Influence of Social Modeling and Learning on Somatic, Emotional and Functional Disability in Children with Headache

C Isensee, B Kröner-Herwig

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Abstract

Background. Several studies evidenced an influence of parental pain variables on the child's processing of pain.

Method. In two successive annual waves, children and parents (n = 1803 at first assessment) were questioned about headaches and various pain-related variables. Parent-child associations concerning pain catastrophizing and pain avoidance behavior were examined in a cross-sectional design. Using hierarchical regression analyses, pain catastrophizing of parent and child, their interaction and parental pain avoidance behavior were examined as predictors of headache-related somatic, emotional and functional disability in the child one year later.

Results. Results demonstrated significant but moderate parent-child concordance in pain catastrophizing and pain avoidance behavior. Regression analyses revealed pain catastrophizing in the child as a significant predictor for all disability variables in both boys and girls. In contrast, parental pain catastrophizing had low predictive power, only for some of the dependent disability variables and depending on the sex of the subsample. In boys and girls, parental pain avoidance behavior was a significant but weak predictor only for functional disability.

Conclusions. Data suggest a low influence of pain-related social learning mechanisms in this population-based sample. This result may be ascribed to the generally rather low level of headaches and related disability.

INTRODUCTION

Headache, compared to abdominal and back pain, is the most common pain complaint from children and adolescents [1]. In an epidemiologic study by Kröner-Herwig, Heinrich and Morris [2] a 6-month prevalence of 53.2% in 7 to 14 year old children and adolescents was found according to parent reports. As childhood headaches can be associated with severe disability and risk of developing a chronic state [2], the identification of etiological and sustaining factors is of high clinical relevance for effective prevention and treatment plans.

Based on the background of biopsychosocial models [3, 4] parental pain experience and behavior are discussed as influential social factors for the development and persistence of childhood headaches [5,6]. In reference to the social learning theory by Bandura [7], pain-associated modeling was repeatedly considered as one mechanism of parental influence on the child's pain. It was hypothesized that children acquire – through observation and interaction with their parents – attitudes and behaviors concerning health and pain-associated symptoms. This parental influence was assumed to also affect the child's appraisal of pain and cognitive, emotional and behavioral coping with pain [5, 8, 9]. Based on the assumption that most health problems are first dealt with in the family context, it was presumed that a parental pain model with pronounced pain symptoms and dysfunctional coping contributes to focusing on pain and negative coping behavior from the child [10-12].

An association between the pain experience of parent and child was confirmed in several cross-sectional correlative and experimental studies [10, 11, 13, 14]. In a correlation study, Turkat [15] investigated pain avoidance behavior as a directly observable behavioral coping response. Results

revealed that individuals with a parental model of passive avoidance showed the same kind and frequency of passive avoidance as their parent and reported a lower quality of life. Moreover, an experimental study by Goodman and McGreath [16] found that children's pain thresholds changed in a cold-pressor test depending on maternal reaction to pain. Children whose mothers were instructed to exaggerate their expression of pain reported lower pain thresholds than children whose mothers were asked to minimize their expression of pain or did not receive specific instructions. In addition, Craig reported that the familial behavioral reaction to pain influenced the child's cognitive-emotional evaluation of pain and pain intensity [17].

In addition to pain behavior, pain catastrophizing, as a cognitive mode of processing pain, has also been shown to play an important role in social modeling. Catastrophizing in children, as a "dysfunctional cognitive coping style when confronted with pain," [18] was assumed to originate in dysfunctional parental pain coping [19]. Several studies [20, 21] revealed a positive association between pain catastrophizing in parent and child, indicating a shared familial pain-related cognitive coping style. Other findings further emphasized the relation between parental pain variables and the child's pain experience [11, 22], documenting associations between pronounced parental pain catastrophizing and increased pain intensity, depressive symptoms, functional disability and pain behavior of the child [23-25].

Moreover, several studies indicated sex- and age-specific differences concerning influences of social modeling. Girls appeared to be more sensitive to a parental pain-related model than boys [22, 26, 27]. This may be due to their higher empathy and awareness of needs, pain-related distress and concerns with their social environment [28], presumably resulting in a stronger influence of parental pain variables on the child's pain experience in girls as compared to boys.

Compared to younger children, older children were less inclined to use parental information when coping with pain [29]. The ability of children to understand and cope with pain was subject to a developmental process, with younger children possessing restricted cognitive and behavioral strategies to counter pain [30]. In consequence, young children must rely more strongly on the emotional support of their parents and the parental coping model when confronted with their own pain episodes.

Since pain catastrophizing as well as pain avoidance behavior in the child were associated with increased pain intensity, functional disability and a lower quality of life [23, 31,34], it was of great interest to examine the impact of these variables on the child's headache experience in a population-based sample. Studies indicating parental influences in terms of social modeling alluded to the necessity of additionally considering parental pain variables when assessing the child's pain-related disability [10, 12, 23]. Previous studies analyzing parental impact addressed many different kinds of pain in children, with headache included in some analyses [10,23]. However, studies exclusively focusing on parental pain models in pediatric headaches were rare [5, 35].

