attention to child pain [see 65]. For each of the 10 children in the stimulus set, 4 pictures reflected each of 4 categories of facial pain expression: one picture of a particular child depicted the child's neutral face (NFE); one picture depicted the child with low pain expression (LFE); one showed moderate pain expression (MFE), and one depicted high pain expression (HFE). Using the 40 picture set, a series of three different picture pairs had been generated and matched for head position, colour intensity and luminance. Each pair consisted of two pictures of the same child presenting a neutral face combined with either (1) a low expressive pain face (NFE-LFE pair), (2) a moderate expressive pain face (NFE-MFE pair), or (3) a high expressive pain face (NFE-HFE pair). This allowed examination of whether children's selective attention to pain faces varied with varying levels of facial pain expressiveness. Furthermore, 8 neutral pictures from two additional children (not part of the stimulus set) were selected for the practice trials. The validity of the present stimulus set is supported by previous findings that differential facial pain expressiveness (i.e., NFE, MFE, LFE, HFE) reflects differences in observers' pain intensity ratings such that increasing levels of facial pain expressiveness corresponded with observers' increasing pain ratings [see 65].

2.5 Dot-probe task

Children were seated in front of a computer at a distance of approximately 60 cm from the screen. Instructions for the dot-probe task were presented on the computer screen. To ensure that the child understood task instructions, the experimenter briefly checked with the child prior to task commencement. Additionally, to enhance personal salience of pain cues (i.e., observed facial pain expression), the children were informed on screen and by the experimenter that they would see several pictures of children who have undergone the same painful procedure as they themselves would have to undergo subsequent to the dot-probe task.

All pictorial stimuli were presented against a black background. Each trial in the dot-probe task began with a 500 ms presentation of a white fixation cross in the middle of the screen. Participants were instructed to fixate their gaze on this location. Then, one picture-pair (NFE-LFE; NFE-MFE; NFE-HFE) appeared and remained visible for 500 ms; each facial image in this pair was 47 mm in width and 78 mm in height; one of the pictures was presented above and one below the fixation cross with the centre of the picture having a distance of 57 mm above and below (respectively) the centre of the screen. Immediately after the offset of these two pictures, a small white rectangle (0.9/1 mm) was presented, at the location of one of the pictures (the probe). Participants had to indicate the probe location by pressing one of two buttons as quickly and accurately as possible on an AZERTY keyboard. The 'q' key was pressed with the left index finger when the probe was presented at the upper location and the 'm' key was pressed with the right index finger when the probe was presented at the lower location. A new trial started after a response or automatically when 2500 ms elapsed without response. When a participant responded erroneously, the term 'error' briefly appeared on the screen (200 ms). In order to discourage participants from attending to only one side of the display and responding to the mere presence or absence of the dot-probe, a number of trials were presented, in which the target was not followed by a probe (catch trials). Furthermore, in order to ensure that participants maintained their gaze at the middle of the screen, a number of digit trials were presented. In these trials, the fixation cross was followed by a randomly selected digit between one and nine for a duration of 100 ms (digit trials). Participants were instructed to type the number on the keyboard [see e.g., 62]. Pictures were presented in randomized order across trials and participants. For each participant, the target pictures as well as the probe were presented equally often at the top or bottom position of the screen in four possible combinations: target top/probe bottom; target top/probe top; target bottom/probe bottom; target bottom/probe top. In this way, the dot-probe was equally likely

to replace either a pain face or neutral face. In the context of the current study, *congruent* trials were those where the probe was presented at the same location as the pain face. *Incongruent* trials were those where the probe was presented at the same location as the neutral face. Each trial type was presented 24 times for each level of facial pain display (LFE, MFE, HFE) and the inter-trial interval was set to 200 ms. The task began with 15 practice trials consisting of neutral face-pairs, none of which appeared in the experimental trials. Practice trials were repeated until the child accurately performed these trials. The experiment itself consisted of 144 trials. The probe detection task was programmed and presented using the INQUISIT Millisecond software package (INQUISIT 2.0) on a Hewlett Packard computer with a 15-inch color monitor. INQUISIT measures reaction times (RTs) with millisecond accuracy [18].

2.6 Picture pain intensity ratings

After completion of the dot-probe task, children were asked to rate each presented pain face on pain intensity using a 0-10 NRS (i.e., ‘How much pain has the child displayed on the picture; anchors; ‘no pain at all’; ‘a lot of pain’). Pictures were presented on a computer screen using Office PowerPoint in randomized but fixed order across participants. Children were instructed to make written ratings of pain intensity of all pictures and were encouraged to proceed as fast as possible. Picture ratings were averaged for each level of facial pain display (NFE, LFE, MFE, HFE) resulting in 4 mean pain intensity ratings ranging from 0-10. This allowed assessment of whether differences in facial expressiveness of the pictures matched differences in the child participants’ pain intensity ratings of the pictures.

