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Environmental and interoceptive influences on chronic low back pain behavior

Anton J.M. Schmidt, Riet E.H. Gierlings and Madelon L. Peters
Department of Medical Psychology, University of Limburg, Maastricht (The Netherlands)

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Summary The operant conditioning theory states that environmental stimuli greatly influence chronic pain behavior. In contrast, the hypochondriasis theory states that pain behavior is the result of an intensified pain perception which is part of a more general augmentation and amplification of normal bodily sensations. The operant theory predicts that pain behavior (operationalized as poorer endurance on the part of chronic low back pain patients as compared to the endurance of control subjects in a series of 6 working-to-tolerance treadmill tests) will decrease when no verbal or non-verbal feedback for treadmilling behavior is given. This hypothesis could not be confirmed in the present study.

The hypochondriasis theory predicts that chronic pain patients will report more bodily sensations, both at rest and after treadmill exercises. This hypothesis was strongly supported by the findings of the present study.

Key words: Hypochondriasis; Environmental stimuli; Pain behavior; Operant conditioning; Interoception

Introduction

Psychological research on the determinants of chronic low back pain (CLBP) behavior generally falls into 2 categories. On the one hand, CLBP behavior can be seen as a function of the environment, and on the other, as a function of a defect in the 'milieu intérieur,' such as nociception, pain perception or personality.

CLBP behavior can be modified considerably by changing social contingencies [8,9,13,22,23]. In particular, application of the operant conditioning paradigm in a therapeutic setting can lead to lower consumption of medication and higher activity levels.

Correspondence to: Dr. A.J.M. Schmidt, Dept. of Medical Psychology, University of Limburg, P.O. Box 616, 6200 MD Maastricht, The Netherlands.

Apart from clinical studies, empirical evidence for the role of operant conditioning in the maintenance of CLBP behavior is meager [18]. Fordyce studied endurance in chronic pain patients who repeatedly submitted to a standardized exertion protocol in working-to-tolerance and no feedback conditions [9,10]. The hypothesis was that if positive reinforcement maintained and augmented chronic pain behavior, the removal of any form of exertion-contingent feedback should result in equal endurance for chronic pain patients and for control subjects (Ss). Unfortunately, the data from his research do not allow clear-cut conclusions to be drawn [18]. In all tests, patients probably had poorer endurance; however, patients and control Ss had virtually identical trend lines of performance across sessions. Retesting the above-mentioned hypothesis was one of the purposes of the present study.

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Contrary to the operant conditioning theory, chronic pain behavior can also be seen as resulting from interoceptive stimuli or as a consequence of certain personality traits. Recently, much attention has been given to a reconceptualization of hypochondriasis [17]. Barsky and Klerman [3] discuss the theory that hypochondriacal patients experience their normal bodily sensations as being more noxious and more intense than normal subjects; they are augmenters and amplifiers of all their bodily sensations. Feuerstein et al. [7] state that this hypochondriasis concept cannot account for pain behavior in CLBP patients, since a higher pain perception threshold has repeatedly been found for this group [6]. In their opinion, these findings lend more support to a pain-adaptational model than to a hypochondriacal model. Contradicting Feuerstein's view is the lower pain tolerance, also found repeatedly in CLBP patients [19]. Furthermore, it may be premature to reject the hypochondriasis hypothesis for CLBP patients on the basis of pain threshold data, since pain is but one of many bodily sensations.

Thus, it would seem worthwhile to look more closely at the sensitivity of CLBP patients to all kinds of interoceptive stimuli. This can be operationalized by measuring and comparing reports of bodily sensations of CLBP patients and control Ss both after standardized exertion and at rest. If it can be shown that CLBP patients report more bodily sensations in different conditions, the hypochondriasis hypothesis will need to be seriously considered as a factor contributing to the maintenance of CLBP behavior.

In summary, repeated, standardized and back-taxing performance tests with CLBP patients can be used to demonstrate a possible increase in endurance as a result of the removal of CLBP behavior-provoking environmental and social contingencies. In addition, by measuring bodily sensations preceding or following these tests, the hypochondriasis hypothesis can be tested.

Methods

Subjects

Sixteen CLBP patients (8 males and 8 females) and 16 control Ss, matched for age and sex, participated in this study. All Ss responded to an announcement in a local newspaper.

Selection citeria for CLBP patients included: (1) having CLBP for at least 1 year, but no other chronic pain complaints; and (2) no cardiovascular risk factors found upon medical examination (pulse, blood pressure, ECG, medical questionnaire).

Control Ss also underwent such a medical examination before they were admitted to the research protocol. All Ss were paid volunteers who gave informed consent.

Apparatus

All Ss performed 6 identically structured working-to-tolerance treadmill tests within a period of 2.5 weeks. Treading speed was maintained at 5 km/h. The grade of ascent was set at 5% for the first minute and was increased by 1% at 1 min intervals. During the treadmill test, heart rate was continuously registered.