In the present study, the relevance of social modeling – concerning pain catastrophizing and pain avoidance behavior – was investigated in a population-based sample of children and their parents reporting headaches at least once in the last six months. Since operant conditioning processes were repeatedly considered as important learning mechanisms in the etiology and maintenance of the child's pain [36-38], the extent of parental reinforcement of the child's pain avoidance behavior was also analyzed with one item in the current study. In order to expand past research, various variables regarding pain processing of children and parents were cross-sectionally and prospectively analyzed. In this way, this is the first study that includes two different study designs by additionally focusing on different pain associated disability dimensions in children. Table 1 presents variables included in the cross-sectional and prospective analyses.

Table 1

Variables Included in Cross-Sectional and Prospective Analyses

Variables (*informant*)	Assessment
• Cross-sectional analyses	
Pain catastrophizing	
CAT-C (*child*)	wave 2
CAT-P (*parent*)	wave 2
Pain avoidance behavior	
ENC-P (*child*)	wave 2
BEH-P (*parent*)	wave 2
• Prospective analyses: Dependent variables	
H-INT (somatic disability; *child*)	wave 3
DEP (emotional disability; *child*)	wave 3
f-DIS* (functional disability; *child*)	wave 3

CAT-C = pain catastrophizing of child; CAT-P = pain catastrophizing of parent; ENC-P = parental encouragement of pain avoidance behavior in the child; BEH-P = parental pain avoidance behavior; H-INT = headache intensity in the child; DEP = depression/anxiety symptoms in the child; f-DIS = functional disability of the child; *interferences with everyday, family or leisure and school activities due to headaches

First, we cross-sectionally examined whether the child and their parent showed a common cognitive and behavioral coping-style concerning headaches. To do this, the focus was on pain catastrophizing and pain avoidance behavior. It was hypothesized that the dysfunctional cognitive coping strategy of pain catastrophizing was acquired through parental modeling, and thus a positive parent-child association was expected. It was furthermore expected that a parent, showing avoidance behavior in case of his/her own pain, would also tend to excuse the child from school-related obligations in the case of child's pain. Additionally, a positive association between parental pain avoidance behavior, i.e. staying away from work and other activities, and excusing the child from school in the case of child's pain, was hypothesized (Table 1). Corroborating this association would indicate parental impact on the child's pain behavior, with the parent's reaction to the child's pain mirroring the parent's own behavioral coping with pain. Additionally, documenting parental support in the child's pain avoidance behavior would allude to an impact of operant conditioning processes [37, 39]. Parents negatively reinforcing the child in case of pain, permitting the avoidance of undesirable activities like school attendance, rather promote pain and disability instead of minimizing it and endorse the likelihood that the child develops a chronic pain status [12, 37].

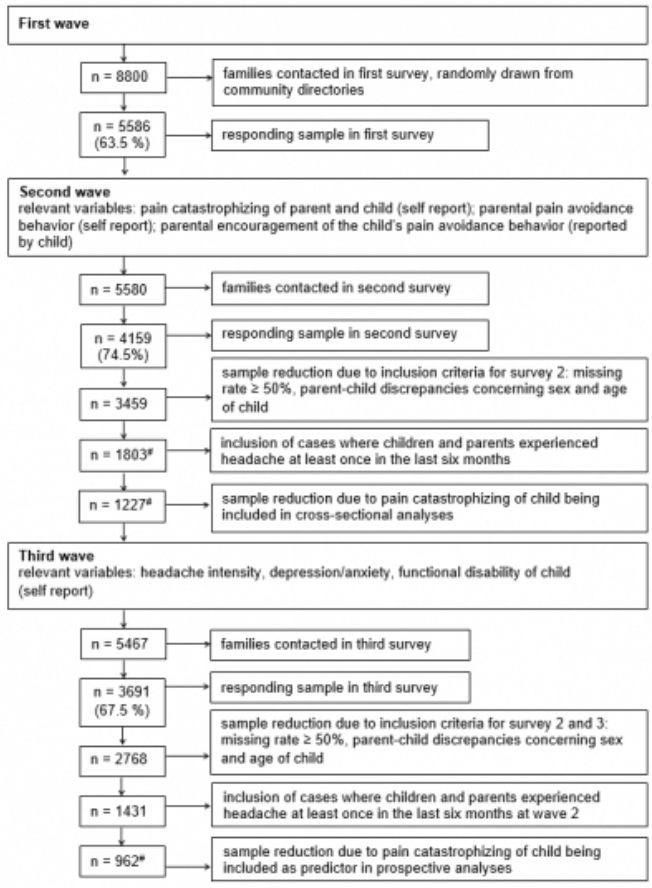
Regarding prospective analyses, parental and child's pain catastrophizing as well as parental pain avoidance behavior were analyzed regarding their predictive value for pain-related disability of the child one year later. Based on influences of social modeling [6, 10, 25, 40] one would expect that the child, when confronted with a highly catastrophizing and pain-avoiding parental model, would learn that pain is threatening and needs to be responded to with concern, helplessness or behavioral avoidance. In consequence, the child may show a similar reaction pattern with their own pain symptoms, experience pain more intensely, and rather tend to react with depression/anxiety symptoms and restriction of activities. Since previous studies also revealed elevated pain-related disability in the child due to the child's own pain catastrophizing [41, 42], this variable was included as well in the analyses as a predictor; we expected that particularly in the context of high pain catastrophizing in both parent and child, increased disability would be seen in the child. The child's disability was multidimensionally assessed, since childhood headaches have been associated with restricted somatic, emotional and behavioral functioning [43]. Thus, in addition to headache intensity (somatic disability), negative affectivity (emotional disability) and interferences with daily activities due to headache (functional disability) were assessed (Table 1).

