Bottom-up or top-down?: The role of child and parent chronic pain and anxiety in the context of parental catastrophizing and solicitousness

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Abstract
Purpose: Children of parents with chronic pain are a high-risk group to develop own chronic pain. There is evidence that parental responses such as catastrophizing and solicitousness play an important role in the familial transmission of chronic pain. However, little is known about factors that modulate these responses. Based on the literature, we assumed that top-down processes, such as parent chronic pain and anxiety, would be associated with increased catastrophizing and solicitousness. Bottom-up processes, such as child chronic pain and anxiety, were assumed to moderate this association.

Methods: N = 118 parents (mean age: 43 years, 80.5% females) with chronic pain and/or anxiety symptoms with N = 190 children (mean age: 11 years, 49% females) were recruited in specialized hospitals and via online panels. Parents reported chronic pain, anxiety, catastrophizing and solicitousness by use of validated questionnaires. Child pain and anxiety were assessed via parent report.

Results: Multilevel model results showed that top-down processes, rather than bottom-up processes, predicted parental responses to child’s pain. Specifically, parents with more severe chronic pain reported less catastrophizing. Parent anxiety was positively associated with parental catastrophizing and solicitousness. While child chronic pain and anxiety did not exert an impact on parental responses, the parents’ and child’s age emerged as additional modulating factors for parental solicitousness.

Conclusion: Findings support the assumption that top-down processes, particularly parent anxiety, rather than bottom-up processes, exert an impact on parental responses. Specific interventions to decrease parent anxiety in the context of chronic pain and effects of adult treatment on parental responses to child’s pain warrant further investigation.

Significance: This study increases our knowledge on modulating factors on maladaptive parental reactions such as parental pain-related catastrophizing towards their children in pain. According to our findings, it is not the child variables, that is (parental perception of) child chronic pain or anxiety that modulate parental reactions but...
1 | INTRODUCTION

Children of parents with chronic pain are considered at high-risk for developing chronic pain (Higgins et al., 2015; Hofun, Romundstad, & Rygg, 2013). Parents’ chronic pain, emotional distress and responses to their child’s pain play a pivotal role for this familial transmission (Stone & Wilson, 2016). In line with previous studies (Hechler et al., 2011; Law et al., 2017; Wilson, Moss, Palermo, & Fales, 2014), Cordts, Stone, Beveridge, Wilson, and Noel (2019) found that parental pain-related catastrophizing – the tendency to highly focus on child pain, to magnify the threatening value of pain (Stone & Wilson, 2016) – was impactful on child pain and functioning. Behavioural responses such as solicitousness (positive reinforcement of child pain behaviours; Noel et al., 2015) are also associated with worsened child pain outcomes (Connelly, Bromberg, Anthony, Gil, & Schanberg, 2017; Hechler et al., 2011; Law et al., 2017).

Parents differ in pain-related catastrophizing and solicitousness (Frerker, Hirschfeld, Thielsch, & Hechler, 2018). However, the vast majority of studies have focused on the impact of parental responses on child outcomes (Connelly et al., 2017; Cordts et al., 2019; Hechler et al., 2011; Higgins et al., 2015; Hofun et al., 2013; Law et al., 2017; Stone, Bruehl, Smith, Garber, & Walker, 2018; Stone & Wilson, 2016; Wilson et al., 2014), rather than investigating modulating factors. Modulating factors may be subdivided into top-down and bottom-up processes (Goubert et al., 2005). Top-down processes refer to processes inherent in the parents, such as parent chronic pain and anxiety that exert an impact on parental responses. Noteworthy, there is evidence for high co-occurrence of anxiety symptoms and chronic pain in adults (Gureje, 2008). Parents with chronic pain and/or anxiety have been consistently found to report higher parental pain-related catastrophizing and solicitousness (Cordts et al., 2019; Wilson & Fales, 2015). Bottom-up processes refer to the impact of child variables, such as child chronic pain and anxiety, on parental responses. Child’s pain, functional disability and anxiety are associated to higher parental pain-related catastrophizing (Cordts et al., 2019).

To the best of our knowledge, no study has yet considered top-down and bottom-up processes simultaneously to account for variance in parental pain-related catastrophizing and solicitousness. To close this research gap, we applied multilevel models (MLM) which allow to investigate potential influential variables at different levels (i.e. at the level of children and parents) and take the nested structure of the data (i.e. children nested within parents) into account. Based on the existing literature, we hypothesized more parental pain-related catastrophizing and solicitousness in parents with increasing severity of chronic pain and anxiety. This association was assumed to be moderated by bottom-up processes, that is child chronic pain and anxiety, in terms of a stronger association when parents assume their child experiences chronic pain and anxiety. Given that several studies have shown gender-differences in parent pain-related catastrophizing and solicitousness towards sons and daughters (Frerker, Hechler, Schmidt, & Zernikow, 2016; Goubert, Eccleston, Vervoort, Jordan, & Crombez, 2006; Goubert, Vervoort, Sullivan, Verhoeven, & Crombez, 2008; Hechler et al., 2011; Moon, Chambers, & McGrath, 2011), child’s and parent’s age and gender were also investigated.

