Attention and the Stages of Pain Processing

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ABSTRACT

Objective. Explore the relationships between the four stages of pain processing and attention in chronic pain sufferers.

Design. A cross-sectional, retrospective study of 736 subjects participating in an outpatient university-based tertiary care pain treatment program.

Methods. Self-report measures of pain, pain-related unpleasantness, and suffering (Pain Experience Visual Analog Scales) in conjunction with a structured interview assessing illness behavior (adaptation of the Psychosocial Pain Inventory) and attention (Digit Span subtest of the Wechsler Adult Intelligence Scale-Revised) were employed.

Outcome Measures. Separate step-wise multiple regression analyses were conducted using variables that measure each of the four stages of pain processing as predictors, with Digit Span being the criterion variable.

Results. Multiple regression analyses showed that, of the four pain stages, only suffering and pain behavior were related to attentional performance. Specifically, an individual's perception of lifestyle interference due to pain, level of depression, and the degree of solicitous responses from others each uniquely contributed to Digit Span performance.

Conclusions. Treatment interventions specifically targeting suffering and pain behavior may prove efficacious in addressing the attentional problems in chronic pain.

Key Words. Chronic Pain; Attention; Pain Stages

Introduction

The need to appreciate the range of problems associated with chronic pain, such as cognitive dysfunction, is underscored by the fact that an estimated 35 to 75 million people in the United States suffer from some type of pain problem [1]. The vast majority of studies have found that chronic pain (independent of traumatic brain injury or other neurologic disorders) adversely impacts cognition. Cognitive impairment is most evident on tests assessing attentional capacity, processing/psychomotor speed, and memory [2,3]. For example, Schwartz et al. [4] found roughly 25% of the low-back pain patients studied demonstrated weakness on a measure of information processing speed and vigilance (i.e., the Paced Auditory Serial Addition Test). Support for this relationship between inattention and pain has been provided by others [5-8]. In contrast with these findings, the work of others [9-11] has failed to demonstrate an association between pain and processing speed/attention. The lack of consistency across these studies may stem from the fact that they have focused primarily on the first stage of pain processing, that of pain intensity. For the last quarter of a century it has been recognized that pain is multidimensional, consisting of sensory-discriminative, cognitive-evaluative, and affective-motivational dimensions [12]. More recently, these dimensions have been reconceptualized as having different subcomponents and as representing different stages of pain processing [13-15].

A conceptual model that lends itself to the study of attentional performance in chronic pain is the...
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The four-stage model of pain processing proposed by Price [16] and Wade et al. [17,18]. Figure 1 depicts the four-stage model of pain processing.

The initial stage is sensory-discriminative, comprised of the spatial, temporal, and intensive features of the painful sensation. The second stage of pain processing, termed immediate unpleasantness, reflects an individual’s immediate affective response and involves limited cognitive processing. The third stage of pain processing is cognitively mediated by an individual’s beliefs and reflects their perception of the real or imagined long-term consequences of having chronic pain. This stage of pain processing is strongly related to higher cognitive processes and has been termed suffering. There are two aspects to suffering, one being emotional (e.g., depression, anxiety, frustration, fear, and anger), and the other ideational (e.g., ability to endure the pain, perception of lifestyle interference, ability to reduce the pain, and likelihood for cure). The fourth and final stage of this pain model is that of overt behavioral expression of pain (e.g., wincing, cringing, and number of hours spent in bed during the day). In this model, the term “stages” refers to separate levels of processing that could occur simultaneously, although earlier stages give rise to later stages over time.

Support for this four-stage model of pain processing comes from multiple sources. Several studies have demonstrated that visual analog scales (VAS) are capable of separately measuring pain intensity and affective dimensions of both experimentally induced and clinical pain [19-21,17]. First, the sensory VAS and affective VAS ratings of experimental heat pain have been shown to be reliably different. Pain intensity and emotional unpleasantness power function exponents were 2.1-2.2 for sensation and 2.7-3.5 for unpleasantness dimensions [21]. Second, psychological factors known to reduce affect have been shown to reduce affective VAS responses but not sensory VAS responses to experimental pain [21]. Finally, psychological factors inherent in different clinical pains (e.g., cancer pain and labor pain) were shown to powerfully and selectively influence VAS affective responses [22,20]. For example, cancer patients have shown to have higher unpleasantness VAS ratings than sensory VAS ratings, whereas the reverse was true for labor pain patients. In addition, psychological set was found to alter unpleasantness but not sensory VAS ratings in labor pain [23].