2.7 Procedure

All participants were invited by phone and received standardized information about the study. When parents and children provided consent, they were invited to the laboratory at Ghent University where the study was conducted (In July 2012 and September/October

2012). Upon arrival at the lab, one of two experimenters (both female) accompanied the parent and child to the test-room. Parent-child dyads were explained that we were interested in “how parents and children think and feel about the pain that children experience”. Children were instructed about having to perform a computerized task and to fill out a number of questionnaires. Parents were informed about having to fill out the measure on sociodemographic characteristics and pain catastrophizing. They were also informed about having to perform a number of other measures which were beyond the scope of the present investigation. Furthermore, the cold pressor apparatus was shown to the parent and child and they were also told that the child could remove their arm from the water at any time, for any reason, and that both parent and/or child could withdraw from participation at any time.

After obtaining written parental and child consent, experimenter 1 stayed with the child in the test-room while experimenter 2 accompanied the parent to an adjacent room where they were asked to fill out sociodemographic and pain catastrophizing measures as well as some additional questionnaire measures (i.e., assessing parental state/trait anxiety, acceptance of child pain, and catastrophizing about child’s pain) which were not directly relevant to the current study aim. Before performing the pictorial dot-probe task, children were requested to fill out the measure of catastrophizing. Following the dot-probe task, the child’s pain tolerance was assessed during CPT performance. Children’s experienced pain was assessed after they completed the CPT. Children and parents could not see or hear each other throughout the duration of the study procedure. In addition, to prevent any contact between the experimenter and the child, the experimenter was seated silently behind a screen during performance of the CPT. After completion of the entire study procedure, parent-child dyads were reunited in the test-room and were fully debriefed about the purpose of the study.

2.8 Data reduction and statistical plan

To investigate *the impact of child and parental catastrophizing upon child selective attention to pain*, the mean reaction times (RT) on congruent and incongruent trials were calculated for each level of facial pain expression (HFE, MFE, LFE) and used as dependent variables in the analyses. Analyses employed a 3×2 factorial repeated measures design with congruency (congruent / incongruent) and facial pain expressiveness (LFE, MFE, HFE) as within subject factors and with child and parental pain catastrophizing (total score) entered as covariates, respectively, in two separate analyses. In case of significant interaction with both congruency and facial pain expressiveness, attentional bias (AB) indices were calculated to ease interpretation of the direction of differences between congruent and incongruent trials. Separate bias scores were calculated for each level of facial pain expressiveness (AB_LFE, AB_MFE, AB_HFE) by subtracting the average detection time on congruent trials from the average detection time on incongruent trials. Positive values on the bias index indicate increased selective attention to pain faces whereas negative values are indicative of attentional avoidance of pain faces. In case of a significant interaction with congruency only, a mean AB index (across the three pain intensity levels) was calculated. In case of a significant interaction with facial pain expressiveness only, the mean RT (across congruent and incongruent trials) was calculated for the three different types of trials (LFE, MFE, HFE). Finally, to explore the predictive value of each of the separate subscales of child and parental pain catastrophizing, similar analyses were performed for each of the three subscales (i.e. rumination, magnification, and helplessness). Subscales were examined in separate analyses since entering all three subscales into one single analysis presented problems of multicollinearity (i.e., Variance Inflation Factors > 2).

To investigate *the impact of child and parental catastrophizing and child selective attention to pain upon child pain tolerance* univariate ANOVAs were performed with child pain tolerance as dependent variable and child mean attentional bias index and child or

parental pain catastrophizing entered as covariates, respectively in two separate analyses. To explore the predictive value of each of the separate subscales of child and parental pain catastrophizing, similar analyses were performed for each of the three subscales separately (i.e. rumination, magnification, and helplessness). Additional analyses were also performed with *child's pain intensity* as the dependent variable, as this was considered a secondary outcome within the present study.

In case of a significant interaction, additional moderation analyses were performed to interpret the interaction effect (i.e., whether the association between the predictor variable and the outcome is significant only for high levels of the moderator variable, low levels of the moderator variable, or both). All moderation analyses followed the procedure outlined by Holmbeck et al. [31]. This procedure does not categorize participants into two groups but allows, by manipulating the 0 point of the moderator, to examine conditional effects of the continuous moderator variable upon the outcome. To this end, two steps were performed. First, two new conditional continuous moderator variables were computed by (1) subtracting 1 SD from the centered moderator variable (i.e., high levels of child/parent catastrophizing dimensions) and (2) adding 1 SD to the centered moderator variable (low levels of child/parent catastrophizing dimensions). Next, two additional ANCOVAs were performed -- incorporating each of these new conditional continuous moderator variables -- to test the significance for high (+1 SD above the mean) and low (-1 SD below the mean) values of the conditional moderator variable (i.e., child/parental pain catastrophizing dimensions). In all analyses, Greenhouse-Geisser corrections (with adjusted degrees of freedom, or NDf) were performed whenever the sphericity assumption was violated (Mauchly's test of sphericity was $p < .05$).

