Attentional Avoidance of Negative Experiences as Predictor of Postoperative Pain Ratings and Consumption of Analgesics: Comparison with Other Psychological Predictors

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Abstract

Objective. Attentional avoidance of negative stimuli and preference for positive stimuli (assessed prior to surgery) have been found to be predictive of postoperative pain. However, findings so far were mainly obtained in young patients with benign diagnoses. The aim of the present study was to test whether this relationship holds for aged patients with poorer prognosis.

Design. Preoperatively assessed psychological predictors, including attentional measures for emotionally loaded stimuli, among others, were used to predict acute postoperative pain as indicated by rating and consumption of analgesics.

Patients. Fifty-eight patients scheduled for surgery due to cancer (89%) with a mean age of 63.5 years participated in the study.

Outcome Measures. As predictors attentional biases for pain-related, social threat, and positive stimuli were assessed in a dot-probe task. Further predictors were self-reported pain vigilance, pain anxiety, pain catastrophizing, general anxiety, depression, and somatization, as well as pressure pain thresholds. As criteria of prediction, numerical scale ratings of acute postoperative pain and the amount of analgesics (patient-controlled intravenous analgesia (PCIA)) requested after surgery were used.

Results. Only the dot-probe task parameters provided significant explanation of acute postoperative pain. A significant 23% of variance of the PCIA use was accounted for by the dot-probe task parameters. Here, it was mainly the avoidance of social threat words which contributed to significant prediction and did not appear to be related to the other psychological predictors. Seventy-seven percent of the patients with frequent PCIA use could be classified correctly by this variable.

Conclusions. Attentional avoidance of emotionally negative stimuli prior to surgery proved to be a powerful predictor of acute postoperative pain reflected by the consumption of analgesics; this time in a sample of aged patients with various but mainly malignant diagnoses. This measure outperformed traditional predictors like depression, anxiety, as well as pain catastrophizing, and deserves further attention.

Key Words. Attention; Postoperative Pain; Psychological Predictor

Introduction

Postoperative pain, in its acute form, is an unavoidable aspect of surgery, which requires intensive analgesic treatment. Although management of acute postoperative pain has become largely efficient, outcome is still variable between patients. In cases of similar tissue lesions, some patients report high levels of acute pain despite reasonable dosage of analgesics whereas other patients are not [1]. Better prediction of the short-term course of postoperative pain would not only allow for more efficient management of postoperative pain but would also enrich our understanding of the multiple factors involved in pain genesis. Alongside somatic factors, psychological factors have also been shown to contribute significantly to postoperative pain [2,3]. When reviewing those psychological factors, that have been examined so far, it become apparent that major emphasis has been placed on measures that are based on self-awareness and self-report. For example, self-rated depression, anxiety, neuroticism, and pain catastrophizing have commonly been studied [2,3].
However, research on "hypervigilance," which has been named a critical candidate as regards the explanation of development of chronic pain [4], has led to a recent change in the research focus by also considering implicit information processing beyond the conscious accessibility to self-report. Hypervigilance is defined as the repetitive and automatic attentional prioritization of pain, with the original function of escape and avoidance from physical threat but with maladaptive consequences on the long run. Attention tests like the visual dot-probe task [5] and the emotional Stroop paradigm [6] have been developed to assess these implicit and unconscious attentional processes. These tests also allow for the assessment of the opposite of hypervigilance, namely attentional avoidance, which may occur when pain or threat-related stimuli are feared and, by that, already unconsciously avoided.

In two studies of the authors, dot-probe task parameters have appeared to be significant predictors of acute and chronic forms of postoperative pain [7,8], once in the form of attentional avoidance of pain-related stimuli and once in the form of attentional preference for positive stimuli. Accordingly, the common denominator in both previous studies (investigating young male subjects undergoing cosmetic surgery) was an attentional bias away from emotionally negative stimuli toward positive stimuli, which significantly predicted postoperative pain. Such a relationship has also been found by other research groups. For example, Munro and Stevenson [9], who were the first to predict postoperative pain due to minor gynecological surgical procedures by a selective processing task (modified Stroop test) using an implicit measure of attention, reported similar findings.

