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The Effect of a Pain Educational Video Upon Child Pain-Related Memory and the Moderating Role of Parental Pain- and Non-Pain-Attending Verbalizations: An Experimental Lab-Based Study

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Abstract

Objectives Early memories of pain contribute to fear and may underlie the maintenance and development of chronic pain into adulthood. Accordingly, understanding determinants that may impact children's pain memory development is key. This study examined (a) the effect of a brief engaging pain educational video in healthy children before undergoing an experimental pain task upon children's recalled pain intensity and pain-related fear and (b) the moderating role of parental pain- and non-pain-attending verbalizations before and after the pain task. **Methods** Seventy-seven children (8–15 years old) participated in an experimental heat pain task, including actual heat pain stimuli delivered through a thermode on their forearm. Children were randomized to the experimental group (i.e., watching a pain educational video) or the control group (i.e., no video). Children's recalled pain intensity and pain-related fear were elicited 2 weeks later. **Results** Findings showed that recalled pain intensity (but not recalled pain-related fear) of children who watched the pain educational video was significantly lower compared to the control group ($p = .028$). Further, parental pain-attending verbalizations before the pain task moderated the impact of the video upon children's recalled pain intensity ($p = .038$). Specifically, children in the control group, but not the experimental group, whose parents used less pain-attending verbalizations recalled higher pain intensity, whereas children whose parents used more pain-attending verbalizations recalled lower pain intensity. **Conclusions** As children's pain memories have important implications for pain

assessment, treatment, and health across the lifespan, these findings might have important implications for the prevention of development or maintenance of maladaptive pain-related outcomes.

Key words: children; experimental pain; pain experience; pain memory; pain education.

Introduction

From a very young age, children develop memories of pain that are highly susceptible to distortion over time and may impact subsequent reactions to future pain experiences (Noel et al., 2012c). Particularly, negatively estimated pain memories (i.e., higher recalled pain than initially reported) appear to be a better predictor of future reporting of pain than the initial pain reporting (Noel et al., 2012a), and may underlie the maintenance and/or development of persistent pain (Flor & Birbaumer, 1994; Noel et al., 2017). Accordingly, understanding determinants that may play a role in children's pain memory development is key.

Increasing one's knowledge about pain may prove particularly valuable in influencing children's pain memory. Indeed, pain neuroscience education implies educating patients about the neurophysiological, psychological, social, and environmental factors contributing to their pain, all aiming for patients' reconceptualization of pain (Moseley & Butler, 2015). Key goals of pain neuroscience education are decreasing the threat value of pain and catastrophic thoughts, while stimulating one's individual's active and adaptive coping mechanisms (Louw et al., 2016). Since higher levels of children's catastrophic worry about pain and anxiety appear to be strong drivers of the development of more negatively recalled pain (Noel et al., 2015b; Pallegama et al., 2017; Rocha et al., 2009), it is likely that pain neuroscience education might have a beneficial impact on children's pain memories as well. Only a few studies investigated the effects of pain neuroscience education interventions in children, indicating beneficial effects of such interventions on children's pain knowledge (Andias et al., 2018; Louw et al., 2018; Rheel et al., 2021b; Wager et al., 2018), beliefs about pain (Louw et al., 2018), pain-related fear (Pas et al., 2020), pain thresholds (Pas et al., 2020; Rheel et al., 2021b), and functional disability (Pas et al., 2020). However, the impact of pain neuroscience education upon children's pain-related memories remains to be investigated.

Additionally, findings suggest that pain-related memories may not only be influenced by altering children's individual factors but may also depend upon parental behavior towards the child in pain and the interaction between both. Memories are often co-constructed in a social context (Reese and Fivush, 2008) and recent findings suggest that children's pain memories may be shaped through verbal interactions with their parents before and after a painful experience (Noel et al., 2015a). Noel et al. (2019) examined the role of parent–child reminiscing about past painful surgery in the development of pain memories in children. Findings showed that more use of pain words by parents predicted more negatively recalled pain. While the latter study (Noel et al., 2019) did not examine the role of parental non-pain-attending verbalizations (i.e., not focusing on the child's pain, like distracting the child with humor), recent findings (Wauters et al., 2020) attest to the potential moderating role of such parental verbalizations in understanding the impact of child individual factors (i.e., attention bias to pain) upon children's pain memory. Specifically, higher child attention bias to pain was positively associated with more negatively recalled fear, but only amongst children whose parents demonstrated low levels of non-pain-attending verbalizations. The opposite pattern was found among children whose parents showed high levels of non-pain-attending verbalizations. To date, findings on the role of parental pain- and non-pain-attending verbalizations in understanding children's pain-related memories are limited and no study has examined whether such verbalizations would interact with the impact of pain neuroscience education upon children's pain-related memory.

Given the literature gaps identified above, this study investigates the effect of a brief engaging pain educational video upon recalled pain intensity and pain-related fear in healthy children undergoing an experimental pain task. Additionally, the moderating role of parental pain- and non-pain-attending verbalizations regarding the child's pain experience is considered. We hypothesized that (a) children who watched the pain educational video would report less recalled pain intensity and pain-related fear compared to the control group, (b) higher levels of parental pain-attending verbalizations would be associated with higher recalled pain intensity and pain-related fear, and (c) beneficial effects of the video (i.e., lower recalled pain intensity and pain-related fear) would be dampened in cases where parents demonstrated high levels of pain-attending verbalizations and enhanced in cases where parents demonstrated high levels of non-pain-attending verbalizations.

Materials and Methods

This study was part of a larger study with three distinct research objectives, i.e., investigating (a) the impact of a brief pain educational video upon child pain-

related outcomes; (b) the effect of child attention to pain upon child pain-related memory bias; (c) the role of parental attention to their child's pain. The methods and results section is restricted to the measures and tasks relevant to the current study (i.e., objectives a and c). Previously, one other paper with data of the larger trial, yet with distinct research objectives, has been published (see Rheel et al., 2021b). The data can be shared on reasonable request to the corresponding author. Ethical approval for this study was obtained from the Ethics Committee of the Faculty of Psychology and Educational Sciences of Ghent University, Belgium.