3. RESULTS

3.1 Participant characteristics

Mean scores, standard deviations and correlations between measures are reported in Table 1. The mean level of child pain catastrophizing in the present sample ($M= 11.59$; $SD = 6.13$) as well as the child's subscale scores on rumination ($M= 5.76$; $SD = 3.12$), magnification ($M= 2.17$; $SD = 1.44$), and helplessness ($M= 3.66$; $SD = 2.64$) are comparable with those obtained in previous samples of school children [15]. Children reported moderate levels of experienced mean pain intensity ($M = 4.68$; $SD = 2.28$) during CPT performance. Children's CPT immersion time ranged from 10 to 240 seconds with a mean of 156.81 s ($SD = 96.43$). Forty-four percent of the children withdrew their hand from the cold water before the four minute ceiling was reached. The mean level of parental catastrophizing about pain ($M= 14.71$; $SD= 8.13$) as well as parent's subscale scores on rumination ($M= 6.44$; $SD = 3.44$), magnification ($M= 2.73$; $SD = 2.09$) and helplessness ($M= 5.54$; $SD = 3.70$) were comparable to mean levels obtained in previous samples of adults [59].

Pearson correlation analyses indicated that child pain tolerance was significantly negatively correlated with experienced pain intensity during CPT performance ($r = -.45$; $p < .0001$). Of further interest, child catastrophizing (total score) was not significantly correlated with parental catastrophizing (total score). However, inspection of subscale correlations indicated that the child magnification subscale was significantly positively correlated with parental catastrophizing (total score) which was accounted for by a significant correlation with parental rumination and parental helplessness, but not parental magnification. The latter was, however, significantly positively correlated with child experienced pain intensity during the CPT. Child self-report measures and pain tolerance did not correlate significantly with child age (all $r \leq |.25|$, ns). Furthermore, girls and boys did not significantly differ on pain tolerance or any of the child self-report measures (all $t(57) \leq |1.32|$, ns). Mothers and fathers also did not differ on their level of pain catastrophizing ($t(57) = 1.18$, ns).

- INSERT TABLE 1 ABOUT HERE -

3.2 Picture ratings

Children's pain intensity ratings of the picture stimuli were examined using repeated measures ANOVA. Results revealed significant differences between ratings of the four expression levels ($F(3,56) = 267.54$, $\epsilon = .57$; $Ndf(1.71, 31.92)$, $p < .0001$). Differences were in the expected direction. Specifically, contrasts revealed that high expressive pain faces ($M= 6.56$; $SD=1.56$) were rated significantly higher than moderate expressive pain faces ($M= 4.96$; $SD=1.50$; $F(1,58) = 377.65$, $p < .0001$). Moderate expressive pain faces were rated significantly higher than low expressive pain faces ($M=3.78$; $SD=1.44$; $F(1,58) = 173.17$, $p < .0001$) and low expressive pain faces were rated significantly higher than neutral faces ($M=2.47$; $SD=1.43$; $F(1,58) = 165.15$, $p < .0001$). Interestingly, adding either child pain catastrophizing or parental pain catastrophizing, respectively, as a covariate to the repeated measures ANOVA revealed a main effect of child pain catastrophizing ($F(1,57) = 7.99$, $p < .01$) and parental pain catastrophizing ($F(1,57) = 3.99$, $p = .05$) indicating that the child's pain ratings of the stimulus set increased with increasing levels of their own *and* parental catastrophizing thoughts about pain. No interaction effects were observed (both $F(3,55) \leq .62$, ns).

3.3 The impact of child and parental pain catastrophizing upon child selective attention to pain

3.3.1 Data preparation

Consistent with previous research [62;65] trials with errors and responses shorter than 200 ms or longer than 2000 ms were discarded from analyses. The number of errors made by participants ranged from 0 to 15 ($M= 3.47$). Within the present sample, none of the RTs fell outside the 200ms – 2000ms range. Probe detection latencies that were three standard deviations above or below the individual mean reaction time of corrected responses were also considered outliers and excluded from analyses [38;65]. The number of outliers from the

individual mean ranged from 0 to 5 per participant ($M= 1.68\%$). Statistical analyses were run on 94.85% of the data.

