

Anxiety sensitivity as predictor of pain in patients undergoing restorative dental procedures

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Abstract – Objectives: The personality disposition to anxiety sensitivity refers to beliefs about negative consequences of bodily arousal. The concept has recently been successfully applied in research on chronic pain conditions. The present study investigated whether anxiety sensitivity interacts with dental fear to increase expected and experienced pain during routine dental treatment.

Methods: Subjects were 97 patients undergoing dental procedures of excavation and filling. Anxiety dispositions were measured by the Anxiety Sensitivity Index and the Dental Anxiety Scale. Expected and experienced pain were assessed by affective and sensory verbal descriptor scales and a numerical rating scale measuring pain intensity. **Results:** Dentally fearful patients scoring high in anxiety sensitivity both expected and experienced more pain than low scorers did. Significant interactions were found predicting expected affective and intense pain and experienced pain intensity. **Conclusion:** The results lend support to the assumption that dentally fearful patients with a disposition to high anxiety sensitivity amplify pain anticipations when exposed to the critical situation. When dentally fearful patients are under treatment, their beliefs about negative consequences of bodily arousal may negatively influence their evaluation of treatment related pain.

Key words: acute pain; anxiety sensitivity; dental anxiety; dental treatment

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Pain discomfort is often reported by patients undergoing dental treatment even in routine restorative procedures (1, 2). In a population-based study 71% of respondents reported they had had a negative dental experience associated with pain, with 30% reporting three or more painful incidents (3). While these figures pertain to lifetime prevalence, 60% of respondents in a community sample indicated that their last dental visit had been painful (4). Additional evidence is reported in a longitudinal study finding 40% of respondents within a 5-year period who had experienced painful dental treatment (5). In explaining the results, it was suggested that not all anesthesia is successful. According to dentists' reports, anesthesia might fail in 5–15% of all cases (6, 7). Morphological conditions or physiological complications have been considered as reasons. However, the

anesthesia failure rate does not explain the much higher proportion of patients reporting pain.

Treatment episodes associated with pain contribute to the development of dental fear, and to irregular dental visiting behavior (3, 8). The report of previous painful treatment episodes has been found to be a predictor of pain experienced during later dental procedures within a 5-year follow-up (5). Thus, 'pain breeds pain', and a vicious circle develops, with painful experiences leading to postponing dental appointments. Irregular care prevents treatment of minor problems, which then leads to the need for stressful dental procedures involving a higher chance of painful stimulation.

While much effort has been put into improving anesthetic procedures and instrumental techniques, a new perspective considers the personality of the patients as a factor contributing to pain. An

extensive review (9) provides evidence of interrelations between anxiety and acute pain perceived in medical procedures. Patients suffering from pain experience physiological arousal similar to anxiety symptoms, with heart palpitations, sweating, muscle tension or rapid breathing (9). Melzack (10) presented a neuromatrix model suggesting interaction between the biological systems of stress response and pain perception.

A theory by Reiss (11) proposes that danger expectancy and sensitivity toward fear predispose people to acquire anxiety disorders. It has been demonstrated that the anticipation of treatment catastrophes (expected danger) is related to general dental fear and acute anxiety in dental procedures (12). Anxiety sensitivity refers to beliefs that anxiety-related symptoms might cause physical, cognitive, or social harm. It is considered a vulnerability factor for the development of anxiety disorders (13). In a population-based study, dentally anxious individuals indicated an elevated level of anxiety sensitivity within the range found in agoraphobic patients (14).

A recent line of research investigates interrelations between anxiety sensitivity and pain. Agoraphobic patients (characterized by high anxiety sensitivity) were found to suffer from multiple pain experiences localized in various body areas (15). In chronic pain, patients' anxiety sensitivity was associated with fearful appraisals of pain, physiological symptoms, pain-related negative affect, and with analgesic consumption (16–18). Experimental studies using a cold pressor task demonstrated that anxiety sensitivity predicted pain intensity (19) and affective and sensory qualities of pain (20, 21). Interestingly, the analgesic effect of caffeine was suppressed in females reporting high anxiety sensitivity (22). A rationale for these findings is that physiological arousal caused by pain is similar to that provoked by anxious alarming states. Thus, persons might expect harm not from pain per se but from accompanying anxiety-like symptoms. A study of university students found support for the hypothesis that anxiety sensitivity might sensitize for the experience of pain. Respondents indicating high anxiety sensitivity reported more previous painful dental episodes than participants with low anxiety sensitivity did (23).