Participants

The study sample consisted of healthy school children (8–15 years old) and one of their parents, recruited through schools (33.63%), sports clubs (2.65%), and youth movements (1.77%) in the vicinity of Ghent University (Belgium), through social media calls (21.24%), and through family and acquaintances of the research team (40.71%). The research team consisted of first-year PhD students and Master of Science students in Psychology and Educational Sciences, minimizing the chance that family and acquaintances of the research team could have participated in a study of this research group before. All participants were recruited and participated between July 2019 and December 2019. Exclusion criteria were: (a) having chronic pain (i.e., pain in $\geq$ 1 anatomic region that persists or recurs for >3 months; Treede et al., 2015); (b) having a chronic illness (e.g., diabetes); (c) having a diagnosed developmental disorder (e.g., autism spectrum disorder); (d) inability of the child or parent to speak and read Dutch. Prior to the start of the study, simple randomization was used to assign participants to the experimental condition (i.e., pain educational video) or control condition (i.e., no video), with a random number generator (www.graphpad.com/quickcalcs/randomize1) using a 1/1 allocation ratio. Participants, but not experimenters, were blinded to group allocation. A priori sample size calculation for the current study objective showed that a total sample size of 55 participants was needed to be able to detect a moderate effect size f^2 of .15 with an 80% power (α = .05). We anticipated the possibility of a 20% drop-out due to the technologically more difficult nature of the overall study and the fact that the children had to perform an experimental pain task, hence we deliberately over-recruited participants. Sample size calculations were performed with G*Power 3.1.9.2 (Franz Faul, Kiel, Germany).

Procedure

Participants were provided with standardized information about the study through a phone call. Parent–child dyads who verbally consented/assented to participate were invited to the laboratory at Ghent University. Upon arrival, participants were again briefed in a standardized manner about the study aims (i.e., investigating how children and their parents think and feel about the child experiencing pain) and procedure. Participants were asked whether or not they had heard something about the study via other participants, friends, or family, which appeared not to be the case in any of the participants. The heat pain task was described and the thermal heat stimulator was shown to the child and parent. The experimenter informed participants that the parent would be able to watch the child during the pain task from an adjacent room, and that they would have two small breaks during the course of the experiment to catch up and have something to drink and eat together. Participants were reminded of their ability to withdraw participation at any time. Finally, written consent/assent was obtained from both the parent and the child. One experimenter stayed in the child test room together with the child while a second experimenter accompanied the parent to an adjacent room. First, socio-demographic information about the child and parent was obtained through an online questionnaire (GmbH.). Afterwards, baseline measures of the dependent variables, including anticipated pain intensity and pain-related fear were completed on paper. Next, children randomized to the experimental group watched a 15 min pain educational video, whereas the control group did not watch a video but proceeded to the next step. Parents could not hear or see the video from the adjacent room.

Then, the parent was invited to enter the child test room for a short break together with the child. During this break, parent–child interactions were videotaped for 3 min. After the break, the parent went back to the adjacent room. Next, the heat pain task was initiated, and parents were able to watch their child throughout. Hereto, a camera was recording the child's face, which was streamed on a television screen in the parent test room. After performing the heat pain task, children were asked to report on their experienced pain intensity and pain-related fear. This was followed by a second break during which parent–child interactions were again videotaped for 3 min. Parents and children were informed of the video recordings at the end of the study to enable spontaneous behavior during the breaks. Upon study completion, the parent and child were reunited and fully debriefed. Written consent/assent was obtained from the child and the parent for using the video material obtained during the breaks. Finally, a sealed envelope was handed to the parent, containing copies of the pain intensity and pain-related fear scales, which the child would need during the memory interview. Participants were asked to leave this envelope closed until the interview. Children and parents were informed that one of the researchers

would call them approximately 2 weeks later, but they were not told that the phone call would be about their memories of the pain task. The total duration of the experiment was approximately 1 hr 30 min. Each participant was compensated €25 for participating in this study and through a lottery system, an iPad was raffled off among the participants.

Pain Educational Video

A 15 min educational video was created (see also Rheel et al., 2021b) to teach children about the biopsychosocial mechanisms of pain. PNE4Kids (Pas et al., 2018), a pain neuroscience curriculum developed for children (aged 6–12 years old) (http://www.paininmotion.be/pne4kids; last accessed May 22, 2022), served as the basis of the pain educational video, with four out of seven target concepts of pain neuroscience education (see Leake et al., 2019) being covered in the video (a) pain is a protector; (b) pain is a brain output; (c) pain is not an accurate marker of tissue state; (d) there are many potential contributors to anyone's pain. Due to the characteristics of the study sample (i.e., pain-free healthy children), the concepts covered in the video were limited to the four concepts above. Story-telling and metaphors have been proven helpful in providing pain neuroscience education (Gallagher et al., 2013; Moseley, 2007), hence the same metaphors and stories (i.e., examples of real-life pain situations) were used as in the PNE4Kids curriculum. The nociceptive system is represented as the army, functioning as a protection mechanism for the human body. Specific neurophysiological terms (e.g., spinal cord) are replaced by language that is more comprehensible for children (e.g., the elevator of the body). At the end of the video, it was explained that pain is not an accurate marker of tissue state and that incoming messages can be regulated at different locations inside the nociceptive system (i.e., at the level of the elevator (i.e., the spinal cord) by the lieutenant and/or in the computer room (i.e., the brain) by the general), using two recognizable situations (i.e., a cyclist breaking his arm during a race and a builder stepping on a large nail piercing his boot). To make the video engaging, children simultaneously used the interactive board game developed within the PNE4Kids program following instructions given in the video.