3.3.2 *The impact of child pain catastrophizing*

To investigate whether the child's selective attention to pain varied with different levels of *child* catastrophizing, a 3×2 repeated measures ANOVA was performed with child catastrophizing (PCS-C total score) entered as covariate. Analyses revealed no main effect of congruency ($F(1,57)= .11$, ns) or facial pain expressiveness ($F(2,56)= .31$, ns), indicating no selective attention to pain and no task interference with increasing levels of facial pain expressiveness. There was also no significant congruency \times facial pain expressiveness interaction ($F(2,56)= 64.$, ns), indicating that selective attention to pain faces did not depend upon the level of facial pain expressiveness. Mean RTs on different trial types are presented in Table 2. Likewise, no significant main effects or interactions emerged for the child's total catastrophizing score (all $F \leq 1.20$, ns).

Analyses utilizing PCS-C subscales as respective covariates revealed a significant congruency \times magnification interaction ($F(1,57) = 8.42$, $p < .01$), indicating that child selective attention to pain faces was dependent upon the child's level of pain magnification. No such pattern was observed for child helplessness and rumination (both $F \leq .42$, ns). To interpret this significant interaction, two univariate ANOVAs were performed with the mean attentional bias (AB) index (i.e., across LFE, MFE, HFE trials) as dependent variable and high (1 SD above the mean) or low values (1SD below the mean) of child magnification as covariate. As shown in Figure 1, the findings indicated greater tendency to shift attention *away* from pain faces among children reporting greater pain magnification. Specifically, the findings showed significant attentional *avoidance* of pain faces ($M_{AB}= -9.24$; $F(1,58) = 5.33$, $p < .05$) among children who reported high pain magnification. In contrast, a trend to

selectively attend to pain was observed for children who reported low pain magnification ($M_{AB} = 7.26$; $F(1,58) = 3.29$, $p = .08$).

-INSERT TABLE 2 ABOUT HERE-

- INSERT FIGURE 1 ABOUT HERE -

3.3.2.2 *The impact of parental pain catastrophizing*

To investigate whether the child's selective attention to pain varied with different levels of *parental* catastrophizing, the above 3×2 repeated measures ANOVA was performed with parental catastrophizing (PCS total score) entered as covariate. Analyses revealed a significant congruency \times PCS interaction ($F(1,57) = 4.45$, $p < .05$), indicating that the child's selective attention to pain was dependent upon the parent's level of pain catastrophizing. Follow-up analyses utilizing PCS subscales as covariates revealed that the congruency \times PCS interaction was accounted for by parental rumination ($F(1,57) = 4.42$, $p < .05$) and helplessness ($F(1,57) = 4.88$, $p < .05$), but not parental magnification ($F(1,57) = .53$, ns). To interpret these significant two-way interactions, additional univariate ANOVAs were performed with the mean attentional bias index (AB) as dependent variable and high (1SD above the mean) or low values (1SD below the mean) of either parental rumination or helplessness as covariate.

As shown in Figure 2, the findings revealed trends to shift attention away from pain faces (i.e., *attentional avoidance*) among children whose parents reported high rumination about pain ($M_{AB} = -7.16$ ($F(1,58) = 3.00$, $p = .09$) or high helplessness about pain ($M_{AB} = -7.45$ ($F(1,58) = 3.28$, $p = .08$)). As with child magnification findings, a non-significant tendency to *selectively attend* toward pain faces was observed among children whose parents reported low levels of rumination about pain ($M_{AB} = 5.18$; $F(1,58) = 1.57$, ns) and low levels of helplessness about pain, respectively ($M_{AB} = 5.47$ ($F(1,58) = 1.77$, ns)).

- INSERT FIGURE 2 ABOUT HERE -

3.4 The impact of child selective attention to pain and child and parental pain catastrophizing upon pain outcomes

Additional ANOVAs were performed to examine the impact of child selective attention to pain (mean bias index; AB) and child and parental pain catastrophizing (total and subscales scores) upon child pain tolerance and experienced pain intensity, respectively.

3.4.1 The impact of child attention to pain and child pain catastrophizing

Child pain tolerance. Analysis with the mean AB index and child pain catastrophizing (total score) revealed no main or interaction effects (all $F \leq .43$, ns). Analyses utilizing PCS-C subscales as covariates revealed a significant interaction between the mean AB index and child magnification ($F(1,58) = 6.73$, $p < .05$). No main or interaction effects were observed for child rumination and helplessness (both $F \leq .64$, ns). To further interpret the significant two-way interaction, additional ANOVAs were performed with high (1 SD above the mean) or low values (1 SD below the mean) values of child magnification. The findings indicated that selective attention toward versus away from pain had a differential impact on pain tolerance only among children who reported high magnification of pain ($F(1,58) = 7.16$, $p < .01$). Specifically, children who reported high levels of magnification demonstrated significantly lower pain tolerance when they avoided pain ($M = 141.11$ s) than when they selectively attended to pain ($M = 240$ s). For children who reported low levels of magnification, attention to versus away from pain had no differential impact on the child's pain tolerance ($F(1,58) = .75$, ns) (see Figure 3).

