Acta Derm Venereol 2010; 90: 46–51

INVESTIGATIVE REPORT

# Role of Attentional Focus on Bodily Sensations in Sensitivity to Itch and Pain

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**Patients frequently report high levels of physical symptoms, such as itch and pain, which do not completely correspond to pathophysiological findings, possibly indication heightened sensitivity to physical symptoms. Sensitivity to itch and pain is thought to be affected by processes such as attentional focus on bodily sensations. We investigated the role of attentional focus in sensitivity to various somatosensory stimuli evoking both itch and pain sensations in healthy female subjects. Different mechanical, chemical and electrical stimuli of quantitative sensory testing were applied. Attentional focus on bodily sensations was measured using validated questionnaires. The results indicated that focusing on bodily sensations is associated with higher levels of experienced itch and pain but not with tolerance to stimuli. This suggests that attentional focusing on bodily sensations is a mechanism responsible for sensitivity to different physical sensations, such as itch and pain.** ***Key words: quantitative sensory testing; attentional focus; sensitivity; itch; pruritus; pain; anxiety sensitivity.***

(Accepted July 2, 2009.)

Acta Derm Venereol 2010; 90: 46–51.

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Patients often report levels of itch and pain that are not correlated with other signs of disease, with the severity of the disease or with the intensity of itch and pain expected according to pathophysiology. There is increasing evidence that heightened sensitivity to physical sensations plays a role in the maintenance and aggravation of complaints such as itch and pain. For example, patients with chronic itch or pain have been shown to be generally more sensitive to itch and pain, respectively, than healthy controls (1–4). Information processes, such as attentional focus towards sensations, are thought to play a main role in sensitivity to different complaints, such as pain (5–9). The extent to which individuals focus on bodily sensations is also of importance in conditions associated with chronic pain. For example, there are indications that patients with chronic pain have heightened attention towards pain-related information (10–12). Attention also plays a role in the response to experimentally applied pain stimuli (13–15). Given that there is an overlap in psychophysiological mechanisms of itch and pain (16–18), attentional focus could also play a role in sensitivity to itch. There is preliminary evidence that patients with psoriasis display heightened attentional focus on disease-specific words (including itch words) compared with healthy subjects (19). However, the role of attentional focus on bodily sensations in itch has not been investigated systematically. In addition, individual differences in personality are thought to be partly responsible for a heightened perception of sensations or hypervigilance to symptoms. For example, subjects relatively high in physical anxiety sensitivity or in neuroticism pay more attention to physically threatening stimuli and are more hypervigilant to physical symptoms (20–22). Consequently, personality characteristics of anxiety sensitivity and neuroticism may affect the relationship between attentional processes and sensitivity to somatosensory stimuli (6, 13, 23–26).

Taking all these factors into account, it is likely that focusing attention on bodily sensations plays a role in the experience of sensations of both pain and itch. Since there is some evidence that both itch and pain are affected by similar mechanisms of sensitization (2, 16, 18), with both patients with chronic itch and pain being relatively more sensitive to somatosensory stimuli than healthy controls, comparison of itch and pain may clarify the differences in peoples' sensitivity to different bodily sensations such as itch and pain. However, no studies have investigated the role of attentional focus on bodily sensations in sensitivity to itch and pain. The aim of this study was to investigate the role of attentional focus on bodily sensations in the sensitivity to various somatosensory stimuli, including mechanical, electrical and chemical stimuli, eliciting sensations of itch and pain, controlling for the role of the personality characteristics anxiety sensitivity and neuroticism. We hypothesized that individuals with a greater attentional focus on bodily sensations would be more sensitive to the test stimuli; in particular, that attentional focus would be related to the higher reports of itch and pain. In addition, it is suggested that attentional focus might be affected by anxiety-based personality characteristics (e.g. neuroticism and anxiety sensitivity) and that it

would mediate the relationship between personality characteristics and sensitivity to itch and pain.