2 | METHODS

The study was approved by the Ethics Committee of the University of Trier. All participants completed an informed consent form, either an online or a paper-pencil version.

2.1 | Participants and procedure

The study was designed as a cross-sectional field study including a heterogeneous group of participants in various stages of chronic pain and anxiety and treatment. Inclusion criteria comprised the following: German speaking parents with children aged 0–21 years who lived at home with their parents at least 5 days per week.

The recruitment included two types of data collection (Figure 1): (a) via several disorder-specific online panels and Facebook groups using online assessment with the online software unipark (www.unipark.de) and (b) in hospitals specialized in the treatment of chronic pain and/or anxiety disorder via paper-pencil or online assessment (see Appendix S1).

Regarding online panels (a), participants were provided access to the link after responding to a call in their panels and groups, respectively. By using the link, they immediately accessed the questionnaire, which took them 15–20 min to complete. Assessments in specialized hospitals were carried...
out by (b) clinicians not involved in the present study who recruited participants for the paper-pencil or online assessment in the cooperating hospitals. They informed eligible parents about the research project and invited them to participate in the study. Suitable patients who agreed to participate were either given the paper-pencil questionnaire and returned the questionnaire to their therapist after completion or were provided the link to the online assessment questionnaire version.

In the online panels (a), a total of $N = 206$ parents started filling out the questionnaire. Of these, $n = 28$ parents (13.6%) completed the questionnaire. High numbers of drop offs are typical for online recruitment for example, because of missing social pressure (Birnbaum, 2004). In specialized hospitals (b), $N = 122$ parents were asked for participation during or after their clinical treatment. Of these, $n = 90$ parents (73.8%) completed the questionnaire; of these, $n = 34$ used the online questionnaire (37.8%) and $n = 56$ used the paper-pencil version (62.2%; Figure 1).

The final sample size included $N = 118$ parents with $N = 190$ children. Basic characteristics are listed in Tables 1 and 2.

Statistical analyses revealed no differences in the majority of characteristics and the pain status between parents recruited via online panels (a) and parents recruited via specialized hospitals, (b) ($p > .05$). There were significant group differences in the age of parents (parents in the specialized hospitals group were older), gender distribution (no fathers participated via online panels) and severity of anxiety symptoms (parents in the online panels reported more anxiety symptoms; Table 3).

2.2 | Measures

We employed eight questionnaires, which were completed by the participating parent. Five questionnaires focused on parental aspects (sociodemographic data, parental responses, parent chronic pain and parent anxiety symptoms), three questionnaires were proxy-reports of their child’s sociodemographic data, child chronic pain and anxiety. Parents were asked to answer the questions focusing on the child separately for each of their children, and up to a total of five children. Time for completion was approximately 15–20 min depending on the number of children involved. When parents responded to the online version, they were asked to answer all questionnaires completely; otherwise the survey could not be continued. In case of dropout during the assessment, the participants were not included in analysis. Single missing data were imputed via the R package missForest (Stekhoven, 2011).

2.3 | Parental variables – top-down variables

2.3.1 | Sociodemographic variables

Parents reported their age, gender, ethnicity, educational level and occupation, marital status, present treatment (inpatient, outpatient, etc.), and number of children under 21 years of age living in their home.

2.3.2 | Parent chronic pain

The Mainz Pain Staging System (MPSS; Schmitt & Gerbershagen, 1990) was employed to assess parent chronic pain. This 10-item measure differentiates three stages of pain chronicity, taking into account temporal (patterns of occurrence, duration and change of intensity) and spatial (1, 2 or multiple pain sites) dimensions of pain during a 4-week recall period. Additional items assessed parents’ medication use (regular and irregular use of analgesics, opioids and co-analgesics), previous drug withdrawal treatments and lifetime utilization of the health care system (e.g. pain-related hospitalizations). The MPSS is frequently used to characterize chronic pain conditions in adults (Frettlöh, Maier, Gockel, & Hüppe, 2003; Gerbershagen, Nagel, Korb, & Nilges, 2001; Pioch, 2005).
2.3.3 | Parent anxiety symptoms

Parents reported general anxiety symptoms using the Depressions-Angst-Stress-Skala (DASS; Nilges & Essau, 2015), the German version of the Hospital Anxiety and Depression Scale (HADS; Snaith, 2003). The DASS assesses symptoms of anxiety, depression and stress on respective 7-item subscales. The anxiety subscale was used dimensionally, and with a Cronbach's alpha of 1.0, it demonstrated excellent internal consistency in the current sample. Subscale-scores for depression, anxiety and stress were calculated by adding the relevant items-scores for the three subscales (depression: item 3, 5, 10, 13, 16, 17, 21; anxiety: item 2, 4, 7, 9, 15, 19, 20; stress: item 1, 6, 8, 11, 12, 14, 18).