Anxiety sensitivity in chronic pain conditions has been shown to be associated with avoidance of potentially harmful stimuli (18). This finding is explained by strong expectancies of pain in anxiety

sensitive individuals. Anticipation of pain in dental procedures is one topic addressed in the present study. It has to be kept in mind that pain is a multidimensional experience including various qualities originating in different brain areas, specifically pain intensity, and sensory and affective pain. To date, most studies of dental pain relied only on the assessment of pain intensity measures using visual analog scales. It is of interest to include measures of the affective and the sensory aspect as well (24). A second consideration has also to be taken into account. It was suggested that studies investigating the impact of personality dispositions on dental distress should use homogeneous samples with respect to dental fear (25). In this context, it has been demonstrated that dentally anxious subjects report more pain in response to electric tooth shock than persons without dental fear (26, 27).

Extensive research provided evidence that anxiety and the experience of acute pain are interrelated (9). These results suggest that anxiety sensitivity, as a predisposition for amplifying anxious response, will predict the experience of acute pain during dental treatment. The present study aims to investigate the extent to which anxiety sensitivity increases expected and experienced pain before and during dental treatment in patients with different levels of dental fear.

Material and methods

Sample and study procedure

Six general dental practitioners located in or near Mainz, Germany, cooperated in this study. Each dentist referred a consecutive series of patients for participation. Inclusion criteria for the study sample were comprehension of the German language, age between 14 and 65, and restorative treatment. Nine subjects of this group refused to participate, and seven questionnaires were excluded because of incomplete data. A total of 90 patients, whose mean age was 30.1 (SD = 11.8), were included in the study. Forty participants were male and 50 female. Nineteen percent of the patients had received only elementary formal education, 34% had finished junior high school, and 47% senior high school.

After giving their informed consent, dental patients awaiting treatment answered questionnaires relating to anxiety sensitivity, dental trait anxiety, and expected pain. The second measurement time point was after treatment had been finished, when subjects rated their just-experienced

pain. All had received restorative treatment including excavation and filling. The treated teeth were incisors in 22% of the subjects, canines in 16%, premolars in 31%, and molars in 31%. All patients were asked if they wanted to have local anesthesia and 70% of them agreed.

Measures

The following instruments were included in the study.

Anxiety Sensitivity Index

The Questionnaire by Reiss et al. (13) comprises 16 items pertaining to beliefs about physical, cognitive, and social harm resulting from anxiety-related symptoms. Example items are: 'When I notice that my heart is beating rapidly, I worry that I might have a heart attack' (physical), and 'When I cannot keep my mind on a task, I worry that I might be going crazy' (cognitive), or 'Other people notice when I feel shaky' (social harm). The Likert scale answering format ranged from 0 (not at all) to 4 (exactly). Sum scores ranged from 0 to 64. The Anxiety Sensitivity Index (ASI) is a widely used measure in anxiety research with good test qualities (28). Reliability in this study according to Cronbach's alpha was 0.90.

Dental Anxiety Scale

The Corah questionnaire (29) asks patients to indicate their degree of anxiety in four dental treatment-related situations using a five-point scale. The sum scores ranged from 4 to 20. The Dental Anxiety Scale (DAS) is the most frequently applied measure in studies on dental anxiety (24). Cronbach's alpha in this study was 0.85.

Affective Pain Scale

Respondents are requested to indicate their endorsement of five affective pain descriptors (e.g. awful, unbearable) on a four-point Likert scale ranging from 'not at all' (= 1) to 'exactly' (= 4). The sum score range was from 5 to 20. The Affective Pain Scale (APS) is part of the Geissner's Pain Experience Scale (30), which has been developed from the McGill Pain Questionnaire and is recommended for research in dentistry (24). The present study included the five items most frequently endorsed by dental patients in previous research (31). Reliability for APS in the present study was Cronbach's alpha = 0.84.