There also appears to be a neurophysiological basis for the distinctions between these stages of pain processing. In a recent study by Rainville et al. [24] of experimentally induced heat pain, subjects were given two separate hypnotic suggestions designed to either enhance or attenuate the immediate unpleasantness (stage 1 affect), but not the pain sensation associated with a noxious heat stimulus. Positron emission tomography (PET) scan imaging permitted the identification of specific brain regions associated with the processing of both pain sensation intensity and the immediate unpleasantness.
ness associated with the painful sensation (stage 1 affect). Interestingly, this selective modulation of pain unpleasantness resulted in parallel modulation of neural activity within anterior cingulated cortex (ACC) but not somatosensory S-1 cortex. The fact that separate higher cortical brain regions are involved in the experience of these two pain stages provides additional support for their uniqueness. A second study by Rainville et al. [25] extended this approach by comparing two experimental conditions. Hypnotic suggestions were targeted specifically toward altering pain unpleasantness in the first condition and were targeted specifically toward altering pain sensation intensity in the second condition. Similar to the first study by Rainville [24], pain unpleasantness ratings, but not pain sensation intensity ratings, were changed in the first condition. However, both pain sensation intensity and pain unpleasantness ratings changed in parallel in the second condition. This experiment helps establish the direction of causation—pain intensity is the cause of pain unpleasantness and not vice versa.

Recently, explicit attempts have been made to validate measures of the third and fourth stages of pain processing [14,15,17,18, 26-28]. In one study [15], the combined ratings of five negative emotion and illness beliefs VAS were shown to represent a psychological stage that was unique and separate from that of the immediate pain-related unpleasantness. Two separate studies [14,26] showed that neuroticism selectively and potently enhanced the third stage of pain processing, referred to as suffering.

In addition to the psychological, psychophysical, and neurophysiological data previously mentioned, a fourth line of evidence for this four-stage model of pain processing comes from multivariate (LISREL) analysis [18]. Path analyses with 506 chronic pain patients demonstrated that VAS could be used to assess pain intensity, pain-related unpleasantness (stage 1 affect), and pain-related suffering (stage 2 affect), and that a structured interview [29] could assess pain-related behavior. The authors subdivided suffering into two subcomponents, illness beliefs and negative emotions. Consistent with our previous theory and several empirical studies [24,25], the linear stage sequence, shown in Figure 1, best fit the relationship between the four stages. Successive stages did not have recursive effects on earlier pain stages. Confirmatory LISREL analysis, with an additional 502 pain patients confirmed the integrity of these findings. In a large population of chronic pain patients (n = 1,434), Wade and Price [30] examined the extent to which demographic factors, such as medical diagnosis (e.g., failed back surgery syndrome, complex regional pain syndrome, and myofascial pain dysfunction), gender, age, and ethnicity (e.g., African American and Caucasian), influenced the magnitude of the four stages of pain processing. They employed a methodology similar to that used by Wade [18], using a multivariate statistical technique (LISREL) to assess the causal interrelationships between the four pain stages. Like the Wade [18] study, a linear sequence best fit the relationship between the four stages of pain processing. Two additional structural equation modeling studies examining the impact on pain processing of age [27] and sex [28] yielded further support for the four-stage model of pain processing. In summary, personality trait analyses, psychophysical, psychological, multivariate, and neurophysiological studies have demonstrated that VAS measures, in conjunction with a structured interview [29], can assess each of these four unique pain stages.

In this retrospective study, we examined the relationship between attention span and each of the four stages of pain processing in a large sample of chronic pain sufferers without a history of traumatic brain injury or other neurologic disease. We hypothesized that the later stages of pain processing would be predictive of attentional impairment for two reasons. First, studies reviewed by Hart [2], which examined multiple variables simultaneously, are consistent with this hypothesis. In particular, associations have been reported between neuropsychological impairment and pain-related emotional state and perceived interference with daily activities. Secondly, our prior work [17,27,30] suggests that the later stages of pain processing are uniquely associated with higher-order cognitive processes and suffering. Through either direct or indirect mechanisms, higher levels of suffering and illness behavior are likely to be associated with poorer attentional performance.