2.3.4 | Parental pain-related catastrophizing

Parental pain-related catastrophizing about their child’s pain was assessed using the German version of the Pain Catastrophizing Scale-Parent Version (PCS-P; Hechler et al., 2011). The PCS-P includes 13 items on the different thoughts and feelings parents may have when their child experiences pain. Items assessing catastrophic thoughts and feelings about their child’s pain are responded to on Likert-type 5-point scales ranging from 0 (not at all) to 4 (extremely). Reliability for the PCS-P was excellent (Cronbach’s α = 1.0) in the current sample. The total score was derived by the sum of all item scores.

2.3.5 | Parental behavioural responses

The Pain-Related Parent Behaviour Inventory (PPBI; ISEV-E; Hermann, Zohsel, Hohmeister, & Flor, 2008) was used to assess parental behavioural responses to their
child's pain. This questionnaire specifically measures the behaviour-related responses toward their child's pain on three subscales: discouraging (“When my child is in pain, I become impatient”, solicitous (“... I take special care of him/her”) and distracting (“... I encourage him/her to do something nice.”) responses. Response options ranged from 1 (never) to 5 (very often). The PPBI/ISEV-E questionnaire has shown good reliability and validity (Hermann et al., 2008). In the current study, we only included the solicitous scale in our analysis of maladaptive parental reactions (Cronbach’s α = 0.914, excellent). The subscale-score for the solicitous scale was calculated by the average score of the relevant items (item 1, 2, 6, 7, 8, 17).

Both types of parental responses (cognitive-affective and behavioural) were assessed for each child so that the duration of questionnaire completion varied with the number of children.

### 2.4 | Child variables via proxy-report – bottom-up variables

To obtain the parental perception of child symptoms, we assessed child sociodemographic variables, chronic pain and anxiety symptoms via parental report.

#### 2.4.1 | Sociodemographic variables

Parents reported their child’s age and gender, their child’s place of living, person with child custody, and type of kindergarten or school the child attended.

#### 2.4.2 | Child chronic pain

Parents rated the child pain on selected items of the German Pain Questionnaire for Children, Adolescents and Parents (DSF-KJ; Schröder et al., 2010). The following items were included: child recurrent or chronic pain, occurrence, duration and change of pain intensity as well as maximal and average pain intensity in the last 4 weeks (reported on a numeric rating scale ranging from 0 = no pain to 10 = maximal pain), pain location and treatment of chronic pain. The DSF-KJ is frequently used in epidemiological (Zernikow et al., 2012) or clinical studies of children and adolescents with chronic pain (Frerker et al., 2016; Hechler et al., 2010, 2014; Wager, Hechler, Hünseler, & Zernikow, 2015; Wager & Zernikow, 2015; Zernikow et al., 2012). Children whose parents judged the child pain as recurrent and existing for more than 3 months were classified as children with chronic pain.

#### 2.4.3 | Child anxiety

Parents reported on child anxiety symptoms via the German version of the Screen for Child Anxiety Related Disorders (SCARED; FAS-E; Birmaher, Khetarpal, Cully, Brent, & McKenzie, 1995), which is a 41-item questionnaire measuring anxiety disorders symptomatology. The FAS-E consists of four subscales (Panic Disorder symptoms, Generalized Anxiety Disorder symptoms, Separation Anxiety Disorder symptoms, Social Phobia symptoms) as well as a total score. Parents rate child anxiety symptoms on a 3-point Likert scale: almost never (0), sometimes (1) or often (2). For total score and each of the five factors, the SCARED showed good internal consistency (αs = .74 to .93), test–retest reliability (intraclass correlation coefficients = .70 to .90), discriminative validity (both between anxiety and other disorders and within anxiety disorders) and moderate parent–child agreement (rs = .20 to .47, p < .001, all correlations; Birmaher et al., 1995). In the current sample, the Cronbach’s α of .976 showed

### Table 2 | Characteristics of the children (N = 190)

| Age of children (M; SD; range) | 11.65 (5.75; 1–21) |
| Sex of children | 50.5% ♂ (n = 96) 48.9% ♀ (n = 93) |
| Child lives with… | |
| Both parents | 70.5% |
| Mother | 18.9% |
| Father | 3.2% |
| Biological parent and new partner | 7.4% |
| Child custody | |
| Both parents | 84.7% |
| Mother | 14.2% |
| Father | 1.1% |
| Child kindergarten and school | |
| Kindergarten | 22.6% |
| Elementary school | 16.3% |
| Special school (for children with mental or physical problems) | 1.6% |
| Secondary school (till year 9) | 1.6% |
| Comprehensive school | 7.9% |
| Secondary school (till year 10) | 10.5% |
| Secondary school (Abitur) | 23.7% |
| Others | 15.8% |
| Child chronic pain (DSF-KJ) | 31.1% |
| Child clinically relevant anxiety symptoms (FAS-E) | 15.5% |

Abbreviations: PCS-P = Parental Pain Catastrophizing Scale (Goubert et al., 2006); ISEV-E = Pain-Related Parent Behaviour Inventory (PPBI; Hermann et al., 2008); MPSS = Mann pain staging system for chronic pain, (Schmitt & Gerbershagen, 1990); DASS = Hospital Anxiety and Depression Scale (HADS; Herrmann-Lingen, Buss, & Snith, 2011; Nigles & Essau, 2015); DFS-KJ = German Pain Questionnaire for Children, Adolescents and Parents (Schröder et al., 2010), FAS-E = Screen for Child Anxiety Related Disorders (SCARED; Birmaher et al., 1995).
excellent internal consistency of this measure. The total score was derived by the sum of all item scores.