Heat Pain Task

Children participated in an experimental heat pain task, including a total of 26 actual heat pain stimuli (see also Van Damme et al., 2004; Van Ryckeghem et al., 2012). The Contact Heat Evoked Potentials Stimulator of the Medoc Neuro Sensory Analyzer, Model TSA-II (Medoc Ltd. Advanced Medical Systems, Ramat, Yishai, Israel) was utilized for heat stimulation. This device delivers heat stimuli through a thermode with a contact area of 572.5 mm^2, attached to the inside of the child's non-dominant forearm with a Velcro strap. Over a time period of 300 ms, with a 70/40°C acceleration/cooling down rate, heat stimuli were applied to the surface of the child's skin. Heat stimuli were delivered at a moderately painful temperature (°C), which was individually determined upon the start of the heat pain task. For safety purposes, the Medoc software limited the maximum temperature of the heat stimuli to 54°C. The heat stimulation task used in the current study is an ethically approved and safe pain task, which has been successfully applied in previous experimental lab-based studies with children (Caes et al., 2012; Hermann et al., 2006; Rheel et al., 2021b; Vervoort et al., 2012; Zohsel et al., 2008). More details on the performed heat pain task can be found as Supplementary Material.

Measures

Experienced Pain Intensity

Children's experienced pain intensity during the heat pain task was assessed with the Faces Pain Scale-Revised (FPS-R) (Hicks et al., 2001). The FPS-R consists of six age- and sex-neutral faces illustrating an increasing level of pain intensity from the most left face ("no pain at all"; 0) to the most right face ("most pain possible"; 5). Instructions of the FPS-R were read aloud by the experimenter. Participants were instructed to encircle the face that corresponded best to their level of experienced pain. Adequate psychometric properties of the FPS-R have formerly been demonstrated (Chambers et al., 2005; Stinson et al., 2006). Moreover, the FPS-R is considered the most appropriate scale to assess acute pain intensity in children from the age of 4 (Hicks et al., 2001; Stinson et al., 2006).

Experienced Pain-Related Fear

Children's experienced pain-related fear during the heat pain task was assessed with the Children's Fear Scale (CFS) (McMurtry et al., 2011). The CFS consists of five age- and sex-neutral faces varying from a neutral face on the left ("not scared at all"; 0) to a face showing extreme fear on the right ("most scared possible"; 4). Instructions of the CFS were read aloud by the experimenter. Participants were instructed to encircle the face that corresponded best to their level of experienced pain-related fear. The CFS has good inter-rater reliability, test–retest reliability, and construct validity in children (McMurtry et al., 2011).

Parent–Child Interactions

Parent–child interaction during both breaks were videotaped for a period of 3 minutes, allowing coding of parent and child verbalizations. The coding system was based on a coding scheme developed by Walker et al.

(2006) and has previously been used in studies in Dutch-speaking children (Caes et al., 2014; Rheel et al., 2021a; Vervoort et al., 2011; Wauters et al., 2020). Parent and child verbalizations were coded as either: (a) *pain-attending*, defined as any parent or child verbalization that focused upon the child's pain experience or the heat pain task (e.g., "Did it hurt a lot?", "Are you still in pain now?"), (b) *non-pain-attending*, defined as any parent or child verbalization that did not focus upon the child's pain experience or the heat pain task (e.g., "What shall we eat tonight?", "Do you have homework?"), or (c) *other*, defined as any parent or child verbalization that was inaudible or related to technical aspects of the experiment (e.g., "How long will it take?", "There were two squares on the screen."). All transcripts of the experimental group were coded by one experimenter, while those of the control group were coded by another experimenter. To calculate inter-rater reliability, the same two experimenters randomly re-coded 20% of the transcripts of the other group. Consistent with Walker et al. (2006), intra-class correlation coefficients were determined for each of the coding categories. In this study, coefficients ranged between .79 and .98 indicating good to excellent inter-rater reliability for all coding categories. For analyses, four proportion scores were calculated, whereby parent pain-attending verbalizations and parent non-pain-attending verbalizations were calculated as the number of parent pain- and non-pain-attending verbalizations respectively, divided by the total number of parent verbalizations. Likewise, child pain-attending verbalizations and child non-pain-attending verbalizations were calculated as the number of child pain- and non-pain-attending verbalizations respectively, divided by the total number of child verbalizations.

Memory Interview

Approximately 2 weeks ($M = 16.26$ days, $SD = 3.51$ days) after testing, participants were contacted by phone and a memory interview was conducted in line with the memory assessment protocol of Noel et al. (2012a). During the interview, children were instructed to rate how much pain intensity and pain-related fear they remembered having experienced during the heat pain task, using the FPS-R (Hicks et al., 2001) and CFS (McMurtry et al., 2011), respectively. In order to facilitate communication during the interview and to avoid introducing a possible confounding numeric rating scale, each FPS-R and CFS face was, in line with previous research (see e.g., Badali et al., 2000; Noel et al., 2010, 2012a, 2019), assigned a random letter of the alphabet directly under the faces, which children had to say aloud to indicate the face of their choice. The mean attempts needed to contact the family for the memory interviews was 1.58 ($SD = 1.12$), with only one attempt for 50/77 (65%).

Statistical Analysis

Data analysis was performed using IBM SPSS Statistics 27 (SPSS IBM, New York City, NY). A p-value of less than .05 was considered statistically significant. Hypotheses were tested using generalized linear models with recalled pain intensity and recalled pain-related fear as the outcome variables. Due to the available independent variables, the best model configuration was analyzed to obtain an unbiased model which neither overfits nor underfits. A two-step procedure was conducted driven by the Akaike information criterion (AIC): first, the main effects were selected by elimination of the least important predictors minimizing the AIC, followed by the inclusion of possible interactions among the selected main effects which further improved the AIC-value rendering an optimal model configuration. The effect of each predictor was evaluated for significance in these two final models ($p < .05$, two-sided), that is, one for pain intensity as outcome variable and one for recalled pain-related fear as outcome variable. In case of a significant interaction effect, we further visualized this effect by plotting the scaled predicted values of the outcome variable for high (i.e., > mean) and low (i.e., ≤ mean) values of the moderator variable for both groups (i.e., control group vs. experimental group).

