PAIN SENSITIVITY IN RECOVERED ANOREXICS, RESTRAINED AND UNRESTRAINED EATERS

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Abstract—The heat pain threshold and local skin temperature were assessed in 23 former anorexic inpatients with an 'intermediate' ($N = 9$) or 'good' outcome ($N = 14$) and in 21 restrained and 20 unrestrained eaters. All subjects were female. The group means of the pain thresholds did not differ significantly from each other, suggesting that the homogeneous increase in pain thresholds we had previously observed in acutely ill eating disorder patients is state dependent. However, a sizeable percentage of the restrained eaters (29%) had pain thresholds clearly above the normal range. Thus it may well be that restrained eating carries a risk of reducing pain sensitivity. Pain threshold and skin temperature correlated significantly ($r = -0.63$) only in the group of patients with an intermediate outcome, a finding resembling that obtained in acute anorexics. This suggests that peripheral thermoregulation and pain sensitivity are linked in the acute and moderately improved phases of anorexia nervosa.

INTRODUCTION

IN AN earlier study we found that patients with acute anorexia or bulimia nervosa had significantly increased heat pain thresholds compared with healthy control subjects [1]. Faris *et al.* [2] have reported similar findings for bulimic patients when measuring pressure pain thresholds. We originally assumed that a hyperactive opioid system, as suggested by the findings of Pickar *et al.* [3], was responsible for the increased pain thresholds. However, the administration of naloxone did not lead to a normalization of the elevated pain thresholds [4]. The hypothesis of a general somatosensory deficit due to a subclinical malnutrition neuropathy also had to be rejected as other sensory modalities (warmth, cold and vibration) showed only slight, non-pathognomonic impairments [5]. Another putative explanation was that the fasting state, which is characteristic for both acute anorexic and acute bulimic patients [6], would, by itself, reduce pain sensitivity. However, a 3-wk 1000-kcal diet did not influence pain sensitivity in healthy volunteers, even though it induced a comparable fasting state [7]. Finally, the strong negative correlation between the pain threshold and local skin temperature, which we found only in anorexic patients, suggested that changes in peripheral thermoregulation and pain sensitivity are associated [1].

New insights into the possible causes of altered pain sensitivity in eating disorder patients might emerge when comparing cases of a high-risk population and of recovered patients with acute cases. This is a common strategy to get first indications as to whether a given dysfunction is associated with the full-blown syndrome only or whether it is also present in pre- and postmorbid conditions. Thus, hypotheses about cause/effect relationships may become available for future prospective investigations.

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There is no general agreement on the precursors of anorexia and bulimia nervosa. However, a behavioural and motivational concept, termed 'restrained eating', has recently attracted interest as it describes a type of eating behaviour on the borderline between non-pathological and pathological eating [8, 9]. Restrained eaters, who are dissatisfied with their bodies, try to control their weight by sticking to a self-imposed diet [10]. It is highly likely that many eating disorder patients have gone through a stage similar to restrained eating before the onset of the full-blown eating disorder. Furthermore, appropriate instruments for assessing restrained eating had already been developed (e.g. Ref. [11]).

We restricted our investigation of former eating disorder subjects to patients with a previous anorexia nervosa to avoid the use of invalid outcome measures: the techniques for outcome research on anorexia nervosa are much more highly developed than those for bulimia nervosa. The criteria of Morgan and Russell [12] have proven useful in a large number of outcome studies [13]; we applied them in the present study to identify former anorexic patients with 'good' and 'intermediate' outcomes. Whereas the criterion 'good outcome' asks for a persistent maintenance of body weight within 15% of the ideal body weight and for regular menstrual cycles, the criterion 'intermediate outcome' is applied when the weight normalization has not been sustained and/or menstrual disturbances have continuously occurred. It must be kept in mind, however, that an 'intermediate' outcome may describe both a certain stage of remission and a chronic form of anorexia nervosa of moderate severity.

In addition to the heat pain threshold, we assessed the local skin temperature in all subjects because of the aforementioned association with pain sensitivity. We expected that elevations of the pain threshold were more likely to be found in restrained eaters and former anorexics with 'intermediate' outcome than in unrestrained eaters and former anorexics with 'good' outcome. The same kind of difference among the groups was assumed in regard to the abnormal association between skin temperature and pain sensitivity.