2.5 | Statistical methods

2.5.1 | Imputation of missing values

The R package missForest (Stekhoven, 2011) was used to impute missing values for paper-pencil data with a maximum number of 10 iterations and 100 random trees. Imputing missing values with missForest has been demonstrated to be superior in comparison to other imputation techniques such as nearest neighbour imputation or multivariate imputation by chained equations (Stekhoven & Bühlmann, 2011; Waljee et al., 2013). In addition, it works well for large amounts of missing values (Stekhoven & Bühlmann, 2011). Fit indices of the imputation were normalized (root-mean-square error [NRMSE] = 0.41, proportion of falsely classified [PFC] = 0.21). Missing data were generally low in the present dataset. The highest proportion of missing scores was present for the solicitous subscale of the PPBI (n_{missing} = 8, 4.21%). Parental catastrophizing was missing for n_{missing} = 3 children (1.58%). Information on parental chronic pain and parental anxiety was missing for n_{missing} = 2 parents (3.51%). For children’s chronic pain and anxiety (proxy-report) no missing values were present.

2.5.2 | Data analysis

Data analysis was carried out via SPSS (IBM Corp. Released, 2013) and R (R Core Team, 2017). All data were screened for normality, appropriate ranges and univariate outliers prior to performing analyses. Descriptive statistics were then performed to characterize the sample, and chi-square and t tests were used to examine potential group differences on parent and child sociodemographic variables.

Multilevel analyses were used to examine predictors like parent pain and anxiety for parental responses (solicitousness and pain-related catastrophizing). Given the hierarchical data structure, that is, children being nested within parents, it is crucial to apply the appropriate statistical procedures that are able to take this clustering into account, namely hierarchical linear models.

For each dependent variable (PCS-P: pain-related catastrophizing; ISEV-E: solicitousness), a sequential modelling approach was chosen that consisted of the following steps. First, a null model was estimated which includes no predictor variables and only partitions the total variability in the dependent variable into variation between parents and variation between children (i.e. within parents). In the second step, the covariates parent age and child age as well as gender (sociodemographic variables) were entered as predictor variables (covariate model). In the third step, parent as well as child chronic pain and anxiety were included in the model (models a). In the remaining four steps, different interactions between parent and child chronic pain and anxiety were tested in separate models (models b-e) to investigate possible moderator effects of child pain and anxiety on parental responses. Prior to entering these interaction effects, continuous predictors were centred on the sample average.

To estimate the effect size of significant findings, a d-like indicator was calculated for categorical predictors (like parent MPSS stage) and an r-like indicator for continuous

| TABLE 3 | Comparison of parents in the online-panels and parents in specialized hospitals |
|---|---|---|
| **Online-panels** | **Specialized hospitals** |
| **n = 31 parents n = 55 children** | **n = 87 parents n = 135 children** |
| **Age of parents (M, SD)** | 39.97 (7.62) | 44.20 (7.61) |
| **Gender of parents** | **T(116) = −2.657 p = .009** |
| Male | 0 (0%) | 23 (26.4%) |
| Female | 31 (100%) | 64 (73.6%) |
| **Number of children (M, SD)** | 2.06 (1.18) | 1.89 (0.99) |
| **Parent chronic pain stage (MPSS) (M, SD)** | 1.86 (1.03) | 1.82 (1.12) |
| **Parent anxiety (DASS) (M, SD)** | 7.71 (6.28) | 4.73 (4.48) |
| **Age of child (M, SD)** | 11.53 (5.44) | 11.70 (5.90) |
| **Gender of child** | **χ²(1) = 0.021 p = .885** |
| Male | 27 (49.1%) | 69 (51.1%) |
| Female | 28 (50.9%) | 66 (48.9%) |

Note: Significant findings are printed in bold; MPSS = Mainz Pain Staging System for chronic pain (Schmitt & Gerbershagen, 1990), DASS = Hospital Anxiety and Depression Scale (HADS; Herrmann-Lingen et al., 2011; Nilges & Essau, 2015).
predictors (like parent anxiety). The $d$-like effect size was calculated by dividing the respective unstandardized coefficient by the standard deviation of the dependent variable. The result indicates how many standard deviations the dependent variable (e.g., parental pain-related catastrophizing) changes from one category to the other category. Thus, this measure can be interpreted similarly to Cohen's $d$ (Nezlek, 2012).