Methods
Sample
The subjects were 736 chronic pain patients consecutively evaluated at a pain management clinic at a large southeastern university medical center. The sample consisted of 317 men and 419 women, 56% of whom were currently married and/or cohabiting. The mean age of the patients was 45.05 years (standard deviation (SD) = 13.13) with a range of 20 to 80. The mean number of years of formal education was 11.69 (SD = 3.07). A total of 500 (68%) were Caucasian, 235 (32%) were African-American, and 1 (1%) were Asian. The mean duration of com-
Complaints was 1.6 years (SD = 0.97). About one half of the patients suffered with low back pain as their chief complaint (50.4%). Myofascial dysfunction (28.7%) and complex regional pain syndrome (8.4%) were the second and third most frequent diagnoses, with most subjects reporting multiple pain complaints.

Measures

Pain Experience Analog Scales. Pain intensity, which represents the first stage of pain processing, and pain unpleasantness, which represents the second stage, were assessed with VAS [15]. The subject was asked to mark along a line reflecting his or her rating for pain intensity or unpleasantness for the past week. These VAS consist of 15-cm lines with verbal anchor points. With regard to pain intensity, the anchor points were “none” and “the most severe imaginable” at the two ends. Unpleasantness anchor point labels were “not bad at all” and “the most intense bad feeling imaginable.” For both pain sensation intensity and immediate pain-related unpleasantness, a subject was required to indicate along the scale how disturbing their pain was when it was at its (1) maximum, (2) usual, and (3) minimum during the past week. Suffering was assessed by asking the subject to place a mark along each scale reflecting the intensity of feeling they experienced as a concomitant of their pain. The five negative emotion VAS were labeled depression, anxiety, frustration, fear, and anger. Four VAS were used to assess pain beliefs. Subjects were asked to place a mark along each 15-cm scale reflecting the strength of their beliefs regarding their pain disorder. The first scale was labeled “How difficult is it for you to endure the pain over time?” Verbal anchor points were labeled “not at all difficult” and “the most difficult imaginable.” A second pain belief VAS was labeled “How likely do you feel your pain will be removed or cured?” Verbal anchor points for this scale were “impossible” and “certain.” The third pain belief scale read “How much can you reduce the intensity of your pain if you want or need to reduce it?” Verbal anchor points were “I can’t reduce it at all” and “I can reduce it completely.” The fourth pain belief scale read “How much does the pain interfere with things you want to do?” Verbal anchor points were “not at all” and “completely.” These scales have been shown to be reliable and valid measures of pain and pain-related emotions [14,17,18,31].

Pain Behavior Subscales. Four subscales from the Psychosocial Pain Inventory [32] were used to evaluate pain behavior. This instrument uses a structured interview format with individual items summed to subscale composite scores. These subscales measure the extent of pain behavior manifested at home, degree of social reinforcement for illness behavior, reduction in family-related responsibilities, and impact of rest and avoidance activity on pain. High inter-rater reliability (0.97) was reported [29,32] and construct validity of this pain inventory has been shown in several studies of pain patients [18,29,32].

Measure of Attention. Digit Span (D.S.) is a subtest of the Wechsler Adult Intelligence Test — Revised (WAIS-R) [33] and represents an auditory simple span task. It measures the temporary storage component of working memory. Procedurally, the subject is asked to repeat back a series of numbers recited by the examiner. The test is discontinued when the subject is unsuccessful at repeating back two sets of numbers of a particular length (i.e., a 5-digit series). The D. S. raw score represents the number of digit series correctly recalled both in forward and reverse order. We then converted the raw score to an age-corrected scale score for each subject. The D.S. subtest has been shown to be a reliable [34,35] and valid [36-39] measure of attention.

Statistical Methods

The primary aim of this study was to examine the impact of the four stages of pain processing on auditory simple attention span. We examined the relationship between attention and (1) pain intensity (using maximum, usual, and minimum ratings), (2) immediate pain-related unpleasantness (using maximum, usual, and minimum ratings), (3) pain-related suffering, and (4) pain behavior. The suffering component included two separate categories of measures: pain beliefs and emotional concomitants (the negative emotion VAS). Thus, there were four sets of independent variables and one dependent measure, D. S. from the WAIS-R [33]. In each of the following analyses, step-wise multiple regression analyses were conducted using variables that measure each of the four stages of pain processing as predictors, and D.S. age-corrected scale score as the criterion.