## MATERIALS AND METHODS

### *Participants*

Thirty-two women (mean age 38 years, standard deviation (SD) 18 years) without acute or chronic itch or pain complaints were recruited via advertisements. Subjects with a minimum age of 18 years were included. Exclusion criteria were: severe morbidity (e.g. multiple sclerosis, diabetes mellitus); severe psychiatric disorders; pacemaker use; and levels of current itch and pain above 1.0 on a scale of 0–10. Of the subjects 59% had completed secondary education and 41% had completed tertiary education. Forty-four percent of the subjects were married or lived with a partner. The protocol was approved by the regional medical ethics committee and all participants gave their informed consent prior to the investigation. On arrival at the test facility, participants were informed about the procedure and asked about their menstrual cycle, smoking, and use of medication, and intake of caffeine, and alcohol over the previous 24 h. Participants had earlier been asked not to drink black tea or coffee 1 h before testing. Three subjects had taken medication for high blood pressure, of which one had taken a selective serotonin reuptake inhibitor antidepressant and one had taken an antihistamine within 24 h prior to testing.

### *General procedure*

Self-report questionnaires were sent to the participants one week before testing. On the day of testing, the participants were asked to indicate the current level of itch and pain at the start of the test on a visual analogue scale (VAS) ranging from 0 to 10. Mean levels of current itch and current pain were 0.1 (SD = 0.3) and 0.2 (SD = 0.4), respectively. Subsequently, quantitative sensory testing (QST) was performed using mechanical, electrical, chemical and thermal stimuli, in the following order: tactile stimulation, electrical stimulation, histamine iontophoresis, cold stimulation and capsaicin application. The same investigator administered all stimuli. The inter-stimulus interval was at least 10 min, with a 15-min interval after the histamine and cold pressor stimuli. On the day of testing, subjects were informed about the procedure and familiarized with the stimuli in a pre-test trial. Subjects were told that stimuli could provoke any type of sensation, for example itch and pain. After each stimulus, subjects were asked to rate their perceived sensation using a 10-point VAS for both itch and pain, ranging from no itch/pain (0) to the worst itch/pain imaginable (10).

### *Self-report questionnaires*

*Attentional focus on the occurrence of bodily sensations*. The Body Sensations Questionnaire (BSQ) (27) was used as a measure of attentional focus on the occurrence of bodily sensations. This questionnaire containing 15 items concerning bodily sensations was used by asking subjects to rate the frequency of bodily sensations (e.g. heart palpitations, dizziness or sweating) occurring when in a nervous or feared situation. Each item was rated on a 5-point Likert scale, ranging from "the sensation never occurs" to "the sensation occurs almost always or always". The total score was obtained by calculating the mean score of the items. Cronbach's alpha for the BSQ in the present study was 0.66.

*Attentional focus on bodily sensations*. The tendency to attend to internal bodily sensations was measured with the Body Vigilance Scale (BVS) (28), consisting of four items, three of which assess the degree of attentional focus, perceived sensitivity to changes in bodily sensations, and the average amount of time spent attending to sensations. The fourth item contains 13 items concerning anxiety-related bodily sensations (heart palpitations, chest pain, numbness, tingling, shortness of breath, faintness, vision changes, dizziness, hot flash, sweating/clammy hands, upset stomach, nausea, choking/throat closing). Items were rated on a 10-point VAS. The ratings for the bodily sensations of item 4 were averaged to obtain an overall score for item 4. The total score of BVS is the sum of items 1 to 4. Cronbach's alpha for the BVS in the present study was 0.82.

*Personality characteristics*. The Anxiety Sensitivity Index (ASI) (29) measured the subjects' fear of bodily sensations that are interpreted as having potentially harmful, physical or psychological, consequences. The ASI consists of 16 items, rated on a 5-point Likert scale (1 = very little, 2 = little, 3 = some, 4 = much, 5 = very much). The total score was obtained by summing the scores for the 16 items (range 0–64). The Cronbach's alpha for the ASI in the present study was 0.91. In order to measure neuroticism, the neuroticism subscale (22 items) of the Eysenck Personality Questionnaire (EPQ) was used (30). In the present study the Cronbach's alpha was 0.88.

### *Somatosensory stimuli*

*Mechanical stimulation*. Twenty Semmes-Weinstein von Frey calibrated monofilaments were used in a range of 0.00045 to 447.0 grams. Filaments were applied to the non-dominant forearm (2 cm distal to the lateral epicondyle of the humerus, C5 dermatome) once vertically and with increasing force, while avoiding contact with body hair. Subjects were asked to report the Aδ-fibre threshold as well as the itch and pain ratings for that threshold (2).