The size of the effect of continuous predictor variables were estimated by computing standardized coefficients, which can be interpreted like a correlation. The following formula is used to compute these correlations: \[ r = \frac{b \cdot (SD(x)/SD(y))}{SD(x)} \] where $b$ is the unstandardized coefficient for the predictor variable of interest from the multilevel model, $SD(x)$ is the standard deviation of that predictor variable and $SD(y)$ is the standard deviation of the dependent variable (Cohen, West, & Aiken, 2014).

3 | RESULTS

3.1 | Sample characteristics

The majority of the $N = 118$ parents were mothers (80.5%) with a mean age of 43.1 years ($SD = 7.8$, range: 26–61). Chronic pain in stage 2 or 3 in the MPSS (Schmitt & Gerbershagen, 1990) reported 65.3% of parents which indicates high severity of chronic pain. One-third of the parents reported clinically relevant anxiety (36.8%) or depressive symptoms (28.9%), and nearly half of the parents reported clinically relevant stress symptoms (43.0%). Of the entire sample, 86.4% reported that they were active in treatment. For all sample characteristics of parents, see Table 1.

The parents reported on $N = 190$ children. They were on average 11.7 years old ($SD = 5.8$, range: 1–21), and half of the children were girls (48.9%). Parents reported child chronic pain in one-third of the children (31.1%) and clinically relevant anxiety symptoms in 15.5% of the children (see Table 2).

3.2 | Prediction of parental pain-related catastrophizing

The mean value of parental catastrophizing to their child’s pain was 18.15 ($SD = 10.55$, range: 2–45). Results of the models predicting parental catastrophizing are summarized in Table 4. The model without any predictors (null model) revealed that 87.02% of the total variation in parental catastrophizing is due to differences between parents, while only about 13% is due to differences between children.

In the second model, only the assumed covariates (age and gender of parent and child, sociodemographic variables) were included as predictors (covariation model). None of the tested variables in this model were significantly associated with parental pain-related catastrophizing. Adding parent and child chronic pain and anxiety variables to the model showed significant associations for parent variables (parent chronic pain, anxiety), but not for child variables (model 1a).

Parents who reported MPSS scores corresponding to stage 2 or 3 – representing high impairment due to chronic pain – reported significantly lower parental pain-related catastrophizing than parents with stage 1 ($b_{2vs.1} = −6.36; SE_{2vs.1} = 2.18; p_{2vs.1} < .01; d_{2vs.1} = .76; b_{3vs.1} = −5.57; SE_{3vs.1} = 2.34; p_{3vs.1} = .02; d_{3vs.1} = .67$). Additionally, parent anxiety was positively associated with parental pain-related catastrophizing ($r_{DASS} = 1.32; SE_{DASS} = 0.18; p_{DASS} < .001; r_{DASS} = 0.62$).

In a last step, interactions between parent and child variables were tested in separate models (models 2b–1e). The following interactions were investigated: Child Anxiety * Parent Anxiety; Child Anxiety * Parent Chronic Pain; Child Chronic Pain * Parent Anxiety; Child Chronic Pain * Parent Chronic Pain. None of the tested interactions significantly improved the model (see Table 4). This suggests that there is not a significant moderating impact of child pain and anxiety neither on the association between parent chronic pain and parental pain-related catastrophizing nor on the association between parent anxiety and parent pain-related catastrophizing.

3.3 | Prediction of parental solicitousness

The mean value of solicitousness was 3.70 ($SD = 0.76$, range: 1–5). Results of the models predicting parental solicitousness are summarized in Table 5. The model without any predictors (null model) revealed that 80.36% of the total variation in parental solicitousness is due to differences between parents, while only about 19.64% is due to differences between children.

In the second model, only the assumed covariates were included as predictors (covariation model with sociodemographic variables). Parents’ as well as children’s age were significantly associated with solicitousness. The older the parent ($b = 0.02; SE = 0.01; p = .02; r = 0.22$) and the younger the child ($b = −0.02; SE = 0.01; p < .01; r = 0.34$), the more solicitousness was reported.

Adding parent and child chronic pain and anxiety to the model showed a significant association only for parent anxiety with parental solicitousness (model 2a). Parents with higher levels of anxiety reported significantly more solicitousness ($b = 0.04; SE = 0.01; p = .01; r = 0.28$).

In a last step, interactions between parent and child variables were tested in separate models (models 2b–2e). The following interactions were investigated: Child Anxiety * Parent Anxiety; Child Anxiety * Parent Chronic Pain; Child Chronic Pain * Parent Anxiety; Child Chronic Pain * Parent Chronic Pain. None of the tested interactions significantly improved
the model for solicitousness (see Table 5). This suggests that there is not a significant moderating impact of child chronic pain and anxiety neither on the association between parental pain and their solicitousness nor on the association between parental anxiety and their solicitousness.

### 4 | DISCUSSION

Our study shows that top-down processes, parent chronic pain and anxiety, rather than bottom-up processes, parental perception of child chronic pain and anxiety, impact parental responses to child's pain.

