

# The German Pain Catastrophizing Scale for Children (PCS-C) – psychometric analysis and evaluation of the construct

## Die deutsche Fassung der Schmerzkatastrophisierungsskala (SKS-D) – psychometrische Analyse und Evaluation des Konstrukts

### Abstract

**Objective:** The Pain Catastrophizing Scale, adapted for children (PCS-C) by Crombez et al. (2003), was translated into German (SKS-D) and evaluated regarding its factorial structure, its reliability and validity. The association of catastrophizing with various pain characteristics and disability measures was examined as well as its association to neighboring constructs.

**Method:** The paper-and-pencil version of the SKS-D was used in two different samples of children and adolescents. Analyses were conducted on a subgroup of participants from an epidemiological sample [ $n=898$ ; age:  $M=12.9$  ( $SD=1.4$ )] who had experienced monthly headaches in the 6-months period before and a clinical sample [ $n=60$ ; age:  $M=12.6$  ( $SD=0.8$ )] seeking treatment for recurrent headaches.

**Results:** Exploratory factor analysis (PCA) suggested a one-factor model in contrast to the 3-factor model suggested by Crombez et al. (2003). The unidimensional scale showed distinct homogeneity and satisfying reliability. The clinical sample showed significantly higher scores than the epidemiological group. Also girls scored higher than boys. The catastrophizing explained a considerable amount of variance in pain and disability parameters in both samples thus underlining its validity. The psychological variables internalising, anxiety sensitivity and somatosensory amplification showed significant small to moderate associations with pain catastrophizing and also with pain and disability. After controlling for the above mentioned psychological variables, catastrophizing still yielded an independent contribution to the explanation of variance in pain and disability parameters.

**Conclusions:** The PCS-C in its German form is a valid and reliable instrument for assessing catastrophizing in children with recurrent pain, in particular headache, in the age of 10–16 years. Pain catastrophizing is suggested to be assessed especially in pediatric pain patients as it is a significant moderator of pain and disability. In children with a distinct tendency to catastrophize cognitive restructuring should become a target of pediatric pain therapy, as a reduction of catastrophizing cognitions may indirectly help to ameliorate pain and disability.

**Keywords:** pain catastrophizing, PCS-C German version, psychometric standards, factor analysis, SKS-D

### Zusammenfassung

**Ziel:** Die „Pain Catastrophizing Scale“ für Kinder (PCS-C) von Crombez et al. (2003) wurde ins Deutsche übersetzt (SKS-D) und hinsichtlich ihrer faktoriellen Struktur, ihrer Reliabilität und Validität evaluiert. Der Zusammenhang von Katastrophisierung mit verschiedenen Schmerzparametern und Beeinträchtigungskennwerten sowie benachbarten Konstrukten wurde analysiert.

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**Methode:** Die Papier-und-Bleistift Version des SKS-D wurde zwei verschiedenen Stichproben von Kindern und Jugendlichen vorgelegt, einer Subgruppe eines bevölkerungsbasierten, epidemiologischen Samples (N=898, Alter: M=12,9 (SD=1,4)), die angab, an wiederkehrenden Kopfschmerzen in den 6 Monaten vor der Erhebung gelitten zu haben und einer klinischen Stichprobe (N=60, Alter: M=12,6 (SD=0,8)), die sich wegen wiederkehrenden Kopfschmerzen um psychologische Behandlung bemüht hatte.

**Ergebnisse:** Eine exploratorische Faktorenanalyse (PCA) ergab ein ein-faktorielles Modell im Gegensatz zu einem drei-faktoriellen Modell, das Crombez et al. (2003) vorgeschlagen hatten. Die eindimensionale Skala zeigt eine sehr hohe Homogenität und zufriedenstellende Reliabilität. Die klinische Stichprobe zeigte signifikant höhere Werte in der Katastrophisierung als die nicht-klinische Gruppe. Mädchen wiesen höhere Werte auf als Jungen. Die SKS-D erklärt in den Schmerz- und Beeinträchtigungsparametern einen bedeutsamen Anteil der Varianz und zwar in beiden Stichproben, was die Validität stützt.

Die ausgewählten psychologischen Variablen nämlich Internalisierung, Angstsensitivität und somatosensorischen Amplifikation, zeigten signifikante kleine bis moderate Korrelationen mit der Schmerzkatastrophisierung sowie mit Schmerz- und Beeinträchtigungskennwerten. Bei Kontrolle der psychologischen Variablen zeigte die Katastrophisierung weiterhin signifikante Korrelationen mit Schmerz- und Beeinträchtigungsparametern, was wiederum als Hinweis für die Validität des Fragebogens gewertet werden kann.

**Schlussfolgerungen:** Die SKS-D ist ein reliables und valides Instrument zur Erfassung katastrophisierender Tendenzen bei Schmerz in der Gruppe von Kindern und Jugendlichen mit wiederkehrenden Schmerzen, insbesondere Kopfschmerz, in der Altersgruppe von 10–16 Jahren. Schmerzkatastrophisierung sollte insbesondere bei pädiatrischen Patienten erfasst werden, da es ein bedeutsamer Moderator von Schmerzerleben und Beeinträchtigungsempfinden ist. Bei Patienten mit starken Katastrophisierungstendenzen sollte kognitive Umstrukturierung ein zentraler Bestandteil der Schmerztherapie sein, da eine Reduktion dieser Tendenzen auf indirektem Wege zu einer Schmerz- und Beeinträchtigungsminderung führen kann.

**Schlüsselwörter:** Schmerzkatastrophisierung, SKS-D, PCS-C deutsche Version, psychometrische Gütekriterien, Faktorenanalyse

## Introduction

Pediatric research has yielded findings that many children not only suffer from episodes of acute pain, but even can be affected by recurrent or chronic pain [6]. Hence, recurrent pain, especially so-called functional pain, is a significant pediatric health problem, with headache being the most prevalent [17], [13].

Research on pain in adults has demonstrated that psychosocial factors play a major role in pain severity and also in disability. Research on adults has especially focused on catastrophizing [10], characterized by negative cognitive appraisal of pain including rumination about its negative consequences and in particular the feeling of helplessness when confronted with pain. Sullivan et al. [25] characterized pain catastrophizing as an “exaggerated negative mental set” leading to a magnification of the negative sensation, at the same time focusing on pain and a worrying about its outcome since successful

copings seems impossible. It has been consistently shown that catastrophizing is associated with more severe pain and disability [15], [25]. Thus catastrophizing represents a particular dysfunctional cognitive coping style [22], when confronted with a stressor, in this case pain.