Additional analyses *within* the group of children who selectively attended to pain indicated that pain tolerance was significantly higher for those children who reported high levels of magnification compared to those who reported low levels of magnification ($F(1,58) = 7.33$, $p < .01$; dotted line in Figure 3). Analyses within the group of children who

demonstrated attentional avoidance of pain showed that child magnification did not impact pain tolerance ($F(1,58) = .34$, ns).

Child experienced pain intensity. Analyses with child reported pain intensity as the dependent variable revealed no main or interaction effects of child attention to pain and child pain catastrophizing total and subscale scores (all $F \leq .262$, ns).

- INSERT FIGURE 3 ABOUT HERE -

3.4.2 *The impact of child attention to pain and parental pain catastrophizing*

Child pain tolerance. Analysis with the AB index and parental pain catastrophizing (total score), revealed a significant interaction effect between the AB index and parental catastrophizing ($F(1,58) \geq 4.15$, $p < .05$). Follow-up analyses utilizing PCS subscales as covariates revealed that the AB x PCS interaction was accounted for by parental rumination ($F(1,58) = 4.87$, $p < .05$), approached significance for helplessness ($F(1,58) = 3.56$, $p = .07$), but was non-significant for parental magnification ($F(1,58) = .18$, ns).

Following up on the above interaction, additional ANOVAs for high (1 SD above the mean) or low values (1 SD below the mean) of parental rumination revealed that child selective attention toward versus away from pain had a differential impact on pain tolerance only among children whose parents reported high rumination about pain ($F(1,58) = 5.49$, $p < .05$). As shown in Figure 4, children whose parents reported high levels of rumination demonstrated significantly lower pain tolerance when the child attentionally avoided pain ($M = 133$ s) than when they selectively attended to pain ($M = 221$ s). No such pattern was observed for children whose parents reported low levels of rumination, that is, attention to versus away from pain had no differential impact on child's pain tolerance when parental rumination was low ($F(1,58) = .17$, ns).

Additional analyses indicated that *within* the group of children who selectively attended, pain tolerance was significantly higher ~~for~~ among children whose parents reported

high levels of rumination compared to those whose parents who reported low levels of rumination ($F(1,58) = 5.39, p < .05$; dotted line in Figure 4). Parental rumination did not impact child pain tolerance *within* the group of children who attentionally avoided pain ($F(1,58) = .46, ns$). Similar analysis following upon the marginal interaction of AB x parental helplessness showed a pattern of results that mirrored that of rumination.

Child experienced pain intensity. Analyses with child reported pain intensity as the dependent variable revealed a main effect of parental magnification ($F(1,58) = 7.70 p < .01$) such that higher levels of parental magnification were associated with higher child self-reported experienced pain. No other main or interaction effects were observed (all $F \leq 1.29, ns$).

4. DISCUSSION

The present study investigated selective attention to pain in children, its implications for child avoidance behaviour (indexed by child pain tolerance), and the moderating role of dimensions comprising child and parental catastrophizing about pain. We expected that (1) children would selectively attend to pain, particularly when child and parental catastrophizing were high, and that (2) increased child attention to pain, particularly in the context of high child and parental catastrophizing, would contribute to increased avoidance behaviour (i.e., lower child pain tolerance). Overall, our findings indicated that both the nature of child selective attention to pain as well as the impact of selective attention upon child pain behaviour were differentially sensitive to specific dimensions of child and parental catastrophizing (i.e., dependent upon child *magnification* of pain, versus parental *rumination* and *helplessness*). These findings corroborate catastrophizing as a multidimensional construct that may differentially impact outcomes [47;55;57] and support the importance of assessing both child and parental characteristics in relation to child pain-related attention and behaviour [3;13;48]. However, findings were largely counter to expectations. In particular, results

revealed a greater tendency to shift attention *away* from pain faces (i.e., attentional avoidance) among children reporting greater pain magnification. A similar pattern was observed in terms of parental characteristics, such that children increasingly shifted attention away from pain with increasing levels of parental rumination and helplessness. Furthermore, child attentional avoidance was associated with greater avoidance behaviour (i.e., lower pain tolerance) among children reporting high levels of pain magnification and those whose parents reported greater rumination about pain.