*Electrical stimulation*. Cutaneous electrodes were applied to the non-dominant forearm (2 cm distal to the lateral epicondyle of the humerus, C5 dermatome) and the trapezius on the dominant side. The electrical tolerance thresholds were measured using a constant current nerve stimulator (MultiStim Vario, Pajunk, Geisingen, Germany). Electrical stimuli consisted of 0.3-ms pulses at 100-Hz frequency with a continuous increasing intensity of about 0.2 mA/s applied until the subject reported the tolerance threshold which was defined by "the moment that the sensation becomes unbearable and you want to stop immediately". After a pretest trial with the trapezius, the tolerance threshold was determined on the forearm and then subjects were asked to rate itch and pain intensity at the tolerance threshold. The mean of two repeated threshold measurements was calculated (2).

*Histamine iontophoresis*. Histamine (31, 32) was applied by means of an iontophoresis system (Chattanooga Group, Hixson, USA). Histamine dihydrochloride (0.5%) was dissolved in a gel of 2% methylcellulose in distilled water and 2.5 ml was placed in an electrode (Chattanooga Ionto Ultra Electrode medium, Hixson, USA). This electrode was applied to the dominant forearm, 2 cm distal to the lateral epicondyle of the humerus (C5 dermatome). The reference electrode was applied to the skin of the lateral side of the triceps brachial muscle. Current level was set at 0.4 mA and histamine was delivered for 2.5 min. Subjects were asked to rate itch and pain during histamine application every 30 sec. Mean scores for itch and pain during histamine application were calculated.

*Capsaicin application*. Capsaicin (Bufa Spruyt-Hillen, Utrecht, The Netherlands) was applied topically, according to the guidelines of Green (33), in a non-evaporative vehicle (Lanette I cream). Capsaicin cream in a concentration of 1% was applied to the volar aspect of the dominant forearm laterally (2 cm proximal of the distal wrist crease, dermatome C5) over an area of 10 $cm^2$ for 7 min. Levels of itch and pain were scored every minute during application and the mean scores for itch and pain were calculated.

*Cold pressor test*. Subjects were instructed to place their dominant hands in a tank of ice water at about 4°C (mean temperature 4.3°C; SD = 0.6) as long as possible, until they could no longer tolerate it. The participants were not aware of the upper time limit of 3 min (34). The immersion time was recorded and the level of itch and pain during the test was assessed immediately after the subjects had withdrawn their hands.

### *Statistical analysis*

All analyses were performed using SPSS 16.0 for Windows. All stimuli evoked both itch and pain, except the cold pressor test, for which only 2 subjects had itch scores above 1.0 (mean 0.1, SD 0.5) and the capsaicin application, for which only 3 subjects had pain scores above 1.0 (M = 0.3, SD = 0.5). Consequently, these variables (itch scores for the cold pressor test and pain scores for capsaicin) were not included in analyses. Variables were checked for normal distribution. Square root transformation was performed to obtain a normal distribution for one stimulus: VAS pain elicited by tactile stimulation. Pearson correlation coefficients were calculated to determine the intercorrelations between the itch and pain reported for each stimulus and between the thresholds and itch and pain reported at the thresholds. In order to test the hypotheses, composite endpoints were made for both the tolerance thresholds and itch and pain scores separately by calculating the means of the standardized thresholds and means of the standardized itch and pain scores for the different stimuli (35). Pearson correlation coefficients were then calculated between attentional focus and these composite scores for the thresholds and itch and pain scores (one-tailed). Additional explorative analyses were further conducted by calculating the single correlations between sensory thresholds and the VAS ratings for itch and for pain for each stimulus separately (one-tailed). In addition, we studied the role of attentional focus as a mediator between personality and itch and pain sensitivity according to the procedure described by Baron & Kenny (36). A necessary condition for mediation is that a significant linear relation exists between the independent variable and mediator, independent variable and outcome, and mediator and outcome variable. Therefore these correlations were calculated with, as independent variables, neuroticism and anxiety sensitivity, as possible mediator attentional focus, and as outcome variables the measures of itch and pain sensitivity. Mediation is then specified by a decrease in the significant relationship between the independent variable and the outcome variable, when controlling for the mediator.