METHODS

Subjects

According to the intention of our study, recruitment aimed at samples that were typical for the population of recovered anorexics, unrestrained and restrained eaters. To obtain recovered anorexics, 57 former female in-patients were considered for participation. They had been admitted in the past 10 yr to two wards of the Max Planck Institute of Psychiatry, which were specialized in the psychobiological assessment and in the treatment of eating disorders. These subjects had formerly been selected as definite cases of acute anorexia nervosa for research studies [14, 15]. A description of the present study and of the exact inclusion/exclusion criteria was mailed to those 35 of the former patients, who lived in or near Munich. Twenty-three of the patients responded and all of them were suitable for participation (none of the respondents had to be classified as 'poor' outcome, a category that describes patients who are thought to be indistinguishable from acutely ill patients). The subjects had a definite lifetime diagnosis of anorexia nervosa according to the DSM-III R criteria [16] and were not severely underweight (less than 75% of the ideal body weight according to the tables of the Metropolitan Life Insurance Company [17]) at the time of our investigation. Fourteen were classified as having a 'good' outcome and nine an 'intermediate' outcome (four because of menstrual irregularities, two because of low weight and three because of both conditions; low weight was defined as a negative deviation of more than 15% from the ideal body weight; for a description of the subjects, see Table I). The former patients with an 'intermediate' outcome had a significantly smaller body mass index (kg/m^2) than any of the other three groups (ANOVA comparing the four groups, $p \leq 0.01$; all Duncan tests including the group with 'intermediate' outcome, $p \leq 0.01$; remaining Duncan tests, $p > 0.05$). The proportion of former

'vomiters' was 17% in the 'good' and 66% in the 'intermediate' outcome group. The two patient groups did not differ with respect to their lowest weight during the acute episode ('good': 40.1 ± 4.5 kg; 'intermediate': 38.8 ± 4.8 kg; *t*-test, $p > 0.05$) but they did differ significantly with respect to the time which had elapsed since the last acute episode ('good': 53.6 ± 31.4 mo.; 'intermediate': 19.8 ± 24.5 mo.; *t*-test, $p \leq 0.05$).

TABLE I.—SAMPLE DESCRIPTION (MEAN ± SD)

	Intermediate outcome ($N = 9$)	Good outcome ($N = 14$)	Restrained eaters ($N = 21$)	Unrestrained eaters ($N = 20$)
Age (yr)	21.1 ± 2.0	24.1 ± 4.2	23.4 ± 2.1	24.1 ± 2.6
BMI (kg/m^2)	18.1 ± 1.0	21.1 ± 2.1	20.9 ± 1.4	20.9 ± 1.3

Restrained and unrestrained eaters were recruited by hanging wall posters in several buildings of the University of Munich. A description of the study and a German version of the Three-Factor Eating Questionnaire (TFEQ; [18]), the 'Fragebogen zum Eßverhalten' [19] including some anthropometric questions were mailed to young women who showed an interest in participating. The subjects were selected out of 97 returned questionnaires. They were required to have no previous diagnosis of an eating disorder and not be underweight or overweight (body mass indices below 19 or above 24; [20]). Women, meeting these criteria, were included in the study as unrestrained eaters if they had a score of 4 or less on the scale 'Cognitive Restraint of Eating' (TFEQ-Restraint) and as restrained eaters if they had a score of 11 or more. (The cut-off scores correspond to the 25th and 75th percentiles of a sample of young women from the general population [19].) A description of the 41 subjects (21 classified as restrained, 20 as unrestrained) is given in Table I. Data on eating attitudes, eating motivation, psychopathology, body measures, body perception and body satisfaction, which we have published elsewhere [10], suggest that our samples are representative for the populations of unrestrained and restrained eaters [11, 21–24].

All subjects gave written informed consent and were paid for their participation in the study.