Procedure

All Ss were tested twice a week; each subject was tested at the same time of day during his or her participation period of 2.5 weeks.

All subjects were informed that the purpose of the experiment was to study physical reactions during repeated and back-stressing physical exertion. Prior to test 1, a short explanation was given about the procedure during the treadmill tests and the informed consent form was signed. Debriefing took place following test 6. Also prior to test 1, Ss were given the opportunity to get used to treadmill walking (speed = 3 km/h, grade = 5%) for about 2 min, depending on individual skill.

Ss performed the treadmill test in sportswear and without watches. Any recording equipment which may have given them exertion-contingent feedback was placed outside their field of vision. The 2 test leaders (1 male, 1 female) took their places behind and beside the treadmill. They gave no exertion-related verbal or non-verbal feedback or information preceding, during or immediately after the treadmill tests. Ss' feedback requests were referred to the debriefing period after test 6. Treadmill test instruction was to continue walking on the treadmill until they felt the need to stop due to pain or fatigue. Ss were instructed to say 'stop' when they wished to finish the protocol. The grade was then reduced to 5%; the treading speed was reduced to 2 km/h and subsequently stopped. Immediately afterwards, Ss filled in a checklist.

Measures

Pre-test biographic and anamnestic measurements included sex, age, marital status, and duration of CLBP (for the CLBP group only). Prior to test 1, all Ss completed a checklist for bodily sensations (CBS), 48 bodily sensations were listed; each item was scored on a 5-point scale. Items were classified as pain-relevant (headache, stomachache, etc.), exertion-relevant (sweating, warmth, increased heart rate, shortness of breath, etc.), or general (hunger, dizziness, coughing, etc.). A total CBS score was obtained by adding the item scores (0 → 4).

Prior to the treadmill tests, visual analogue scale (VAS) scores [15] for CLBP were obtained (patients only) and heart rates for all Ss were recorded. During the treadmill tests, heart rate was measured continuously. Immediately after the treadmill tests, maximal heart rate was registered. Ss also filled in momentary VAS scores for CLBP (patients only) and for subjective fatigue. After treadmill tests 1 and 6, the CBS was also administered.

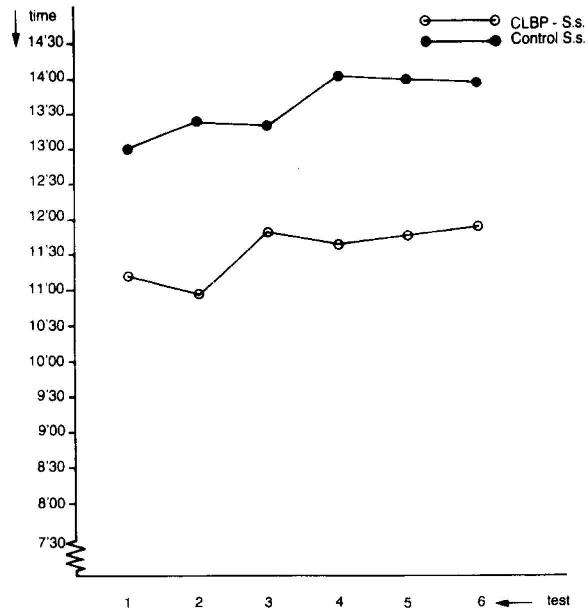

Fig. 1. Endurance of CLBP patients and control Ss in 6 treadmill tests.

Results

Mean age of both groups was 44 years. For the CLBP patients the duration of pain complaints averaged 10 years. CLBP VAS levels prior to the 6 treadmill tests were 38, 42, 43, 48, 43 and 42 respectively. Results of the operant hypothesis study and of the hypochondriasis hypothesis study will be presented separately.

Study I: the operant hypothesis

Treadmill test results of both groups are summarized in Fig. 1. From this it would seem that CLBP patients perform significantly worse on the treadmill tests. The difference is more significant for women. $\overline{X}$ (CLBP men) = 908 sec (s = 370); $\overline{X}$ (control men) = 1020 sec (s = 280); $t = 1.67$, $df = 46$, $P = 0.05$). $\overline{X}$ (CLBP women) = 479 sec (s = 170); $\overline{X}$ (control women) = 616 sec (s = 245); $t = 3.18$, $df = 46$, $P < 0.01$).

Increased endurance was explored by ANOVA with repeated measurements. An overall repetition effect was demonstrated ($F = 2.33$, $df = 5$, $P = 0.04$) but differences in performance increment between the CLBP group and the control group were not present (interaction repetition × group: $F = 0.57$, $df = 5$, $P = 0.72$).