The current findings represent a significant advance in attentional bias research. While a few adult studies have used facial pain stimuli to assess pain-related attention [44;50;65], the current study is the first to do so in children. Compared to commonly used linguistic (i.e., word) stimuli [8;19;36;41;51], facial stimuli have increased ecological validity [17;50]. Furthermore, as child participants were told that they would undergo a similar pain procedure, the facial stimuli employed were likely to be more personally relevant, further improving ecological validity of the outcomes [16;17]. The current study is also the first to assess the relevance of child selective attention to pain for child pain behaviour and to take into account the impact and interrelationship of specific dimensions of child and parental catastrophizing. As such, the current investigation refines our understanding of whether and under which circumstances children's selective attention to pain matters [40].

Of the three dimensions comprising catastrophizing, only child magnification related to child attentional processing and behavioral avoidance. It is possible that magnification of anticipated consequences of pain and associated fears (i.e., something serious may happen/the pain will get worse) reflect elements of catastrophizing most sensitive to the experimental challenge (i.e., anticipation of an unfamiliar pain stimulus among otherwise healthy children). Alternatively, it is possible that pain magnification is most relevant to the construct of child pain catastrophizing for children aged 10-16 years and that rumination and helplessness

regarding pain emerge later with respect to a catastrophizing orientation toward pain. The current results underscore that further research is needed to examine the developmental trajectory of child pain catastrophizing [3;22;45].

Likewise, research is needed to examine mechanisms underlying the relationship between child magnification and attentional avoidance of pain. One potential explanation is that, for children reporting high levels of pain magnification, attentional avoidance aims to alleviate distress elicited by pain anticipation. The emotion-regulatory function of attentional avoidance toward threatening information has been well documented in anxiety literature [4;26;33;34]. Additionally, similar processes may operate in the context of high pain catastrophizing adults. Studies demonstrate that pain may elicit aversive states of personal fear or distress as well as attentionally avoidant tendencies among adults with higher pain catastrophizing [10;11;65;66].

Among children reporting high pain magnification, attentional avoidance may serve a similar regulatory function in terms of behavioral outcomes. Specifically, among children reporting high pain magnification, attentional avoidance of pain was associated with increased avoidance behaviour (i.e., lower pain tolerance). Both attentionally and behaviourally avoidant strategies can be considered adaptive in terms of protecting the child from elevated negative emotion during anticipation of acute pain and from further pain or harm when pain is experienced. However, in the context of long term or inescapable pain experiences, attentional and behavioural avoidance of potentially pain-inducing activities may become maladaptive. Avoidant behaviours diminish engagement in valued and daily activities, fostering disability and exacerbating pain problems [3;7;21;69;70]. Further, since attentionally/behaviourally avoidant strategies are often deployed in anticipation of rather than in response to pain, avoidant patterns may persist as there are fewer opportunities to correct erroneous expectancies about pain as a signal of danger [70].

The current findings highlight that, while dimensions of child and parental catastrophizing were differentially associated with child pain responses, elevations on these dimensions had broadly similar behavioural and attentional impact. In particular, parental rumination and (to a lesser extent) helplessness affected child selective attention and avoidance behaviour in a manner similar to child magnification. That is, children showed greater attentional avoidance in the context of high parental rumination and helplessness about pain. In turn, this attentional pattern was related to increased avoidance behaviour.

Not surprisingly, child magnification was significantly correlated with both parental rumination and helplessness. This association, which is likely to underlie observed similarities, is consistent with a broad social learning perspective which posits that parents may directly and indirectly affect their children's pain responses by means such as reinforcement, modelling, and observational learning [13;25;48]. Studies demonstrate that children's response to pain is likely influenced by parental response to children's pain [72;73;74]. In terms of indirect learning processes, children observing their parents displaying pain/fear/avoidant behaviour toward pain-inducing activities may adjust their appreciation of such activities and their consequences accordingly [23;25;28;46;58]. For high parental catastrophizing, direct and indirect learning processes may be important. Specifically, parental pain catastrophizing is associated with greater efforts to control their child's pain (e.g., by restricting the child's pain-inducing activities) [10;11;39]. Furthermore, adult catastrophizing is associated with increased pain expressiveness [53;56] and behavioural pain avoidance [35;69], which may in turn be communicated to observing others. Our findings suggest that research addressing such learning processes should focus specifically on parental rumination and helplessness, as these appear most associated with children's attention and behavioural response to pain. For instance, it may be that the observed relationship of adult catastrophizing with pain expressive [53;56]/ avoidance behaviours [35;69] and with pain

control [10;11;39] are largely accounted for by rumination and helplessness. However, more empirical investigation is needed to go beyond speculation.