Sullivan et al. [24] developed the Pain Catastrophizing Scale for adults suggesting 3 factors (helplessness, magnification, rumination). It was adapted by Crombez et al. [4] for the application in children (PCS-C) and was tested on 814 Belgian school children and a small clinical sample. After controlling for sex and age, catastrophizing explained 17% of variance in pain intensity [4]. Another study by Vervoort et al. [30] showed that catastrophizing predicted pain-related disability six months after the first assessment, even after controlling for initial pain. Thus findings regarding the significance of catastrophizing in adults were replicated for children and adolescents.

The general aim of the current study was the psychometric evaluation of a German version of the PCS-C, since

we wanted to provide the opportunity for its application in German pediatric research and in particular in the assessment of pediatric pain patients in clinical settings. We also wanted to further examine whether cross-cultural similarities regarding the validity of the construct especially in regard to its association with various parameters of pain and disability can be observed.

Testing the psychometric quality of the questionnaire included the examination of its factorial structure and other basic standards (e.g. homogeneity, reliability). In the pursuit of exploring the validity of the construct we studied its association with various characteristics of pain and pain related disability as well as its correlation with neighboring constructs like internalising, anxiety sensitivity and somatosensory amplification.

There is rather consistent evidence that an internalising processing style, indicating depressive and anxiety driven coping in daily life, is associated with headache and other pain symptoms [20], [17]. Also anxiety sensitivity, a tendency to feel threatened by physical symptoms of anxiety and arousal, has recently been shown to correlate with pediatric pain [33], [29], [5]. Somatosensory amplification, denoting a disposition to focus on and emphasize somatic sensations, so far has been rarely examined regarding pediatric pain. However, a recent study by our research group underlined its significance for the occurrence of different primary headache syndromes, especially migraine [12]. It will be examined whether these variables correlate with catastrophizing and may even explain more variance in pain, in this case recurrent headache, than catastrophizing.

Our study included two samples, a large population-based subsample of German children and adolescents with at least monthly headaches [16] and a small clinical sample of children with disabling headaches, seeking treatment via an internet-based self-management intervention [26]. Thus, we had the chance to study the consistency of our psychometric findings.

## Methods

### Characteristics of the two study samples

#### The epidemiological subsample (ES)

The study sample was subgroup of a general population cohort of families with at least one child (aged 7–14) residing in Southern Lower Saxony. The sample was randomly drawn from 8,800 families registered in community files. Only citizens whose mother tongue was German were included. The study was conducted via a postal survey. The survey comprised 4 annual waves, of which mainly wave 2 delivered data for this study (for further details, see [14]).

In wave 2 children from age 11 on received a comprehensive and demanding self-report questionnaire (12 pages) also including the PCS-C (n=2,518). From these, only those children who reported to have experi-

enced *headaches at least on a monthly basis during the last 6 months* were selected for analysis. Headache was the pain on which the most detailed information was collected and, thus, could best be analysed regarding its association with pain catastrophizing.

The selection of a subsample of children with recurrent pain was assumed to ensure that the responses to the PCS-C were based on a real-life experience with this type of functional pain. We assumed that this selection would render the children's responses to the pain catastrophizing questionnaire more reliable and valid.

They reported an average intensity of pain (see Table 1) of 4.41 (11-point numerical rating scale, NRS) and the interference of pain with daily activities was rated to be 2.04 (11-point NRS). Forty-two percent reported headache to appear on a monthly basis, the rest to be more frequent (weekly headache). Only 7.5% reached a moderate or high pain grade of 3 or 4 regarding the von Korff et al. [32] classification (see Methods). On average children experienced pain at 2 different sites (e.g. head and back) at least "*sometimes*", i.e. not only head pain.

Only if *no* PCS-C item was missing, individual data were used in the analyses (final sample size: n=898). The mean age of the children in the ES was 12.95 years (standard deviation (SD)=1.44) with a range of 11–15 years, 55% of them were female.

#### The clinical sample (CS)

In this independent study, children with a primary headache disorder were recruited through newspaper advertisements and several websites giving information about an internet-based self-management training aimed at the reduction of headaches. The participants from the CS had suffered from headache for a mean duration of 2.8 years (SD=3.0). Their average pain intensity was 6.18 on a numerical rating scale (NRS: 0–10). Nearly 50% experienced weekly headaches and one third nearly daily episodes. They reported being interfered with pain regarding their daily activities on nearly 14 days in the month prior assessment (PedMidas: [8]). Fluent German was a prerequisite for participation in the study (for further details see [26]).

A total of 78 children and adolescents fulfilled the inclusion criteria and baseline data on the PCS-C was available from 60 children. The mean age was 12.6 years (SD=0.80, range 10–17 years), 55% were female. Thus both samples were quite similar regarding the demographic parameters as well as the main type of pain.

## Assessment

### The PCS-C /SKS-D

The questionnaire version applied by Crombez et al. ([4]; English language) was translated into German by a bilingual member of the research team and translated back to English by a native English speaker. The German version of the PCS-C can be obtained from the authors. The

Table 1: Descriptive data on variables

Variables	Epidemiological sample (ES)	n	Clinical sample (CS)	n
	M/SD		M/SD	
Pain catastrophizing (total score; 1–5) <sup>a</sup>	<b>2.04 (0.60)</b>	896	pre: <b>2.57 (0.69)</b>	60
			post: <b>2.43 (0.65)</b>	55
			f-u: <b>2.02 (0.65)</b>	40
<i>Sum score</i> <sup>b</sup>	<b>26.44 (7.83)</b>		<b>33.35 (8.91)</b>	60
Pain intensity (0–10)	<b>4.54 (1.77)</b>	896	<b>6.18 (1.74)</b>	60
Pain frequency	monthly: <b>47.2%</b> weekly: <b>52.8%</b>	898	<b>16.7%</b> (≥2/month; less often) <b>49.1%</b> (≥1/week) <b>33.3%</b> (nearly each day)	60
Pain vulnerability index (number of pain sites)	<b>2.01 (0.52)</b>	891		
Pain grade	(1) <b>60.1%</b> <sup>c</sup> (2) <b>32.5%</b> (3) <b>7.4%</b>	872		
Interference in the ES (0–10) <sup>d</sup> interference in the CS (no. of days) <sup>e</sup>	<b>2.04 (1.79)</b>	899	<b>13.77 (12.56)</b>	59
Internalizing (ES)/depression (CS)	<b>1.91 (0.62)</b>	879	<b>9.31 (5.44)</b>	59
Anxiety sensitivity	<b>1.48 (0.53)</b>	891		
Somatosensory amplification	<b>1.95 (0.64)</b>	881		