Results

Participant Flow

A total of 37 out of 56 contacted schools, sport clubs, and youth associations agreed to internally distribute flyers about the study to their students/members aged 8–15 years old and their parents. A total of 151 families were interested to participate and contacted the research team. After an informative phone call with the interested families, 14 families refused to participate and 4 children appeared ineligible for study participation. Main reasons for refusal of participation were: the child felt too anxious or uncomfortable about the experimental pain task ($n = 6$) and/or lack of time due to busy work/family life ($n = 8$). Another 20 families canceled their appointment because of similar reasons. For the purpose of the current study, 90 of 113 children participating in the larger study were randomly assigned to either the experimental group ($n = 45$) or the control group ($n = 45$). One participant ended participation before watching the video and was therefore excluded from the study, and data from 12 children and their parents were discarded from analyses (see "Lost to follow-up", Figure 1). The final sample for analyses included 77 children; 38 and 39 children in the experimental and control group, respectively. Participant flow details are presented in the Consolidated Standards of Reporting Trials (CONSORT) Flow Diagram (Figure 1).

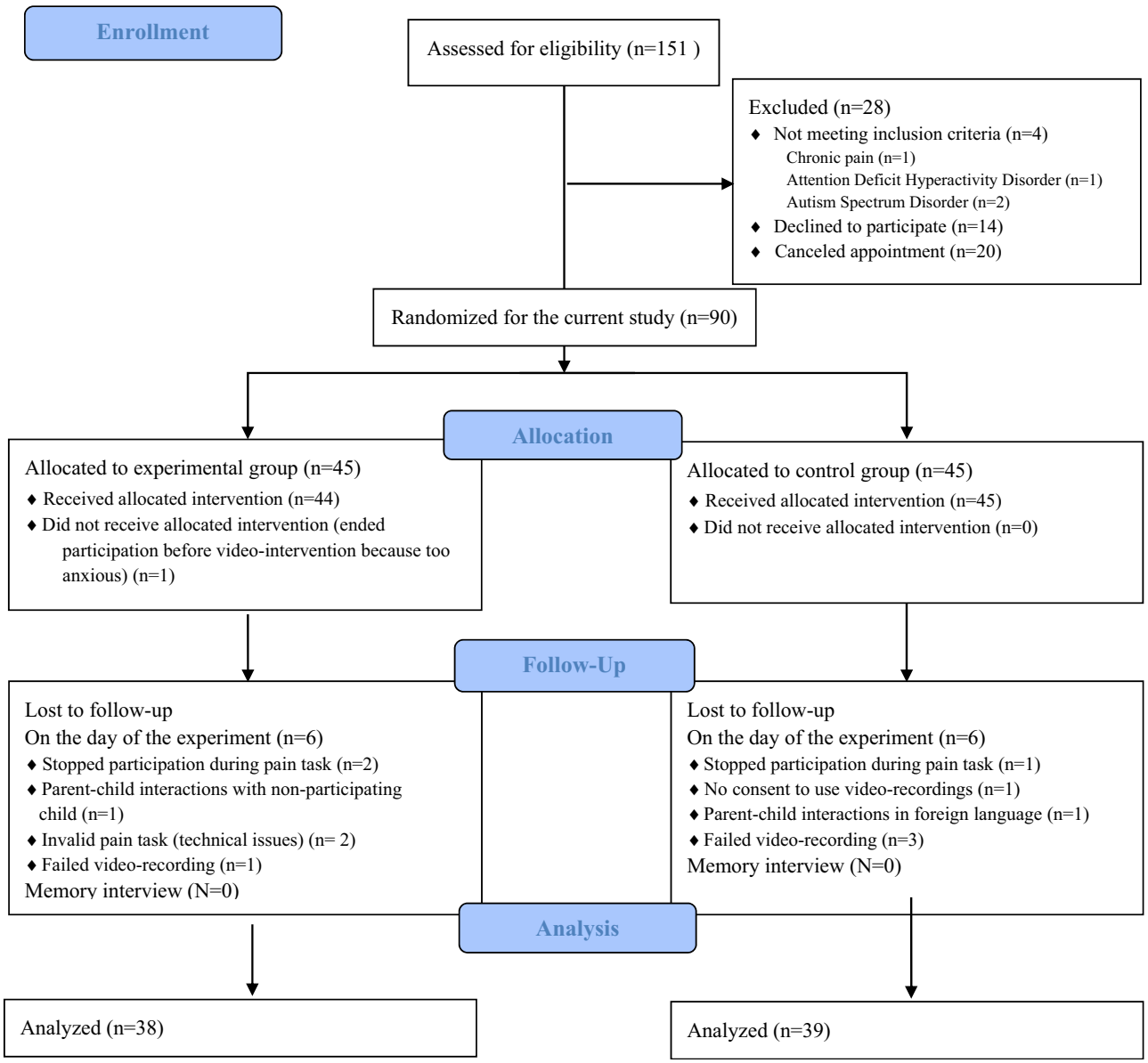

Figure 1. CONSORT flow diagram of participants through the study.

Descriptive Participants Characteristics

The final study sample comprised 77 Flemish healthy school children (44 boys, 33 girls; M_{age} = 12.01 years; SD = 1.75 years; Range = 8–15 years) and one of their parents (16 fathers, 61 mothers; M_{age} = 43.87 years; SD = 5.03; Range = 32–55 years). The majority of children (72.37%) reported to have experienced pain in the last 2 weeks prior to study participation, yet 87.27% of these children scored this pain as "a little" to "moderate," and only "once" or "a few times." None of them were therefore categorized as having chronic pain (Treede et al., 2015). Demographic characteristics are presented in Table I.

Independent samples *t*-tests indicated no significant differences between children who were excluded from the analyses ($N = 13$) and those who were not ($N = 77$) in terms of baseline anticipated pain or pain-related fear. However, they did differ in terms of age ($M_{excluded} = 10.83$, SD = 1.70; $M_{included} = 12.01$, SD = 1.75, 95% confidence interval [−2.26, −0.10], $p = .032$). Parental pain-attending verbalizations were significantly higher in the control group compared to the experimental group before as well as after the pain task, ditto for child pain-attending verbalizations before and after the pain task. No other between-group differences were found (see Table II).