Now, it seems necessary to expand the data base as replication and to include patients with different types of surgery as well as with different somatic and psychological conditions. Therefore, the major aim of the present study was to assess attentional biases toward emotionally negative and positive stimuli in adult patients with indications for surgery due to malignant diseases. We hoped to prove the predictive power of our dot-probe task parameters for acute postoperative pain and in comparison with psychosocial predictors, namely self-reported pain catastrophizing, pain vigilance, pain anxiety, general anxiety depression, and somatization parameters, which have been used in the past with some success [2,3]. In addition, a pressure pain threshold was entered into our predictor analysis. We tested the predictive value of these variables for prognosis of acute postoperative pain 24 hours after surgery, reflected by numerical pain ratings and the use of patient-controlled analgesia (PCA). With PCA analgesia, the analgesic demand is the measure of pain, which is an indirect but clinically relevant approach [10].

Materials and Methods

Subjects

Fifty-eight patients (10 women, 48 men) with a mean age of 60.5 years (standard deviation = 9.4 years) participated in the present study. Subjects were recruited among inpatients of the Hospital am Bruderwald (Bamberg, Germany) and were presented with mixed instrumental tasks for surgery (see Table 1) with a clear preponderance of cancer. Types of surgery were: major abdominal operations (n = 18), hepatic surgery (n = 2), pancreatic surgery (n = 2), and cholecystectomy (n = 3). All patients were operated on for tumor excisionation, and in total 13 patients received a regular i.v. replacement. Patients diagnosed with chronic pain or taking pain medication or co-analgesics including gabapentin, pregabalin, or any type of antiepileptics or antidepressants on a regular basis were excluded. The occasional intake of anesthetics did not lead to exclusion. In the days before surgery, patients took medication for cardiovascular diseases (44.8%), metabolic diseases (18.0%), urological diseases (6.9%), anesthetics (5.8%), and medication for other diseases (10.2%). Multiple medications were taken by 24.1%. The perioperative protocol for anesthetics and analgesia is detailed under the section "Assessment of the criterion variables."

The present study was approved by the ethics committee of the Medical Faculty of the University of Erlangen. All participants gave written informed consent.

Materials and Procedure

In order to assess the psychological predictor variables, a test session took place in the afternoon of the day before
The reasons, which lasted for approximately 90 minutes, included running the dot-probe task, filling out questionnaires (pain catastrophizing, pain-related anxiety and pain vigilance), assessment of pressure pain thresholds, and again filling out questionnaires (general anxiety, depression, somatization). Still in the recovery room after surgery, numerical scale ratings (NRS, see below) for pain were recorded every 30 minutes and every 30 minutes after each paravertebral drug administration. Patients were transferred to the normal ward when the Addiction score was 11 or higher [11] and when pain was rated 3 or over on the NRS. Acute postoperative pain was assessed by the mean of NRS ratings in the first hours after surgery (recovery room). Furthermore, the amount of requested analgesics (POIA) was evaluated during the first 2 days after surgery. Table 2 gives an overview about all predictor and criterion variables assessed.

### Assessment of the Predictor Variables

Predictor variables were grouped for theoretical reasons into four categories: 1) attentional biases toward emotionally loaded words (dot-probe task); 2) self-report on pain-related emotions and cognitions (pain catastrophizing, pain-related anxiety, pain vigilance); 3) pressure pain thresholds; and 4) self-report on emotional and bodily distress (general anxiety, depression, somatization). During the test session these categories were determined in this order and are described below.

#### Attentional Biases Toward Emotionally Loaded Words (Dot-Probe Task)

Attentional biases toward emotionally loaded words were assessed via the dot-probe task described by Koogh et al. [5]. It contains three emotional word categories: pain-related (e.g., stochendolingen), social threat (e.g., beschaam of schaam), and positive words (e.g., glad, blij, happy). These words are paired with neutral words (Andrich/pointwork), neutral-neutral word pairs served as filler items. We translated the words of the original version by Koogh et al. [5] into German, as not all words fulfilled the criteria of being similar in length and frequency of use, a series of words had to be replaced. In a pilot study, it was tested whether each word of the new list (containing more items than necessary) was representative for the designated word category. If this was not the case, these words were excluded from the final use in the dot-probe task.

Following Koogh et al. [5], a fixation cross was presented in the center of a computer screen for 500 ms. Then, two words (a neutral one paired with an emotional one) were presented, one below and one above the fixation cross for another 500 ms. After this, a dot appeared at the location of one of the two words. Subjects were required to indicate as quickly as possible, by pressing one of two keys (below, above), where the dot had appeared. Reaction time was measured. After 20 practice trials, participants had to complete 120 test trials (32 trials per word-center category), all of which were presented in a random order by the computer. Bias indices were calculated on the basis of reaction times to assess separately the attentional bias toward each emotional word category (for more details, see Koogh et al. [5]). A positive score indicates an attentional preference for the location of the emotional word, which may suggest vigilance, whereas a negative score may suggest avoidance.