<sup>a</sup> response scale<sup>b</sup> sum score given<sup>c</sup> grade: (1) low (2) moderate (3) considerably high; derived from the Pain Grade formula (von Korff et al. 1992, see text)<sup>d</sup> metric variable interference derived from the Pain Grade formula (von Korff et al. 1992, see text)<sup>e</sup> interference (no. of days) derived from the PedMIDAS (Hershey et al. 2001, see text)

shaded cell: no information assessed

PCS-C (SKS-D) consists of 13 items, devised according to the same principle: “When I am in pain... It is awful and I feel it overwhelms me” (item 4), “...I can’t seem to keep it out of my mind.” (item 9), “...I wonder whether something serious may happen.” (item 13). Responses to the statements denote the grade of agreement on a 5-point rating scale (English/German labels): “not at all” or “überhaupt nicht” (1), “mildly” or “ein wenig” (2), “moderately” or “ziemlich” (3), “severely” or “stark” (4), “extremely” or “sehr stark.” (5). Some of the response labels were not translated literally because they were evaluated as inadequate in the German language.

Like the ES, also the CS received a paper-and-pencil version of the SKS-D. In the ES, the SKS-D was presented as a section of a comprehensive questionnaire on various aspects of health, psychological characteristics and social environmental features.

## Assessment of pain and disability and further psychological variables

### Epidemiological sample (ES)

#### Pain and disability

*Frequency of headache* was reported regarding the period of the last six months. A four-category response scale was presented: “none” (0), “at least once” (1), “at least once per month” (2), “at least once per week” (3). For statistical analysis a categorical variable was used (monthly/weekly). Average headache *intensity* (6 months) was rated on a NRS (0 (no pain)–10 (worst imaginable pain)) (see Table 1).

Furthermore, the so-called *pain grade* ([32], see also [9]) was assessed regarding headache. This index is based on reports of average pain severity (6 months) and interference due to pain regarding everyday activities i.e., *family* or *leisure* activities, as well as *school activities* (NRS: 0–10). From this information the “pain grade” is

determined to mirror the level of disability: “none” (0), “low” (1) to “high” (4) (see [32]). As all participants were afflicted by headache, grade 0 was non-existent. Grade 3 and 4 were collapsed to create a three-category variable (pain grade: low, moderate, considerably high) because only a small number of children reached a grade of 3 or 4 (together 7.5% of the whole sample).

Three items of the pain grade instrument (see Table 1) assessing the extent of *interference* with daily activities (NRS 0–10) in the aforementioned areas of life were averaged to create a metric variable.

Furthermore, a *pain vulnerability index* was calculated by adding up the pain sites where children reported to have experienced pain at least “sometimes” (scale: “never” (0) to “always” (5)) in the last 6 months. Eleven pain sites (e.g. arm, knee, belly) were asked for.

### Psychological trait variables

The three psychological trait variables were assessed to examine their propinquity to the construct of catastrophizing and their association with pain and disability variables. *Anxiety sensitivity* was measured by five items from the questionnaire of Blais et al. [3] and *somatosensory amplification* by five items from the questionnaire of Barsky et al. [2], as well as *internalising* by eight items from the YSR [1]. The complete test forms could not be applied because of the comprehensiveness of the total questionnaire asking for various psychosocial and health-related aspects. The item selection regarding each of the variables was based on closest item-scale correlations of the items or high factor loadings identified in studies which had evaluated the original instruments. Correlation of the reduced scales with the comprehensive scale – which was tested in a subsample of the ES (n=257) – were high ( $.74 \geq r \leq .95$ ). Cronbach’s alpha for the scales was satisfactory (internalising symptoms = 0.86; anxiety sensitivity = 0.71), except for somatosensory amplification ( $\alpha=0.57$ ).

### Clinical sample (CS)

#### Pain and disability variables

In the CS average *headache frequency* (last 6 months) was assessed by a categorical rating scale with the response categories “every or nearly every day” (4), “at least once per week” (3), “at least 2 times per month” (2) and “less often” (1), which was not identical to the scale used in the ES. The rating of pain frequency in the patients had to be more differentiated as changes due to therapy should be assessable. It was transformed into a categorical scale for analysis (see Table 1). *Headache intensity* was measured by the same scale that was applied in the ES. A metric measure of *interference* by pain was derived from the PedMIDAS [8], by adding the days that school was missed because of headache and the days with interference in family activities and social activities (PedMIDAS: items 2, 4, 5) during the last 6

months. Although this measure is different from the one used in the ES, it is comparable regarding the meaning of the construct (interference with the activities of daily life).

### Psychological trait variables

In the CS, the well-validated German Children’s *Depression Inventory* by Stiensmeier-Pelster et al. [23] was administered in its original version (26 items, three response categories, Cronbach’s  $\alpha=0.84$ , retest reliability = 0.76) [26]. In the context of the current analysis it is supposed to measure a similar construct as internalising.

### Statistical analysis

Exploratory factor analyses (PCA) on the pain catastrophizing-items were conducted in both samples by means of SPSS version 18. Psychometric analyses of the SKS-D were performed with data sets from both samples regarding its distribution, homogeneity (Cronbach’s  $\alpha$ ), inter-item correlations, item-scale correlations, and retest reliability.

The association of pain catastrophizing and the pain variables was analysed depending on the type of the dependent variable by correlation or logistic/multinomial regression analysis. It was determined how much of the variance in the dependent variable was explained by pain catastrophizing when age and sex was controlled for.

The same kind of analysis was also conducted with the psychological trait variables additionally assessed. In a last step, it was examined whether pain catastrophizing could significantly predict a unique amount of variance in the pain variables when not only the demographic variables (age, sex) but also one of the further assessed psychological trait variables was controlled for (hierarchical regression analysis). Alpha was set at  $p < 0.05$ .

## Results

### Psychometric analysis of the SKS-D

#### Item properties and demographic differences

The mean item response score (see Table 1) on the 5-point rating scale was close to 2 in the ES (“mildly”); it was significantly higher in the CS (see Table 1;  $t=6.95$ ,  $df=954$ ,  $p < 0.001$ ). In both the ES and the CS the item with the highest agreement score was item 8 (“...I anxiously want the pain to go away”) with a mean of  $M^{ES}=4.11$  (1.10) and  $M^{CS}=4.65$  (0.80). Item 3 (“...it’s terrible and I think it’s never going to get any better”) had the lowest score in the ES with  $M=1.45$  (0.77) and item 7 (“...I keep thinking of other painful events”) in the CS with  $M=1.42$  (0.87).