METHOD

Study Sample. 8800 families were randomly drawn from community directories in Southern Lower Saxony (Germany) as a population-based sample [44]. Questionnaires were only sent to families with German as their native language (to avoid language problems) and at least one child between seven and 14 years. Families participating at first assessment were again contacted for the three following panels. The current study included families participating in waves 2 and 3. Cases with ≥ 50% missing data and parent-child discrepancies in statements concerning sex and age of the child were excluded from the dataset. Headache was operationalized as a four-category frequency variable ("no headache" (0), "less than monthly" (1), "at least monthly" (2), "at least weekly" (3)). Family data were included in the sample only if both the child and reporting parent stated to have had a headache in the last six months at least once at wave 2. Figure 1 presents characteristics of the responding samples.

Figure 1

Flowchart on sample selection; # = outcome groups of interest for cross-sectional and prospective analyses



In the cross-sectional analysis regarding the association of parental pain avoidance behavior and concordant support of child's pain avoidance behavior, the reports from both children and parents were assessed. Whereas parent's self-reported their own pain avoidance behavior, children were asked for an evaluation of parental behavior during the child's headache episodes. This resulted in a sample of n = 1803 from wave 2. Regarding the hypothesis of parent-child concordance in pain catastrophizing, self-reported data from both parent and child were included. For the sake of reliability and validity of responses, children younger than 11 years were excluded from questioning pain catastrophizing, which resulted in a smaller sample of n = 1227. Previous studies that validated the child's version of the pain catastrophizing scale included samples with a mean age of 12 years [18, 41].

The prospective analyses of data included predictors from wave 2 and dependent variables from wave 3. Since the child's pain catastrophizing was included as a predictor, again children younger than 11 years at wave 2 were excluded. Furthermore, only children and parents reporting the experience of a headache at least once in the last six months at wave 2 were included. This led to a sample of n = 962 (Figure 1).

Procedure. The study was based on two annual postal surveys (2004-2005) [44, 45]. Participating families were asked via questionnaires about the health of the child, focusing on headaches and other relevant psychosocial variables. All participating families were informed about the anonymity of data and received separate child and parent questionnaires. Since pretests revealed that children younger than nine years had problems reading, understanding and responding to the questions, only children of nine years and older received the child questionnaire [44]. More comprehensive questionnaires were sent to children 11 years and older.

The ethics committee of the German Association of Psychology approved the study protocol [2]. More details about the study characteristics can be found in Kröner-Herwig et al [2].

Design. The parent-child concordance in pain catastrophizing was tested within a cross-sectional correlational design (wave 2) with two continuous variables, and was conducted similarly for parental pain avoidance behavior and support of the child's pain avoidance behavior.

Concerning the second set of hypotheses, pain catastrophizing in the child and parent as well as parental pain avoidance behavior (wave 2) were prospectively analyzed regarding the child's somatic, emotional and functional disabilities (wave 3).

Assessment: **Pain Catastrophizing and Pain-Related Avoidance Behavior**. The child and adult versions of the "Pain Catastrophizing Scale" [41, 46] with 13 items (example: "When I am in pain it's awful and I feel it overwhelms me.") were translated into German by a bilingual speaker and translated back to English by a native English speaker [18]. The German versions were used for the current study. Ratings were made on a 5-point scale from "not at all" (1) to "extremely" (5). For the current study the mean score of the items was used for every child and parent. The Cronbach's alpha for the total scale of the child version was good (= 0.87) [18]. A validation of the German version of the "Pain Catastrophizing Scale" for adults also indicated excellent internal reliability (= 0.92) [47].

The parental pain avoidance behavior was assessed with one item chosen from the "Questionnaire on Pain Behavior and Reinforcement in Low Back Pain" by Herda et al. [48], evaluating on a five-point scale from "never" (1) to "always" (5) the extent of parental avoidance behavior (i.e. staying away from work and household duties) during pain episodes in the last six months. In order to investigate parental behavior in relation to the child's pain, the child was asked for an evaluation (item: "How often do your parents let you stay home from school when you have a headache?"; 5-point scale from "never" (1) to "always" (5)). This item was chosen from the child version of the "Illness Behavior Encouragement Scale" (IBES) [36], an instrument measuring to what extent parents encourage pain avoidance behavior in the child (operant conditioning).

Assessment of Dependent Variables: **Somatic, Emotional and Functional Disability**. Average headache intensity in the last six months was rated by the child with one item ("During the past 6 months on average, how intense was your pain?") on an 11-point numerical rating scale from "no pain" (0) to "worst imaginable pain" (10). It was extracted from the "Chronic Pain Grade" by von Korff [49]. Only children who experienced a headache in the last six months at wave 3 were asked to answer questions concerning headache intensity.