Apparatus and procedures

Sessions started at 9.30 a.m., 11.30 a.m. and 1.30 p.m. The measurement of pain sensitivity was part of a series of assessments, including questionnaires on eating behaviour and body size perception tests, not presented here. The site of measurement was always the right foot. Pain thresholds were obtained with a PATH-Tester MPI 100 (Phywe Systeme GmbH, Göttingen; for details see Ref. [25]). The thermode, which had a contact area of 6 cm^2, was attached to the lateral dorsum pedis. For determination of the pain threshold eight heat stimuli were applied with a rate of temperature change of 0.7°C/s, beginning at 38°C. The subjects were instructed to press a button as soon as they felt pain. Each time they pressed the button the temperature returned to the base value at a cooling rate of 1.5°C/s. The pain threshold was calculated as the mean of the peak temperatures of the last five stimuli. The start of each trial was announced visually and acoustically, but the stimulus was presented with a pseudo-randomized delay of between 1 and 3 sec. Skin temperature was assessed concurrently by a thermistor placed on the dorsal side of the same foot at a distance of approximately 3 cm from the edge of the thermode. Three readings were taken, from which the average was calculated.

For statistical evaluation one-way analyses of variance (ANOVA) with Duncan tests, *t*-tests, binominal tests, and Pearson correlations were computed. For the correlations one-sided testing was used since only a negative correlation between heat pain threshold and skin temperature could be considered meaningful (see Introduction).

RESULTS

As shown in Table II, the groups of former anorexic patients with a 'good' and 'intermediate' outcome and restrained and unrestrained eaters did not differ significantly from each other with respect to their pain thresholds (ANOVA comparing the four groups, $p > 0.05$). All groups had clearly lower mean pain thresholds than the patients with acute anorexia nervosa and bulimia nervosa from our previous study [1]. They did differ significantly in local skin temperature, however, with the 'good' outcome patients having higher skin temperatures than the subjects of the other three

groups (ANOVA comparing the four groups, $p \leq 0.05$; Duncan tests comparing the group with 'good' outcome to the groups with 'intermediate' outcome and of restrained eaters, $p \leq 0.05$; Duncan test comparing the group with 'good' outcome to the group of unrestrained eaters, $p \leq 0.01$; remaining Duncan tests, $p > 0.05$).

TABLE II.—HEAT PAIN THRESHOLD (°C, MEAN ± SD), RELATIVE FREQUENCY OF ABNORMALLY INCREASED PAIN THRESHOLDS (%) AND LOCAL SKIN TEMPERATURE (°C, MEAN ± SD)

	Intermediate outcome ($N = 9$)	Good outcome ($N = 14$)	Restrained eaters ($N = 21$)	Unrestrained eaters ($N = 20$)
Pain				
(°C)†	42.5 ± 2.2	42.5 ± 1.8	42.9 ± 2.4	43.3 ± 1.5
(%)‡	11	0	29	5
Skin Temp.				
(°C)	27.1 ± 3.8	30.0 ± 3.7	27.8 ± 3.2	26.2 ± 2.5

†Acute anorexics: 44.5 ± 2.4°C; acute bulimics: 44.4 ± 1.5°C (reference data from previous study [1]).

‡Acute anorexics: 42%; acute bulimics: 35% (reference data from previous study [1]).

To determine whether a reduced pain sensitivity existed at least in some of our subjects, we computed the frequency of abnormally increased pain thresholds. The healthy control subjects ($N = 46$) from two earlier studies [1, 7] served as a reference group, and 'abnormally increased' was defined as equalling or exceeding the 95th percentile (45.1°C) of this group. As shown in Table II, only in the group of restrained eaters was there a sizeable number of subjects with abnormally increased pain thresholds, which approached the figures for acute eating disorder patients. According to the binomial test, this proportion was also significantly different ($p \leq 0.01$) from the 5% that had to be expected because of our definition of 'abnormally increased' (remaining binomial tests, $p > 0.05$). This indicates a considerable heterogeneity among the restrained eaters because, as a group, they did not exhibit increased pain thresholds.