Correlation Analyses

Means, standard deviations, ranges, and Spearman correlation coefficients for all variables of interest are presented in Table III. Pain- and non-pain-attending

Table I. *Demographic Participant Characteristics for the Total Group and Study Groups*

Characteristic	EG ($n = 38$) *M* (SD)	CG ($n = 39$) *M* (SD)	Total ($N = 77$) *M* (SD)
Age child in years	12.16 (1.86)	11.90 (1.67)	12.01 (1.75)
Age parent in years	43.92 (4.99)	43.82 (5.13)	43.87 (5.03)
	n (%)	*n* (%)	*n* (%)
Sex child			
Girl	17 (44.74)	16 (41.03)	33 (42.86)
Boy	21 (55.26)	23 (58.97)	44 (57.14)
Sex parent			
Mother	28 (73.68)	33 (84.62)	61 (79.22)
Father	10 (26.32)	6 (15.38)	16 (20.78)
Nationality child			
Belgian	37 (100.00)	39 (100.00)	76 (100.00)
Other	0 (0.00)	0 (0.00)	0 (0.00)
Pain in the last 2 weeks child			
Yes	28 (73.68)	27 (71.05)	55 (72.37)
No	10 (26.32)	11 (28.95)	21 (27.63)
Pain intensity last 2 weeks child			
No pain	10 (26.32)	11 (28.95)	21 (27.63)
Little bit pain	8 (21.05)	7 (18.42)	15 (19.74)
Moderate pain	17 (44.74)	16 (42.11)	33 (43.42)
Much pain	3 (7.89)	4 (10.53)	7 (9.21)
Very much pain	0 (0.00)	0 (0.00)	0 (0.00)
Pain frequency last 2 weeks child			
Never	10 (26.32)	11 (28.95)	21 (27.63)
Once	5 (13.16)	9 (23.68)	14 (18.42)
Few times	19 (50)	15 (39.47)	34 (44.74)
Often	4 (10.53)	3 (7.89)	7 (9.21)
Continuously	0 (0.00)	0 (0.00)	0 (0.00)
Health status parent			
Excellent	7 (18.92)	7 (17.95)	14 (18.42)
Very good	11 (29.73)	17 (43.59)	28 (36.84)
Good	15 (40.54)	15 (38.46)	30 (39.47)
Moderate	4 (10.81)	0 (0.00)	4 (5.26)
Poor	0 (0.00)	0 (0.00)	0 (0.00)
Family status			
Married or cohabiting	28 (75.68)	33 (84.62)	61 (80.26)
Divorced	1 (2.70)	5 (12.82)	6 (7.89)
Widow(er)	0 (0.00)	0 (0.00)	0 (0.00)
Single parent or unmarried	6 (16.22)	0 (0.00)	6 (7.89)
Newly assembled family	2 (5.41)	1 (2.56)	3 (3.95)
Education level parent			
Primary education ($\leq$12 yo)	0 (0.00)	0 (0.00)	0 (0.00)
Lower secondary education ($\leq$14 yo)	0 (0.00)	0 (0.00)	0 (0.00)
Higher secondary education ($\leq$18 yo)	9 (24.32)	11 (28.21)	20 (26.32)
Higher education (bachelor or master)	28 (75.68)	28 (71.79)	56 (73.68)
Occupation parent			
Housewife/househusband	0 (0.00)	2 (5.13)	2 (2.63)
Laborer	4 (10.81)	2 (5.13)	6 (7.89)
Employee	23 (62.16)	24 (61.54)	47 (61.84)
Liberal profession	2 (5.41)	2 (5.13)	4 (5.26)
Self-employed	2 (5.41)	2 (5.13)	4 (5.26)
Manager position	3 (8.11)	1 (2.56)	4 (5.26)
Unemployed	0 (0.00)	0 (0.00)	0 (0.00)
Other	3 (8.11)	6 (15.38)	9 (11.84)

Note. EG = experimental group; CG = control group; M = mean; SD = standard deviation; yo = years old. Note that no socio-demographic data were collected from one child (except child sex and age, which was collected from the informed consents) and one parent due to technical issues.

Table II. *Descriptive Data for Independent and Dependent Variables of Interest for the Total Sample and per Group*

Variables	Total sample ($N = 77$) *M* (SD)	EG ($n = 38$) *M* (SD)	CG ($n = 39$) *M* (SD)	*p*-value	95% CI (lower upper)
Age	12.01 (1.75)	12.13 (1.85)	11.90 (1.67)	.561	(−1.03, 0.56)
Anticipated pain (T_0)	2.08 (0.84)	2.11 (0.86)	2.05 (0.83)	.780	(−0.44, 0.33)
Anticipated fear (T_0)	1.23 (0.94)	1.18 (0.77)	1.28 (1.10)	.651	(−0.33, 0.53)
Experienced pain (T_2)	1.26 (0.98)	1.24 (0.82)	1.28 (1.12)	.840	(−0.40, 0.49)
Experienced fear (T_2)	0.69 (0.85)	0.61 (0.79)	0.77 (0.90)	.399	(−0.22, 0.55)
Recalled pain (T_3)	1.19 (0.78)	1.16 (0.68)	1.23 (0.87)	.684	(−0.28, 0.43)
Recalled fear (T_3)	1.00 (0.86)	1.03 (0.79)	0.97 (0.93)	.793	(−0.44, 0.34)
P PA verbalizations (T_1)	0.23 (0.19)	0.18 (0.14)	0.27 (0.22)	.024*	(0.01, 0.18)
P PA verbalizations (T_2)	0.51 (0.20)	0.46 (0.19)	0.56 (0.20)	.039*	(0.00, 0.18)
P NPA verbalizations (T_1)	0.26 (0.19)	0.27 (0.20)	0.25 (0.17)	.707	(−0.10, 0.07)
P NPA verbalizations (T_2)	0.20 (0.21)	0.21 (0.21)	0.20 (0.20)	.844	(−0.10, 0.09)
C PA verbalizations (T_1)	0.25 (0.17)	0.20 (0.16)	0.28 (0.17)	.034*	(0.01, 0.16)
C PA verbalizations (T_2)	0.49 (0.20)	0.44 (0.18)	0.53 (0.21)	.032*	(0.01, 0.19)
C NPA verbalizations (T_1)	0.22 (0.19)	0.22 (0.19)	0.22 (0.19)	.980	(−0.09, 0.09)
C NPA verbalizations (T_2)	0.17 (0.22)	0.18 (0.22)	0.16 (0.21)	.745	(−0.12, 0.08)

*$p < .05$.

