Learning to fear pain after observing another's pain:

An experimental study in schoolchildren

Running head: Observational learning of pain-related fear

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Conflict of interest

None declared.

Significance

Children may acquire pain-related fear by observing pain in others and this learned fear can diminish after first-hand experience. Remarkably, observational learning did not depend on the children's relationship with the model, but it did depend on the intensity of pain that is perceived. A better understanding of the impact of observing (parental) pain may help clarify the intergenerational transmission of risk for pain and inform the development of preventive programs.

Abstract

Background: Children of individuals with chronic pain have an increased vulnerability to experience pain problems, possibly through observation of pain in their parents. As pain-related fear (PRF) is a critical factor in the development and maintenance of chronic pain, the current experimental study examined the acquisition of PRF through observational learning and subsequent extinction after first-hand experience of the feared stimulus.

Methods: Healthy children (8-16 years) observed either their mother or a stranger performing two cold pressor tasks (CPT) filled with coloured water. In a differential conditioning procedure, one colour (CS+) was combined with genuine painful facial expressions and the other colour (CS-) with neutral facial expressions. Following this observation phase, children performed both CPTs (10°C) themselves.

Results: Children expected the CS+ to be more painful than the CS- and they reported being more afraid and hesitant to immerse in the CS+ compared to the CS-. Moreover, this fear was reflected in children's level of arousal in anticipation of CPT performance. This learned association extinguished after performing both CPTs. Effects were not moderated by whether the child observed their mother or a stranger, by the child's pain catastrophizing, trait PRF or trait anxiety. Remarkably, learning effects increased when the child perceived a larger difference between the model's painful and neutral facial expressions.

Conclusions: This study provides evidence for observational learning of PRF and subsequent extinction in schoolchildren. This acquisition of PRF by observing parental pain may contribute to vulnerabilities in children of parents with chronic pain.

Introduction

Chronic pain (CP) tends to cluster within families (Higgins et al., 2015; Umberger, 2014). Different mechanisms for the transmission of risk for CP from parents to children such as genetics, parenting and observational learning have been suggested (Stone & Wilson, 2016). In the current study we were particularly interested in how Pain-Related Fear (PRF) can be acquired through observational learning. According to the Fear-Avoidance Model, PRF is related to pain catastrophizing and an essential part of a vicious cycle of avoidance, disability and pain in adults and children (Asmundson, Noel, Petter, & Parkerson, 2012; Leeuw et al., 2007; Vlaeyen & Linton, 2000). PRF is the fear that emerges when stimuli and activities related to pain are perceived as threatening (Leeuw et al., 2007). Theoretically, it has been proposed that risk factors for developing CP, such as PRF, may arise through observational learning (Bandura, 1977; Goubert, Vlaeyen, Crombez, & Craig, 2011; Hermann, 2013; Stone & Wilson, 2016), but empirical research is scarce.

Generally, fears can develop through direct experience, verbal instructions or observational learning (Rachman, 1977, 1991). Adult studies showed that PRF is triggered after observing another's pain (Helsen, Goubert, Peters, & Vlaeyen, 2011; Helsen, Goubert, & Vlaeyen, 2013; Olsson, Nearing, & Phelps, 2007; Olsson & Phelps, 2004), especially when observers' levels of pain catastrophizing and trait PRF are high (Helsen et al., 2013; Trost, France, Vervoort, Lange, & Goubert, 2012). The acquisition of PRF through observational learning is particularly relevant in the context of parental CP, because children of parents with CP frequently observe parental pain (Stone, Bruehl, Smith, Garber, & Walker, 2018). While it is not possible to fully capture the complexity of the daily observation of parental pain in experimental research, this research is needed to start understanding the processes of, and conditions for, observational learning. Yet, only one study reported that observing (exaggerated) parental pain affected children's fear (Boerner, Chambers, McGrath, LoLordo, & Uher, 2017). The current study aimed to extend this finding in several ways. In contrast to the study by Boerner et al. (Boerner et al., 2017), children observed genuine pain expressions which are known to differ from feigned (or exaggerated) pain (Craig, Hyde, & Patrick, 1991). Moreover, a within-subjects

differential design was used which is more powerful than a between-subjects design because individual differences are controlled for (Lonsdorf et al., 2017). We also not only examined acquisition, but also extinction of PRF in children. Finally, we compared observational learning effects in children when observing maternal pain versus pain in a stranger. As children are related to and share characteristics with their parents, observational learning may be enhanced (Bandura, 1977; Goubert et al., 2011).

To achieve this, children (8-16 years) observed a model (mother or stranger) performing two Cold Pressor Tasks (CPTs) filled with coloured water. Using a differential conditioning paradigm (Helsen et al., 2011, 2013), one colour (conditioned stimulus, CS+) was paired with genuine painful facial expressions (unconditioned stimulus, UCS) and the other colour (CS-) with neutral facial expressions. After this observation phase, children performed both CPTs themselves. Children regularly reported their (expected) pain intensity for and PRF towards both CPTs, and how hesitant they were to perform the CPTs. Children's Skin Conductance Response (SCR) was also monitored, indexing their arousal. We expected that children would report higher expected pain intensities, more PRF, more hesitation, and demonstrate more arousal, for the CS+ than the CS-, which would support successful observational learning. Observational learning was expected to be more pronounced in children reporting high pain catastrophizing, trait PRF and anxiety, and in children observing their mother compared to a stranger. Although more exploratory, we also expected extinction of the CS+/CS- differences after performing the CPTs, as found in adults (Helsen et al., 2011, 2013).

Methods

Participants

Sixty-two dyads, composed of healthy children/adolescents (from now on referred to as "children") and their mother, participated in this study. The mean age of the children in the full sample was 10.94 years (*SD* = 2.64, range 8-16) and 56.5% of them were girls. The mean age of the mothers was 43.58 years (*SD* = 4.61, range 30-54). Children were randomly assigned to one of two groups: the first group of children observed movies of their own mother performing two cold pressor tasks (CPT) (i.e., mother-group). The movies of these mothers were also shown to the children of the second

group; thus, these children observed an unknown woman (i.e., stranger-group). The study was approved by the Ethics Committee of the Faculty of Psychology and Educational Sciences of Ghent University, Belgium. Informed consent was obtained from the mothers (for themselves and their child) and informed assent from the children. Furthermore, consent was requested from the mothers to re-use their video recordings in this study. Each dyad received 20 euro as compensation for their participation.