Depression/Anxiety were measured with eight selected items from the "Youth Self-Report" [50] (example: "I feel guilty.") concerning the last three months. In contrast to the original 3-point rating scale, a 5-point scale ("never" (1) to "always" (5)) was used to ensure better comparability with other scales on the questionnaire. The mean of the eight items was used for every child. The homogeneity of the shortened scale was good (Cronbach's = 0.86).

To assess the child's experienced interferences with daily activities, three items of the "Chronic Pain Grade" [49] were averaged to create a metric variable (functional disability). These items assessed the extent of interference with daily activities due to headache in the last six months, addressing three areas of life (everyday activities, family or leisure and school activities) (example: "In the past 6 months how much have headaches interfered with your daily activities?"). The items were rated on an 11-point numerical rating scale from "no interference" (0) to "unable to carry on any activities" (10). Only children 11 years and older received the rather complex questionnaire which included all three items. Furthermore, as for headache intensity, only those children who stated having experienced a headache in the last six months at wave 3 were asked to answer questions concerning functional disability.

Statistical Analysis. Data from parents and children were included in the analyses
only if more than half of the items on a scale were answered. If a scale consisted of three items, only children and parents answering all three items were included.

Since no variable was normally distributed, Spearman rank correlation was chosen. Furthermore, explorative sex- and age-specific correlational analyses were carried out. Fisher's Z-test was used to test for differences between correlation coefficients within sex and age subgroups, concerning pain catastrophizing and pain avoidance behavior. Three multiple linear regressions were conducted concerning the prospective hypotheses. Age and sex were included as control variables in the first step of each multiple linear regression analysis. Each regression analysis used all the described predictors for each of the three dependent variables. Regarding the interaction hypothesis, it was assumed that the relationship between pain catastrophizing of child and child's pain-related disability would be moderated by parental catastrophizing. Therefore an interaction term of child's and parental pain catastrophizing was included.

Analyses of multicollinearity concerning the predictors revealed Variance Inflation Factors under the critical value of 10. All predictors reached values between 1.00 and 1.80. The alpha level was set at .05. SPSS Statistics 20 was used for the statistical analyses.

RESULTS

Descriptive Statistics: Sociodemographic and Pain Variables. Since the samples largely overlapped, only the descriptive data from the largest sample (n = 1803, wave 2) are presented. Slightly more girls than boys were included in the analyses of wave 2 (Table 2), with a mean age of 11.99 years (SD = 2.03; boys: M = 11.83, SD = 2.03; girls: M = 12.12, SD = 2.03). In a large majority of cases, the parental questionnaires were completed by the child's mother (85.1 %).

Table 2

Sample Descriptives (n = 1803, Wave 2):

Variables	n	%
Sex		
Boys	820	45.5
Girls	983	54.5
Age (M, SD)	11.99	2.03
Parental report		
Mother	1526	85.1
Father	106	5.9
Both	158	8.8
Other caregivers*	4	0.3
Headache in children		
< 1/monthly	704	39.0
≥ 1/monthly	531	29.5
≥ 1/weekly	568	31.5
Headache in parents		
< 1/monthly	570	31.6
≥ 1/monthly	869	48.2
≥ 1/weekly	364	20.2
SES		
Low	60	4.0
Middle	648	42.9
High	801	53.1
Single parent household	300	16.7

*adoptive parents, foster parents, grand-parents; SES = socioeconomic status; n varies because of item-specific missing values

The distribution of headache frequencies of children (Table 2) documented that the majority of children reported suffering from headaches rarely (less than monthly). About one third each reported experiencing monthly or weekly headaches. A chi-square test showed significant sex differences regarding the child's headache frequency with girls experiencing a higher percentage of weekly headaches than boys (35.2 % vs. 27.1 %) and boys reporting a higher percentage of rare headaches than girls (43.7 % vs. 35.2 %; $P < 0.001$).

The prevalence rates for parental headache differed significantly from those reported by the children ($P < 0.001$). As displayed in Table 2, weekly and rare headaches were experienced more often by children than by parents, whereas monthly headaches were reported more often by parents than by their children.

Concerning socioeconomic status as defined by the Winkler-Index [51] – assessed at wave 1 – the lower status group was underrepresented in the sample (Table 2). About one sixth of the questioned parents stated living in a single parent household.

Descriptive statistics on pain variables (Table 3) were based on n = 1803 for variables assessed at wave 2 and on n = 1431 for variables assessed at wave 3. Children and parents reported low average scores for pain catastrophizing (scale ranging from 1-5). Furthermore, the extent of parental encouragement on the child's pain avoidance behavior (range 1-5) was limited, and parents showed a low level of avoidance behavior in their own pain episodes (range 1-5). Low mean scores were also found for the variables of depression/anxiety (range 1-5) and functional disability (range 0-100) of the child.