Note. M = mean; SD = standard deviation; T_0 = baseline (i.e., before video intervention); T_1 = just before pain task; T_2 = immediately after pain task; T_3 = memory interview; PA = pain-attending; NPA = non-pain-attending; P = parent; C = child; pain = pain intensity (FPS-R); fear = pain-related fear (CFS); CI = confidence interval.

Table III. *Means (M), Standard Deviations (SD), Ranges, and Spearman Correlation Coefficients for All Independent and Dependent Variables of Interest*

Variables	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Anticipated pain (T_0)	.51**	.20	.09	.26*	.30**	−.05	.12	−.24*	.04	.06	.05	−.17	−.09
2. Anticipated fear (T_0)	–	.18	.34**	.22	.50**	.13	.06	−.30**	−.00	.20	.06	−.22*	−.10
3. Experienced pain (T_2)		–	.62**	.50**	.32**	−.09	.24*	−.10	−.15	−.06	.19	−.06	−.13
4. Experienced fear (T_2)			–	.44**	.51**	−.03	−.03	−.02	.02	.06	−.05	−.04	.06
5. Recalled pain (T_3)				–	.35**	−.15	.16	−.11	−.15	−.05	.16	.01	−.15
6. Recalled fear (T_3)					–	.03	−.09	−.06	.06	.03	−.09	.01	.04
7. P PA verbalizations (T_1)						–	.09	−.37**	−.22	.65**	.19	−.29*	−.21
8. P PA verbalizations (T_2)							–	−.17	−.60**	−.02	.78**	−.18	−.54**
9. P NPA verbalizations (T_1)								–	.30**	−.37**	−.22	.84**	.30**
10. P NPA verbalizations (T_2)									–	−.17	−.50**	.37**	.88**
11. C PA verbalizations (T_1)										–	.08	−.36**	−.18
12. C PA verbalizations (T_2)											–	−.29	−.57**
13. C NPA verbalizations (T_1)												–	.35**
14. C NPA verbalizations (T_2)													–

*$p < .05$; **$p < .01$.

Note. T_0 = baseline (i.e., before video intervention); T_1 = just before pain task; T_2 = immediately after pain task; T_3 = memory interview; PA = pain-attending; NPA = non-pain-attending; P = parent; C = child; pain = pain intensity (FPS-R); fear = pain-related fear (CFS).

verbalizations at corresponding time points (i.e., before the pain task or after the pain task) were significantly negatively related in parents and in children (all $p \leq .001$). Parents and children demonstrating more non-pain-attending verbalizations before the pain task also demonstrated more non-pain-attending verbalizations after the pain task ($p = .007$ for parents, $p = .002$ for children). Children's pain- and non-pain-attending verbalizations were always strongly and significantly positively associated with the corresponding category of parents' pain- and non-pain-attending verbalizations (all $p < .001$). Recalled pain intensity and pain-related fear were significantly positively correlated with each other ($p = .002$), but not with any of the other key variables.

Impact of the Pain Educational Video and Parental Pain- and Non-Pain-Attending Verbalizations upon Recalled Pain Intensity and Recalled Pain-Related Fear

By virtue of the backward elimination procedure, child age, sex, and verbalizations were excluded from the models, hence each generalized linear model assessed the impact of the experimental condition (control group coded as 0, experimental group coded as 1) and one of the four categories of parental verbalizations (i.e., pain-attending verbalizations before the pain task, pain-attending verbalizations after the pain task, non-pain-attending verbalizations before the pain task, and non-pain-attending verbalizations after the pain task), while controlling for children's

Table IV. *Results of Generalized Linear Models Examining the Effect of the Experimental Condition (i.e., Control Group vs. Experimental Group) and Parental (Non-)Pain-Attending Verbalizations on Children's Pain Memory (i.e., Recalled Pain Intensity) and Pain-Related Fear Memory (i.e., Recalled Pain-Related Fear), Controlling for Children's Anticipated and Experienced Pain Intensity/Pain-Related Fear*

Outcome variable	Step	Predictor	Exp(B)	*p*-value	AIC
Recalled pain intensity (T_3)	1	Condition	5.59	.028*	
	2	Anticipated pain intensity (T_0)	1.58	.132	
	3	Experienced pain intensity (T_2)	4.06	.000*	
	4	Parental pain-attending verbalizations (T_1)	8.35	.382	153.14
	5	Condition × parental pain-attending verbalizations (T_1)	0.002	.038*	150.59
Recalled pain-related fear (T_3)	1	Condition	0.396	.162	
	2	Anticipated pain-related fear (T_0)	2.93	.000*	
	3	Experienced pain-related fear (T_2)	3.27	.000*	
	4	Parental non-pain-attending verbalizations (T_2)	1.13	.847	154.88
	5	Condition × parental non-pain-attending verbalizations (T_2)	7.57	.363	156.05

*$p < .05$.

Note. T_0 = baseline (i.e., before video intervention); T_1 = just before pain task; T_2 = immediately after pain task; T_3 = memory interview; condition = control group (coded as 0) versus experimental group as the reference group (coded as 1).

anticipated and experienced pain intensity (for the outcome recalled pain intensity) and pain-related fear (for the outcome recalled pain-related fear).