In the ES, significant differences between sexes were found with the girls scoring higher ( $t(898)=2.75$ ,  $p=0.006$ ). No sex differences were observed in the CS

( $t(58)=1.12$ ,  $p=0.26$ ). Differences between ages were only examined in the ES, showing a trend but no significant difference ( $t(898)=1.77$ ,  $p=0.08$ ), with the younger participants scoring a little higher than the older.

## Factor and item analyses

An exploratory principal component analysis (preset 3 factors) with varimax rotation was conducted on the ES data revealing three components with eigenvalues  $>1$ , which explained 58.5% of variance. The first component explained 41.1%, the second 9.5% and the third component 7.8% of the variance (Table 2). Items of the first component are mainly characterized by the expression of helplessness when confronted with pain.

Although three components with eigenvalues  $>1$  (Table 2) were identified, the scree-test distinctly suggested a one-factor model (Figure 1). Thus a one-factor solution is suggested, which by statistical terms is the most acceptable and parsimonious model. This is in contrast to Sullivan et al. [24] who decided on a three-factor model of the PCS in the adult version. However, the publication does not allow to recognize the methodological background for this decision, but rather gives cause to question it (for details see discussion section).

The Kaiser-Meyer-Olkin Test of sampling adequacy indicated a good adequacy of the data ( $KMO=0.78$ ), as well as the high significance of the Bartlett test of sphericity;  $\chi^2=301.9$ ,  $df=78$ ).

The results of the factor analysis on the CS data were similar, also resulting in three components with eigenvalues  $>1$  and an almost identical variance explanation (58.9%). The first component explained 39.3% of the variance. Components 2 and 3 explained 10.5% and 9.1% of variance, respectively. According to the scree-test a one-factor model was also adequate for the data from CS (Figure 1). Again, sampling adequacy was good and the identity hypothesis could be rejected.

Since a one-factor model of the SKS-D data was accepted data of the ES and CS were analysed to determine the *homogeneity* of the total scale. This resulted in a high and nearly identical Cronbach's alpha scores (0.87/0.86). Although in the CS exclusion of item 8 or item 12 would have led to a higher homogeneity of the scale, this increase would have been minute (change on the third decimal), whereas no such exclusion would have had any beneficial effect in the ES. In the ES item-scale correlations produced coefficients between 0.40 and 0.70. Similar correlations were found in the CS with the exception of item 8 (0.17) and 7 (0.34).

The distribution of sum scores of the scales was examined, since these were reported in most of the international reports on pain catastrophizing. The analysis was only conducted in the ES because of the higher number of subjects (Ss) involved and less selectivity in recruiting the non-clinical sample. The sample mean is 26.44 ( $SD=7.83$ ) and the median = 25 with a range of 13–58. The distribution deviates significantly from a normal distribution showing a positive skewness (0.849, standard

error (SE)=0.082) and a positive kurtosis (0.795, SE=0.163).

## Retest reliability

In the ES, to which the SKS-D (first assessed at W2) was presented again after one (W3) and two years (W4), retest correlations attained coefficients of 0.53 (W2/W3), 0.61 (W3/W4) and 0.47 (W2/W4).

In the CS, the retest correlation of pain catastrophizing was assessed by pre- and post-therapy scores (5 months after the first test) and yielded an  $r$  of 0.51. However, the post/follow-up [ $r=0.71$  (3 months apart)] was assumed to be a "genuine" reliability estimation, since there was no systematic intervention in-between.

## Validity analysis

### Association of the SKS-D with pain and disability variables

The correlations of pain catastrophizing with the metric pain-related variables yielded significant correlations between  $r=0.25$  and 0.41 when looking at both samples (see Table 3). The highest correlation was found between pain catastrophizing and activity interference (ES), and the lowest regarding pain intensity (CS). All ORs based on the analysis of categorical variables were significant except for the prediction of pain frequency (CS).

The amount of explained variance in the dependent variable is the best index to compare the predictive power of pain catastrophizing for the different pain-related variables, being metric or not (see Table 3). Based on data from ES pain catastrophizing was closely associated with activity interference (with 16.7% of explained variance), with pain grade (12.3%) and pain vulnerability (11%).

Correlations were lower in the CS, where the amount of variance explained was highest regarding activity interference (8%). The only non-significant result found here also related to pain frequency (see Table 3).

### Association of the SKS-D with the psychological trait variables

The correlations between the pain catastrophizing and the additionally assessed psychological variables were all significant with coefficients varying between  $r^{int}=.31$ ,  $r^{anx}=.44$ , and  $r^{som}=.49$ , and a common variance of about 10 to 25%. The highest covariance ( $r=0.54$ ) was found between pain catastrophizing and the depression score in the CS with a common variance of more than 29%.