Study II: the hypochondriasis hypothesis

The CBS was administered at 3 stages: at rest and immediately following tests 1 and 6. To increase comparability between CLBP and control groups, low back pain scores for CLBP patients were omitted from the calculation of their total CBS score. Results are summarized in Fig. 2.

Compared to control Ss, CLBP patients reported more bodily sensations after physical exertion. Taken together, the test 1 and test 6 CBS data show a difference that is clearly significant: $\overline{X}$ (CLBP) = 37 (s = 22); $\overline{X}$ (control Ss) = 25 (s = 13); $t = 2.65$, $df = 62$, $P < 0.01$. This difference

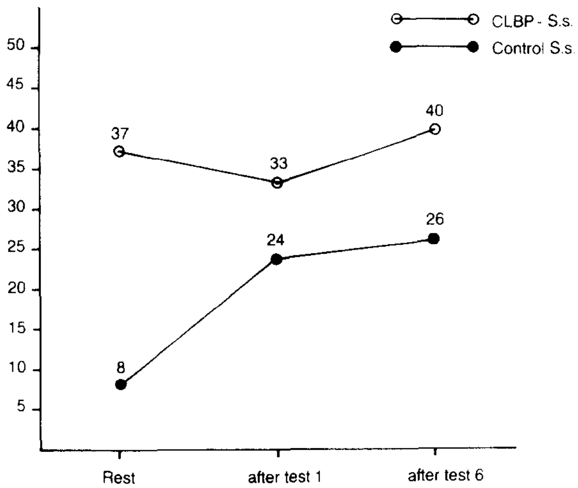

Fig. 2. CBS scores for CLBP patients and control Ss in 3 conditions.

cannot be accounted for by the CLBP group being objectively more exhausted than the control group. On the contrary, $\overline{X}$ (max. heart rate) for the CLBP group was 157 beats/min (bpm); for the control group, this was 166 bpm.

CBS group differences become even more striking when one considers the rest condition: $\overline{X}$ (CLBP) = 37 (s = 25); $\overline{X}$ (control Ss) = 8 (s = 12); $t = 4.11$, $df = 30$, $P < 0.001$. In this condition, all but one of the CLBP patients had CBS scores > 10, while all but one of the control Ss had CBS scores < 10.

Discussion

Contingent positive reinforcement of 'well behavior' can positively influence activity levels and consumption of medication in CLBP patients [13]. However, this does not automatically imply that operant conditioning is responsible for the maintenance of CLBP behavior. As Linton et al. state [14]: 'Support from clinical studies is based on a dangerous type of logic: if the treatment works, then the hypothesis must be correct. Obviously, this need not be so.' It seems to be extremely difficult to demonstrate this influence outside the treatment setting.

Block et al. [4] demonstrated that pain intensity reports are systematically influenced by social reinforcers because patients with supportive spouses rated their pain as being higher when the spouse was present and lower when the spouse was absent. The opposite was true for patients with nonsupportive spouses. Recently, Turk et al. [24] reviewed studies of family influence on the maintenance of chronic pain behavior. These studies rely heavily on pain intensity ratings and not strictly on pain behavior as dependent variables, an exception to this rule being a very recent study by Gill et al. [11], who demonstrated a relationship between social support and pain behavior.

Pain ratings were also used in a study conducted by Linton and Götestam [14], who showed that positive reinforcement of increasing pain intensity reports following a standardized, experimental pain stimulus led to increasing pain ratings even when the stimulus intensity objectively decreased.

Thus, Fordyce's attempt to demonstrate that removal of pain behavior contingencies in repeated, pain behavior-provoking tests leads to identical endurance and identical trend lines of performance across sessions between chronic pain patients and control Ss is interesting.

In our study, Fordyce's findings could be replicated only partially. Removal of exertion-contingent feedback did not prevent CLBP patients' endurance from being systematically poorer than the endurance of control Ss. Repeated testing demonstrated increasing performance tendencies both for the control group and the CLBP group. It should be noted that in this study, effects of training manifested as an increase in endurance. However, physical training effects can only be established when physiological parameters are also considered. It can be concluded from the heart rate registrations that a tendency towards better endurance was accompanied by a slight maximal decrease in heart rate (169 bpm after test 1; 165 bpm after test 6) for control subjects; for CLBP patients, maximal heart rates did not change (test 1 = test 6 = 157 bpm).

Differences between Fordyce's findings and our own may be explained by the fact that Fordyce's group was more severely handicapped than our group of CLBP patients, making greater improvements in the beginning of an exercise protocol possible for his group. However, there are no quantitative data available to test this explanation. An alternative explanation may be the difference in test frequency. Fordyce's tests — consisting of a number of different physical exercises per session — were administered within a shorter period of time than our twice-a-week frequency, which was chosen for practical reasons. However, it is virtually impossible under daily treadmill test conditions for endurance to increase by almost 100% in only 4 sessions, as Fordyce claims. Besides, the initial differences in endurance that were found between both groups in test 1 were not affected by different between-test periods.