Table 3

Descriptive Statistics for Variables from Cross-Sectional (Child and Parent) and Prospective Analyses (Child) in Waves 2 and 3

Variables (*Informant*)	M (SD)	Range	n
Cross-sectional analyses (wave 2)			
CAT-C (*child*)	1.99 (0.59)	1 - 4.46	1227
CAT-P (*parent*)	1.86 (0.55)	1 - 5	1700
ENC-P (*child*)	2.03 (1.10)	1 - 5	1779
BEH-P (*parent*)	1.81 (0.88)	1 - 5	1693
Prospective analyses (wave 3)			
H-INT (*child*)	4.15 (1.79)	0 - 10	1159
DEP (*child*)	1.85 (0.60)	1 - 4.63	1410
f-DIS (*child*)	17.71 (17.44)	0 - 100	984

CAT-C = pain catastrophizing of child; CAT-P = pain catastrophizing of parent; ENC-P = parental encouragement of pain avoidance behavior in the child; BEH-P = parental pain avoidance behavior; H-INT = headache intensity in the child; DEP = depression/anxiety symptoms in the child; f-DIS = functional disability of the child; n varies because of item-specific missing values

T-tests revealed significant sex differences concerning depression/anxiety and pain catastrophizing in children, with girls being a little more affected by depression/anxiety symptoms (girls: M = 1.98, SD = 0.61; boys: M = 1.70, SD

= 0.55; P < 0.001; d = 0.49) and showing slightly more pain catastrophizing (girls: M = 2.03, SD = 0.60; boys: M = 1.94, SD = 0.57; P = 0.015; d = 0.43). Concerning other pain variables, no significant sex differences in children were found (all P > 0.05). Significant, but only slightly more pain catastrophizing in children than parents (children: M = 1.99, SD = 0.59; parents: M = 1.86, SD = 0.55; P < 0.001; d = 0.23) was documented.

Correlation Analyses: Analyses of Pain Catastrophizing and Pain Avoidance Behavior. As shown in Table 4, correlations between pain catastrophizing of parent and child were significant but low for the total sample (rs = 0.12, P < 0.001). Sex-specific analyses showed no significant differences between parent-child associations in boys and girls (Z = 0.34, P = 0.733). A similar result was found for the association between parental pain avoidance behavior and parental support of pain avoidance behavior in the child (total sample: rs = 0.15, P < 0.001), with no significant sex differences (Z = 0.41, P = 0.682). Age-specific analyses also failed to show significant differences regarding associations of pain catastrophizing and pain avoidance behavior (all P > 0.05).

Table 4

Spearman-Rho-Correlation Analyses on Pain Catastrophizing and Pain Avoidance Behavior of Parent and Child, for the Total Sample, and Subdivided by Sex.

	Total sample:		Boys:		Girls:	
Correlated variables	r_s	n	r_s	n	r_s	n
CAT-C / CAT-P	0.12**	1156	0.14*	509	0.12*	647
ENC-P/ BEH-P	0.15**	1672	0.16**	762	0.14**	910

CAT-C = pain catastrophizing of child; CAT-P = pain catastrophizing of parent; ENC-P = parental encouragement of pain avoidance behavior in the child; BEH-P = parental pain avoidance behavior; ** p < 0.001; * p < 0.05; n varies because of item-specific missing values

Multiple Regression Analyses. Hierarchical regression analyses comprising the total sample, with sex and age as control variables, showed the child's sex as a significant predictor for depression/anxiety of the child. For consistency reasons, separate analyses for the subsamples of girls and boys on all disability dimensions were conducted. Each variable was examined in a separate hierarchical regression with age as a control variable (model 1) and catastrophizing of child and parent and their interaction (model 2) as well as parental pain avoidance behavior (model 3) as predictors, entered in each model with forced entry (see Table 5).

Table 5

Sex-Specific Regression Analyses for Headache Intensity, Depression/Anxiety and Functional Disability

Dependent variables	H-INT						DEP						f-Dis					
	Boys			Girls			Boys			Girls			Boys			Girls		
Predictors	B	SE	β	B	SE	β	B	SE	β	B	SE	β	B	SE	β	B	SE	β
Model 1																		
Constant	4.39	0.91		2.66	0.76		1.22	0.26		1.24	0.26		19.67	9.36		4.46	7.09	
Age	-0.03	0.07	-0.02	0.12	0.06	0.11*	0.04	0.02	0.10*	0.06	0.02	0.15*	-0.12	0.73	-0.01	0.93	0.54	0.08
R^2			0.00			0.01*			0.01*			0.02*			0.00			0.01
ΔR^2			0.00			0.01*			0.01*			0.02*			0.00			0.01
Model 2																		
Constant	4.18	0.91		3.03	0.71		1.11	0.25		1.38	0.25		18.80	9.40		9.18	6.71	
Age	-0.01	0.07	-0.01	0.09	0.05	0.08	0.05	0.02	0.13*	0.06	0.02	0.13*	-0.01	0.73	0.00	0.55	0.51	0.05
CAT-C	0.29	0.10	0.17*	0.51	0.06	0.31**	0.12	0.03	0.22**	0.20	0.03	0.32**	2.48	1.05	0.14*	4.99	0.74	0.32**
CAT-P	0.08	0.10	0.05	0.15	0.06	0.11*	0.06	0.03	0.10*	0.02	0.03	0.03	1.16	1.04	0.07	1.41	0.71	0.09
Interaction	-0.06	0.10	-0.03	-0.14	0.07	-0.09*	-0.02	0.03	-0.04	-0.03	0.03	-0.04	0.16	1.06	0.01	0.19	0.68	0.01
R^2			0.03*			0.12**			0.07**			0.12**			0.03			0.12**
ΔR^2			0.03*			0.11**			0.06**			0.10**			0.03			0.11**
Model 3																		
Constant	3.95	0.92		2.86	0.73		1.18	0.26		1.37	0.25		13.55	9.42		6.42	6.83	
Age	-0.02	0.07	-0.01	0.09	0.05	0.08	0.05	0.02	0.13*	0.06	0.02	0.13*	-0.15	0.72	-0.01	0.51	0.51	0.05
CAT-C	0.29	0.10	0.17*	0.51	0.06	0.31**	0.12	0.03	0.22**	0.20	0.03	0.32**	2.40	1.04	0.14*	4.87	0.74	0.31**
CAT-P	0.03	0.11	0.02	0.15	0.06	0.09	0.07	0.03	0.13*	0.02	0.03	0.03	0.12	1.09	0.01	0.97	0.76	0.06
Interaction	-0.06	0.10	-0.03	-0.15	0.07	-0.10*	-0.02	0.03	-0.03	-0.02	0.03	-0.04	0.07	1.05	0.00	0.12	0.68	0.01
P-BEH	0.15	0.11	0.08	0.11	0.10	0.05	-0.04	0.03	-0.07	-0.01	0.04	-0.02	3.30	1.17	0.18*	1.91	0.96	0.10*
R^2			0.04*			0.13**			0.08**			0.12**			0.08*			0.13**
ΔR^2			0.01			0.00			0.01			0.00			0.02*			0.01*