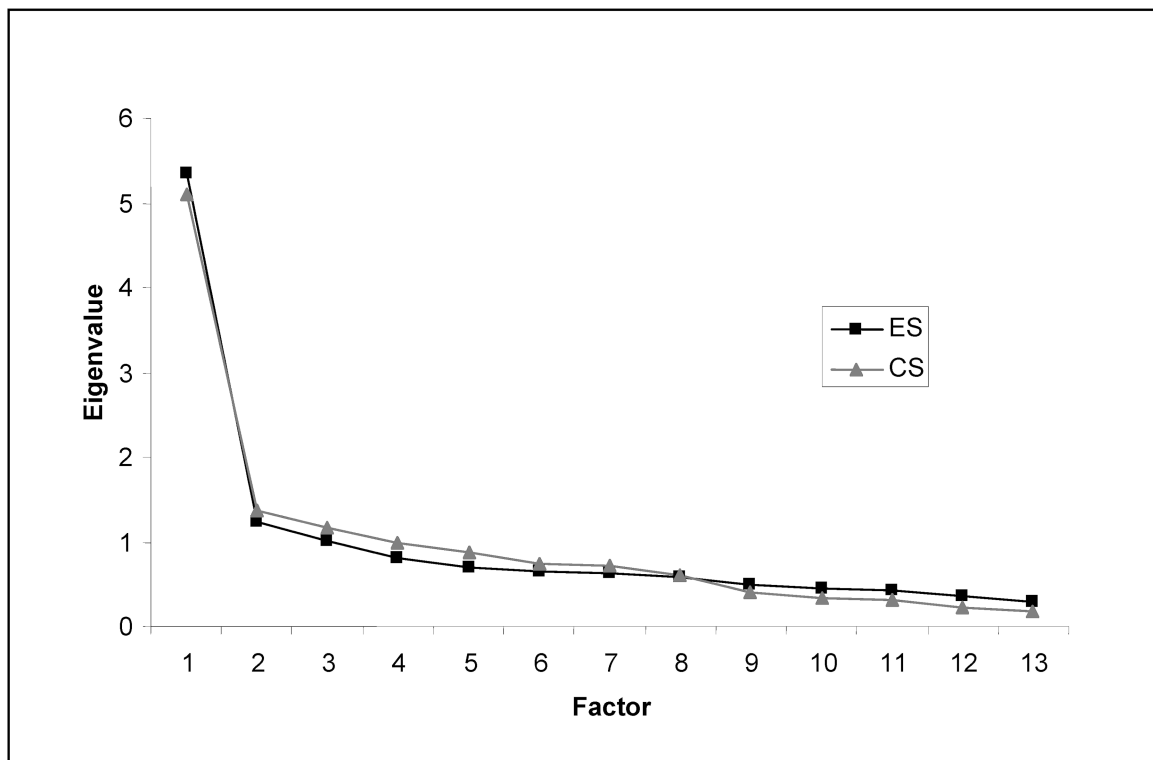
## Predicting pain and disability

For the sake of comparing the size of correlations of pain catastrophizing with the pain and disability variables to those of the additionally assessed psychological trait variables regression analyses using the same model as

**Table 2: Item loadings from the principal component analysis of the SKS-D from the epidemiological (ES) and clinical sample (CS) (preset 3 factors)**

	Components (ES)			Components (CS)		
	1	2	3	1	2	3
1	0.803	0.150	0.159	0.551	0.078	0.553
2	0.726	0.078	0.302	0.465	0.086	0.559
3	0.708	0.275	0.157	0.716	0.263	0.309
4	0.694	0.140	0.182	0.800	0.269	0.044
5	0.643	0.401	0.017	0.766	0.346	0.078
6	0.051	0.727	0.072	0.551	0.486	0.247
7	0.277	0.698	0.162	-0.104	0.552	0.471
8	0.184	0.635	0.438	0.222	0.439	-0.524
9	0.338	0.616	0.380	0.152	0.826	0.025
10	0.173	0.594	0.052	0.382	0.698	0.046
11	0.082	0.089	0.785	0.332	0.537	0.280
12	0.249	0.172	0.697	0.594	0.014	-0.040
13	0.412	0.308	0.563	0.121	0.269	0.689

shaded cells: loading > .40



ES: epidemiological sample  
CS: clinical sample

**Figure 1: Eigenvalues of PCA from both samples**

**Table 3: Results of regression analysis: Pain catastrophizing as a predictor of pain and disability (see B: hierarchical regression)**

Dependent variables	Epidemiological Sample		Clinical Sample	
	Correlation (r)/ Odds ratio (OR)	– Increase in expl. variance <sup>a</sup> when entering pain catastrophizing after age, sex / – <b>total expl. variance by the model</b>	Correlation (r)/ Odds ratio (OR)	– Increase in expl. variance when entering pain catastrophizing after age, sex / – <b>total expl. variance by the model</b>
Pain intensity	r=0.31*	9.1%*/ <b>9.6%*</b>	0.25*	6.1%*/ <b>7.7%*</b>
Pain frequency (monthly/ weekly)	OR=1.50 (#1.20–1.87)*	2.3%*/ <b>3.4%*</b>	OR: ns	ns/ <b>9.1%*</b>
Pain vulnerability	r=0.35*	11%*/ <b>16.1%*</b>		
Pain grade low/moderate/ high	OR <sub>1/2</sub> =2.77 (2.14–3.60)* OR <sub>1/3</sub> =4.50 (3.01–6.71)*	12.3%*/ <b>12.6%*</b>		
Interference (ES,CS)	r=0.41*	16.7%*/ <b>16.8%*</b>	r=0.30*	8%*/ <b>16.4%*</b>

# CI (95): confidence interval of OR at 95%

<sup>a</sup> explained variance in % (R<sup>2</sup> or Nagelkerke)

\* p<0.05

(\*) p<0,10

described above were conducted (Table 4). In general, the associations found were significant but lower than those found for pain catastrophizing. One exception is the high correlation of internalising and the pain vulnerability index. This variable explained more than 19% of variance compared to 11% explained by pain catastrophizing.

Given the considerable overlap between the pain catastrophizing and the other psychological trait variables, we examined whether a unique amount of variance in the pain related variables could be explained by pain catastrophizing when these variables were controlled for. Thus we calculated regression analyses that controlled for sex and age and additionally either for internalising symptoms, somatosensory amplification or anxiety sensitivity (hierarchical regression analysis). These analyses revealed (Table 5) that in each case pain catastrophizing significantly improved the model, explaining additional 1.6–13.1% of variance.

## Discussion

### Psychometric features of the SKS-D

The average item response in our two samples, i.e. the epidemiological and the clinical, varied between the response categories “mildly” (2) and “moderately” (3). As expected, the mean level of catastrophizing was significantly higher in the clinical sample seeking headache treatment, with a high effect size (Cohen’s d) of 0.82.

It should be remembered that our epidemiological sample was selected on the basis of monthly headache. Thus, it

was not unexpected that catastrophizing is higher in our sample (M=26.44, SD=7.83) than in the community sample of Crombez et al. [4] (M=16.79, SD=8.78) (see Table 1, sum score). However, a similar difference is seen in the clinical samples, with our sample of headache sufferers scoring higher (M=33.35, SD=8.91) than the chronic pain sample of children recruited by Crombez et al. [4] from a pediatric pain ward for evaluation of psychological problems (M=21.88, SD=11.44). The comparison with scores from the studies of Verwoort et al. [30] documents even lower scores in the school sample than reflected in the data of Crombez et al. [4] [13.27 (8.33)], whereas Tremblay et al. [27] reported scores in between [22.56 (8.13)]. Thus the size of the scores varies considerably between studies conducted in different countries and on different samples. The causes for these differences may be manifold (linguistic differences in the questionnaire forms, differences in cultural characteristics, differences in the samples regarding mean age, the affliction with pain, time of assessment etc.). Unfortunately they cannot be tracked down.

This means that the scores are to be used with utmost caution regarding the classification of individuals. Thus it is recommended to use rather “approximate” or crude classifications like denominating a “*slightly increased tendency*” to catastrophize if a score is beyond 1 SD above the mean and a score beyond 2 SD as an “*apparently increased tendency*” to catastrophize, providing cut-offs of 34.27 and 42.10 (±4.1). This procedure is suggested despite non-normality of the distribution.