### Table 2: Basics statistics of all predictor and criterion variables

<table>
<thead>
<tr>
<th></th>
<th>Male Mean (SD)</th>
<th>Female Mean (SD)</th>
<th>T</th>
<th>p</th>
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<tbody>
<tr>
<td><strong>Age (years)</strong></td>
<td>60.53 (9.74)</td>
<td>60.44 (9.53)</td>
<td>0.16</td>
<td>0.870</td>
</tr>
<tr>
<td><strong>Predictor variables</strong></td>
<td></td>
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<tr>
<td>Attention bias</td>
<td>7.90 (77.33)</td>
<td>3.79 (55.78)</td>
<td>-0.58</td>
<td>0.560</td>
</tr>
<tr>
<td>Attentional bias social threat</td>
<td>0.38 (53.40)</td>
<td>0.64 (48.09)</td>
<td>-0.06</td>
<td>0.943</td>
</tr>
<tr>
<td>Attentional bias positive</td>
<td>2.43 (44.77)</td>
<td>1.21 (41.74)</td>
<td>0.45</td>
<td>0.657</td>
</tr>
<tr>
<td>PASS</td>
<td>84.18 (37.76)</td>
<td>83.67 (35.93)</td>
<td>0.21</td>
<td>0.838</td>
</tr>
<tr>
<td>PCS</td>
<td>19.38 (10.27)</td>
<td>19.50 (10.46)</td>
<td>0.19</td>
<td>0.846</td>
</tr>
<tr>
<td>PVAQ</td>
<td>39.95 (19.98)</td>
<td>40.42 (13.87)</td>
<td>0.53</td>
<td>0.596</td>
</tr>
<tr>
<td>STAI state</td>
<td>44.79 (11.64)</td>
<td>42.66 (11.31)</td>
<td>2.96</td>
<td>0.004</td>
</tr>
<tr>
<td>GOMS</td>
<td>14.59 (14.91)</td>
<td>13.00 (11.47)</td>
<td>1.02</td>
<td>0.317</td>
</tr>
<tr>
<td>CES-D</td>
<td>16.88 (9.36)</td>
<td>15.86 (6.54)</td>
<td>-1.72</td>
<td>0.084</td>
</tr>
<tr>
<td>Pressure pain threshold</td>
<td>448.57 (237.33)</td>
<td>481.23 (245.17)</td>
<td>4.11</td>
<td>0.001</td>
</tr>
<tr>
<td><strong>Criterium variables</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>NRS (postoperative pain)</td>
<td>3.59 (2.70)</td>
<td>3.61 (2.66)</td>
<td>0.11</td>
<td>0.909</td>
</tr>
<tr>
<td>POIA (pentamid mg)</td>
<td>81.71 (60.67)</td>
<td>81.29 (63.12)</td>
<td>-0.12</td>
<td>0.905</td>
</tr>
</tbody>
</table>

SD = standard deviation; PASS = Pain Anxiety and Symptom Scale; PCS = Pain Catastrophizing Scale; PVAQ = Pain Vigilance and Awareness Questionnaire; STAI = State-Trait Anxiety Inventory; GOMS = Screening for Somatoform Symptoms; CES-D = Center for Epidemiologic Studies Depression Scale; NRS = numerical rating scale; POIA = patient-controlled intravenous analgesia.
Self-Report of Pain-Related Emotions and Cognitions. We used to assess pain-related emotions and cognitions using three questionnaires, namely the Pain Catastrophizing Scale (PCS [12]), the Pain Anxiety Symptom Scale (PASS [13]) and the Pain Vigilance and Awareness Questionnaire (PVAQ [14]).

The PCS [12] was developed as a measure of catastrophizing related to pain. It contains 13 items that can be divided into three subcales, namely rumination, magnification, and helplessness. The items are rated on a 5-point scale. For further analyses, we used the combined sum score of the PCS.

The PASS [13] is composed of four subscales: cognitive anxiety, escape/avoidance, behavioral appraisal, and physiological anxiety, and is designed to measure pain anxiety across cognitive, behavioral, and physiological domains. The items are rated on a 6-point scale. For further analyses, we used the combined sum score (40 items) of the PASS.