An exclusion criterion for participation was the presence of chronic pain in children and/or mothers. This exclusion criterion was set to limit confounding effects of experiencing chronic pain by the child or frequent observation of maternal pain behaviors. Before study enrollment, we screened for the presence of chronic pain during a telephone call with the parent. On the day of the experiment, the presence and severity of pain complaints was assessed using the Graded Chronic Pain Scale (GCPS, Von Korff, Keefe, & Dworkin, 1992) and an adapted version thereof for children (Vervoort, Logan, Goubert, De Clercq, & Hublet, 2014). Using the GCPS, participants can be classified into five grades based on their reported pain intensity and pain-related disability for the past six months. In both versions of the GCPS (GCPS-mother and GCPS-child), *pain intensity* was derived from averaging the responses on three 0-10 scales (ranging from 'no pain' to 'pain as bad as could be') measuring worst and average pain in the past six months and pain intensity at the current moment. *Pain-related disability* was determined based on the number of disability days in the past six months combined with the degree of interference. In mothers, this degree of interference is based on items questioning interference with daily activities; social activities or family; and with work (ranging from 0 = 'no interference' to 10 = 'unable to carry on any activities'). In children, the degree of interference is based on one item questioning interference of pain with daily activities. Based on the scores for pain intensity and pain-related disability, five grades are distinguished: grade 0, no pain problem; grade I, low pain intensity and low disability; grade II, high pain intensity and low disability; grade III, high disability which is moderately limiting; grade IV, high disability which is severely limiting. The GCPS has been shown to be reliable and valid in adult and pediatric populations (Huguet & Miró, 2008; Smith et al., 1997; Vervoort et al., 2014; Von Korff et al., 1992). The following criteria were used to

exclude participants because of the presence of pain problems. The first criterion was the combination of a positive answer of the mother on the item "Does your child suffer from chronic or recurrent pain?" and a classification of the child in grade III or IV based on the child's GCPS-results (Von Korff et al., 1992). The second criterion, which was independent from the first one, was the presence of pain at the moment of the experiment as reported by the child (rating higher than 5 on the item assessing present pain in the child-version of the GCPS). This last criterion was used to prevent interference with the execution of the CPT. Based on both criteria, two children were excluded. Additional exclusion criteria were insufficient knowledge of the Dutch language, recent fracture or wounds on the hand or forearm, history of cardiovascular disorders, fainting or seizures, frostbite or Reynaud's disease. Children with colour blindness were also excluded. On the day of the experiment, participants were not allowed to ingest analgesic pain medication.

Both groups of participants performed three experimental phases which are summarized in Figure 1. All aspects of the design and procedure of the study are described in detail below.

- Insert Figure 1 about here -

Apparatus and materials

Cold pressor tasks

Pain was induced using a cold pressor task (CPT), which is a safe and frequently used pain induction method in adult and pediatric samples (Birnie, Caes, Wilson, Williams, & Chambers, 2014; von Baeyer, Piira, Chambers, Trapanotto, & Zeltzer, 2005). In the present study, three boxes were used. The temperature of the water in a first box (type Techne B-26 with TE-10D thermoregulator, size 53 x 32 x 17 cm) was held at 3°C (±1°C) and used to induce pain in the mothers (mother-group). They were asked to immerse their hand in this box for 30 seconds. The two other CPTs were identical Plexiglas boxes (Julabo, with FT200 thermoregulator and ED-19A batch circulator, size 39 x 27 x 18 cm) filled with water coloured with harmless food colouring (pink for one box and yellow for the other, see Figure 1). Children consecutively immersed their dominant hand in both CPTs for a maximum duration of 1 minute (order counterbalanced). The temperature of the water in both boxes

was held at 10°C (±.03°C) which is the upper-limit of the range used in research with children and adolescents (i.e., 5-10°C, Birnie, Hons, Parker, & Chambers, 2014). An immersion of 1 minute in 10°C was chosen to induce a sensation that is unpleasant but not too painful (see also Helsen et al., 2011). This enables us to investigate the interaction between PRF and the first-hand experience of the feared stimulus. Indeed, if the experienced pain is very high, it can be expected that pain expectancies and PRF are rapidly adapted based on this direct experience, while expectations might be less easily corrected by a more ambiguous sensation (Büchel, Geuter, Sprenger, & Eippert, 2014; Crombez & Wiech, 2011). Crucially, to be able to compare children's self-reported pain intensity, PRF and hesitation after completing both CPTs a fixed immersion paradigm was chosen. If the immersion time between both CPTs differs too much (as for example with longer immersion times) it is difficult to compare these outcome measures. An additional advantage of such a fixed immersion interval is that the potential impact of age differences in tolerance time (e.g., Birnie, Hons, Parker, & Chambers, 2014) can be reduced, which is important given the age range (8-16 yrs) in the current study. Before each CPT immersion, mothers and children held their hand in a box filled with water at room temperature (21± 1°C). Mothers were asked to immerse their hand in this box for 120 seconds. Because the children immersed in two CPTs with the same hand (which was necessary given the measurement of the skin conductance response on the other hand), children were asked to immerse their hand in the box until skin temperature did not differ more than 1°C (assessed by means of a thermometer that assesses surface temperature, Beurer FT65) before performing both CPTs.

Unconditioned and conditioned stimuli

To create aversive unconditioned stimuli (UCS) as well as neutral stimuli, each woman in the mother-group (further referred to as "model") was filmed two times for 30 seconds. First, the models were filmed having been asked to retain a neutral facial expression (i.e., they received the instruction to simply look in the camera). Second, they were filmed while performing the CPT at 3°C. This was done to capture real painful facial expressions rather than asking the mothers to feign pain. These painful facial expressions were used as UCS. Only the face of the model was filmed to rule out any influence of the body posture. To assess the validity of the UCS, all movies were rated by a group of

18 independent raters after study completion. For each movie, raters were asked to rate the model's pain on a scale from 0 ('no pain') to 10 ('pain as bad as could be'). In line with previous studies (Helsen et al., 2011, 2013), we used a differential conditioning paradigm in which the colour of the CPT box for the child pain task (pink and yellow) served as a conditioned stimulus (CS). Third, we filmed the model's hand immersing in each of the coloured CPTs for 30 seconds. In the observation phase, children observed two 30-second film fragments. Figure 1 shows examples of how the movies were presented to the children. In the painful movie, the model's painful facial expression (UCS) was shown on the left side of the screen and her hand immersing in the CPT box with the colour associated with this UCS (CS+) was shown on the right side. In the neutral movie, a neutral facial expression of the model was shown together with the model's hand immersing in the CPT box with the other colour (CS-). The colour that was associated with the UCS was counterbalanced across participants. The movies were presented using E-Prime 2.0 software (Psychology Software Tools Inc., 2012) on an Intel Pentium 4 computer with 17-inch LCD screen. The order of the movies (painful – neutral) was randomized. Each pair of movies was shown to two children: to the child of the model (mother-group) and to a child unknown to the model (stranger-group). In this way, the facial expressions used in the two experimental groups were identical.

Psychophysiological measurements

To measure children's arousal during the observation of the models and during CPT performance, their skin conductance response (SCR) was monitored using the Nexus 10 and Biotrace+ software (Mind Media B.V., n.d.). Ag-AgCl skin conductance electrodes (0.001 μS) were attached to the palmar surfaces of the medial phalanges of the index and ring finger of the non-dominant hand. The electrodes were secured by Velcro straps. The children were asked to let their hand rest on the table and to minimize movements throughout the experiment. The start and end of each phase of the experimental procedure (as depicted in Figure 1) were logged in E-prime 2.0 software (Psychology Software Tools Inc., 2012) and were transmitted to Biotrace+ by using the Nexus trigger interface (Mind Media B.V., n.d.). Results of each participant were exported from Biotrace+ and imported in

the Ledalab toolbox (Benedek & Kaernbach, 2010a, 2010b) in MATLAB (The Mathworks, Natick, MA, USA).