In the community or school samples of other researchers [28], [30] girls showed higher catastrophizing tendencies than boys, which was also seen in our epidemiological



**Table 4: Results of regression analysis of ES data: Internalizing, somatosensory amplification and anxiety sensitivity as predictors of pain and disability (see B: hierarchical regression)**

Predictors	Internalising		Somatosensory amplification		Anxiety sensitivity-sens	
Dependent variables	Correlation (r)/ Odds ratio (OR)	– Increase in expl. variance when entering pain catastrophizing after age, sex /  – <b>total expl. variance by the model</b>	Correlation (r)/ Odds ratio (OR)	– Increase in expl. variance when entering pain catastrophizing after age, sex /  – <b>total expl. variance by the model</b>	Correlation (r)/ Odds ratio (OR)	– Increase in expl. variance when entering pain catastrophizing after age, sex /  – <b>total expl. variance by the model</b>
<b>Pain intensity</b>	0.10	0.5*/1.1*	0.16*	2.2%*/2.7%	0.10*	0.6*/1.1*
<b>Pain freq. (monthly/weekly)</b>	OR=1.45 (1.16–1.80)*	1.3%*/4.9%*	OR=1.49 (1.20–1.84)*	1.7%*/3.2%*	OR: ns	ns/1.9%*
<b>Pain vulnerability Index</b>	0.48*	19.2%*/24.3%*	0.42*	9.2%*/14.4%*	0.36*	10.7%*/15.9%*
<b>Pain grade</b>	OR <sup>1/2</sup> =1.80 (1.43–2.41)* OR <sup>1/3</sup> =3.00 (2.00–4.51)*	5.1%*/5.5%*	OR <sup>1/2</sup> =1.44 (1.13–1.84)* OR <sup>1/3</sup> =3.10 (2.12–4.54)*	4.9%*/5.4%*	OR <sup>1/2</sup> =1.92 (1.44–2.59)* OR <sup>1/3</sup> =3.1 (2.04–4.80)*	4.9%*/5.4%*
<b>Interference</b>	0.19*	4.0%*/4.1%*	0.20*	4.0%*/4.1%*	r=0.25*	6.8%*/6.9%*

OR: Odds ratio and confidence interval at 95%

\* p<0.05

**Table 5: Results of hierarchical regression analysis of ES data: The amount of variance explained by pain catastrophizing after controlling for the indicated psychological control variables as well as sex and age**

Variable controlled for >	Internalising	Somatosensory amplification	Anxiety sensitivity
<b>Dependent variable</b>			
<b>Pain intensity</b>	8.3%*	6.6%*	8.1%*
<b>Pain frequency</b>	2.8%*	0.9%*	1.6%*
<b>Pain vulnerability index</b>	4.2%*	3.4%*	4.3%*
<b>Pain grade</b>	7.2%*	7.3%*	7.4%*
<b>Interference</b>	13.1%*	12.6%*	11.3%*

\* p<0.05

sample, although the effect size was small (0.20). Such a difference was not seen in our clinical sample in which catastrophizing reached a rather high level for both girls and boys. In accordance with these findings and the argumentation for a cautious interpretation of “raw scores”, we do not plead for sex-specific cut-offs.

Researchers of the referenced studies observed no significant age differences, which was replicated in our data.

### Factorial structure of the SKS-D

One early decision of the authors was not to conduct confirmatory factor analyses on the PCS-C data, which Crombez et al. [4] carried out relating to the results of Sullivan et al. [24] on the adult version of the scale. As

explained before, we had substantial doubts regarding the adequacy of deciding on a 3-factor model in the original study on the PCS for adults (no scree test reported, variance explanation of factors doubtful). Moreover we wanted a solution based on a sample the questionnaire would most probably be used on, i.e. children with recurrent pain (excluding rare episodic headache). Unfortunately Crombez et al. [4] as well as Tremblay et al. [27] only reported data on the confirmatory factor analysis of the PCS-C and not on their exploratory analyses so that we could not check the agreement between theirs and ours.

Our data from both samples clearly suggest a one-factor model for the SKS-D. Indirectly the very high homogeneity scores in our own study (>.85) as well as in the study by

Crombez et al. [4] underline the adequacy of the assumption of a 1-factor instrument, as do the reported extremely high correlations between the subscales and the total score varying between .85 and .94 [4]. Also Tremblay et al. [27] found very high correlations.

Taking the long retest intervals of one year in the epidemiological sample into account, the coefficients are satisfactory ( $r=0.47-0.61$ ), since a perfect stability of the construct over one year cannot be assumed. The retest reliability estimate is higher in the clinical sample ( $r=0.71$ ). It is based on the post-follow-up assessment with an interval of 3 months. The retest reliability based on a 3 to 4 month interval reported by Tremblay et al. [27] ( $r=0.73$ ) compares well to the one found in our study. Thus, pain catastrophizing seems to be a quite stable trait variable and the SKS-D a reliable instrument.

## Validity analysis

### Catastrophizing and its relation to pain and disability

We observed significant correlations of catastrophizing with all assessed pain parameters except one. Associations were found with pain intensity in both samples, as well as with the pain vulnerability index in the epidemiological sample. Headache frequency was not significantly correlated with catastrophizing, which could have been caused by its low variability and the use of a categorical variable. Thus, the results from earlier studies were replicated in principle; however, the size of the associations with pain was lower than had been reported by others. Whereas in the study by Crombez et al. [4] an additional 17% of the variance in pain intensity was explained by catastrophizing, when sex and age were controlled for, only half or less of this was found in our samples (ES: 9.1%; CS: 6.1%). Vervoort et al. [31] reported a moderate correlation ( $r=0.49$ ) with pain severity, which was also higher than the correlations found here (ES:  $r=0.31$ ; CS:  $r=0.25$ ). To conclude, all studies including our own showed that pain catastrophizing predicts a significant and substantial proportion of variance in pain intensity. The numbers of pain sites in a child, interpreted as an index of pain vulnerability, were even more closely associated with the SKS-D total score, explaining about 17% of the variance.

Above that measures of disability, i.e. interference with activities of daily life and the pain grade showed close links to pain catastrophizing explaining between 8% and nearly 17% of the variance which is supported by findings of Vervoort et al. [31] and Lynch et al. [18].

The disposition to catastrophize pain obviously results in emphasizing the negative and harmful consequences of pain and the felt inefficacy to cope with it (helplessness). Of course, the association can also be interpreted in the direction that the perceived severity of pain and its disabling consequences lead to a catastrophizing cognitive style. However, the prospective study of Vervoort et al. [31] make the first sequence of events more probable.