The PVAQ [14] was developed as a comprehensive measure of attention to pain and has been validated for use in chronic pain and nonclinical samples [15]. It consists of 16 items that are rated on a 6-point scale and which assess awareness, vigilance, preoccupation, and observation of pain. For further analyses, we used the combined sum score of the PVAQ.

With the exception of the PASS, which had been translated into German and validated by Weiller et al. [16], we had to translate the other two questionnaires into German, using a standard "forward-backward" procedure. Only if the resulting back translated English version was very similar to the original version according to the evaluation of an English native speaker, translation accuracy was considered sufficient. The interrater-reliability of the three German questionnaires ranged between $r = 0.532$ and $r = 0.741$, which is in accordance with intercorrelations reported in the literature for English and Dutch versions [17-20].

Pressure Pain Thresholds. The assessment of pressure pain threshold was performed using a handheld pressure algometer (Algo II, Somedic Sales AB, Hörby, Sweden) with a probe area of 1 cm². Site of stimulation was the solar site of the right forearm. The pressure was increased from 0 kPa at a rate of change of 50 kPa/s until the subject felt the first pain sensation and pressed a button. There were five trials and the threshold was determined as the average of these trials.

Self-Report on Emotional and Bodily Distress. Emotional and bodily distress was assessed with three different questionnaires, namely the German versions of the Screening for Somatization Symptoms (SOCS [21]), the German version of the State Anxiety Inventory (STAI state [22]), and the German version of the Center for Epidemiological Studies Depression Scale (CES-D, German version: ADS [28]).

The SOCS [21] is a self-report scale, which assesses 53 organically unexplained physical symptoms. The shorter version of the SOCS was applied where subjects are asked to rate the intensity of each symptom and the extent of interference with well-being during the last 7 days on a 5-point Likert scale. For further analyses, we used the sum of all items ("somatization severity index").

The STAI state [22] is a self-report scale and contains 20 items that were designed to measure short-term anxiety states—i.e., subjective feelings of apprehension, tension, and worry that vary in intensity and fluctuate based on the situation. Items are rated on a 4-point rating scale.

The CES-D [23] is a self-report scale that was designed to assess emotional, somatic and cognitive symptoms of depressive mood during the last week. It contains 20 items that are rated on a 4-point Likert scale.

Assessment of the Criterion Variables.

As criterion variables, we assessed patients' self-report ratings of postoperative pain as well as their requests of analgesics (PCA).

Self-Report of Postoperative Pain. In the recovery room a few hours after surgery, patients were asked in intervals of 30 minutes and 30 minutes after each intravenous drug administration to rate the intensity of their current pain on an 11-point numerical rating scale (NRS). As the stay in the recovery room was variable in length, the number of ratings obtained was individually variable too. The NRS is labeled with the verbal anchors "no pain" and "worst pain imaginable." The mean of the NRS ratings was entered into further analyses.

PCA. For a better understanding of the PCA procedure, the general protocol of anaesthesia and analgesia is given first. Patients received a thoracic epidural catheter before induction of general anaesthesia. The patient was in a sitting position and puncture of the epidural space was performed at Th/L7 with an 18-gauge needle (Tuohy, B. Braun Melsungen AG, 34200 Melsungen, Germany). After identification of the epidural space with the loss of resistance technique the epidural catheter was inserted and a test dose of 3-4 mL ropivacaine (0.5%) was injected. If no signs of spinal anaesthesia were observed after 5 minutes general anaesthesia was induced by intravenous injection of sufentanil (10 µg), thiopental (5-7 mg/kg), and disopropylbromethane (0-10 mg/kg) followed by tracheal intubation. General anaesthesia was maintained with the intravenous anaesthetic isoflurane or by intravenous propofol infusion (propofol 1%, 6-12 mL/h). After induction of general anaesthesia 4-8 mL of a mixture containing 8 mL ropivacaine 0.5% plus 10 µg sufentanil (2 mL, Sufentanil 5 µg/mL) was injected epidurally. During surgery epidural top-ups of 2-4 mL of the mixture were given every hour.

Postoperatively, epidural analgesia was achieved during the first hours by continuous infusion of 0.128%
In addition, the patients were instructed to use a PCA pump. Phentomid boluses of 2 mg (1 mL) could be requested at a lock-out interval of 10 minutes with a 1 hour maximum of 15 mg, a 4-hour maximum of 30 mg and a 24-hour maximum of 60 mg. The patients were instructed to use the pump in a way that prevents higher ratings than 3 on the NRS. The readouts over 48 hours were recorded. The variable of interest was the requested dosage of phentomid over this period.