The present findings may be theoretically and clinically relevant. In terms of theoretical implications, our findings suggest that the motivational qualities of pain-related attention are not intrinsic to attention. That is, selective attention to pain does not – in and of itself – lead to avoidance behaviour. Similarly, attentional avoidance of pain may not always relate to pain persistence, but may also motivate escape or avoidance behaviours. Future research is encouraged to take individual difference variables in account when examining pain-related attention and its consequences. In terms of clinical implications, our findings not only attest to the importance of including parents in child pain management but also suggest that interventions focusing upon altering pain-related attention [43;52] should not rely on a ‘one size fits all’ method. In line with this notion are findings indicating that, particularly in the case of high threat, attentional bias to pain may be associated with higher pain tolerance [1] and threshold [8], and that distraction from pain may be counterproductive for high catastrophizing individuals [12;24;64].

Results of the present study are preliminary and await replication. A number of limitations deserve consideration, highlighting directions for future research. First, our sample comprised school children and parents who reported relatively low levels of catastrophizing. Second, this was a lab-based study using experimental pain induction. Future studies are needed to establish whether the results generalize to clinical samples or samples with more severe levels of pain catastrophizing. In addition, over half of the children did not withdraw their hand during the CPT. This could possibly have led to ceiling effects. Future research avoiding these effects is therefore needed to replicate current findings. Additionally, the operationalization of avoidance behaviour in the current study may have been unduly limiting (leading to exclusion of two child participants); future investigations may wish to examine a

broader range of avoidance behaviours. Third, new technologies such as eye-tracking can supplement the ecological limitations of dot-probe methodology by providing direct and continuous indices of attentional processing and allowing precise examination the temporal dynamics of children's selective attention [e.g., 68;75]. For instance, it remains possible that hypervigilance preceded attentional avoidance observed within the present study [see e.g., 9]. Finally, research is necessary to examine whether attentional strategies captured by the dot-probe paradigm reflect those deployed during actual pain experience.

These limitations notwithstanding, the current findings extend our understanding of the role of child selective attention to pain in child avoidance behaviour, as well as the moderating impact of different dimensions of child and parental catastrophizing about pain. Specifically, findings showed greater attentional avoidance among children reporting higher pain magnification and those whose parents reported higher levels of rumination and helplessness. In turn, this attentional pattern functionally related to increased child avoidance behaviour.

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FIGURE LEGENDS

Figure 1: Average bias indices for pain faces (averaged across LFE, MFE, HFE trials), as a function of low (-1SD below the mean) and high (+1SD above the mean) levels of child magnification (magn) of pain ** $p < .01$; * $p < .05$; (*) $p < .10$

Figure 2: Average bias indices for pain faces (averaged across LFE, MFE, HFE trials) as a function of low (-1SD below the mean) and high (+1SD above the mean) levels of parental rumination (rum) and helplessness (help) about pain * $p < .05$; (*) $p < .10$

Figure 3: Mean child pain tolerance (in seconds) as a function of child selective attention to versus away from pain and low and high levels of child magnification (magn) of pain ** $p < .01$

Figure 4: Mean child pain tolerance (in seconds) as a function of child selective attention to versus away from pain and low and high levels of parental rumination about pain * $p < .05$

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Table 1: Means (M), standard deviations (SD) and Pearson correlation coefficients for all parent and child self-report measures and child pain tolerance

	Range	<i>M</i>	<i>SD</i>	1	1a	1b	1c	2	3
1. Child pain catastrophizing	0-52	11.59	6.13	---	.92***	.91***	.59***		
1a. Rumination - C	0-16	5.76	3.12		---	.36**	.76***	.12	-.06
1b. Magnification - C	0-12	2.17	1.44			---	.40**	.04	.09
1c. Helplessness - C	0-24	3.66	2.64				---	.13	-.02
2. Experienced child pain intensity	0-10	4.86	2.28					---	-.45***
3. Child pain tolerance	0-240	156.81	96.43						---
4. Parental pain catastrophizing	0-52	14.71	8.13						
4a. Rumination - P	0-16	6.44	3.44						
4b. Magnification - P	0-12	2.73	2.09						
4c. Helplessness - P	0-24	5.54	3.70						

*p < .05; **p < .01; ***p < .0001

P = parent report / C = child report

Table 2: Mean reaction times (in milliseconds) and standard deviations (SD) on congruent and incongruent trials for low, moderate and high painful expressions.