Furthermore, all analyses were controlled by conducting partial correlation analyses for the following possible confounders: age, body mass index, educational level, menopausal status, medication intake and VAS itch and pain at the day of testing. Since these control variables did not significantly correlate with any of the measures for attentional focus and the same levels of significance were found when controlling for these variables by use of partial correlation analyses, the uncorrected data are presented.

## RESULTS

### *Quantitative sensory testing outcome measures and outcome measures for attention*

The means, SD and range of the thresholds and VAS scores for itch and pain elicited by the stimuli are presented in Table I. Means, SD and range of both measures of attentional focus are displayed in Table II. The itch and pain scores for the same QST stimulus were not significantly correlated for all applied stimuli (data not shown). There were also no significant correlations between the thresholds and itch or pain scores for the same stimulus for all applied stimuli, except for a significant correlation between the tolerance threshold of electrical stimulation and the pain score at this threshold ($r = 0.37$, $p < 0.05$).

### *Association between attentional focus and tolerance thresholds*

There were no significant associations between the measures of attentional focus and the composite scores for the tolerance thresholds for the applied somatosensory stimuli (Table III). There were also no significant correlations when exploratively testing the single correlations between attentional focus and the different measures of the tolerance thresholds for the tactile, electrical or cold pressor stimuli (Table III).

### *Association between attentional focus and itch and pain elicited by the stimuli*

The composite scores for itch and pain both were significantly correlated with the BVS, indicating that a greater attentional focus on bodily sensations was significantly associated with higher levels of itch and pain evoked by the somatosensory stimuli applied. In addition, the composite score for itch, but not the composite score for pain, was significantly correlated with the BSQ, indicating that a greater attention to the occurrence of sensations was significantly associated with higher levels of itch evoked by the somatosensory

Table I. *Means, standard deviations (SD) and range of tolerance thresholds and visual analogue scale (VAS) scores for itch and pain elicited by different somatosensory stimuli*

| | Mean (SD) | Range |
|---|---|---|
| *Thresholds* | | |
| Tactile[a] | 13.0 (4.6) | 6–20 |
| Electrical[b] | 7.2 (4.0) | 1.5–15.0 |
| Cold pressor[c] | 55.6 (50.7) | 4–180 |
| *Itch and pain ratings – VAS*[d] | | |
| Tactile | | |
| itch | 0.9 (1.3) | 0.0–4.0 |
| pain | 0.8 (1.1) | 0.0–5.0 |
| Electrical stimulation | | |
| itch | 1.6 (2.2) | 0.0–7.0 |
| pain | 2.9 (2.5) | 0.0–8.5 |
| Cold pressor | | |
| pain | 4.5 (2.8) | 0.0–8.5 |
| Histamine | | |
| itch | 2.9 (2.1) | 0.0–7.0 |
| pain | 1.8 (2.1) | 0.0–6.7 |
| Capsaicin | | |
| itch | 1.1 (1.4) | 0.0–5.4 |

[a]Tactile threshold: hair number out of a total of 20 von Frey monofilaments; [b]electrical threshold: electrical current in mA; [c]cold pressor immersion time in seconds.
[d]VAS itch/pain: score of itch/pain evoked by the stimuli on a visual analogue scale ranging from 0 to 10.

Table II. *Means, standard deviations (SD) and range of both measures of attentional focus (BSQ and BVS) and the measures of the personality characteristics neuroticism and anxiety sensitivity (EPQ and ASI)*

| | Mean (SD) | Range[a] |
|---|---|---|
| Attention to occurrence of sensations (BSQ) | 1.86 (0.36) | 1.13–2.87 |
| Attentional focus (BVS) | 3.42 (1.55) | 1.32–6.81 |
| Neuroticism (EPQ) | 6.13 (4.85) | 0–22 |
| Anxiety Sensitivity (ASI) | 1.35 (0.66) | 0.27–2.87 |

[a]Theoretical scale ranges of questionnaires: BSQ: 1–4; BVS: 0–10; EPQ: 0–22; ASI: 0–4.
BSQ: Body Sensations Questionnaire; BVS: Body Vigilance Scale; EPQ: Eysenck Personality Questionnaire; ASI: Anxiety Sensitivity Index.

stimuli (Table III). The explorative correlations for each of the stimuli separately further showed that a greater attention to the occurrence of sensations (BSQ) was significantly associated with a higher itch score during tactile, electrical, histamine, and capsaicin stimuli and to a higher pain score during the cold pressor test. In addition, a greater attentional focus on bodily sensations (BVS) was significantly correlated with a higher itch score for capsaicin application and a higher pain score for both histamine iontophoresis and the cold pressor test (see Table III).