Measures

Cold Pressor Task: Expectations and experiences

Self-Report measures. On five occasions (see Figure 1), children completed a set of numerical rating scales (NRS) ranging from 0 to 10. Before observing the model (Baseline), they rated expected pain intensity (0 = no pain; 10 = a lot of pain) for each coloured CPT and how fearful (Pain-related fear or PRF; 0 = not fearful; 10 = very fearful) and hesitant (hesitation; 0 = not at all, 10 = very hesitant) they would be to perform each of the coloured CPTs. These baseline measures were used to rule out any prior preferences for a certain CPT (e.g., based on colour) before the observation phase. Post-observation, children rated the pain intensity of the model based on the facial expressions observed in the painful and neutral movie (Pain estimation). Again, their expectations towards both CPTs (pain intensity, PRF, hesitation) were measured. Immediately after each immersion (Post-immersion), children's pain intensity was assessed by rating the worst pain experienced during that immersion. Children also rated their experienced fear and how hesitant they would be to immerse their hand in that CPT again (PRF and hesitation). After completing both CPTs (Post-test) they again rated their experienced hesitation to immerse their hand in each of the CPTs and indicated which CPT was experienced as the most painful. Finally, they were asked which CPT they would prefer to do again if necessary (Avoidance).

Psychophysiological measures. The children's SCR was monitored throughout the experiment; SCR during the observation phase was used to measure children's arousal while observing other's pain and during the immersion phase to evaluate whether children's arousal differed while performing the CS+ CPT as compared to the CS- CPT (see Figure 1).

Questionnaires

Catastrophizing about pain. Catastrophizing thoughts and feelings about pain were assessed by means of the child version of the Pain Catastrophizing Scale (PCS-C, Dutch version, Crombez et al., 2003). Children are asked to reflect on past pain experiences and to rate the frequency of the thoughts and feelings described in 13 items, using a five-point scale (0 = not at all, 4 = extremely). In this study, the total scores (0 – 52) were used in the analyses. The PCS-C has been shown to be reliable and valid (Crombez et al., 2003).

Trait Fear of Pain. Children completed the 'Fear of Pain' subscale of the Dutch version of the Fear of Pain Questionnaire, child report (FOPQ-C, Dekker et al., 2018; Simons, Sieberg, Carpino, Logan, & Berde, 2011). Pain-related fear is assessed with 13 statements for which children are asked to indicate how much they agree or disagree on a five-point scale (1 = strongly disagree, 5 = strongly agree). The subscale scores (range: 13-65) were used in this study. In children and adolescents with chronic pain, the FOPQ-C has been shown to be a reliable and valid instrument to measure pain-related fear (Dekker et al., 2018; Simons et al., 2011).

Trait Anxiety. Children's anxious disposition was measured using the trait version of the State-Trait Anxiety Inventory for Children (STAIC-T, Dutch version, Bakker, van Wieringen, van der Ploeg, & Spielberger, 1989; Spielberger, Edwards, Lushene, Montuori, & Platzek, 1973). Children are asked to describe how they generally feel by rating 20 statements on a three-point scale (almost never, sometimes, often), resulting in a total score between 20 and 60. The Dutch translation of this instrument has been shown to be reliable and valid (Bakker et al., 1989).

Procedure

Participants were recruited primarily through schools; 45 schools were contacted of which 20 agreed to participate. In total, 2681 invitation letters with general information about the study were distributed via the schools and 46 positive responses (i.e., mothers who were interested to receive more information about participating in the study) were received. Additionally, we recruited from a sample of mothers who participated in previous studies of the Department of Experimental-Clinical

and Health Psychology (Ghent University) and who had consented to be re-contacted. We also posted advertisements in a local newspaper, online and at public locations (e.g., fitness, bakery). Finally, flyers were distributed in sport clubs and youth organizations. Mothers who were interested in participating, were asked to complete an online form or to send an e-mail with personal information. These mothers were contacted by telephone, they were given more information about the study and exclusion criteria were checked. If both mother and child agreed to participate, they were invited to the laboratories at the Vrije Universiteit Brussel or Ghent University. Upon arrival, mothers and children were informed about the different phases of the study (i.e., baseline, observation and immersion phase). Although only mothers assigned to the mother-group were asked to perform a CPT, all children were told that their mother would perform the CPT first. Finally, participants were informed about the measures that would be obtained, including the measurement of the SCR.

After signing the consent forms, one of two experimenters accompanied the mother to record the four film fragments (i.e., the model's painful and neutral facial expression and the model's hand immersing in each of the two coloured CPTs). This was only the case for mothers that were allocated to the mother-group. Mothers assigned to the stranger-group were informed that they did not need to perform a CPT and the distinction between two experimental groups was briefly explained. In the meantime, the other experimenter stayed with the child who first filled in the questionnaires (PCS-C, FOPQ-C, STAIC-T). After the children had completed the questionnaires and the film segments had been created using the model's pain expressions, the experimenter accompanied the child to the room with the coloured CPTs. The child was asked to sit on a chair that was placed between the CPTs (on the side of the child's dominant hand) and a computer screen (at the child's non-dominant hand). Then, the electrodes of the Nexus were applied to the child's non-dominant hand and the SCR-measurement was checked. Next, the experiment started, the instructions for each phase (i.e., baseline, observation and immersion) were given verbally and were shown on the computer screen. To check good comprehension of the instructions (especially for the immersion of the CPTs), children were asked to repeat the instructions. In the *baseline phase*, expectations towards the CPTs were assessed (Baseline NRS). In the *observation-phase*, the children observed a model (mother or stranger)

consecutively immersing her hand in each of the two coloured CPTs for 30 seconds (order randomized). During both film fragments, SCR was measured. Afterwards, the children completed the Post-observation NRS. In the *immersion phase* the children performed both coloured CPTs for maximum 1 minute (order counterbalanced) and SCR was measured. After each CPT, the Post-immersion NRS were completed. When the three experimental phases were finished, the children completed the Post-test NRS, which was immediately followed by the removal of the Nexus electrodes. Afterwards, the children were rejoined with their mother and they were fully debriefed about the purpose of the study. At this moment, children in the stranger-group were also informed that their mother did not perform the CPT.

Statistical analyses

All analyses were conducted in SPSS 25.0 with α set to .05. At first, it was checked whether there were baseline differences that could impact our main analyses. Based on these pre-analysis checks, it was determined whether participants needed to be excluded. Paired-samples *t*-tests were run on the scores of the 18 independent raters to test for each model whether the painful expression was significantly higher in the painful compared to the neutral movie. Children who observed a model for whom this difference was not significant, were excluded.

To analyze the course of the (expected) pain intensity, PRF and hesitation throughout the experiment, these measurements were used as dependent variable in three separate repeated measures analyses of variance. This enabled us to evaluate observational learning and extinction effects for each of these variables. For all repeated measures analyses of variance, CS type (2 levels: CS+ versus CS-) and time (3 levels: baseline, post-observation, post-immersion) were used as within-subject variables and experimental group (2 levels: mother-group versus stranger-group) and gender (2 levels: boy versus girl) as between-subject factors. Children's mean-centered age was added as a covariate to control for age differences. Observational learning and/or extinction effects would be indicated by a significant CS type x time interaction. These analyses also allow to examine differences in learning/extinction effects for children who observed their own mother versus a stranger as well as for boys versus girls. To follow up on significant (interaction) effects, contrasts were used. When

applicable, the α-level was corrected for multiple testing (i.e., when comparing the crucial levels of time, that is post-observation with baseline and post-immersion with baseline, entailing two pairwise comparisons, α was adjusted to .025). In order to investigate potential moderating effects, children's mean-centered pain catastrophizing, trait PRF and trait anxiety were added one by one as covariates to the analyses in a second stage. Finally, binomial tests were used to test whether the proportion of choosing the CS+ in the post-test NRS (most painful and avoidance) differed from a proportion of 50%.