**Statistical Analysis**

In case of missing data the patient was not completely excluded from evaluation but only from the analysis containing missing data.

The predictive power of the four categories of predictors, attentional biases toward emotionally loaded words (dot-probe task), self-report on pain-related emotions and cognitions, pressure pain thresholds as well as self-report on emotional and anxiety distress was evaluated separately for each category by a separate regression analysis. As we predicted, two criterion variables, namely NRS and PCA, separately, eight regression analyses in total were run and presented in Table 3. Multivariate $R^2$ and univariate $\beta$ coefficients were used for description of the goodness of prediction and tested for significance. As the clinically oriented reader might be especially interested in the diagnostic accuracy as regards the postoperative pain outcome, we defined good and poor outcome groups.

A first analysis only patients scoring below the first and above the third quartile in NRS and PCA were classified as poor and good outcome; this analysis contained mainly the definite cases and set by that, the easier classification task. In a second analysis all patients were grouped by median split of the NRS and PCA scores; this analysis included also the questionable cases and set the more difficult classification task. Thereafter, we computed the classification rates for the two outcome groups (poor vs. good), which could be obtained by use of our predictors (see Table 3).

For description of simple relationships, Pearson’s correlation coefficients were computed. For comparisons between males and female $t$ tests for independent samples were used.

Findings were considered to be statistically significant at $p < 0.05$.

**Results**

**Clinical Characteristics of the Patients**

Descriptive statistics as regards the predictor and criterion variables are given in Table 2. A few findings are worth mentioning here.

Although beyond the scope of the present study, the known sex differences in state anxiety (STAI state) (higher in females) and pain thresholds (lower in females) were found in the present sample, thus suggesting unbiased sampling.

For interpretation of the questionnaire data a comparison with our earlier study [7] on acute postoperative pain in

**Table 3** Regression analyses for evaluation of the predictive power of psychological predictors for the prognosis of acute postoperative pain

<table>
<thead>
<tr>
<th>Predictor groups</th>
<th>$R^2$</th>
<th>$\beta$</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>NRS</td>
<td>PCA</td>
</tr>
<tr>
<td>Attentional biases for emotionally loaded words (dot-probe task)</td>
<td>0.013</td>
<td>0.234*</td>
</tr>
<tr>
<td>Pain-related emotions and cognitions</td>
<td>0.048</td>
<td>0.081</td>
</tr>
<tr>
<td>Pressure pain threshold</td>
<td>0.072</td>
<td>0.022</td>
</tr>
<tr>
<td>Emotional and bodily distress</td>
<td>0.048</td>
<td>0.021</td>
</tr>
<tr>
<td></td>
<td>NRS</td>
<td>PCA</td>
</tr>
<tr>
<td>pain-related</td>
<td>-0.105</td>
<td>0.137</td>
</tr>
<tr>
<td>social threat</td>
<td>-0.066</td>
<td>-0.035</td>
</tr>
<tr>
<td>positive</td>
<td>0.076</td>
<td>0.224</td>
</tr>
<tr>
<td>PCS</td>
<td>0.862</td>
<td>-0.516</td>
</tr>
<tr>
<td>PASS</td>
<td>0.005</td>
<td>-0.286</td>
</tr>
<tr>
<td>PVAQ</td>
<td>0.191</td>
<td>0.269</td>
</tr>
<tr>
<td>$SOMS$</td>
<td>0.266</td>
<td>0.149</td>
</tr>
<tr>
<td>STAI state</td>
<td>0.164</td>
<td>0.153</td>
</tr>
<tr>
<td>CES-D</td>
<td>0.162</td>
<td>0.080</td>
</tr>
</tbody>
</table>

* $p < 0.05$; ** $p < 0.01$.

PASS = Pain Anxiety and Symptom Scale; PCS = Pain Catastrophizing Scale; PVAQ = Pain Vigilance and Awareness Questionnaire; STAI = State Trait Anxiety Inventory; $SOMS$ = Screening for Somatoform Symptoms; CES-D = Centre for Epidemiologic Studies Depression Scale; NRS = numerical rating scale; PCA = patient-controlled intravenous analgesia.
Table 4  Pearson correlations between psychological predictor variables.