### Catastrophizing and its association with neighboring constructs

As could be expected, pain catastrophizing is substantially correlated with the depression score assessed in the clinical sample. As statements denoting *helplessness* in dealing with pain form a large part of the SKS-D, and general helplessness is a major component of depression, the correlation can be interpreted as a sign of construct validity of both trait measures.

The lower, but also significant, correlations with internalizing (depicting depression and anxiety) in our epidemiological sample ( $r=.31$ ) may be explained by the limited variance in these scores in this population-based sample despite being afflicted by recurrent headache. Vervoort et al. [31] found a moderate correlation of pain catastrophizing with negative affectivity ( $r=0.57$ ). A lower but also significant association was reported by Tremblay et al. [27] ( $r=0.20$ ) and Hermann et al. [7], using the catastrophizing scale of the PCQ [21].

Also the moderate, but nonetheless substantial, correlations of anxiety sensitivity and somatosensory amplification with pain catastrophizing are interpreted as an indication that they indeed represent constructs different from the SKS-D, but at the same time they seem to share common components. Thus, it can be assumed that catastrophizing is influenced by a disposition to respond particularly sensitively to sensory stimuli including interoceptive information as the variable somatosensory amplification suggests. This assumption was also brought forward by Muris et al. [19] on the basis of their results regarding catastrophizing and perceptual sensitivity. Tsao et al. [29] interpreted their result on anxiety sensitivity and catastrophizing, both being elevated in children with recurrent pain, and both correlating with somatization, to show their distinct nature and at the same time their definite common characteristics. These include a hypersensitivity to somatic stimuli and a disposition to respond to these perceptions with a cognitive appraisal characterized by anxiety and a feeling of being threatened.

Theoretically, these findings agree well with the construct of catastrophizing described by Sullivan et al. [25] and its relation to pain, which is determined by hypersensitivity to pain and the amplification of its interfering and disabling consequences and helplessness.

### The relative significance of pain catastrophizing as a predictor of pain

The trait variables internalizing, somatosensory amplification and anxiety sensitivity, which all correlated with pain catastrophizing, were significantly associated with all dependent variables (pain and disability), but in general they were less predictive than catastrophizing. Hierarchical regression analyses controlling for each of the aforementioned variables documented in all cases an additional and unique amount of explained variance in the dependent variables by catastrophizing, in particular

regarding interference (11.3–13.1%). These findings denote that that pain catastrophizing is in most cases a more effective predictor than each of the other variables. However, there was one remarkable exception, pain vulnerability, defined by feeling pain in multiple body sites, was best predicted by the internalizing score, explaining nearly 20% of the variance.

## Conclusions

### Limitations of the study

The SKS-D was not examined in an unselected sample of children, as was done by Crombez et al. [4] with community sample. Regarding the potential application of the instrument the authors do not view this as a disadvantage. However, it makes a direct comparison to the original study difficult. All children of our sample reported of recurrent headache, though characterized by a very different severity level based on reports of pain intensity and frequency. It was noted that most of the children were also afflicted by other recurrent pain. An automatic generalization of the results to different samples of children with no selection bias at all cannot be made.

Also because no confirmatory analyses were performed a direct comparison of factor solutions from the original study conducted by Crombez et al. [4] cannot be made. Furthermore the samples of both studies comprised data from children mainly between 10 and 16 years. Thus no conclusions can be made regarding different age groups, though no significant differences in catastrophizing between age groups have so far been detected.

Our results are based on two independent and different samples and both indicate that the PCS-C in the German version is a reliable and valid instrument, thus, comparing well to the English and French versions of the scale. It measures a cognitive trait comprising hypersensitivity to aversive interoceptive stimuli, i.e. pain, and a tendency to appraise its features and consequences as negative and harmful, accompanied by a sense of helplessness when coping with the pain.

We suggest the use of the SKS-D total scale. The construction of a more economical instrument with fewer items can be foreseen with no impairment of reliability. Stable findings from different studies in different countries, including our own, suggest a moderate predictive power for the intensity of experienced pain and even the level of disability.

Thus, it seems a promising aim to therapeutically target the reduction of catastrophizing especially in children and adolescents with a distinct level of catastrophizing. A positive effect on pain and disability can be expected as a consequence of coping more effectively with this stressor, as preliminary results of a treatment study suggested [11].

Research studies should further deal with the interesting interrelations, including mediator or moderator effects, of the psychological variables studied here, like somato-

sensory amplification, anxiety sensitivity and internalising and maybe others, since they are apt to elucidate the processes associated with pain catastrophizing.

## Notes

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### Competing interests

The authors declare that they have no competing interests.

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## References

1. Achenbach TM. Manual for the Youth Self-Report and 1991 profile. Burlington: University of Vermont, Department of Psychiatry; 1991.
2. Barsky AJ, Goodson JD, Lane RS, Cleary PD. The amplification of somatic symptoms. *Psychosom Med.* 1988 Sep-Oct;50(5):510-9.
3. Blais MA, Otto MW, Zucker BG, McNally RJ, Schmidt NB, Fava M, Pollack MH. The anxiety sensitivity index: item analysis and suggestions for refinement. *J Pers Assess.* 2001 Oct;77(2):272-94. DOI: 10.1207/S15327752JPA7702\_10
4. Crombez G, Bijttebier P, Eccleston C, Mascagni T, Mertens G, Goubert L, Verstraeten K. The child version of the pain catastrophizing scale (PCS-C): a preliminary validation. *Pain.* 2003 Aug;104(3):639-46. DOI: 10.1016/S0304-3959(03)00121-0
5. Fuss S, Pagé G, Katz J. Persistent pain in a community-based sample of children and adolescents. *Pain Res Manag.* 2011 Sep-Oct;16(5):303-9.
6. Ghandour RM, Overpeck MD, Huang ZJ, Kogan MD, Scheidt PC. Headache, stomachache, backache, and morning fatigue among adolescent girls in the United States: associations with behavioral, sociodemographic, and environmental factors. *Arch Pediatr Adolesc Med.* 2004 Aug;158(8):797-803. DOI: 10.1001/archpedi.158.8.797
7. Hermann C, Hohmeister J, Zohsel K, Ebinger F, Flor H. The assessment of pain coping and pain-related cognitions in children and adolescents: current methods and further development. *J Pain.* 2007 Oct;8(10):802-13. DOI: 10.1016/j.jpain.2007.05.010
8. Hershey AD, Powers SW, Vockell AL, LeCates S, Kabbouche MA, Maynard MK. PedMIDAS: development of a questionnaire to assess disability of migraines in children. *Neurology.* 2001 Dec 11;57(11):2034-9. DOI: 10.1212/WNL.57.11.2034