Skin conductance signals were processed with the Ledalab software (Benedek & Kaernbach, 2010b, 2010a) written in MATLAB (The Mathworks, Natick, MA, USA). Visual inspection of the data revealed that some artefacts were present at the start of immersion in the CPTs, therefore Ledalab's adaptive smoothing algorithm was applied first. Next, phasic and tonic activity were separated and a continuous measure of phasic activity was obtained by means of continuous decomposition analysis (CDA, Benedek & Kaernbach, 2010a). CDA is a robust method, additionally reducing the influence of movement artefacts. Changes in SCR were determined within a response window of 30s during the observation phase (i.e., duration of the movie) and 15s during the immersion phase (i.e., anticipation of performing the CPT, 5s before start of immersion and first 10s of the immersion). Minimum amplitude deflection was set to 0.01 µS. Average phasic activity during the observation of the painful and neutral movie was computed per participant and exported to SPSS 25.0. Data were normalized using a square root transformation prior to statistical analysis. To examine differences in children's arousal while observing painful facial expressions compared to neutral expressions and while immersing in the CS+ compared to the CS-, paired-samples *t*-tests were used.

Results

Exclusion of participants and pre-analysis checks

The analysis of the model's pain as estimated by 18 independent raters indicated that, overall, the painful movies (M = 4.77, SD = 1.24) were rated as more painful than the neutral movies (M = 2.27, SD = 1.29), $t(17) = -9.61$, $p < .001$. However, paired samples *t*-tests for each model separately revealed that for seven of the 31 models, the pain-rating for the painful and neutral movie did not

differ significantly (all $p > .15$). For these models and, hence, for the children observing these models, the crucial experimental manipulation was not successful as the model's facial expressions did not differ for the CS+ and the CS-. Consequently, the UCS was not valid for these children, precluding observational learning. For this reason, the fourteen children who observed these models (seven in the mother-group and seven in the stranger-group) were excluded from further analyses. In a second stage, we computed a difference score for the children's estimation of the model's pain intensity by subtracting the pain estimation for the neutral movie from the pain estimation for the painful movie ($\text{Pain estimation}_{\text{painful movie}} - \text{Pain estimation}_{\text{neutral movie}}$), with positive scores indicating that the child correctly perceived expressions in the pain movie as more painful compared to the neutral movie . One child's perception of the model's pain was more than 2.5 SD below the average perception-score. This child rated the model's pain in the neutral movie 6 points higher (scale: 0 = no pain; 10 = a lot of pain) than the model's pain in the painful movie and was excluded from further analyses. One additional participant was excluded because of a strong preference for the yellow CPT at baseline: the difference between the CS+ and CS- rating at baseline was more than 2.5 SD above the average difference-score for pain intensity and hesitation and more than 2 SD above the average difference-score for PRF. For some other children the baseline difference-scores also deviated from the mean; however, none of them showed a strong bias across all three dependent variables and were therefore not excluded from further analyses. Crucially, after excluding these 16 children, the expected pain intensity, the self-reported PRF and hesitation towards both CPTs (future CS+ and future CS-) did not differ at baseline (all $p > .72$), indicating that children's expectations towards both CPTs were comparable at baseline. Furthermore, the final group of children overall rated the model's pain higher for the painful (M = 4.77, SD = 2.62) compared to the neutral movies (M = 2.00, SD = 1.73), $t(43) = 6.99$, $p < .001$.

There was a tendency to dislike the pink CPT, irrespective of whether this was the future CS+ or the future CS-. Children expected this box to be more painful ($t(43) = -3.07$, $p = .004$) and were more afraid ($t(43) = -2.11$, $p = .041$) and hesitant ($t(43) = -2.71$, $p = .010$) to immerse their hand in the pink water. Furthermore, children's hand temperature was in general higher before the immersion in the first CPT (M = 23.78, SD = 1.24) compared to the second CPT (M = 23.28, SD = 1.29), $t(42)$ =

7.77, $p < .001$. The absolute difference in temperature was less than 0.5°C which is very small considering the measurement accuracy for objects of the thermometer (±1.5°C). As the colour conditioning as well as the order of immersion was counterbalanced across participants, the impact of these two baseline differences is minimal. Therefore, no additional participants were excluded.

Sample characteristics

The final sample consisted of 44 participants of which 27 were girls. The mean age of the children was 10.43 years (*SD* = 2.23, range 8-16). The mean age of the mothers was 42.89 years (*SD* = 4.67, range 30 – 54). Twenty-two children were assigned to the mother-group (M_{age} = 10.18, SD_{age} = 2.02), nine of them were boys. The final stranger-group consisted of 22 children (M_{age} = 10.68, SD_{age} = 2.44), of which eight boys. The child's age and gender in both experimental groups did not differ ($t(42) = -.74$, $p = .46$; $\chi^2(1) = 0.096$, $p = .76$ respectively).

In Table 1, the questionnaire scores of the participants are presented. Boys and girls did not differ in their mean scores on any of the questionnaires (all $p > .085$). Furthermore, total scores were not correlated with child age as revealed by Pearson correlation analyses (all $p > .057$). Based on Pearson correlation analyses it can be concluded that children's levels of catastrophizing, trait fear of pain and trait anxiety were all positively correlated (see Table 1).

- Insert Table 1 about here -

Observational learning and extinction effects

The timecourse of the children's self-reported (expected) pain intensity, PRF and hesitation was examined by means of three separate (one per outcome variable) repeated measures analyses of variance. The results of these analyses are summarized in Table 2. Concerning **pain intensity**, main effects of stimulus type ($F(1, 39) = 25.20$, $p < .001$, $\eta_p^2 = 0.39$) and time ($F(2, 38) = 27.25$, $p < .001$, $\eta_p^2 = 0.59$) were found. On average, children rated the CS+ ($M = 5.00$) as more painful than the CS- ($M = 4.07$). Furthermore, contrasts revealed that pain intensity ratings (irrespective of CS type) after observing the model ($M = 3.71$) did not differ from the baseline rating ($M = 3.76$, $p = .81$). Pain intensity ratings were significantly higher though after immersion ($M = 6.14$) compared to baseline (*M*

= 3.76; $F(1, 39) = 35.74$, $p < .001$, $\eta_p^2 = 0.48$). Crucially, the interaction between CS type and time was significant ($F(2, 38) = 19.03$, $p < .001$, $\eta_p^2 = 0.50$), indicating that the difference between ratings for the CS+ and CS- varied across the three experimental phases. This interaction effect is shown in Figure 2. Children learned from observing the model's pain: contrasts revealed that the difference between pain intensity ratings for the CS+ and the CS- was significantly larger after observation than at baseline (see Figure 2; $F(1, 39) = 36.34$, $p < .001$, $\eta_p^2 = 0.48$). Additionally, the difference between pain intensity ratings for the CS+ and the CS- did not differ significantly after immersion compared to baseline ($p = .52$). Although there was a general increase in pain intensity ratings after immersion, the learned CS-UCS association decayed, suggesting extinction of the observationally learned PRF after immersion. No age and gender differences in observational learning and extinction effects were found (see Table 2, non-significant three-way interaction between CS type, time and age/gender). Neither did the results reveal an enhanced learning or extinction effect when children observed their own mother as opposed to a stranger ($p = .98$). In a second stage children's mean-centered pain catastrophizing, trait PRF and trait anxiety were added one by one as covariates to the analyses to explore their role in the strength of observational learning and extinction effects. Note that, given the substantial reduction in sample size after the exclusion of participants (see 'Exclusion of participants and pre-analysis checks'), a cautious interpretation of these results is warranted. The crucial stimulus type x time interaction was not moderated by pain catastrophizing ($p = .45$), trait PRF ($p = .34$) or trait anxiety ($p = .46$).