CAT-C = catastrophizing of child; CAT-P = catastrophizing of parent; Interaction = interaction between parental and child's pain catastrophizing; P-BEH = parental pain avoidance behavior; H-INT = headache intensity in the child; DEP = depressionlanxiety symptoms in the child; f-DIS = functional disability of the child; ΔR^2 = difference in explained variance between previous and current model; ** p < 0.001; * p < 0.05

Sex-Specific Analyses for Headache Intensity. Age was not significantly associated with headache intensity in all models examined and in both subsamples (all P > 0.05), except for model 1 in girls (P = 0.031). Catastrophizing of child proved to be significant both in models 2 and 3 in both boys (both models: P < 0.05) and girls (both models: P < 0.001). Standardized regression coefficients demonstrated stronger positive associations with the child's pain catastrophizing and headache intensity in girls as compared to boys. Parental pain catastrophizing reached significance only in model 2 in the subsample of girls (P = 0.018). The interaction term was only significantly associated with headache intensity for girls, both in models 2 and 3 (both models: P < 0.05). Except for the interaction, all the included predictors showed positive associations with headache intensity. The interaction effect described that at low values of parental pain catastrophizing, the association of the child's catastrophizing and headache intensity was positive, whereas for high values it was negative. Including parental pain avoidance behavior in model 3 did not significantly increase the amount of explained variance, in either boys or in girls (both P > 0.05). Thus, model 3 only explained about 4 % of variance in boys and 12 % of variance in girls.

Sex-Specific Analyses for Depression/Anxiety. Age was significantly positively associated with depression/anxiety in both subsamples and all models (all P < 0.05). The child's pain catastrophizing also was significant in all models and in both boys and girls (all P < 0.001). As already reported, the child's pain catastrophizing explained more variance in girls as compared to boys. Parental pain catastrophizing reached significance only in the subsample of boys, positively associated with depression/anxiety, both in models 2 and 3 (all P < 0.05). The interaction was not significant for either

boys or girls nor for models 2 and 3 (all $P > 0.05$). As for headache intensity, including parental pain avoidance behavior in model 3 did not significantly increase the amount of explained variance either in boys or in girls (all $P > 0.05$). Thus, model 3 explained 8 % of variance in boys and 12 % of variance in girls.

Sex-Specific Analyses for Functional Disability. Age was not a significant predictor for functional disability in all models examined and in both subsamples (all $P > 0.05$). The child's pain catastrophizing was significantly positively associated with functional disability in models 2 and 3 and for both boys (both models: $P < 0.05$) and girls (both models: $P < 0.001$). Again, the child's pain catastrophizing explained more variance in the subsample of girls than in boys. Parental pain catastrophizing and the interaction were not significantly associated with functional disability in all models examined and in both subsamples (all $P > 0.05$). Including parental pain avoidance behavior in model 3 significantly increased the amount of explained variance in functional disability, for both boys ($P = 0.005$) and girls ($P = 0.048$). Thus, the explained variance in model 3 amounted to 5 % in boys and 13 % in girls.

In summary, the total amount of variance explained by the predictors was rather small regarding all three disability variables, both for boys and girls. At maximum, the predictors explained 13 % of variance in girls and only 8 % in boys. The higher amount of overall variance explained in girls as compared to boys was not due to the impact of parental pain variables but can be attributed to the stronger association of the child's pain catastrophizing with the disability variables in girls.

DISCUSSION

This study sought to examine the relevance of social modeling in a randomly drawn population-based sample of German children between 9 and 16 years and their parents who reported to have had a headache at least once in the last six months. To this end, the parent-child concordance in pain catastrophizing, presumably influenced by social modeling, was analyzed cross-sectionally.