<table>
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<th>7</th>
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<tbody>
<tr>
<td>Attentional biases for emotionally loaded words (dot-probe task)</td>
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<td></td>
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</tr>
<tr>
<td>1. Pain-related words</td>
<td>-0.025</td>
<td>0.203</td>
<td>0.077</td>
<td>0.085</td>
<td>-0.046</td>
<td>-0.102</td>
<td>-0.064</td>
<td>0.123</td>
<td>0.066</td>
</tr>
<tr>
<td>2. Social threat words</td>
<td>0.107</td>
<td>0.131</td>
<td>0.168</td>
<td>0.065</td>
<td>0.130</td>
<td>0.263</td>
<td>0.193</td>
<td>0.117</td>
<td></td>
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<tr>
<td>3. Positive words</td>
<td>-0.262</td>
<td>-0.085</td>
<td>-0.027</td>
<td>0.113</td>
<td>-0.249</td>
<td>-0.073</td>
<td>-0.084</td>
<td></td>
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</tr>
<tr>
<td>Pain-related emotions and cognitions</td>
<td>4. PCS</td>
<td>0.621**</td>
<td>0.300*</td>
<td>0.162</td>
<td>0.172</td>
<td>0.318*</td>
<td>0.280*</td>
<td></td>
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<tr>
<td></td>
<td>5. PASS</td>
<td>0.451***</td>
<td>-0.005</td>
<td>0.360**</td>
<td>0.429***</td>
<td>0.316*</td>
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<td></td>
<td>6. PVAO</td>
<td>0.060</td>
<td>0.230</td>
<td>0.103</td>
<td>0.198</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Pressure pain threshold</td>
<td>-0.258</td>
<td>0.128</td>
<td>0.285*</td>
<td></td>
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<tr>
<td>Emotional and bodily distress</td>
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<tr>
<td>8. SOMS</td>
<td>0.301**</td>
<td>0.472***</td>
<td>0.392**</td>
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<tr>
<td>9. STAI state</td>
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<td>10. CES-D</td>
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</table>

* P < 0.05; ** P < 0.01; *** P < 0.001.

Pass = Pain Anxiety and Symptom Scale; PCS = Pain Catastrophizing Scale; PVAO = Pain Vigilance and Awareness Questionnaire; STAI = State-Trait Anxiety Inventory; SOMS = Screening for Somatoform Symptoms; CES-D = Centre for Epidemiological Studies Depression Scale.

The correlations between our predictor variables showed some typical clusters of relationship within and across certain categories of predictors (see Table 4). Most interesting, parameters of the dot-probe task, which appeared to be the only good predictors of the POIA use, were not strongly related to any other predictor. In other words, their contribution to the explanation of acute postoperative pain appeared to be independent from other psychological predictors. Importantly, our two criterion variables, namely NRS rating and POIA use, were only weakly related (r = 0.105, P = 0.343), suggesting that they provided independent information about acute postoperative pain.

As a more clinically oriented test of the relevance of our predictors, we computed the classification rates for patients with good and poor outcomes as regards their NRS and POIA scores, which could be obtained by use of our predictors (see Statistical analysis and Table 5). The two corresponding analyses, which once again stressed the more extreme outcomes (both good and bad ones) and neglected the cases in between (easy classification task), and which another time used all patients including those with questionable outcomes (difficult classification task), showed again the relevance of attentional avoidance of social threat words in the dot-probe task for prognosis of the POIA use, which allowed for the maximum of 77% (easy classification task), or 63% (difficult classification task) correct classifications. The results for the NRS were less consistent. The scores in the PASS and the pressure pain thresholds appeared suitable for prediction of the more extreme outcomes (easy classification task) by classification rates of 77% and 73%, respectively. The analysis, including all patients, also showed more questionable outcomes (difficult classification task), found only the attentional avoidance of pain-related words in the dot-probe task to be reasonably good for classification by a rate of 62%.
Table 5  Rate of correct classifications of patients with poor and good postoperative pain outcome (PCIA-Q and NRS-Q; the distinction of poor and good pain outcome was based on the lower and upper quartiles; PCIA-M and NRS-M; the distinction of poor and good pain outcome was based on median split; see also Statistical analysis) by use of single predictors