The same analysis was conducted for self-reported **pain-related fear** (see also Table 2). A main effect of CS type was again found ($F(1, 39) = 23.80$, $p < .001$, $\eta_p^2 = 0.38$). On average, children reported more fear towards the CS+ ($M = 4.16$) compared to the CS- ($M = 3.30$). We did not find a significant main effect of time ($p = .97$). Crucially, the interaction between CS type and time was significant ($F(2,38) = 10.35$, $p < .001$, $\eta_p^2 = 0.35$), indicating that the difference between ratings for the CS+ and CS- varied across the three experimental phases. This interaction effect is shown in Figure 2. Children learned from observing the model's pain: contrasts revealed that the difference between PRF ratings for the CS+ and the CS- was significantly larger after observation than at baseline (see Figure

2; $F(1, 39) = 21.13$, $p < .001$, $\eta_p^2 = 0.35$). Additionally, the difference between PRF ratings for the CS+ and the CS- did not differ significantly after immersion compared to baseline ($p = .25$). This indicates that the learned CS-UCS association decayed after immersion, suggesting extinction of the observationally learned PRF. Again, no age or gender differences in observational learning and extinction effects were found (see Table 2, non-significant three-way interaction between CS type, time and age/gender). Neither did the results reveal an enhanced learning or extinction effect when children observed their own mother as opposed to a stranger ($p = .55$). In a second stage children's mean-centered pain catastrophizing, trait PRF and trait anxiety were added one by one as covariates to the analyses to explore their role in the strength of observational learning and extinction effects. The crucial stimulus type x time interaction was not moderated by pain catastrophizing ($p = .60$), trait PRF ($p = .92$) or trait anxiety ($p = .52$).

Finally, the same analysis was conducted for self-reported **hesitation** to immerse in the CPTs (see also Table 2). A main effect of CS type was found for self-reported hesitation ($F(1, 38) = 16.76$, $p < .001$, $\eta_p^2 = 0.31$). On average, children were more hesitant ($M = 3.36$) to immerse their hand in the CS+ compared to the CS- ($M = 2.71$). We did not find a significant main effect of time ($p = .44$). Crucially, the interaction between CS type and time was again significant ($F(2, 37) = 12.48$, $p < .001$, $\eta_p^2 = 0.40$), indicating that the difference between ratings for the CS+ and CS- varied across the three experimental phases. This interaction effect is shown in Figure 2. Children learned from observing the model's pain: contrasts revealed that the difference between hesitation ratings for the CS+ and the CS- was significantly larger after observation than at baseline (see Figure 2; $F(1, 38) = 24.44$, $p < .001$, $\eta_p^2 = 0.39$). Additionally, the difference between hesitation ratings for the CS+ and the CS- did not differ significantly after immersion compared to baseline ($p = .50$). This indicates that the learned CS-UCS association decayed after immersion for self-reported hesitation as well, suggesting extinction of the observational learning effects. Again, the learning effect (as indicated by the crucial CS type x time interaction) was not moderated by experimental group (mother or stranger) ($p = .55$). However, in contrast with the other dependent variables, the learning effect (as indicated by the crucial CS type x time interaction) differed based on the child's age ($F(2, 37) = 4.35$, $p = .020$, $\eta_p^2 = 0.19$) and gender

($F(2, 37) = 3.30$, $p = .048$, $\eta_p^2 = 0.15$) for children's self-reported hesitation. After visual inspection of the data we can cautiously conclude that stronger observational learning effects were found with increasing child age and in girls as compared to boys. Extinction effects did not seem to depend on either child's age or gender. Given the small effect sizes for these three-way interactions, we refrain from making strong inferences about these three-way interactions. In a second stage, children's mean-centered pain catastrophizing, trait PRF and trait anxiety were added one by one as covariates to the analyses to explore their role in the strength of observational learning and extinction effects. The crucial stimulus type x time interaction was not moderated by pain catastrophizing ($p = .46$), trait PRF ($p = .88$) or trait anxiety ($p = .67$).

- Insert Figure 2 and Table 2 about here -

Child perception of model's pain

Since the level of pain expressiveness differed between models and these differences were perceived as such by the children, we explored whether the child perception of the model's pain moderated the observational learning and extinction effects. To test this, we used the above-mentioned difference score (perception-score: $\text{Pain estimation}_{\text{painful movie}} - \text{Pain estimation}_{\text{neutral movie}}$) as an indicator of child perception of model's pain. The mean-centered perception-score was added as covariate to repeated measures analyses of variance with CS type (2 levels: CS+ versus CS-) and time (3 levels: baseline, post-observation, post-immersion) as within-subject variables and one of the child CPT-ratings (pain intensity, PRF and hesitation) as an outcome in three separate analyses. A three-way interaction between time, CS type and perception-score would indicate that learning effects depended on children's perception of the model's pain. Only this crucial three-way interaction (CS type x time x perception-score) is discussed here. This interaction was significant for child pain intensity ($F(2, 41) = 56.11$, $p < .001$, $\eta_p^2 = 0.73$), child self-reported PRF ($F(2, 41) = 17.06$, $p < .001$, $\eta_p^2 = 0.45$) and for child self-reported hesitation ($F(2, 40) = 14.49$, $p < .001$, $\eta_p^2 = 0.42$). These three-way interactions are depicted in Figure 3. At baseline and post-immersion, there was no difference between the CS+ and CS-, independent of child's perception-score. After observation, however, the difference between the CS+ and CS- increased with increasing child perception of model's pain. The observational learning

effect, defined as the difference between the CS+ and CS- ratings after the observation phase, was largest in children with higher perception-scores. We also explored the relationship between the children's perception-scores and the pain intensity ratings given by the 18 raters. Regression analysis indicated that child perception of the model's pain was indeed related to the ratings given by the independent raters (B = .47, $F(1,42)$ = 12.07, p = .001). Almost one fourth (22.3%) of the variance in child perception of the model's pain can be accounted for by the difference in pain expression between the pain and neutral movie as rated by the independent raters.

- Insert Figure 3 about here -

Psychophysiological responses

Although the analysis of the self-reported data indicated that children learned from observing pain in others, this was only partially reflected in their level of arousal. Children's average SCR did not differ while observing painful facial expressions (M = 0.051, SD = 0.028) compared to observing neutral facial expressions (M = 0.048, SD = 0.030; $t(43)$ = 1.11, p = .28). However, average SCR was significantly higher in anticipation of performing the CS+ CPT (M = 0.067, SD = 0.034) than in anticipation of performing the CS- CPT (M = 0.056, SD = 0.033; $t(43)$ = 2.31, p = .026).