	Congruent trials	Incongruent trials
Low facial pain expression	530 (98)	532 (103)
Moderate facial pain expression	533 (114)	528 (101)
High facial pain expression	529 (103)	529 (98)

Figure 1

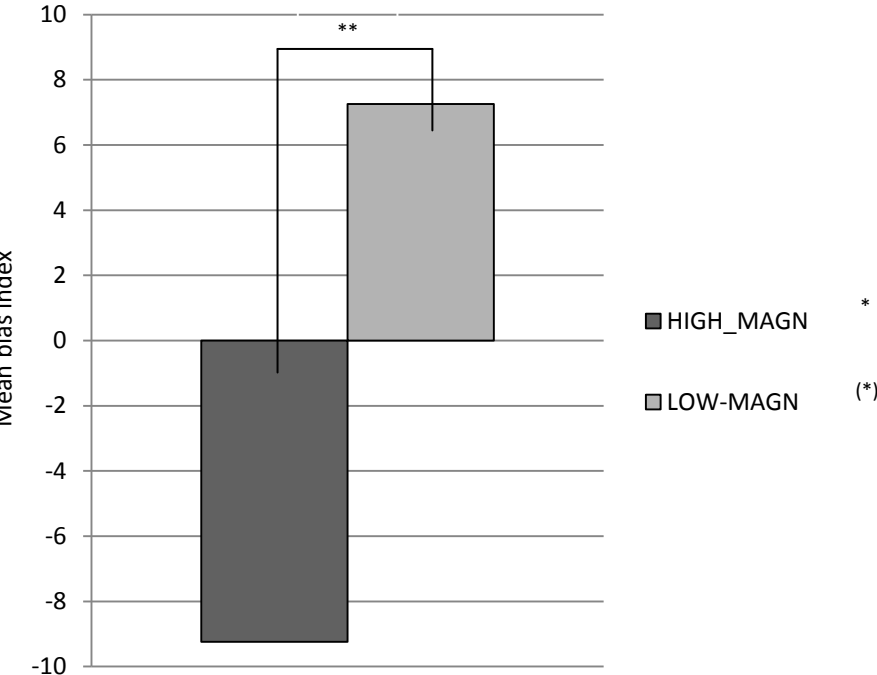


Figure 2

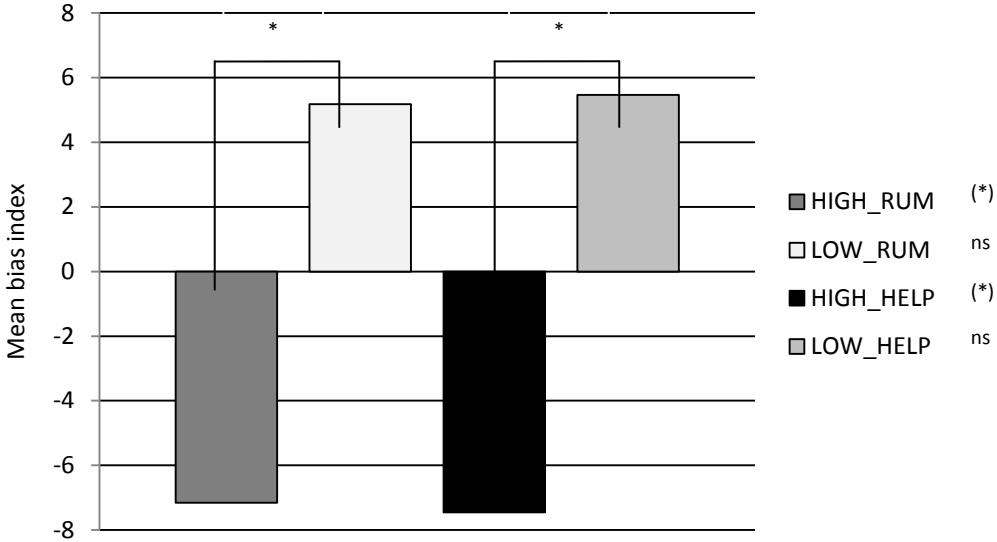


Figure 3

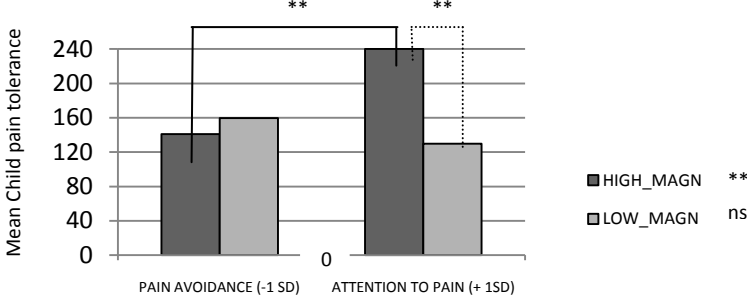


Figure 4