Parents with more severe chronic pain reported less parental pain-related catastrophizing. Parents’ anxiety was positively associated with parental pain-related catastrophizing. Parental perception of child chronic pain and anxiety did not impact parental pain-related catastrophizing, nor did age and gender of parent and child.

Parent anxiety but not chronic pain, was associated with higher solicitiousness. Parental perception of child chronic pain and anxiety did not impact parental solicitousness. The older the

| Models | Null model | Cov. | Model 1a | Model 1b | Model 1c | Model 1d | Model 1e |
|--------|------------|------|----------|----------|----------|----------|----------|
| Intercept | 18.03* | 24.18* | 13.57*** | 22.06* | 14.01*** | 22.07* | 14.93*** |
| Parent age | — | —0.19 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 |
| Parent gender | — | 0.86 | 0.74 | 0.74 | 0.72 | 0.75 | 0.62 |
| Child age | — | 0.13 | 0.05 | 0.06 | 0.06 | 0.05 | 0.05 |
| Child gender | — | —0.21 | —0.41 | —0.48 | —0.44 | —0.41 | —0.28 |

**Parent predictors**

| MPSS Stage 2 versus 1 | — | — | —6.36** | —6.47** | —6.47*** | —6.36** | —7.07** |
| MPSS Stage 3 versus 1 | — | — | —5.57*** | —5.62*** | —5.63*** | —5.57*** | —7.31** |
| DASS anxiety | — | — | 1.32* | 1.31* | 1.30* | 1.33* | 1.32* |

**Child predictors**

| Chronic pain | — | — | 0.07 | 0.17 | 0.07 | 0.75 | —2.38 |
| FAS-E | — | — | —0.01 | —0.02 | 0.02 | —0.01 | —0.01 |

**Interactions**

| FAS-E*DASS | — | — | — | 0.01 | — | — | — |
| FAS-E*MPSS 2 versus 1 | — | — | — | — | —0.00 | — | — |
| FAS-E*MPSS 3 versus 1 | — | — | — | — | —0.06 | — | — |
| Chronic Pain*DASS | — | — | — | — | — | —0.01 | — |
| Chronic Pain*MPSS 2 versus 1 | — | — | — | — | — | — | 1.91 |
| Chronic Pain*MPSS 3 versus 1 | — | — | — | — | — | — | 3.38 |

**Random part**

| Level 2 | 98.05 | 96.21 | 69.44 | 69.33 | 69.59 | 69.38 | 69.61 |
| Level 1 | 14.62 | 14.35 | 11.23 | 11.16 | 11.10 | 11.25 | 11.01 |

Note: N = 190 children, 118 parents; Numbers refer to unstandardized coefficients. Abbreviations: PCS-P, Parental Pain Catastrophizing Scale (Goubert et al., 2006); MPSS, Mainz pain staging system for chronic pain (Schmitt & Gerbershagen, 1990); DASS, Hospital Anxiety and Depression Scale (HADS; Herrmann-Lingen et al., 2011; Nilges & Essau, 2015); FAS-E, Screen for Child Anxiety Related Disorders (SCARED; Birmaher et al., 1995).

*p = .000.

**p < .001.

***p < .05.
4.1 Modulating factors of parental pain-related catastrophizing

Compared to other parent samples with children suffering from chronic pain (see Frerker et al., 2018), the mean value of parental pain-related catastrophizing observed here was lower. An explanation could be the small number of children suffering from severe chronic pain in the current sample (31.5%). Contrary with our expectations, more severe parent chronic pain was associated with less pain-related catastrophizing. The vast majority of the parents (86.4%) were currently receiving pain- or anxiety-specific treatment (outpatient treatment: n = 72 (61.0%); day patient or inpatient treatment: each n = 18 (16.1%); self-help groups: n = 6 (5.1%)). This difference in treatment status may account for this finding. In line with this, most of the parents (n = 72; 93.5%) suffering from severe pain (MPSS stage 2 or 3) were grouped to outpatient, day patient or inpatient treatment. The

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**TABLE 5** Multilevel model results for models predicting solicitousness (*ISEV-E*)