Post-test

After completing both CPTs, children indicated that they were more hesitant to immerse their hand in the CS+ (M = 3.53, SD = 2.38) than the CS- (M = 2.64, SD = 2.11; $t(44)$ = 3.18, p = .003). This suggests that their acquired PRF towards the CS+ had an impact on their self-reported avoidance. In the post-test, children were also asked which CPT they found the most painful and which CPT they would choose to perform again when being asked to do so. Results indicated that 55% of the children found the CS+ to be the most painful and 48% of the children would avoid the CS+ when being asked to perform an additional CPT, both proportions did not differ from 50% (respectively p = .65 and p = .88). So, children did not express a clear preference towards the CS- after completing both tasks, indicating that they perceived both CPTs equally aversive.

Discussion

In this experimental study, observational learning of pain-related fear (PRF) and subsequent extinction after first-hand experience of the feared stimulus was investigated in healthy children. A differential fear conditioning paradigm was used in which children observed a model performing two coloured cold pressor tasks (CPTs). The models displayed genuine pain while performing one CPT (CS+) and neutral facial expressions while performing the other (CS-). One group of children observed their mother performing the CPTs (mother-group); another group observed an unknown woman (stranger-group). In line with expectations, the results showed that children acquired PRF after observing another's pain. This PRF extinguished after first-hand exposure. Unexpectedly, observational learning effects were not enhanced in children observing their own mother, nor in children reporting high levels of pain catastrophizing, trait PRF, or trait anxiety.

The current experiment provided evidence for observational learning of PRF in children, corroborating previous results in adults (Helsen et al., 2011, 2013; Olsson et al., 2007; Olsson & Phelps, 2004) and extending results in children (Boerner et al., 2017). Self-reported PRF was accompanied by altered pain expectancies and hesitation to perform the task that is now believed to be painful. Moreover, children were more aroused in anticipation of performing the CS+ compared to the CS-. Note that children in the current study acquired PRF after only one presentation of the CS+ together with painful facial expressions and one presentation of the CS- together with neutral facial expressions. The number of trials per CS type varies in fear conditioning studies but is usually higher (Lonsdorf et al., 2017). This demonstrates the strength of observational learning in this study. Still, such 'one-shot' observations of pain in a model are rather unlikely in daily life, especially for children whose parent has CP. Remarkably, the more a child perceived a difference between the model's facial reaction to the CS+ versus the CS- task, the larger the learning effects (i.e., larger differences between CS+ and CS- post-observation). This interesting finding deserves further examination, as it suggests that children who perceive high levels of parental pain might be especially vulnerable to acquire PRF and, consequently, may be more vulnerable to develop pain-related disability themselves. Moreover, while some children probably reached a smaller learning effect because the painful expressions were

less clearly noticeable, it is also possible that some children are less sensitive to others' pain or less prone to acquire PRF through observational learning. Indeed, differences in children's perception of a model's pain could not be completely accounted for by the independent raters' estimates of models' pain. To come to an understanding of the real-life bidirectional interactions between a person in pain and an observer, further research should evaluate which factors in both the model and observer might alter observational learning (see also Goubert et al., 2011).

This is the first study to show that observationally learned PRF in children diminishes after subsequent first-hand exposure. A comparable differential conditioning procedure with CPTs in adults yielded similar results (Helsen et al., 2011, 2013). While the CS+/CS- difference in pain intensity ratings decreased after immersing in both CPTs (i.e., extinction of the learned association), the experienced pain intensity ratings (post-immersion) were on average higher than the expected pain intensity ratings (post-observation), irrespective of CS type. This contrasts previous findings indicating that the actual pain experience can be altered by pain expectancies (Colloca & Benedetti, 2009; Peerdeman, Laarhoven, Peters, & Evers, 2016; Swider & Bąbel, 2013; Vögtle, Barke, & Kröner-Herwig, 2013). Possibly, both CPTs were much more painful than anticipated, which may have prevented effects of pain expectancies and PRF on the actual experience of pain (Büchel et al., 2014; Crombez & Wiech, 2011). Alternatively, self-reported pain intensity ratings may not be sensitive enough to capture differences in experienced pain caused by expectancies. One study reported an effect of expectations on pain threshold and tolerance, but not on self-reported pain intensity and unpleasantness (Krummenacher et al., 2014). Future research should evaluate whether and under which conditions the experience of pain in children can be moderated by observationally learned PRF and pain expectancies by, for example, using a less painful task. Alternatively, a staircase procedure could be used which increases and decreases the stimulus intensity and duration, until a subjective pain intensity of a predetermined level is established. Moreover, self-reported pain could be combined with other pain outcomes, such as pain threshold or tolerance.

As posited in Bandura's social learning theory (Bandura, 1977), individuals learn more readily from a model they are related to and share characteristics with (e.g., parents, same sex peers). Indeed,

observational fear learning in adults depends on model-observer similarity (Golkar, Castro, & Olsson, 2015) and research in young children (12-21 months) suggests that the observation of maternal responses is more influential than the observation of strangers' responses (Egliston & Rapee, 2007; Zarbatany & Lamb, 1985). However, the current results did not show enhanced observational learning effects in the mother-group compared to the stranger-group. Similar results were found in a study in 6-10-years-olds examining fear for animals (Dunne & Askew, 2013). It is possible that the influence of parental modelling decreases as children get older and are more frequently confronted with other models (e.g., teachers). In support of this reasoning, recent results indicated that fear learning in children (6-10 years) also did not depend on whether the fear was modelled by the child's mother or a peer (Dunne & Askew, 2018). Alternatively, the absence of differences between the mother-group and stranger-group may be a consequence of the current design. All children were led to believe that their mother performed the CPTs and this may have increased the value and personal relevance of the behaviour of the stranger. Moreover, the stranger models shared a lot of characteristics with the children's own mother, possibly masking potential differences in observational learning effects that might be more prevalent in a situation where the model resembles the children's own parents less (e.g., different racial or age group, Golkar, Castro, & Olsson, 2015). In the context of pain, no other studies directly compared learning from observing a known (e.g., mother) versus an unknown model. More research is needed to evaluate whether the current results can be replicated or whether the lack of a group difference was due to limited power after exclusion of a high proportion of children.

Contrary to our hypotheses, observational learning and extinction effects were not moderated by child pain catastrophizing, trait PRF and trait anxiety. While this contrasts some earlier findings (Helsen et al., 2013; Trost et al., 2012), it is in line with others (Helsen et al., 2011). Possibly, levels of trait PRF and pain catastrophizing were not high enough to impact observational learning effects in this sample of schoolchildren. Additionally, our study was likely underpowered for the detection of small effects. Because genuine painful expressions were used, the intensity of model's pain expression could not be controlled for. A substantial number of children were excluded because the model's painful and neutral facial expressions were too similar. An alternative method to ensure that every

participant can learn from observing someone else's pain, is to carefully select movies of genuine pain. An additional advantage of this procedure is that the level of observed pain expression is kept constant across participants, and under these conditions, moderating effects of individual differences may be better captured. However, an important asset of the current study is that children observed their own mother performing the same tasks or at least believed that their mother performed the same tasks (stranger-group). This heightened the personal relevance of the observation phase and made the situation more real-life for the participants. Moreover, the design enabled us to examine differences in learning effects based on the relationship between the model and observer.