The best fit main effects model was the model with parental pain-attending verbalizations before the pain task as a predictor for the outcome recalled pain intensity, and the model with parental non-pain-attending verbalizations after the pain task as a predictor for the outcome recalled pain-related fear. Additionally, the interaction term experimental condition × parental pain-attending verbalizations before the pain task was included in the model for recalled pain intensity, as this further improved the AIC-value. Based on the best fit interaction model for recalled pain intensity, the interaction term experimental condition × parental non-pain-attending verbalizations after the pain task was included in the model for recalled pain-related fear, although this did not further improve the AIC-value.

Table IV reports the results of generalized linear models examining the effect of the experimental condition (i.e., control group vs. experimental group) and parental pain- and non-pain-attending verbalizations on children's recalled pain intensity or recalled pain-related fear, controlling for children's anticipated and experienced pain intensity or pain-related fear respectively.

The analyses with recalled pain intensity indicated that children assigned to the control group recalled significantly higher pain intensity compared to children who watched the pain educational video ($p = .028$). As expected, experienced pain intensity reported immediately after the pain task predicted recalled pain intensity ($p < .001$). No other main effects on children's pain memory were observed. However, a significant experimental condition × parental pain-attending verbalizations (before the pain task) interaction effect was observed ($p = .038$), indicating that the effect of the video was dependent upon the level of pain-attending verbalizations expressed by the parent before the start of the pain task (see Figure 2). The slopes depicted in Figure 2, although both not significantly different from zero, show a significant cross-over interaction, suggesting that the impact of low versus high levels of parental pain-attending verbalizations on children's recalled pain intensity was significantly different and opposite between groups (i.e., experimental group vs. control group).

While these findings are in line with expectations, close inspection of Figure 2 suggests that the interaction effect mainly derived from the difference within the control group as a function of low versus high levels of parental pain-attending verbalizations, and not within the experimental group. Specifically, within the control group, children whose parents used less pain-attending verbalizations reported higher recalled pain intensity, whereas children whose parents used more pain-attending verbalizations reported lower recalled pain intensity. Parental pain-attending verbalizations before the pain task had virtually no impact on children's recalled pain intensity within the experimental group, suggesting that the pain educational video "nullified" the effect of parental pain-attending verbalizations prior to the start of the pain task.

The analysis with recalled pain-related fear indicated that both anticipated (i.e., baseline) and experienced pain-related fear showed to have a significant positive effect on children's recalled pain-related fear ($p < .001$). No other main or interaction effects were observed on children's pain-related fear memory.

Discussion

This study examined the impact of a pain educational video and the moderating role of parents' pain- and non-pain-attending verbalizations on memories of pain intensity and pain-related fear in healthy children experiencing experimental heat pain compared to a

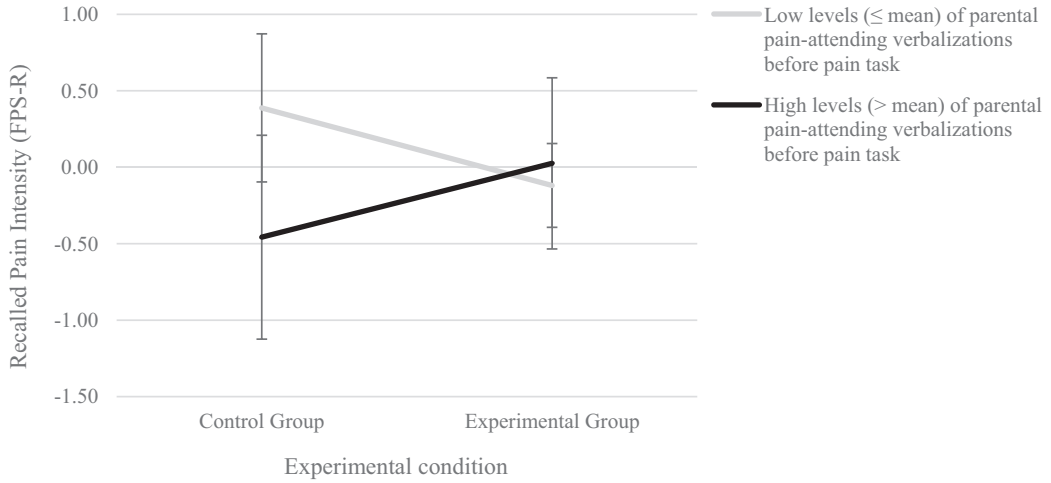

Figure 2. Interaction effect of the experimental condition and low versus high levels of parental pain-attending verbalizations before the pain task upon children's recalled pain intensity.

control group experiencing the same experimental pain without watching any video. Findings show that recalled pain intensity of children who watched the pain educational video was significantly lower compared to children assigned to the control group. No such effect was observed for recalled pain-related fear. Furthermore, in line with expectations, parental pain-attending verbalizations (assessed before the pain task, not after), moderated the impact of the pain educational video upon children's recalled pain intensity. Significantly different and opposite effects of low versus high levels of parental pain-attending verbalizations before the pain task were found for the experimental group compared to the control group. Yet, the impact of parental pain-attending verbalizations was primarily present in the control group, where children whose parents used low levels of pain-attending verbalizations reported higher recalled pain intensity, and children whose parents used lower levels of pain-attending verbalizations reported higher recalled pain intensity. Children who watched the pain educational video appeared almost unaffected by pain-attending verbalizations of their parents.

The current findings extend previous literature on the effects of pain educational interventions in children and adolescents (see e.g., Abram et al., 2007; Andias et al., 2018; Cox et al., 2017; Louw et al., 2018; Pas et al., 2020; Rheel et al., 2021b; Wager et al., 2018). Indeed, the current study indicated that a brief pain educational video, educating children about the biopsychosocial mechanisms of pain, resulted in lower self-reported recalled pain intensity 2 weeks later, compared to recalled pain intensity in children that did not watch any video. Children's pain memories have important implications for pain assessment, treatment and health across the lifespan (Ornstein et al., 1999; von Baeyer et al., 2004). For example, pain memories have an impact on how much pain, pain-related anxiety, and distress children experience during subsequent painful events (Noel et al., 2012c). Additionally, pain memories may play an important role in the transition of pain from an acute to chronic state (Chen et al., 2000; Flor & Turk, 1989). Therefore, the current study findings might have important preventive implications for the development or maintenance of future maladaptive pain-related outcomes. A possible explanatory variable for the observed effect is a reduction of the threat value associated with pain or attention to pain. Indeed, study findings in adults chronic pain populations show that pain educational interventions result in more favorable pain-related beliefs such as lower catastrophic worry about pain (Meeus et al., 2010; Moseley, 2004; Moseley et al., 2004). Future studies assessing explanatory variables such as pain catastrophizing and attention to pain are recommended.