| Models | Null model | Cov. | Model 2a | Model 2b | Model 2c | Model 2d | Model 2e |
|--------|------------|------|----------|----------|----------|----------|----------|
| Fixed part |            |      |          |          |          |          |          |
| Intercept | 3.71*      | 2.78* | 2.48*    | 2.69*    | 2.43*    | 2.64*    | 2.57*    |
| Covariates |          |      |          |          |          |          |          |
| Parent age | —         | 0.02*** | 0.03*** | 0.03**   | 0.03**   | 0.03***  | 0.02***  |
| Parent gender | —       | 0.25  | 0.26     | 0.26     | 0.25     | 0.25     | 0.24     |
| Child age | —         | −0.02** | −0.02** | −0.02**  | −0.02**  | −0.02**  | −0.02*** |
| Child gender | —       | 0.04  | 0.01     | 0.02     | −0.02    | 0.02     | 0.01     |
| Parent predictors |            |      |          |          |          |          |          |
| MPSS Stage 2 versus 1 | — | — | −0.03 | −0.02 | 0.04 | −0.01 | −0.14 |
| MPSS Stage 3 versus 1 | — | — | −0.25 | −0.24 | −0.26 | −0.23 | −0.26 |
| DASS anxiety | — | — | 0.04*** | 0.04** | 0.04** | 0.02 | 0.04** |
| Child predictors |            |      |          |          |          |          |          |
| Chronic pain | — | — | 0.11 | 0.09 | 0.10 | 0.12 | −0.03 |
| FAS-E | — | — | −0.00 | 0.00 | 0.00 | −0.00 | −0.00 |
| Interactions |            |      |          |          |          |          |          |
| FAS-E*DASS | — | — | — | −0.00 | — | — | — |
| FAS-E*MPSS 2 versus 1 | — | — | — | −0.00 | — | — | — |
| FAS-E*MPSS 3 versus 1 | — | — | — | 0.00 | — | — | — |
| Chronic Pain*DASS | — | — | — | — | 0.02 | — | — |
| Chronic Pain*MPSS 2 versus 1 | — | — | — | — | — | 0.25 | — |
| Chronic Pain*MPSS 3 versus 1 | — | — | — | — | — | — | 0.08 |
| Random part |            |      |          |          |          |          |          |
| Level 2 | 0.45 | 0.45 | 0.43 | 0.42 | 0.43 | 0.43 | 0.44 |
| Level 1 | 0.11 | 0.1 | 0.1 | 0.1 | 0.1 | 0.09 | 0.09 |

*Note: N = 190 children, 118 parents. Numbers refer to unstandardized coefficients.

Abbreviations: ISEV-E = Pain-Related Parent Behavior Inventory (PPBI; Hermann et al., 2008); MPSS = Mainz pain staging system for chronic pain (Schmitt & Gerbershagen, 1990); DASS = Hospital Anxiety and Depression Scale (HADS; Herrmann-Lingen et al., 2011; Nilges & Essau, 2015), FAS-E = Screen for Child Anxiety Related Disorders (SCARED; Birmaher et al., 1995).

*p = .000, **p < .001, ***p < .05.
majority of studies on adult pain treatment focuses on outcomes concerning adults' chronic pain status (see Dworkin et al., 2008). Parental pain-related catastrophizing decreases when children get intensive interdisciplinary pain treatment (Frerker et al., 2016). If this holds also true for adult pain treatment, then further investigation is clearly warranted. As expected, we found high association between parent anxiety and pain-related catastrophizing. This suggests an overlap between anxiety symptoms and the cognitive-affective style of pain-related catastrophizing, as shown in children by Durand et al. (2017). Results suggest that also other clinical samples, such as parents with anxiety disorders, tend to catastrophize which is in line with previous findings (Lester, Field, & Cartwright-Hatton, 2012). Therefore, it seems to be necessary to develop prevention strategies especially for parents with anxiety disorders. An initial way might be to implement psychoeducation for the parent and his/her children concerning the parental disorder and its potential influence on the children.

Regarding bottom-up processes, parental pain-related catastrophizing was not associated to child chronic pain and anxiety. Parent chronic pain and anxiety thus seem to overlay the perceived child's chronic pain and anxiety so that we may have assessed not only a bottom-up but more a combination of bottom-up and top-down processes.

Parental pain-related catastrophizing was also independent of age of the parent and the child. This finding suggests that we assessed a trait-like and rather stable construct – in line with Durand et al. (2017) who revealed that child and parent trait catastrophizing did not relate to child pain intensity and child state anxiety. The independence of gender of parents and parental pain-related catastrophizing may be caused by the unbalanced distribution of mothers and fathers in the present dataset (95 mothers and 23 fathers). Therefore, the power to detect a significant gender difference might be too low. Consequently, this finding should be treated with caution.

4.2 Modulating factors of parental solicitousness

Similar to previous findings (Evans et al., 2016; Orchard, Cooper, & Creswell, 2015), parent chronic pain did not impact solicitousness while parent anxiety did. Parents with higher anxiety reported more solicitousness. Hence, it seems that it is more the emotional state of the parents rather than their chronic pain status that affects parental solicitousness. A core aspect of clinical anxiety is the cognitive avoidance of negative stimuli (Sibrava & Borkovec, 2006). Parents might try to reduce their negative thoughts concerning the child’s pain as well as to support their child via solicitous responses (Hermann et al., 2008). Solicitousness was not influenced by parental perception of child chronic pain and anxiety. The distance to the child because of being in (inpatient) treatment might also account for this finding. Another reason could be the proxy-report of child pain and anxiety. Parents in treatment might report lower solicitousness as a positive treatment effect.