Table III. *Pearsons correlations between attentional focus on bodily sensations and the composite and single scores for the tolerance thresholds and visual analogue scale (VAS) scores for itch and pain elicited by different somatosensory stimuli*

| | Attention to occurrence of sensations (BSQ) | Attentional focus (BVS) |
|---|---|---|
| *Thresholds* | | |
| Composite score for thresholds[a] | –0.22 | –0.01 |
| Tactile[b] | –0.05 | 0.01 |
| Electrical[c] | –0.15 | 0.12 |
| Cold pressor[d] | –0.21 | –0.14 |
| *Itch and pain scores – VAS*[e] | | |
| Composite score for itch[a] | 0.55*** | 0.30* |
| Composite score for pain[a] | 0.05 | 0.50** |
| Tactile | | |
| itch | 0.34* | 0.13 |
| pain | –0.23 | 0.25 |
| Electrical stimulation | | |
| itch | 0.49** | 0.24 |
| pain | –0.15 | 0.27 |
| Cold pressor | | |
| pain | 0.40* | 0.52*** |
| Histamine | | |
| itch | 0.34* | 0.13 |
| pain | 0.10 | 0.39* |
| Capsaicin | | |
| itch | 0.43** | 0.36* |

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$ (one-tailed).
[a]Composite score for tolerance thresholds: means of the standardized scores for the tolerance thresholds for tactile, electrical and cold pressor stimuli. Composite score for VAS scores: means of the standardized scores for itch and pain evoked by the tactile, electrical, cold pressor, histamine, and capsaicin stimuli.
[b]Tactile threshold: hair number out of a total of 20 von Frey monofilaments; [c]Electrical threshold: electrical current in mA; [d]Cold pressor immersion time in seconds.
[e]VAS itch/pain: score of itch/pain evoked by the stimuli on a visual analogue scale ranging from 0 to 10.
Corresponding levels of significance were found after controlling for the variables age, body mass index, educational level, menopausal status, medication intake, and current itch and pain at the day of testing.
BSQ: Body Sensations Questionnaire; BVS: Body Vigilance Scale.

### *Role of personality characteristics*

Means, SD and range of the questionnaires measuring neuroticism and anxiety sensitivity are displayed in Table II. Personality characteristics were not significantly associated with the measures of attentional focus or the thresholds or itch and pain scores at these thresholds. Consequently the personality characteristics did not play a role in the relationship between attentional focus and itch and pain sensitivity to the somatosensory stimuli.

## DISCUSSION

Focusing attention on bodily sensations might play a role in heightened sensitivity or hypervigilance of patients with symptoms of itch or pain (5–7). In the present study, we therefore examined the role of attentional focus on bodily sensations on the experience of both itch and pain. A relatively high attentional focus on bodily sensations was associated with higher scores for itch and pain elicited by different somatosensory stimuli. Our results are consistent with previous studies in pain (8, 14) and preliminary results for itch (19), indicating that attentional focus, next to pain, also plays a role in the sensitivity to itch. This suggests that attentional focusing is a generic mechanism, which plays a role in the sensitivity to different somatosensory stimuli.

The association between heightened attentional focus on bodily sensations and increased sensitivity to itch and pain sensations could be analogous to anxiety related symptoms (37). Generally speaking, aggravation of common sensations could increase awareness of these sensations, which may in turn aggravate the occurrence or intensity of the sensations. This increased awareness of the occurrence of sensations could influence the interpretation and expectancy of consequences, which may lead to negative misinterpretations of normal physiological sensations (37, 38). The combination of an increased awareness of bodily sensations and a negative interpretation of these sensations may, in turn, lead to a higher reporting of the frequency and/or intensity of a given sensation. These information processing mechanisms are thought to play a role in the experience of pain (6, 7, 15) and similar mechanisms may also play a role in the experience of itch. Especially in patients with chronic itch and pain, attentional focus thus might be relevant in the high symptom reporting and, in turn, might also be involved in processes of both peripheral

and central sensitization. Future research might elucidate the role of attentional focus in central sensitization processes of itch and pain, for example by assessing temporal summation, hyperalgesia, or hyperknesis as measures for central sensitization of pain and itch.