Sensory Pain Scale

This scale includes five sensory pain adjectives. The answering format is identical to that of the APS

with sum scores ranging from 5 to 20. Four items describe invasive pain qualities (e.g. tugging, piercing), and one item pertains to thermal sensation (hot), which is often reported in drilling procedures. The items are part of the Pain Experience Scale (30) and were selected based on endorsement by dental patients in the cited study (31). Cronbach's alpha for Sensory Pain Scale (SPS) in the present study was 0.71.

Numerical Pain Rating

Patients rated the intensity of pain on a 120 mm horizontal line with decimal points ranging from 0% to 100%. Verbal anchors were 'no pain at all' (0%) and 'worst pain imaginable' (100%).

All three pain measures were presented in two forms relating to expected pain and experienced pain during the dental procedure.

Treatment Distress Rating (TDR)

After completion of treatment, dentists rated the distress caused to the patient by the dental procedure from the medical point of view. The answering format was the same as in the Numerical Pain Rating (NPR). Zero percent was defined as 'no distress at all', and 100% as the 'worst distress possible'.

Statistical analyses

The SPSS statistical software was used in all statistical analyses. Using a median split applied to the DAS, patients were separated into subgroups with low and with high dental fear. The mean value of the DAS in this sample was 9.43 (SD = 2.88). The median split point of the DAS was a value of 9. The median split procedure was also applied to the ASI to subdivide subjects into those with high and those with low anxiety sensitivity. The sample mean of the ASI was 16.45 (SD = 10.24). The median of the ASI was 14.

Two-way ANOVA were applied to compare high and low anxiety sensitive patients and the high and low dental fear subgroups and to determine the interaction between the two independent factors on pain *anticipation*. An ANOVA is an analysis of the variation in the outcomes of an experiment to assess the contribution of each variable to the variation. To investigate effects on pain *experience*, two-way ANCOVAs were applied. Treatment distress rating (TDR) was the covariate to control for the influence of dental procedure invasiveness on experienced pain.

Results

Descriptive statistics of the DAS and ASI within the sample subgroups were as follows: DAS scores showed a mean of 7.29 (SD = 1.45) for the 48 subjects in the low dental fear group. A mean of 11.88 (SD = 2.02) was found for the 42 highly dental fearful patients. The ASI median split the sample evenly, with 45 scoring a mean of 8.64 (SD = 3.44) in the low anxiety sensitivity group, and the 45 high anxiety sensitivity patients scoring a mean of 24.62 (SD = 8.69). These findings for the two groups conform with normal distribution ($Z = 0.87$, $P = 0.42$ and $Z = 0.96$, $P = 0.31$) as established by the Kolmogorov–Smirnov test.

The correlation between anxiety sensitivity and dental anxiety – as measured by ASI and DAS respectively – was $r = 0.27$ ($P = 0.008$). Within the 48 subjects with low dental anxiety, 25 were low and 23 high ASI scorers. Among the 42 subjects with high dental anxiety, 20 belonged to those with low and 22 to those with high anxiety sensitivity. A comparison of these four groups using the chi-square test found the patients to be equally distributed under all four conditions ($\chi^2 = 0.179$, $P = 0.673$).

To ascertain whether patients differed in experienced discomfort depending on the type of tooth being treated, preliminary ANOVAs were conducted. They compared experienced affective (APS), sensory (SPS), and intense pain (NPR) and TDR in subjects undergoing restorative procedures in incisors, canines, premolars, and molars. No differences in the four dependent measures were found among types of tooth being restored. Patients under local anesthesia, compared with those without it (using t -tests), were found not to differ in pain experience measures and TDR. Therefore,

subsequent analyses did not further consider the teeth involved or anesthesia given.

Anticipation of pain before treatment

As shown in Table 1, subjects indicating high anxiety sensitivity expected more affective (APS) and sensory pain (SPS), and stronger pain intensity (NPR), than ASI-low scorers. Patients scoring high in the DAS indicated stronger anticipation of both affective pain and pain intensity. Two significant interactions were found. The effect of anxiety sensitivity on expected affective pain and on pain intensity was stronger in dentally fearful patients. Planned contrasts demonstrated that high anxiety-sensitive patients within the subgroup of elevated dental fear expected more affective pain, as per APS ($t = 2.80$), and pain intensity, as per NPR ($t = 3.29$, both $P < 0.01$), than their low anxiety-sensitive counterparts. Within the low dental fear group, however, no significant differences were found. A statistical trend for a DAS by ASI interaction was indicated in expected sensory pain ($P = 0.06$). Calculating planned contrasts, the difference between low and highly anxiety-sensitive patients was only significant in highly fearful patients ($t = 2.84$, $P < 0.01$).