<table>
<thead>
<tr>
<th>Predictors</th>
<th>PCIA-Q</th>
<th>PCIA-M</th>
<th>NRS-Q</th>
<th>NRS-M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attention bias</td>
<td>0.67</td>
<td>0.59</td>
<td>0.96</td>
<td>0.62</td>
</tr>
<tr>
<td>Pain-related</td>
<td>0.77</td>
<td>0.63</td>
<td>0.50</td>
<td>0.45</td>
</tr>
<tr>
<td>Social threat</td>
<td>0.54</td>
<td>0.57</td>
<td>0.43</td>
<td>0.53</td>
</tr>
<tr>
<td>Positive</td>
<td>0.64</td>
<td>0.49</td>
<td>0.77</td>
<td>0.50</td>
</tr>
<tr>
<td>PCS</td>
<td>0.58</td>
<td>0.55</td>
<td>0.57</td>
<td>0.54</td>
</tr>
<tr>
<td>PASS</td>
<td>0.57</td>
<td>0.56</td>
<td>0.67</td>
<td>0.59</td>
</tr>
<tr>
<td>PWQO</td>
<td>0.42</td>
<td>0.50</td>
<td>0.73</td>
<td>0.58</td>
</tr>
<tr>
<td>Pressure pain</td>
<td>0.53</td>
<td>0.52</td>
<td>0.58</td>
<td>0.53</td>
</tr>
<tr>
<td>threshold</td>
<td>0.38</td>
<td>0.57</td>
<td>0.60</td>
<td>0.53</td>
</tr>
<tr>
<td>SOMS</td>
<td>0.60</td>
<td>0.48</td>
<td>0.64</td>
<td>0.56</td>
</tr>
<tr>
<td>STAI state</td>
<td>0.77</td>
<td>0.50</td>
<td>0.73</td>
<td>0.58</td>
</tr>
<tr>
<td>CES-D</td>
<td>0.67</td>
<td>0.59</td>
<td>0.96</td>
<td>0.62</td>
</tr>
</tbody>
</table>

PAS = Pain Anxiety and Symptom Scale; PCS = Pain Catastrophizing Scale; PWQO = Pain Vigilance and Awareness Questionnaire; STAI = State-Trait Anxiety Inventory; SOMS = Screening for Somatoform Symptoms; CES-D = Centre for Epidemiological Studies Depression Scale; PCIA = patient-controlled intravenous analgesia.

Discussion

Psychological predictors of acute postoperative pain were studied in a group of aged persons with many maladies diagnostic signs (e.g., cancer) as cause of surgery. The exact indications for surgery were heterogeneous. Not surprisingly, the scores for depression were high in these patients, suggesting that some of them had developed clinically relevant depression before surgery. In these patients, psychological prediction of acute postoperative pain appeared to be difficult because a variety of indicators, which had earlier appeared to be successful, failed to provide sufficient diagnosis. There was one exception, namely, attention bias toward emotionally loaded words as assessed by the dot probe task. These biases and especially the attentional avoidance of social threat words allowed significantly predicting the amount of requested analgesics (PCIA use) in the first 2 days after surgery. What might appear as chance finding at first glance is likely a reliable result because similar findings have been observed earlier in different samples as will be discussed in the following.

In our earlier study [7] on acute postoperative pain in patients with a surgical correction of a funnel chest, the dot-probe parameters also accounted for a significant proportion of variance in the amount of postoperatively requested analgesics (patient-controlled analgesia, PCIA). The single best parameter was, however, the attentional avoidance of pain-related words. The common denominator of our present and our earlier studies might be that the attentional avoidance of emotionally negative experiences prior to surgery does not ready patients for coping successfully with pain. For more, this occurs at an unconscious and automatic level of stimulus processing. It might depend on the samples investigated that once the attentional avoidance of pain-related words were best predictors. In the earlier study, young patients without major psychological distress but also without major pain experience served as subjects, whereas in the present study moderately depressed patients with mainly cancer diagnoses and probably sufficient pain experiences took part. This might explain why the first group was more worried about the impending pain whereas the second group was more concerned about negative evaluations by others. This explanation relies on the assumption that these patients, in an intentionally avoided mental but analytically and psychosocially threatening information for pain coping and management before surgery, had poor pain outcome afterward. Alternatively, these patients in the present study, who feared and avoided social threat stimuli might have felt the strong urge to be "good" patients, supplying sufficient analgesics without the help of others, solely by using the PCIA system. This response bias might have increased the PCIA dosage. The validity of the two explanations cannot be determined by our data.