While the degree of attention paid to bodily sensations seemed to be related to reported levels of itch and pain, attentional focus was not associated with the tolerance thresholds. This is in line with the previous findings for the tolerance threshold for the cold pressor test (9) and suggests that attentional mechanisms particularly play a role in the subjective experience of sensations, probably reflecting the more cognitive-affective sensitivity, while the tolerance to stimuli, reflecting the more sensory-discriminative part of sensitivity, may be more dependent on, for example, genetic factors (34, 39).

With regard to the influence of personality on sensitivity to itch and pain, we expected that attentional focus might be affected by anxiety-based personality characteristics, thus that attentional focus might mediate the relationship between, for example, anxiety sensitivity and itch and pain reporting. However, our results showed no association between personality and attentional focus or sensitivity to itch and pain. Our results, that anxiety sensitivity and neuroticism were not associated with the measures of attentional focus, are in line with earlier findings in healthy individuals (14, 40). However, mean scores of anxiety sensitivity and neuroticism were relatively low in this sample of healthy subjects, which may explain the low correlation with the level of itch and pain sensations experienced (20, 21). In future research it may be important to also include subjects with high levels of anxiety (e.g. generealized anxiety disorder) to investigate whether anxiety based mechanisms of attentional focus in relation to itch and pain sensitivity might be particularly relevant to subjects scoring high on anxiety measures (21). In addition, as it has been shown that not only anxiety processes, but also other emotional states such as depression play an important role in the perception of itch (41), future research should also focus on the role of emotional states such as depression in relation to attentional focus and the sensitivity to itch or pain. Also, the role of a threatening character of stimuli may be further explored, for example by giving catastrophic instructions about the stimuli.

Some limitations have to be taken into account. First, since for all subjects stimuli were applied in the same order, we cannot exclude habituation or priming effects due to the preceding stimuli. Although it was attempted to minimize interaction between stimuli, by intervals in-between the stimuli, in future research the sequence of stimuli applied could be alternated. Secondly, using composite scores for the different measures of mechanical, electrical, chemical, and thermal stimuli might not be sensitive enough to study different sensory aspects of itch and pain sensitivity, while the explorative analyses of the single correlations of all measures might lead to possible problems of multiple testing and type I error. Thirdly, to get more insight into the causal effects of attentional mechanisms on sensitivity to itch and pain, it might be important to experimentally manipulate attentional focus, for example by using distraction tasks or attentional focusing tasks (40). Fourthly, this study provides support for the role of attentional focus in itch and pain sensitivity of healthy female subjects. Since sensitivity to pain differs slightly between men and women (42), additional mechanisms and their role in sensitivity to itch and pain have to be replicated in men. Fifthly, due to possible response bias, it may be preferable to combine the questionnaires with implicit tasks to measure pre-attentive processes (11). Sixthly, the items of the questionnaires measuring attentional focus are about anxiety-related complaints and are generally in contrast to the QST stimuli evoking mainly itch or pain. Correlations may be stronger if the attentional mechanisms concern sensations related to the specific applied stimuli or if they are of direct relevance for the subjects. Since itch and pain are highly relevant to patients with chronic itch and pain, respectively, it would be appropriate to include these patients in future research. For clinical purposes future research might focus on identifying and screening of patients at risk for disturbed attentional processes, followed by tailored treatment to reduce dysfunctional hypervigilance for physical symptoms of itch and pain.

In summary, the results of the present study indicate that a greater attentional focus on bodily sensations is not only relevant to the experience of pain, but also of itch, suggesting that a generic attentional focus on bodily sensation is a mechanism that plays a role in sensitivity to different physical sensations. Future research is needed to investigate whether mechanisms of attentional focus may also be involved in symptom reporting of patients with skin disease who suffer from chronic itch.

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