9. Huguet A, Miró J. The severity of chronic pediatric pain: an epidemiological study. *J Pain*. 2008 Mar;9(3):226-36. DOI: 10.1016/j.jpain.2007.10.015
10. Jensen MP, Turner JA, Romano JM, Karoly P. Coping with chronic pain: a critical review of the literature. *Pain*. 1991 Dec;47(3):249-83. DOI: 10.1016/0304-3959(91)90216-K
11. Kröner-Herwig B, Denecke H. Die Behandlung von Kopfschmerz bei Kindern und Jugendlichen: Eine Praxisstudie. [The treatment of headache in children and adolescents: An effectiveness study]. *Verhaltensther Verhaltensmed*. 2007;28:373-85.
12. Kröner-Herwig B, Gassmann J. Headache disorders in children and adolescents: their association with psychological, behavioral, and socio-environmental factors. *Headache*. 2012 Oct;52(9):1387-401. DOI: 10.1111/j.1526-4610.2012.02210.x
13. Kröner-Herwig B, Gassmann J, van Gessel H, Vath N. Multiple pains in children and adolescents: a risk factor analysis in a longitudinal study. *J Pediatr Psychol*. 2011 May;36(4):420-32. DOI: 10.1093/jpepsy/jsq099
14. Kröner-Herwig B, Heinrich M, Morris L. Headache in German children and adolescents: a population-based epidemiological study. *Cephalalgia*. 2007 Jun;27(6):519-27. DOI: 10.1111/j.1468-2982.2007.01319.x
15. Kröner-Herwig B, Jäkle C, Frettlöh J, Peters K, Seemann H, Franz C, Basler HD. Predicting subjective disability in chronic pain patients. *Int J Behav Med*. 1996;3(1):30-41. DOI: 10.1207/s15327558ijbm0301\_3
16. Kröner-Herwig B, Morris L, Heinrich M. Biopsychosocial correlates of headache: what predicts pediatric headache occurrence? *Headache*. 2008 Apr;48(4):529-44. DOI: 10.1111/j.1526-4610.2007.00945.x
17. Larsson B, Sund AM. Emotional/behavioural, social correlates and one-year predictors of frequent pains among early adolescents: influences of pain characteristics. *Eur J Pain*. 2007 Jan;11(1):57-65. DOI: 10.1016/j.ejpain.2005.12.014
18. Lynch AM, Kashikar-Zuck S, Goldschneider KR, Jones BA. Sex and age differences in coping styles among children with chronic pain. *J Pain Symptom Manage*. 2007 Feb;33(2):208-16. DOI: 10.1016/j.jpainsymman.2006.07.014
19. Muris P, Meesters C, van den Hout A, Wessels S, Franken I, Rassin E. Personality and temperament correlates of pain catastrophizing in young adolescents. *Child Psychiatry Hum Dev*. 2007 Oct;38(3):171-81. DOI: 10.1007/s10578-007-0054-9
20. Powers SW, Gilman DK, Hershey AD. Headache and psychological functioning in children and adolescents. *Headache*. 2006 Oct;46(9):1404-15. DOI: 10.1111/j.1526-4610.2006.00583.x
21. Reid GJ, Gilbert CA, McGrath PJ. The Pain Coping Questionnaire: preliminary validation. *Pain*. 1998 May;76(1-2):83-96. DOI: 10.1016/S0304-3959(98)00029-3
22. Rosenstiel AK, Keefe FJ. The use of coping strategies in chronic low back pain patients: relationship to patient characteristics and current adjustment. *Pain*. 1983 Sep;17(1):33-44. DOI: 10.1016/0304-3959(83)90125-2
23. Stiensmeier-Pelster J, Schürmann M, Duda K. Depressions-Inventar für Kinder und Jugendliche (DIKJ): Handanweisung [The inventory of depression for children and adolescents: manual]. 2nd ed. Göttingen: Hogrefe; 2000.
24. Sullivan MJ, Bishop SR, Pivik J. The Pain Catastrophizing Scale: Development and validation. *Psychol Assess*. 1995 Dec;7(4):524-32. DOI: 10.1037/1040-3590.7.4.524
25. Sullivan MJ, Rodgers WM, Kirsch I. Catastrophizing, depression and expectancies for pain and emotional distress. *Pain*. 2001 Mar;91(1-2):147-54. DOI: 10.1016/S0304-3959(00)00430-9
26. Trautmann E, Kröner-Herwig B. A randomized controlled trial of Internet-based self-help training for recurrent headache in childhood and adolescence. *Behav Res Ther*. 2010 Jan;48(1):28-37. DOI: 10.1016/j.brat.2009.09.004
27. Tremblay I, Beaulieu Y, Bernier A, Crombez G, Laliberté S, Thibault P, Velly AM, Sullivan MJ. Pain Catastrophizing Scale for Francophone Adolescents: a preliminary validation. *Pain Res Manag*. 2008 Jan-Feb;13(1):19-24.
28. Tremblay I, Sullivan MJ. Attachment and pain outcomes in adolescents: the mediating role of pain catastrophizing and anxiety. *J Pain*. 2010 Feb;11(2):160-71. DOI: 10.1016/j.jpain.2009.06.015
29. Tsao JC, Allen LB, Evans S, Lu Q, Myers CD, Zeltzer LK. Anxiety sensitivity and catastrophizing: associations with pain and somatization in non-clinical children. *J Health Psychol*. 2009 Nov;14(8):1085-94. DOI: 10.1177/1359105309342306
30. Vervoort T, Eccleston C, Goubert L, Buysse A, Crombez G. Children's catastrophic thinking about their pain predicts pain and disability 6 months later. *Eur J Pain*. 2010 Jan;14(1):90-6. DOI: 10.1016/j.ejpain.2009.03.001
31. Vervoort T, Goubert L, Eccleston C, Bijttebier P, Crombez G. Catastrophic thinking about pain is independently associated with pain severity, disability, and somatic complaints in school children and children with chronic pain. *J Pediatr Psychol*. 2006 Aug;31(7):674-83. DOI: 10.1093/jpepsy/jsj059
32. Von Korff M, Ormel J, Keefe FJ, Dworkin SF. Grading the severity of chronic pain. *Pain*. 1992 Aug;50(2):133-49. DOI: 10.1016/0304-3959(92)90154-4
33. Vulić-Prtorić A, Galić S, Coha R, Grubić M, Lopižić J, Padelin P. Anxiety in children with headache. *Psychological Topics*. 2007;16:201-24.

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