The impact of the pain educational video was limited to recalled pain intensity; no impact of the video upon children's recalled pain-related fear could be identified. These findings underline that, although memories of pain intensity and pain-related fear are related to one another, they reflect different, i.e., sensory (pain intensity) and affective (fear), aspects of the pain experience, and can be differentially associated with child and parental variables (Noel et al., 2015b; Wauters et al., 2020). It is also likely that children who were highly anxious about the experiment did not participate in the study because they declined to participate. Accounting for certain trait variables, such as trait anxiety and anxiety sensitivity might have provided more insight here, as evidence shows that children with higher levels of trait anxiety and anxiety sensitivity report higher recalled pain-related fear (Noel et al., 2012b).

The impact of the pain educational video on children's recalled pain intensity was moderated by the

level of parental pain-attending verbalizations prior to the heat pain task (not after). Children who watched the pain educational video appeared almost unaffected by their parents' pain-attending verbalizations, hence showing some sort of buffering effect for their parents' verbalizations. Pain neuroscience education is considered to be a conceptual change strategy, facilitating individuals' understanding of biopsychosocial mechanisms of pain, resulting in a decrease in the threat value associated with pain (Moseley & Butler, 2015). Therefore, the observed "immunity" for parents' pain-attending verbalizations before the pain task in children that watched the pain educational video, might be a direct result of children's conceptual shift about pain induced by the content covered in the video. Conversely, a clear impact of parental pain-attending verbalizations was shown in the control group, where children whose parents expressed lower levels of pain-attending verbalizations reported higher recalled pain intensity, and the opposite pattern was shown for children whose parents expressed higher levels of pain-attending verbalizations.

Despite this pattern being contrary to expectations, we offer some tentative explanations. A direct effect may be observed of not seeing the pain educational video, and thus not being taught about pain science. Even though children and their parents were not aware that some children were shown a video and other children were not, children in the control group remained "in the dark" about the upcoming pain task and were not given the opportunity to reframe the threat value associated with the upcoming heat pain stimuli, whereas children in the experimental group had the opportunity to improve existing conceptual gaps or misconceptions regarding pain. Therefore, children in the control group might have sought (non-)verbal affirmation or answers regarding pain from their parents. Accordingly, high parental pain-attending verbalizations may have provided the child with missing (correct or incorrect) information about pain, decreasing threat value, whereas low levels of parental pain-attending verbalizations might have increased the child's uncertainties, maintaining the anticipated threat associated with the upcoming pain task. Following this rationale, it makes sense that mainly parents' pain-attending verbalizations before the pain task (not after) were impactful and interacted with the experimental condition.

Yet, these explanations remain speculative; more research is needed on why parental pain-attending verbalizations amongst children who did not receive pain education exerted this impact. Coding of non-verbal child–parent communication features may definitely add to our understanding. For instance, children report more fear when reassured or distracted by their parent when the parent demonstrates a fearful facial expression as opposed to the same parenting behaviors but with a happy facial expression (McMurtry et al., 2010). Therefore, although parents in the control group expressed more pain-attending verbalizations than parents in the experimental group, when for example accompanied by an unconcerned or happy facial expression, pain-attending verbalizations of parents could result in lower recalled pain intensity and vice versa. Additionally, independent *t*-tests showed that children and parents in the control group expressed significantly more pain-attending verbalizations at both time points (i.e., before and after the heat pain task) compared to the experimental group, which could confirm the above hypothetical explanation of a direct effect of the pain educational video. However, the above rationale is only tentative and further empirical inquiry is recommended. From a clinical perspective, we do not suggest that parents should restrain from talking with their child about future potential or experienced pain (i.e., a needle procedure). From the current study findings, we rather believe that children would benefit (i.e., lower recalled pain intensity/pain-related fear) from their parents' adaptively reminiscing about future or past painful experiences, providing correct and insightful information about pain and pain coping to their child. This could be supported by inviting parents to attend pain neuroscience education sessions delivered to children, which is supported by preliminary evidence (Bacardit Pintó et al., 2021).

A number of potential limitations should be considered. First, participants were healthy school children undergoing a standardized pain task within a safe experimental environment. Second, children who were highly anxious about the pain stimuli, presumably declined to participate, which potentially created some selection bias. As such, generalizability of the current findings to clinical or more anxious children remains to be investigated. Third, non-verbal communication features were not included in the coding of parent–child interactions. Future studies should use more fine-grained coding systems, in which non-verbal communication aspects, like tone of voice, interpersonal distance and facial expressions are accounted for. Fourth, as the heat pain task included repeated heat stimuli (i.e., 26 heat stimuli in total), the heat stimuli's threat value might have dropped and habituation might have occurred (Kleinböhl et al., 2006). This might partly explain the overall rather low experienced and recalled pain intensity. Finally, children assigned to the control group did not receive any intervention and thus received less attention from the experimenter. This could have potentially biased the results. In addition, as no "control-video" was shown to the control group, we cannot say with certainty that the results found in the experimental group are due to the content of the pain educational video.

To conclude, this study shows that a brief pain educational video resulted in lower self-reported recalled pain intensity in healthy school children, compared to recalled pain intensity in children that did not watch any video. Findings also showed that parental pain-attending verbalizations moderated the impact of the video upon children's recalled pain intensity (but not recalled pain-related fear). Children's pain memories are key in pain assessment, pain treatment, and the transition of acute to chronic pain, hence findings of this study might have important implications for the development or maintenance of maladaptive pain-related behavior in children.

Supplementary Data

Supplementary data can be found at: https://academic.oup.com/jpepsy.

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