Experience of pain during treatment

The results presented in Table 2 demonstrate that highly anxiety-sensitive patients experienced more pain, as indicated by all three measures, than ASI-low scorers did. Patients with high dental fear experienced more affective pain and higher pain intensity than their counterparts. The interaction between DAS and the ASI proved to be significant with the NPR. This interaction indicates that the effect of anxiety sensitivity on pain intensity was stronger in the DAS-high group than in the DAS-low group. Analyses of contrast revealed that the

Table 1. Mean (SD) scores of expected pain (APS, SPS and NPR) for patients with high versus low anxiety sensitivity (ASI) and high versus low dental anxiety (DAS)

	DAS	Anxiety Sensitivity Index (ASI)				F-value		
		Low		High		ASI	DAS	DAS by ASI
Expected pain		M	SD	M	SD			
Affective (APS)	Low	6.36	1.62	6.43	1.50	7.34**	18.89***	6.59*
	High	7.30	2.84	10.09	3.58			
Sensory (SPS)	Low	6.52	1.63	6.91	1.78	7.78**	3.81	3.54
	High	6.55	1.79	8.54	2.70			
Intensity (NPR)	Low	26.40	19.33	23.91	15.88	4.45*	12.78**	7.33**
	High	30.00	22.00	50.00	21.15			

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

Table 2. Mean (SD) scores of experienced pain (APS, SPS and NPR) for patients with high versus low anxiety sensitivity (ASI) and high versus low dental anxiety (DAS) controlling for treatment distress (TDR)

Expected pain	DAS	Anxiety Sensitivity Index (ASI)				F-value		
		Low		High		ASI	DAS	DAS by ASI
		M	SD	M	SD			
Affective (APS)	Low	5.72	0.89	6.52	1.80	14.40***	9.15**	3.56
	High	6.30	2.49	9.22	4.31			
Sensory (SPS)	Low	5.96	1.42	6.82	2.51	10.24**	0.20	1.28
	High	5.65	1.22	7.63	3.06			
Intensity (NPR)	Low	23.60	19.76	23.04	17.17	9.96**	0.82	8.15**
	High	16.00	18.46	39.55	27.16			

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

difference between high and low anxiety-sensitive patients was significant only among DAS-high scorers ($t = 4.08$, $P < 0.001$). A similar statistical trend for an interaction was found for the experienced affective quality of pain with an error probability of 0.06. Planned contrasts showed that the difference in affective pain experienced between ASI-high and low scorers was significant within the elevated dental fear group ($t = 3.89$, $P < 0.001$), but not within low fear patients. Furthermore, highly anxiety-sensitive patients experienced more sensory pain only within the elevated dental fear group ($t = 2.96$, $P < 0.01$).

Discussion

In such restorative dental treatment as the familiar excavation and filling procedures, patient-reported discomfort is usually lower than in more invasive procedures like tooth extraction, root canal treatment, or periodontal surgery (1–3). In the present study, experienced pain was substantial overall, with a mean value of 30 on a scale ranging from 0 to 100. This finding lends support to the assumption that routine dental treatment is not pain-free (3).

The patients investigated for dental anxiety had a mean DAS score of 9.34 (SD = 2.88). This corresponds to mean values reported in different studies (32) and may indicate that the patient sample is representative of the general population. The ASI mean was 16.45 (SD = 10.24), slightly above the mean of 15.2 found in patients with chronic intractable pain (33). It may be concluded that subjects in this sample are representative for patients in medical settings (28).

Investigating pain anticipation before dental procedures, this study found that patients with

elevated compared to low anxiety sensitivity expected more pain in all three measures (APS, SPS, NPR). These effects were found mainly in patients with high dental fear. Within this subgroup patients with elevated compared to low anxiety sensitivity differed significantly in all the measures of pain anticipation. Whereas within low DAS scorers no significant differences were found. It was hypothesized that the impact of anxiety sensitivity on pain anticipation may be different in patients with high and low levels of dental fear. This assumption was substantiated by significant interaction in affective and intense pain and a strong statistical trend in sensory pain expectation. It may be concluded that patients with elevated anxiety sensitivity are especially prone to exaggerated pain expectations when the anticipated challenge situation is perceived as fear relevant.