The Pearson correlation coefficients for the association between the pain threshold and the local skin temperature were $r = -0.63$ ($p \leq 0.05$) for the former anorexic patients with an 'intermediate' outcome, $r = 0.28$ ($p > 0.05$) for the former anorexic patients with a 'good' outcome, $r = 0.08$ ($p > 0.05$) for the restrained eaters and $r = 0.15$ ($p > 0.05$) for the unrestrained eaters. Thus, only in the 'intermediate' outcome group was there a significant, negative relation between the two variables.

DISCUSSION

The present study demonstrates that restrained eaters (high-risk cases) and former anorexic patients (remitted cases) do not display as comparably homogeneous increases in their pain thresholds as observed in acutely ill eating disorder patients [1]. Therefore, our findings suggest that a reduction in pain sensitivity is restricted to acute episodes of eating disorders, at least of anorexia nervosa. Within the group of restrained eaters, however, almost one-third of the subjects had pain thresholds clearly above the normal range. It may help to keep in mind that restrained eaters

have been found to be more similar to eating disorder patients with respect to eating pathology than with respect to general psychopathology [22]. Many alterations of eating behaviour have been described for this group, e.g. in food preferences, nutrient composition of meals and variability of food intake and body weight [21, 24, 26]. Furthermore, restrained eaters showed a reduced norepinephrine response to standardized test meals and had other biological abnormalities, such as low plasma insulin levels during the night [23]. Whether one or more of these changes influences pain sensitivity remains to be determined. Our findings on pain sensitivity changes in restrained eaters and acutely ill eating disorder patients appear to be similar to those in depressed subjects, where individuals with only single symptoms are less affected, and more variably, than those with a full-blown syndrome [27].

The former anorexic patients did not show a reduced pain sensitivity and they seem to differ from acutely ill patients in this respect. However, we observed exactly the same strong, negative correlation between pain threshold and local skin temperature in the patients with an 'intermediate' outcome as we had seen in acutely ill anorexics ($r = -0.6$ in both studies [1]). In the present study, no other group showed this relation; this supports the notion that local skin temperature usually does not influence pain sensitivity to any great degree [28]. There is obviously an abnormal association between peripheral thermoregulation, as measured by skin temperature, and pain sensitivity whereby this association did not appear to be limited to acute episodes of anorexia nervosa. The fasting state of acutely ill and moderately improved anorexics is probably not, by itself, the cause because a 3-wk caloric-reduced diet did not produce the same association in healthy controls [7]. Although it is tempting, we cannot explain this finding simply in terms of alterations in sympathetic activity because the relation between skin temperature, pain sensitivity and sympathetic activity is very complex, as recently stressed by Jänig [29]. Since these findings were the first indications as to the mechanisms that change pain sensitivity in anorexia nervosa, replications with larger samples and experimental manipulations of the skin temperature are needed.

Although more a by-product of this study, the significantly increased skin temperature at normal room temperature (mean: 23.4°C, SD: 1.6°C, in the present study) of the 'good' outcome group deserves comment. Neither the acutely ill [1] nor the former anorexic patients with an 'intermediate' outcome showed such an increase compared with healthy controls. This could mean that, after complete weight normalization, anorexic patients develop an increased heat loss and, possibly as a consequence, a higher energy expenditure to preserve their body temperature.

Some methodological considerations are necessary at this point. Our primary intention was to study pain sensitivity in subjects who were certainly not patients with an acute eating disorder but represented pre- and postmorbid conditions with graded distances from the acute episode. These distances should be clearly defined in both directions by using validated criteria as to what is meant by low and high risk cases and moderately and well remitted patients. Such an approach aims at samples that are typical for certain conditions but are not necessarily representative for all persons being either at risk of developing an eating disorder or having had one. Of course, the approach resulted in a reduced number of subjects in the present study because all unclear conditions were excluded.

In summary, our findings suggest that restrained eating is accompanied, at least

in some cases, by a reduction in pain sensitivity, although the more manifest changes appear to be restricted to acute episodes of eating disorders (anorexia nervosa, bulimia nervosa [1]. Presumably there is a gradual rather than an abrupt change in pain sensitivity from restrained eating to manifest eating disorder. Furthermore, an abnormal association between peripheral thermoregulation and pain sensitivity has now also been found in only moderately improved anorexic patients, and can therefore be assumed to be a rather stable feature of anorexia nervosa.

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