The results of the present study have some clinical implications. First, children learned from observing others' behaviours, irrespective of their relationship with the model. This result emphasizes the interpersonal effects of pain and supports the presumed role of observational learning in the development of risk factors for developing CP, such as PRF (Goubert et al., 2011; Stone & Wilson, 2016). Second, observationally learned PRF diminished after exposure, further supporting the use of graded exposure therapy in clinical practice to reduce PRF (Simons, 2016; Vlaeyen, de Jong, Geilen, Heuts, & van Breukelen, 2002). There are also some limitations to the present study. First and foremost, the power of the study was substantially reduced after the exclusion of eighteen children. Therefore, it cannot be ruled out that nonsignificant results were due to limited power and further research is warranted to determine whether the current results can be replicated in a larger sample. Second, given the experimental task and setting, conclusions on observational learning in families confronted with parental CP cannot be drawn. Third, children's pain behaviour was not examined and this precluded any conclusions on whether the previously reported effect of parental modelling on child facial expressions of pain (Boerner et al., 2017; Goodman & McGrath, 2003) was replicated. Fourth, and relatedly, observational learning and extinction effects were derived mostly based on self-report ratings. According to Lang (1968), fear consists of three response systems: verbal report, avoidance behaviour and physiological states. No objective measure of avoidance behaviour was included in the current study. Future studies should examine whether observational learning of PRF in children can be demonstrated by increases in the three response systems. Fifth, children were recruited

within a broad age range (8-16 years) but sample size was too small to thoroughly study age differences in learning and extinction effects. More information on plausible age differences, by running a similar study in a larger sample, can help determining whether there is a crucial age-period for preventive efforts (e.g., positive modelling) directed at children of parents with CP. Finally, it is unclear whether the current results extend to other populations and situations (e.g., different pain tasks, different colours as CSs). Participating families were mainly white, healthy and most mothers were highly educated, which restricts external validity.

To summarize, given the importance of PRF in both the development and sustainment of CP, examining how PRF develops in children might improve the understanding of vulnerabilities in children of parents with CP. This experimental study in schoolchildren provided evidence for observational learning of PRF and subsequent extinction after first-hand experience. Interestingly, observational learning was as effective regardless of whether the pain was modelled by the child's mother or a stranger.

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Conception and design: EVL, LG, TV, GH, EVDB; Data collection: EVL; Data analysis and interpretation: EVL, EVDB; Article drafting: EVL, LG, EVDB; All authors discussed the results and commented on the manuscript. The authors thank E. De Clercq, K. Vrijdagh and L. Cools for their assistance in recruitment and data collection, and B. Aben for designing Figure 3.

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Figures and Tables

Figure 1. Overview of the experimental procedure. The different phases of the experiment are depicted together with the measurements between and during these phases. The order and colour of the cold pressor task (CPT) is counterbalanced and the order of the observation (painful and neutral movie) is randomized. *Note.* NRS = Numerical Rating Scale, PRF = Pain-Related Fear, SCR = Skin Conductance Response, CPT = Cold Pressor Task

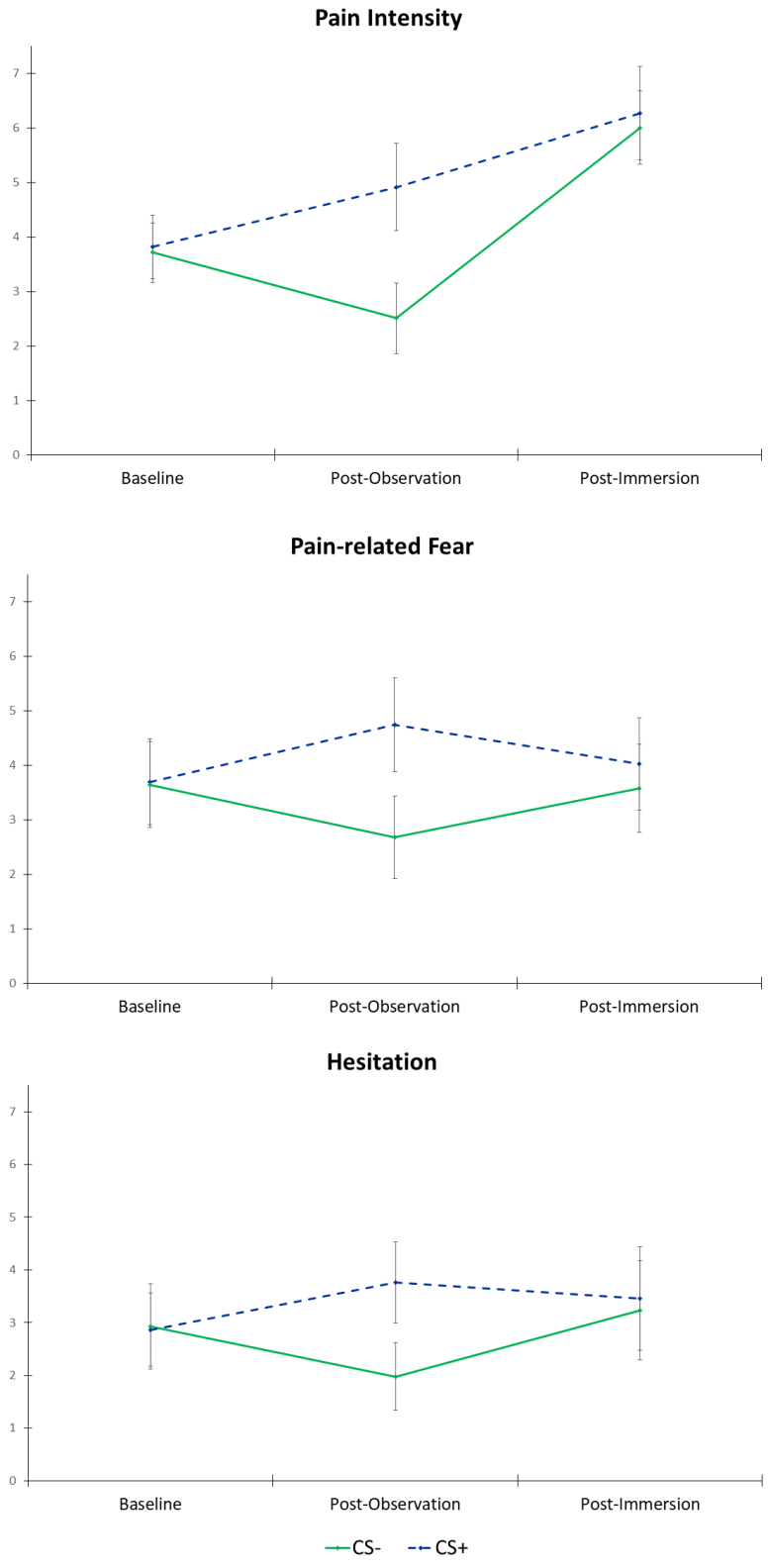

Figure 2. The course of the children's mean (and 95% CI) pain intensity, pain-related fear and hesitation ratings for CS+ and CS- throughout the three experimental phases (Baseline, Post-Observation and Post-immersion).