Overestimation of pain has been conceived as a factor contributing to chronic pain development (34). Amplified pain expectancy may cause patients to avoid confrontation with the stressor. Thus they have no chance to disconfirm or calibrate their expectations by comparing them to actual experience. In chronic pain conditions, anxiety sensitivity was related to fear of pain, which in turn predicted avoidance of situations anticipated as painful (18). Patients awaiting dental treatment may consider escape impossible or difficult to manage. It would be of interest for further research to investigate whether anxiety sensitivity is related to dental avoidance, such as postponing or canceling appointments. The present results corroborate findings on the role of anxiety sensitivity in research on chronic pain and extend them to the domain of pain anticipation in dental procedures.

With regard to pain experienced during dental treatment, the present study found that patients with elevated anxiety sensitivity reported more

affective, sensory, and intense pain. As indicated by the *F*-values, the effects were even stronger than those found in anticipation of pain. It may be assumed that the experience of bodily arousal during treatment activates fear of bodily symptoms leading to amplified pain perception. Because of slight effects in the low dental fear group, the interaction between ASI and DAS proved not to be significant in sensory pain. In affective pain experience it was within the range of a statistical tendency. A significant interaction was found in pain intensity. Thus the interaction hypothesis was only partially supported. Analyses of contrast, however, showed that anxiety sensitivity increased pain perception in all three measures under the condition of high dental fear, but not under the low fear condition. Overall, it might be concluded that patients with elevated anxiety sensitivity and dental fear are especially inclined to amplify experienced pain intensity. Experimental studies have found relationships between anxiety sensitivity and pain report (19–22). The present study confirms these results within the clinical context of dental treatment.

The effects of anxiety sensitivity on pain report were strongest in affective pain. Previous studies found equivocal results with regard to impacts of anxiety sensitivity on different pain qualities. A significant association between anxiety sensitivity and sensory but not affective pain has been reported (35). Research using a cold pressor task showed anxiety sensitivity had an effect on sensory pain only (20). In a subsequent study, high anxiety sensitive subjects reported more affective pain than their low anxiety-sensitive counterparts (22) did. In a further study, however, anxiety sensitivity had a significant impact on both sensory and affective pain. Its effect on affective pain was stronger than on sensory pain (21). It would be of interest to investigate under what conditions which quality of pain may be primarily affected by a personality disposition to anxiety sensitivity.

Several methodical considerations have to be taken into account in interpreting the results of the study. First, it could be argued that ASI and DAS might be indicator variables of a latent construct related to anxiety. Combining both indicators would result in a more precise test of the difference between groups by reduction of measurement error. However, although statistically significant, the common variance shared by DAS and ASI was only 7% ($r = 0.27$). This seems to be too low to warrant regarding both measures as indicators of a

common latent factor. Secondly, dichotomizing the independent variables of dental trait anxiety and anxiety sensitivity corresponds to a loss of information compared with using continuous predictors. On the contrary, dichotomization has the advantages of robustness to outliers and accommodation to nonmonotonic relations (36). Moreover, it may reduce bias due to measurement error (37). Median split cut off points have been used to attain approximately equal cell counts of sufficient sizes. They proved to be sensitive for exposure–response relationships. Large-scale studies are needed for exploring alternative thresholds (38). Thirdly, it may be objected that the ASI findings are not specific to patients with high DAS scores, as other fear and anxiety measures have not been examined additionally. This question should be investigated in further research applying instruments to assess fear involved in other types of medical procedures. Finally, the results are confined to patients with subclinical dental fear and anxiety sensitivity. They might not be generalized to subjects with dental phobia completely avoiding dental services. Investigating the role of anxiety sensitivity in dental phobic patients should be a topic for further research.

Methodological limitations notwithstanding, the findings of the present study are the first to suggest that anxiety sensitivity predicts anticipation and experience of pain in dental procedures. Experimental findings on the impact of anxiety sensitivity on pain perception during pain challenge procedures (19–22) were supported within the context of clinical treatment. The results might explain why patients do not change their appraisal of dental treatment as painful, although progress has been made in instrumentation and anesthesia (1–6). Further studies are needed for replication.

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