Results

Separate step-wise multiple regression analyses were conducted using variables that represented each of the four pain stages as predictors (e.g., pain intensity, unpleasantness, suffering, and illness behavior) and the D.S. age-corrected scale score as the criterion.
the criterion variable. Each of the step-wise multiple regression analyses adopted the following criteria for variable entry: probability of F to enter < 0.5; probability of F to remove > 0.1. Therefore, based on each variable’s amount of unique variance, the computer determined whether it entered into the equation and in what order. The first step-wise multiple regression analysis examined the relationship between pain intensity and attention. Therefore, the first regression analysis consisted of three independent variables (e.g., pain intensity VAS at its highest, usual, and lowest intensity) and one dependent variable (D. S. age-corrected scale score). Based on the rules for variable entry, none of the pain intensity VAS accounted for enough unique variance to enter the step-wise regression equation. The second step-wise multiple regression examined the relationship between immediate pain-related unpleasantness and attention. Therefore, the regression model included three independent variables (e.g., pain unpleasantness VAS at its highest, usual, and lowest intensity) and one dependent variable (D. S. age-corrected scale score). Like the pain intensity regression analysis, none of the unpleasantness VAS accounted for enough unique variance to enter the regression model. Therefore, the first two regression analyses indicated that neither the pain intensity, nor immediate pain-related unpleasantness predicted D.S. performance.

The relationship between suffering and attention was examined using two separate regression analyses. The first regression included five predictor variables (e.g., depression, anxiety, frustration, fear, and anger VAS) and one dependent variable (D. S. age-corrected scale score). Like the pain intensity regression analysis, none of the unpleasantness VAS accounted for enough unique variance to enter the regression model. Therefore, the second regression analysis indicated that neither the pain intensity, nor immediate pain-related unpleasantness predicted D.S. performance. The second regression was conducted that included only those predictor variables that were reliably related to attention in the first set of analyses. Therefore, this model consisted of four independent variables (depression VAS, degree of lifestyle interference VAS, degree of social reinforcement for pain-related behavior, and changes in activities related to daily household responsibilities). This regression analysis indicated that perceived lifestyle interference due to

| Table 1 | Stepwise regression analysis of emotional suffering predicting digit span*a |
|---|---|---|---|
| Predictor Variable in Equation | Fb | Rb² | Fb² |
| Depression VAS | 16.076 | 0.02 | 16.076* |

N = 736.

*a This F represents the unique prediction of each variable after the preceding variables are removed.

*b This F represents the test of significance of the total regression equation for all variables included in the equation up to that step.

*c Method: Stepwise (criteria: probability of F to enter < 0.50; probability of F to remove > 0.10).

*p < 0.0001.

four independent variables (e.g., degree of lifestyle interference, level of control in reducing the pain, ability to endure the pain, as well as hope regarding cure VAS) and one dependent variable (D. S. age-corrected scale score). This regression analysis showed that, of the four predictors, only perceived lifestyle interference due to pain predicted D.S. performance \( r^2 = 0.02, p < 0.0001 \) (Table 2).

We conducted an additional regression analysis to assess the impact of illness behavior on attention. The four independent variables included in this regression model were derived from the Psychosocial Pain Inventory, a semi-structured clinical interview [29] that quantifies pain behavior. The first variable measured the extent of pain behavior manifested by the patient at home. The second item assessed the degree of social reinforcement for pain-related behavior (frequency of solicitous responses from family and friends). The third predictor variable addressed changes in activities related to daily household responsibilities. The fourth predictor variable was a direct measure of the role that rest and avoidance of activity may have on the patients' pain; the subject was asked to specify the number of hours spent lying down in bed during the day due to pain. The regression analysis indicated that the variables measuring solicitous behavior and change in daily activities (sickness impact) predicted D.S. \( r^2 = 0.02 \) and \( r^2 = 0.01, \) respectively, \( p < 0.0001 \) for both (Table 3). To eliminate collinearity and identify unique relationships between stages of pain processing and attention, a final regression was conducted that included only those predictor variables that were reliably related to attention in the first set of analyses. Therefore, this model consisted of four independent variables (depression VAS, degree of lifestyle interference VAS, degree of social reinforcement for pain-related behavior, and changes in activities related to daily household responsibilities). This regression analysis indicated that perceived lifestyle interference due to
pain ($r^2 = 0.03$), level of depressed mood ($r^2 = 0.04$), and the extent of solicitous responses from others ($r^2 = 0.04$) each uniquely were related to performance on D.S. (Table 4).