In accordance with findings emphasizing the important role of operant conditioning processes in the etiology and maintenance of the child's pain [36-38], parental encouragement of the child's pain avoidance behavior due to headache was examined. The association of this variable with parental pain avoidance behavior was also investigated in a cross-sectional design. Based on previous evidence for a shared behavioral style of coping with pain in parents and their children [6, 8, 9, 11, 15], it was expected that parents staying away from work and household duties in the case of their own pain should respond to their child's pain in an analogous way, permitting the avoidance of undesirable activities such as school attendance.

According to social modeling theory [7], parental pain cognitions and behaviors were expected to predict the child's pain-related disability. In a series of prospective multiple regression analyses, the predictive power of parental pain catastrophizing and pain avoidance behavior on three aspects of the child's disability was analyzed: headache intensity (somatic disability), depression/anxiety (emotional disability) and interferences with daily activities due to headaches (functional disability).

Cross-sectional Analyses.

Pain Catastrophizing. A significant positive correlation between parent's and child's pain catastrophizing was found. This corroborated past research reporting a shared dysfunctional cognitive coping style in parents and their children [20, 52]. However, higher parent-child concordance in pain catastrophizing was found in prior studies [20, 21]. The weaker association found in the present study may be related to the high percentage of children (almost 70 %) who only experienced monthly or even less frequent headaches. This was also true for 80 % of the examined parents (Table 2). Furthermore, as relatively low mean values for the indicators of parental pain catastrophizing and avoidance behavior as well as for the child's catastrophizing and emotional and functional disability were observed (Table 3), the findings indicated that overall the experience and impact of headaches in the given sample was rather low.

Hermann and Flor [21] as well as Jamison and Walker [53] concluded that a social modeling effect can only be seen if a child is frequently exposed to parental cognitive and behavioral pain coping. Correspondingly, parents examined in the current study may not have provided an effective learning model for their children's processing of pain and pain dependent behaviors thus limiting a possible social modeling effect and the magnitude of a positive parent-child association in pain catastrophizing.

On the other hand, parental social modeling will only have an impact on the child's own pain and related cognitions and behaviors if these are frequent and relevant aspects of his/her

daily life. Since children of the current sample experienced a low level of headache-related emotional and functional interference, the relevance of a parental pain model and therefore the extent of a parent-child concordance in pain-related cognitive coping may have been reduced.

The small standard deviations for all analyzed pain-related variables, except for functional disability, further indicated that the variation in the data was considerably limited. For example, supplementary analyses of frequency distributions of the pain catastrophizing scales (scale ranges 1-5) revealed that 93 % of the analyzed children and 95 % of the questioned parents reached values of less than 3. Therefore, the small standard deviations further reduced the parent-child correlation in pain catastrophizing. Since an extreme right-skewness for functional disability was found, it may be expected that the high variability in this variable was due to only a few children with high scores on this disability dimension.

Pain Avoidance Behavior. The small positive correlation of parental pain avoidance behavior and encouragement of pain avoidance behavior in the child may also be explained by the potentially suppressing effect of small standard deviations and biased distributions.

Cross-Sectional Explorative Sex- and Age-Specific Analyses. While past research [22, 26] reported a higher sensitivity to parental pain models in girls as compared to boys, no sex differences were found for the parent-child concordance in pain catastrophizing, nor for the association of parental pain avoidance behavior and encouragement of pain avoidance behavior in the child.

Furthermore, a reduced reliance on the parental pain model in older as compared to younger children was reported [29]. After separately calculating and comparing all correlations for each individual age level, no significant impact of age group on their magnitude was found.

Prospective Analyses. Adopting a longitudinal perspective, the predictive power of child and parent pain behaviors and cognitions was prospectively investigated in regression analyses. Suggested by the data that revealed sex of the child as a significant predictor for depression/anxiety, sex-specific regression analyses were conducted. In summary, results of the regression analyses documented that for all disability variables only moderate amounts of variance were explained by the predictors, with a higher explanation of variance in girls.

Predictors for Somatic, Emotional and Functional Disability.

Age. Age was included as a predictor in regression analyses in order to control for possible age effects concerning the different disability variables. In accordance with past research [54, 55], depression/anxiety covaried with age, with older children showing more emotional disability. In contrast, headache intensity and functional disability were less age-dependent in the current study. Previous findings also reported few age effects for these disability dimensions [25, 42].

Child's Pain Catastrophizing. Pain catastrophizing was defined as a multidimensional mental set of exaggerated negative thoughts and expectations towards actual pain or potentially painful stimuli [56]. Corresponding with previous studies [23, 41], results documented that the level of headache intensity covaried with the magnitude of the child's pain catastrophizing. Pain catastrophizing was linked to increased attention towards pain and to the interpretation of potentially painful stimuli as being highly aversive. This may contribute to a preferential processing of pain-related information and, thus, probably also to an increase in the reported pain intensity [57, 58].

The positive association of the child's pain catastrophizing and depression/anxiety found in the current and prior studies [59, 60] can be attributed to the inclusion of helplessness as an important component of both pain catastrophizing and depression. As helplessness is considered to be one of the three main components of pain catastrophizing [56] (besides magnification and rumination) this can be seen as the main link to depression.

In accordance with previous findings [41, 42], results further revealed that elevated pain catastrophizing of the child was related to enhanced functional disability. This may again be explained by intensified attention towards pain and fear-related appraisal of pain [25, 56], possibly leading to an avoidance of activities and subsequently to an experienced increase in functional disability.