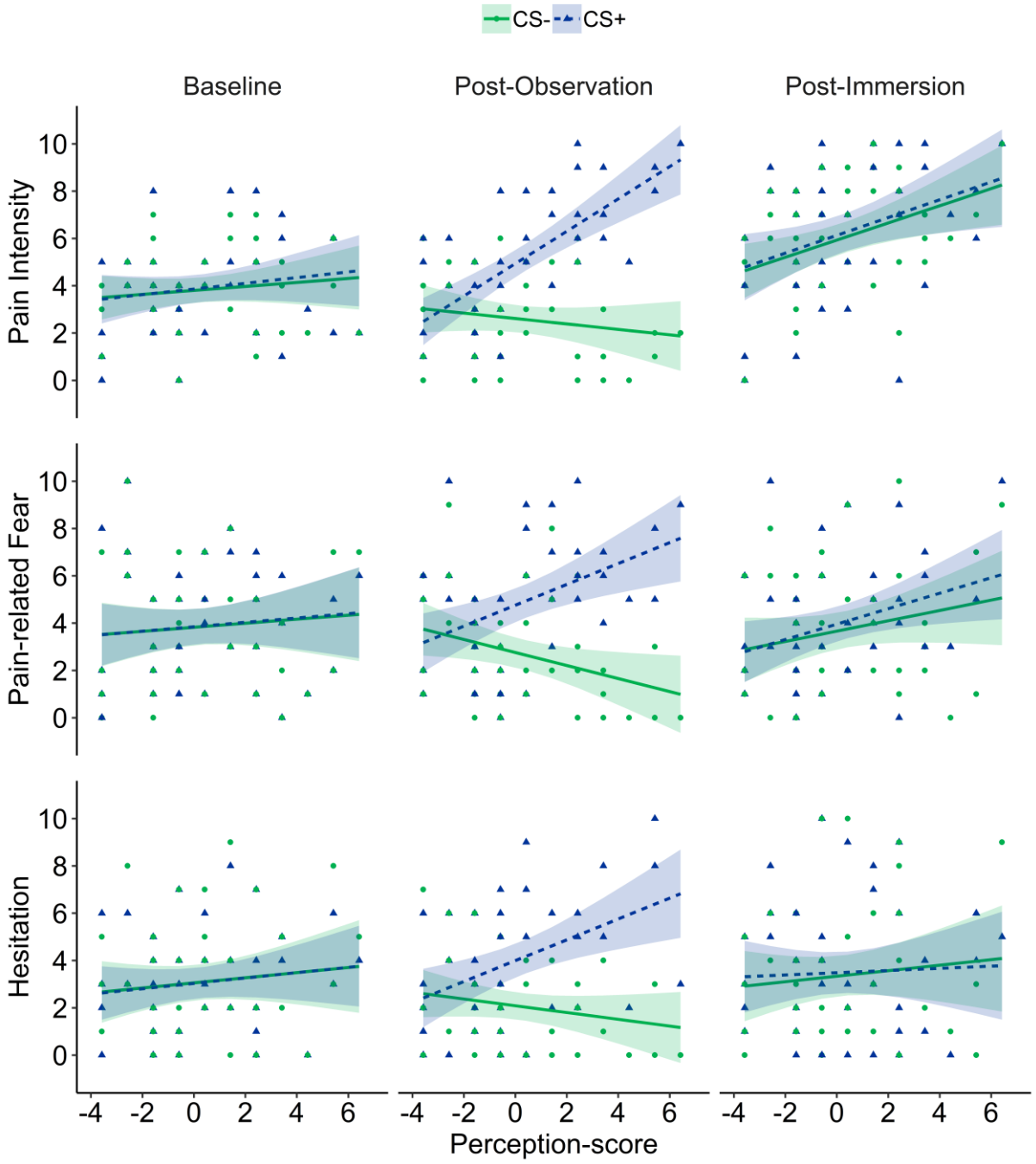

Figure 3. Graphical depiction of the three-way interaction between CS type (CS+ versus CS-), time (Baseline, Post-Observation, Post-Immersion) and child perception of models' pain (Perception-score). Dots represent scores for each participant for each CS type (thus, each participant is depicted twice per measurement moment). Lines represent children's mean (and 95% CI) pain intensity, pain-related fear and hesitation ratings for CS+ and CS-. Larger differences between CS+ and CS- indicate a stronger observational learning effect.

Table 1. Descriptive statistics, internal consistency and Pearson correlation coefficients for child questionnaire measures

Questionnaire	**Range**	***M***	***SD***	**Cronbach's Alpha**	**Pearson Correlation Coefficient**		
					Child Age	FOPQ-C	STAIC
PCS-C	6 - 29	15.91	6.03	.72	.15	.63***	.44**
FOPQ-C	13 - 46	33.82	7.07	.77	.20	-	.39**
STAIC	23 – 50	34.76	6.81	.83	.24		-

PCS-C: total scores on Pain Catastrophizing Scale-Child version; FOPQ-C: 'Fear of Pain'-subscale scores on the Fear of Pain Questionnaire-Child version; STAIC: total scores on the State-Trait Anxiety Inventory for Children;
*p <.05; ** p <.01; *** p <.001

Table 2. Results of the three separate (one per outcome variable) Repeated Measures Analyses of Variance

Measure	Model	Effect	*df*	*F*	*p*	η_p^2
Pain Intensity	Step 1: no covariates	**CS type**	**1,39**	**25.20**	**<.001**	**0.39**
		Time	**2,38**	**27.25**	**<.001**	**0.59**
		CS type x Time	**2,38**	**19.03**	**<.001**	**0.50**
		CS type x Time x Group	2,38	0.02	.98	0.001
		CS type x Time x Gender	2,38	2.31	.11	0.11
		CS type x Time x Age	2,38	2.97	.064	0.14
	Step 2: covariates entered one by one	CS type x Time x PCS-C	2,39	0.83	.45	0.041
		CS type x Time x FOPQ-C	2,39	1.12	.34	0.054
		CS type x Time x STAIC-T	2,39	0.79	.46	0.039
Pain-Related Fear	Step 1: no covariates	**CS type**	**1,39**	**23.80**	**<.001**	**0.38**
		Time	2,38	0.034	.97	0.002
		CS type x Time	**2,38**	**10.35**	**<.001**	**0.35**
		CS type x Time x Group	2,38	0.61	.55	0.031
		CS type x Time x Gender	2,38	2.37	.11	0.11
		CS type x Time x Age	2,38	1.11	.34	0.055
	Step 2: covariates entered one by one	CS type x Time x PCS-C	2,39	0.52	.60	0.026
		CS type x Time x FOPQ-C	2,39	0.089	.92	0.005
		CS type x Time x STAIC-T	2,39	0.66	.52	0.033
Hesitation	Step 1: no covariates	**CS type**	**1,38**	**16.76**	**<.001**	**0.31**
		Time	2,37	0.84	.44	0.043
		CS type x Time	**2,37**	**12.48**	**<.001**	**0.40**
		CS type x Time x Group	2,37	0.62	.55	0.032
		CS type x Time x Gender	**2,37**	**3.30**	**.048**	**0.15**
		CS type x Time x Age	**2,37**	**4.35**	**.020**	**0.19**
	Step 2: covariates entered one by one	CS type x Time x PCS-C	2,38	0.80	.46	0.040
		CS type x Time x FOPQ-C	2,38	0.13	.88	0.007
		CS type x Time x STAIC-T	2,38	0.40	.67	0.021

Note. Covariates: PCS-C = Pain Catastrophizing Scale-Child Version, FOPQ-C = Fear of Pain Questionnaire-Child report, STAIC-T = State-Trait Anxiety Inventory for Children - Step 1: Model = CS Type (2 levels: CS+/CS-) * Time (3 levels: baseline, post-observation, post-immersion) * Group (2 levels: mothers/strangers) * Child gender * Child age - Step 2: Model = CS Type (2 levels: CS+/CS-) * Time (3 levels: baseline, post-observation, post-immersion) * Child gender * Child age * Covariates (Entered one by one)