### Discussion

Consistent with prior studies, we found a relationship between chronic pain and attention. Our study extends previous findings in showing that the later stages of pain processing play a unique role in mediating the disruptive influence of pain on attention. The attentional impairment was associated with suffering and illness behavior, and not the pain intensity itself. Of the variables studied, level of depression, an individual’s perception of their lifestyle interference due to pain, and the degree of solicitous responses from others were each unique contributors to attentional performance. Of the three predictors, it is perhaps not surprising to find an association between level of depression and attentional abilities in chronic pain patients given the well-known effects of depression on neuropsychological functioning [40]. Additionally, it is plausible that maladaptive beliefs and negative thoughts, such as those relating to lifestyle interference, might also affect concentrated effort or attentional resources. Interestingly, a study of acute pain challenge in normal individuals has shown that anticipation of a painful experience may disrupt attention [41]. Although not directly relevant to chronic pain patients, this finding raises the possibility that expectations of negative consequences alone may have disruptive effects on cognition. Eccleston et al. [42] showed that the detrimental effect of pain on an attention-demanding task was accounted for by an increased somatic awareness associated with higher levels of depression and anxiety. They speculated that a somatic focus and emotional factors increase the disruptive influence of pain on attention by facilitating access of pain into awareness. Social reinforcement of pain behaviors (e.g., solicitous responses) and negative pain-related thoughts may serve to increase somatic focus, and thereby increase the risk of attentional difficulties.

Neuroplastic events associated with the later stages of pain processing may impact attentional capacity. Since the studies of Jones et al. [43] and Talbot et al. [44], there have been more than 35 studies using functional imaging (e.g., PET, single photon emission computed tomography [SPECT], and functional MRI [fMRI]) to shed light on the brain structures associated with pain processing [45]. The brain structures consistently implicated in nociceptive processing include: medial midbrain, thalamus, lentiform nucleus, cerebellum, insular, prefrontal, parietal (S1 and S2 regions), and anterior cingulate regions [46]. More recently, studies have begun to shed light on which brain regions are uniquely related to the different stages of pain processing (e.g., sensory and affective). Rainville [24] used hypnosis to selectively increase the affective component of pain processing and found increased regional cerebral blood flow (rCBF) in the ACC. In a second paper, Bushnell et al. [47], again using hypnosis and PET, selectively enhanced the sensory component of pain, resulting in increased rCBF to the S1 region. These studies, along with others [44], provide support for the notion that different brain systems are associated with the sensory stage (lateral structures such as area S1 and S2 of the parietal lobe) and affective stage (medial structures such as the ACC and insular cortex) of pain processing.

While activation of the ACC is often interpreted to represent the affective component of pain processing [48], this region has also been implicated in cognitive processes [49]. Indeed, fMRI studies suggest that, while the ACC’s rostral-ventral region is

### Table 3

<table>
<thead>
<tr>
<th>Predictor Variable</th>
<th>$F^a$</th>
<th>$R^2$</th>
<th>$F^b$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solicitous Responses</td>
<td>7.817</td>
<td>0.018</td>
<td>7.817*</td>
</tr>
<tr>
<td>Sickness Impact</td>
<td>9.523</td>
<td>0.011</td>
<td>7.817*</td>
</tr>
</tbody>
</table>

N = 736.

* This $F$ represents the unique prediction of each variable after the preceding variables are removed.

$^a$ This $F$ represents the test of significance of the total regression equation for all variables included in the equation up to that step.

$^b$ Method: Stepwise (criteria: probability of $F$ to enter $<0.50$; probability of $F$ to remove $>0.10$).

$p < 0.0001$.

### Table 4

<table>
<thead>
<tr>
<th>Predictor Variable</th>
<th>$F^a$</th>
<th>$R^2$</th>
<th>$F^b$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depression VAS</td>
<td>14.400</td>
<td>0.035</td>
<td>11.803*</td>
</tr>
<tr>
<td>Perceived Lifestyle Interference</td>
<td>21.680</td>
<td>0.027</td>
<td>11.803*</td>
</tr>
<tr>
<td>Solicitous Responses</td>
<td>11.803</td>
<td>0.042</td>
<td>11.803*</td>
</tr>
</tbody>
</table>

N = 736.

* This $F$ represents the unique prediction of each variable after the preceding variables are removed.