Higher solicitousness was associated with older parent age and younger child age. This contradicts previous findings (Frerker et al., 2016; Hermann et al., 2008). In light of developmental aspects, parental solicitousness may be more pronounced for younger children than for older children, because adolescents need to separate emotionally from their parents (Zimmer-Gembeck & Collins, 2003). This increasing autonomy may result in decreasing levels of parental solicitousness (Noel et al., 2015). The independence of parental solicitousness and gender of child or parent may also be caused by the unbalanced distribution of mothers and fathers.

4.3 Limitations

Our findings must be interpreted in view of some methodical limitations: First, we assessed child symptoms by proxy-report of parents. We focused on parents experiencing chronic pain and/or anxiety symptoms from various contexts (online panels, specialized hospitals) while investigating top-down and bottom-up-influences simultaneously and hence, giving a first orientation concerning potential modulating factors on parental responses to child's pain. Furthermore, the assessment via child-report was not feasible as the parents were assessed online or while being in treatment. Given the subjective and internalizing nature of these symptoms, the proxy-report might not have accurately reflected the child’s experience, particularly for youth with subclinical symptoms that were not experiencing impairment as a result and may result in an underestimation of child symptoms (Kamper, Dissing, & Hestbaek, 2016). There is similar evidence in acute and postoperative pain in children with poor agreement between parent and child pain estimation (Zhou, Roberts, & Horgan, 2008). Future studies should include parental and child report of symptoms and parental responses.

Second, the present study included a heterogeneous sample of parents with chronic pain and anxiety assessed via online panels and at specialized hospitals. Parents in specialized hospitals were seeking treatment while some of the parents recruited via online-panels did not receive any treatment. This was done to achieve a high variance in chronic pain and anxiety. While the two groups (online panel, specialized hospitals) displayed similar levels of chronic pain, parents recruited from online panels were younger and reported more anxiety symptoms. Furthermore, while it can be speculated from our findings that being in treatment might affect parental responses, we did not assess the type of treatment in detail.
Future studies that look into the effects of adult interventions beyond usual outcome parameters (Dworkin et al., 2008) are clearly warranted. While the cross-sectional nature of the study is a limitation of the present study, future longitudinal studies are warranted to investigate how parental responses to child's pain unfold with time, and which factors such as mental health, or memories of painful events might impact on the development (Noel et al., 2019).

Third, while we assessed child chronic pain via items of the DSF-KJ (Schröder et al., 2010), we did not assess child pain-related disability. Given that pain-related disability is a core aspect to determine the severity of the child's chronic pain (Stahlschmidt, Barth, Zernikow, & Wager, 2017; Von Korff, Ormel, Keefe, & Dworkin, 1992), we cannot draw conclusions to the pain-severity in this study. Future studies should include a comprehensive assessment of child's chronic pain.

Fourth, by using online-recruitment we accepted a low completion rate. The present rate of 13.6% returns seems extremely low. Explanations might be the higher level of anxiety symptoms in the online-panel group in comparison to the paper-pencil-recruitment as well as the length of the questionnaire and the missing of monetary incentives (Deutskens, Ruyter, Wetels, & Oosterveld, 2004).

Finally, in the present study we used validated questionnaires. Future studies should assess parental responses to child pain during direct interaction (Birnie, Chambers, Chorney, Fernandez, & McGrath, 2016; Boerner et al., 2016; Vervoort, Trost, Sütterlin, Caes, & Moors, 2014).

5 | CONCLUSIONS

The present study aimed to elucidate the role of top-down and bottom-up processes (here, proxy-report), on parental pain-related catastrophizing and solicitousness in a sample of parents with chronic pain and anxiety symptoms. Findings highlight the importance of top-down processes, particularly parent anxiety, as modulating factors. Our findings call for future research in parents that suffer from anxiety disorders who may also be at risk to display maladaptive responses to child pain. Additionally, relationships between parent variables and child pain and anxiety should be considered as mediated or moderated by parent responses in future studies. The present findings also call for clinical research on psychological interventions to decrease parent anxiety and parental pain-related catastrophizing (Law et al., 2016). Of importance, bottom-up processes, such as parental perception of child chronic pain and anxiety, did not impact parental responses. The question of whether parental responses to child's pain may change because of adult treatment clearly warrants investigation in future studies. Both lines of research (reducing parent anxiety, the role of adult treatment to change parental responses) are essential to decrease the familial transmission of chronic pain and anxiety in children with parents with chronic pain and anxiety.

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CONFLICT OF INTEREST

None declared.

AUTHOR CONTRIBUTION

All listed authors have contributed substantially to the manuscript: MW was responsible for conducting the study, coordinating the recruitment and the assessment, data management, data analysis, drafting and revising the paper, and conception of tables and figures. JR supervised and supported the study design and methodological aspects, data management, conducted the data analysis, designed tables and revised the paper. IO and CD supported the study design and methodological aspects, recruitment and assessment, and revised the paper. TH was the principal investigator and responsible for the design and conception of the study, supervision of the recruitment, assessment and all involved steps, revision of the drafts of the paper and the final revision of the paper. All listed authors discussed the results and commented on the manuscript.

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