The question arises whether our findings—extending the prediction of self-controlled analgesics after surgery by attentional avoidance of anxiety stimuli—can be generalized to other indicators of postoperative pain. It is still a widely held belief that the demand of analgesics can be used as an indirect measure of pain [10], although the correlations between this behavioral measure and self-ratings have been found to be low here and in other studies. However, self-ratings have been shown to be also far from being free of judgment biases, which justifies multi-method approaches such as ours for assessing postoperative pain.

We are not the first, finding attentional avoidance of negative experiences to be a significant predictor of postoperative pain. Munsb and Stevenson [8] added evidence by use of a different method namely a modified Stroop test. They found in patients with acute postoperative pain due to minor gynaecological surgical procedures that the avoiders of pain-related information presented with higher postoperative pain levels. In their case, the prediction was successful also by use of self-reported postoperative pain as criterion whereas in our studies the PCIA use as an indirect behavioral indicator of postoperative pain [10] was best predicted. Interestingly, in an earlier study [9] on psychological predictors of persistent forms of postoperative pain in patients with surgical funnel chest correction we found the predictive attentional preference for positive words to be a significant predictor of self-reported pain months after surgery. Accordingly,
also in our studies, prediction is not always limited to
improved behavioral measures of postoperative pain like
PCIA or PCA use. Furthermore, it seems that attentional
focusing on positive stimuli and not only defocusing away
from negative stimuli may help to distract from pain and
may involve maladaptive preparatory coping with post-
operative pain. The underlying mechanism may be a lack
of psychological adaptation to the impending situa-
tion and a lack of information preparing the patient to
cope with pain. Although evidence for the maladaptive
role of preoperative, attentional preference for positive
stimuli and avoidance of negative stimuli for the develop-
ment of postoperative pain has now accumulated, repli-
cations are required for final conclusions.

Slightly in contrast to other studies and similarly to our
earlier study, variables like pain catastrophizing, depres-
sion, and general and pain-related anxiety did not prove
to be significant predictors of acute postoperative pain
[2,3,5,26]. Interestingly, depression did not appear to be
a significant predictor of postoperative pain in both of
our two studies, although the levels of depression were
quite substantial and once clinical. However, we would
like to refrain from doubting these differences between
our studies and those of others too intensively because none
of these predictor candidate—although definitely of rele-
ance in certain conditions—have been shown to
regulate predictably as regards the development of acute
postoperative pain. Therefore, it is rather the question
what is the best combination of these predictors for
certain patients and certain surgical procedures given
a certain amount of time available for assessment.

A comment is necessary as regards the criterion vari-
date in our study, i.e., self-reported postoperative pain and
patiente use of PCA. The two criteria did not span exactly
across the same time window, as PCA use was assessed
during the first 2 days after surgery whereas the ratings of
acute pain were recorded only for a few hours after
surgery. The correlation between the self-reported post-
operative pain and the PCA use was not surprisingly quite
low. The instruction to use the PCA at a certain pain
levels (NIS > 3) should have led to higher correlations
and average pain ratings below 3, which both did not
happen. The PCA use was apparently not only influenced
by the experience of pain but also by the expected degree
of pain, the fear of pain, the fear of using potent anales-
gics, and other variables. Furthermore, a frequent use
of the PCA might have reflected insubordinately high
levels of pain or strong efforts to control any pain.
However, none of these theoretical alternatives accounts
one of the two criterion measures because both reflect
clear variance effective in the management of postop-
ervative pain and distress. Furthermore, also the indirect
measure of postoperative pain provided by PCA use has
become an established parameter [10].

A limitation of the study might have been the low number
of patients for testing a sizeable number of predictors
of postoperative pain outcome. Testing sensitivity at patient
1 day before surgery is ambitious and explains why we did
not end with higher numbers, however, this argument
does not heal the statistical problem. Fortunately, the find-
ing, which suggests that an attentional bias away from
threatening stimuli is a good predictor of poor outcome,
has now been repeatedly obtained in our studies and
could be, by that, considered as replicated.

In sum, the attentional bias in the form of avoidance of
negative experiences, namely visual threat, prior to
surgery was a significant predictor of the amount of
required analgesics (PCA) in the acute phase of postopera-
tive pain in aged patients with mainly malign indications
for surgery. As similar results have been obtained in earlier
studies on different samples of patients, research on
unconscious, mental and automatic selection of emotional
loaded information may be worth being pursued in the
future for a better understanding of the development of
postoperative pain.

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