$^a$ This $F$ represents the test of significance of the total regression equation for all variables included in the equation up to that step.

$^b$ Method: Stepwise (criteria: probability of $F$ to enter $<0.50$; probability of $F$ to remove $>0.10$).

*p $< 0.0001$.
associated with affective processes, the dorsal region plays a critical role in cognition [50,51]. Recent studies suggest that the ACC participates in executive function by facilitating sustained attention and gating irrelevant, distracting stimuli [49,52-54]. This hypothesis is also supported by findings of increased ACC activation in anticipation of performing cognitive tasks [55,56]. Derbyshire et al. [57] evaluated the specificity of regional ACC activation using three-dimensional PET imaging under multiple conditions. The subjects performed a measure of selective attention (i.e., Stroop test) under two conditions: (1) During heat; and (2) During noxious heat stimulation. Their data revealed substantial ACC regional activation overlap during performance of an attentional task and noxious pain stimulation. These data support the notion that the same brain regions partially mediate both attentional mechanisms and the processing of emotional and evaluative components of the pain experience. A greater degree of pain-related suffering may limit the reserve capacity of these neural structures to support attentional control. However, this is clearly speculative since it is unclear whether the changes noted on functional imaging studies actually represent a type of neuroplastic effect of chronic pain.

Because this is a correlational study, the direction of the relationship between attentional impairment and negative aspects of the chronic pain experience cannot be ascertained. However, attentional impairment as a consequence of pain-related suffering seems plausible, while the reverse (i.e., pre-existing attentional problems causing pain-related suffering and illness behavior) seems unlikely. Another limitation of this study is that attention was assessed using only the D. S. subtest of the WAIS-R [33]. Follow-up studies that assess the multidimensional aspects of chronic pain should include multiple measures of attention, working memory capacity, and information processing speed. Another limitation of this study is that medication use was not assessed. While some studies suggest that opioids cause neuropsychological impairment, other studies have not demonstrated this relationship. Indeed, there have been several reports suggesting a beneficial effect of opioid use on neuropsychological performance in pain patients [58, 59,60]. A recent study by Sjogren et al. [61] evaluated the influence of oral opioids and pain on neuropsychological performance in 130 cancer patients. The neuropsychological tests included measures of attention and information processing speed (e.g., the Paced Auditory Serial Addition Task). The authors found oral opioids did not impact on attention.

Importantly, although a statistically significant relationship was noted between some of the independent variables and attention, the unique amount of variance accounted for by these variables was small. The implication of this is that the impact of suffering and illness behavior on attention might be difficult to ascertain in the clinical setting. Nevertheless, the notion that negative mood, such as depression, impacts on neuropsychological performance is not novel. Such a relationship is well described in patients with depressive disorders, as well as with chronic nonmalignant pain conditions [62,63]. We used VAS to separately assess the contribution of depression, anxiety, frustration, fear, and anger on the attention task. The limited amount of variance accounted for between emotional suffering and attention in our study may reflect the VAS’s lack of sensitivity in identifying clinical mood disorders (such as major depression). We recognize the limitation of this screening approach, and suggest that future studies may wish to include additional measures of these negative emotions. In addition, it would be interesting to see whether these findings could be replicated using other neuropsychological measures, such as with a measure of verbal learning. Furthermore, examining the ACC’s pattern of activation while pain patients are at “rest” and while they perform the D.S. subtest may clarify the ACC’s role in pain and cognitive processing.

In summary, we found that attentional impairment in chronic pain patients was more closely related to the later stages of pain processing (e.g., suffering and illness behavior) than to pain intensity itself. The cognitive complaints of chronic pain sufferers may be attenuated by treatment interventions specifically targeting pain-related mood change, negative thoughts, and socially reinforced illness behavior.

Conclusions

A four-stage model of pain processing was employed to examine attentional performance in a large sample of chronic pain sufferers. Interestingly, neither the pain intensity (stage 1 of the model), nor the associated immediate pain-related unpleasantness (stage 2 of the model) impacted on attention. Rather, only the later stages of pain processing (suffering and illness behavior) were related to attentional performance. Recent Studies [16,31,32,34-36,39-41] suggest that the same brain regions (e.g., ACC) associated with the later stages of pain processing also facilitate attention. Our data support this notion and raise the possibility that a greater degree of pain-related suffering
may limit the reserve capacity of these neural structures to support attentional control.

References