Results further documented that the consequences of pain catastrophizing on somatic, emotional and functional disability were more pronounced in girls. Pain catastrophizing, as a negative orientation towards pain, should be more salient in children with higher headache frequency [25]. As in previous studies [61, 62], higher rates of headaches were found in girls as compared to boys.

Hence, pain catastrophizing should be of greater importance to girls in the present study, thus also exerting a higher detrimental influence on the examined disability variables. Although significant influences of the child's pain catastrophizing were found for both subsamples, overall, catastrophizing thoughts proved to be of rather moderate relevance for the child's disability dimensions.

Parental Pain Catastrophizing. One of the main objectives of this research was to
determine the extent of parental influence on the child's pain-related disability one year later. Following social modeling theory [7], a catastrophizing and pain avoiding parent was expected to serve as a model for the child's own coping with pain, sensitizing the observing child with respect to his/her own pain-related symptoms, and increasing the child's interpretation of pain and related symptoms as being highly aversive. This, in turn, could possibly contribute to an intensified perception of the child's own pain symptoms and related somatic, emotional and functional disability.

In accordance with social modeling theory, parental pain catastrophizing influenced the child's disability. However, these influences were rather weak for both subsamples and limited to the specific areas of headache intensity in girls and anxiety/depression in boys. Moreover, the interaction between parental and child's pain catastrophizing failed to yield the expected enhancing effect on the child's disability.

Parental Pain Avoidance Behavior. In contrast to the original expectations, parental pain avoidance behavior affected the child's pain-related functional disability, but not headache intensity (somatic disability) or depression/anxiety (emotional disability). However, due to the behavioral connotation of both variables, an impact of the parent's pain avoidance behavior on the child's behavioral way of coping with pain (functional disability), seems to be more plausible than an association of parental pain avoidance behavior and the child's headache intensity or depression/anxiety.

In summary, results of regression analyses revealed small influences of parental pain variables on the child's disability indicators. Possible explanations for the limited relevance of the parental pain model have already been discussed with regards to cross-sectional analyses and may also be applicable here.

Limitations. Several limitations of the study need to be considered when interpreting the results. One factor concerned the assessment of pain avoidance behavior. Asking parents about their encouragement of pain avoidance behavior in the child may have easily provoked their reluctance to admit to an inadequate way of coping with their children's pain. Thus, since parental encouragement of the child's pain avoidance behavior was likely to be denied in parent reports, the children themselves were asked to describe their parents' behavior. However, whether the children were able to validly evaluate the parental behavior during these pain episodes remains debatable.

In the majority of cases, the child's mother answered the questionnaire, which is a common problem in this research area [63]. Nevertheless, the information lacking about paternal headache frequency and resulting coping leaves an incomplete picture of familial pain experiences and behaviors.

Due to inclusion criteria, the generalization was of course limited to population-based samples where for the vast majority of children headaches were not a severe problem. Additionally, strictly causal interpretations were not justified even though a prospective design was applied to analyze influences of parental pain catastrophizing and avoidance behavior on the child's disability variables.

CONCLUSION

The current study set out to investigate the relevance of pain-related social modeling and learning in a population-based sample of children and parents reporting experiencing a headache at least once in the previous six months. Strengths of the current study were the large sample size permitting the detection of even small differences because of the high test power, and the use of a population-based sample which allowed for a broad generalization of the observed results. Moreover, for the first time the impact of parental pain catastrophizing and pain avoidance behavior on pain-associated variables of children were examined in a prospective design and with respect to the child's somatic, emotional and functional disabilities in one single combined study.

Hypotheses derived from social modeling theory7 were partially supported by the obtained results, but the predicted associations were rather weak and often limited to subgroups or specific disability domains. The potential statistical effect on correlation and regression analyses, related to biased distributions and standard deviations, was already discussed.

The limited relevance of operant conditioning in the current study may be related to the high percentage of children experiencing headaches only monthly or even less frequently, which prevented frequent parental reinforcement of pain avoidance behavior in these children.

Findings of the current study call for further in-depth exploration of the factors, conditions and mechanisms of social modeling and operant conditioning processes related to headache and associated disability in children. Specifically, observed sex differences in the association of the child's pain catastrophizing and disability variables further emphasize the importance of considering sex-specific processing and expression of pain when examining pediatric headaches in children and adolescents.

Future work should include a more detailed and comprehensive assessment of pain avoidance behavior in order to analyze effects of operant conditioning. In the current study, parental pain catastrophizing was related to the parent's own pain. Prospective research should also analyze the dependence of the child's disability on parental pain catastrophizing about the child's pain experience. In this way, similarities and differences of these two pain catastrophizing variables of parents could be evaluated. Further aspects that should be considered in future work include the role of the father in pain modeling processes and long-term influences of pain-related social learning concerning coping with pain in adulthood.

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Author Information

Corinna Isensee
Georg-Elias-Müller Institute of Psychology, Dept. of Clinical Psychology and Psychotherapy, University of Göttingen
Germany
corinna.isensee@psych.uni-goettingen.de

Birgit Kröner-Herwig, PhD
Georg-Elias-Müller Institute of Psychology, Dept. of Clinical Psychology and Psychotherapy, University of Göttingen
Germany
bkroene@uni-goettingen.de