Thus, little direct experimental evidence was found for the presumed importance of operant factors in the maintenance of a very specific kind of CLBP behavior. Other studies, however, might find such evidence. In principle, the design used by Block et al. [4] seems promising. They postulate spouses of chronic pain patients as being the most important operant reinforcers of chronic pain behavior. This reinforcement can be positive (solicitous partner) or negative (non-solicitous partner). Thus, presence or absence of solicitous vs. non-solicitous spouses in a working-to-tolerance treadmill test setting could theoretically influence endurance of CLBP patients. This type of research still has to be carried out.

The second part of this study was concerned with the reporting of bodily sensations by CLBP patients and control Ss at rest and after physical exertion. Findings should be regarded as preliminary, since the CBS is far from being a validated questionnaire. It can be compared to the PILL, used by Pennebaker [16], which is a real trait measure. The CBS, in contrast, measures exclusively one's momentary state.

The CBS has strong discriminative properties. After treadmill test exertion, CLBP patients reported more bodily sensations, although they were objectively less fatigued. Under rest conditions these differences even become dramatic: healthy persons had very low scores while CLBP patients generally scored as high as after a working-to-tolerance treadmill test. In this condition, there were only 2 exceptions: 1 CLBP patient scoring very low and 1 control subject scoring very high.

The high-scoring control subject was a very nervous 41-year-old female. In the treadmill test, her endurance was the poorest of all Ss tested (test 1: 1 min 43 sec; max. heart rate: 116 bpm), due to strong exertion avoidance and a high anxiety level, as was reported in the debriefing period. Her CBS rest score was greatly influenced by general anxiety symptoms [2], such as trembling, dizziness, shortness of breath, feelings of tension, sweating, etc.

In contrast, the low-scoring CLBP patient, a 43-year-old male, had the highest endurance of all Ss (test 1: 25 min). He considered his LBP a stimulus to continue all kinds of physical activities in his daily life and did not rest because of high LBP levels. He admitted having LBP every day, especially in the morning, but he made a conscious effort to disregard it completely.

The finding that CLBP patients reported more bodily sensations in all conditions is in accordance with the expectations. It is noteworthy, however, that the reporting of bodily sensations in the patient group does not increase with exertion. There is, in fact, no clear explanation at hand for this phenomenon. Possibly the very high resting score that was measured is not representative of the whole CLBP population, but is actually of a somewhat lower level. Another possible explanation could be that in CLBP patients reporting and interoception are hardly related to each other. Verbal reporting, then, has a primarily communicative function and hardly refers to what is happening within the body.

The high CBS scores for CLBP patients give rise to some interesting hypotheses. Firstly, high CBS rest scores can be seen as a response tendency. Here, pain complaints, as one aspect of pain behaviors, have generalized to other bodily sensations. This is learned behavior; it is assumed that complaining about more than just chronic pain elicits more positive reinforcement from the environment. This generalization theory makes no statements about interoception or perception of bodily signals; it only refers to the fact that the patient discovers by trial-and-error learning how to get maximal reinforcement from his or her environment [12].

Another hypothesis is the hypochondriacal one. High CBS scores for CLBP patients come from augmentations and amplifications of normal bodily sensations, including pain. For chronic pain patients in particular, this can also mean that pain labeling takes the place of other bodily sensations. Barsky and Klerman [3] give an example: what the normal individual perceives as abdominal tightness or pressure, the hypochondriacal patient experiences as abdominal pain. They also mention 2 main factors that can be responsible for this augmentation: attention and anxiety. In the pain literature, there is no doubt that these factors can enhance pain [21]. Following this line of thought, it can be hypothesized that CLBP patients experience more bodily sensations because they focus more attention (perhaps unconsciously and automatically) on all kinds of normal bodily sensations. This hypothesis can be verified for it implies that healthy subjects who are instructed to concentrate on bodily sensations in rest conditions will have CBS scores comparable to those of CLBP patients.

A recent study by Ahles et al. [1] lends some support to this hypothesis. They asked a group of undergraduate college students to concentrate on different parts of their body and, subsequently, to score pain responses in these regions. Seventy-eight Ss gave 947 positive pain responses on a 25-item checklist, meaning non-zero ratings for 50% of the pain items. For the CBS, administered to 16 CLBP patients, a non-zero rating of 40% was obtained, indicating that our CBS findings for the CLBP group in rest conditions are not exceptional.

Support for the hypochondriasis view of chronic pain patients does not imply that these patients are also more sensitive to painless or painful experimental stimuli. On the contrary, Seltzer and Seltzer [20] found that these patients had higher 2-point tactile discrimination thresholds than pain-free individuals, thus indicating a lower sensitivity. This combination of a lower sensitivity and the reporting of more bodily sensations at rest demonstrates that — imitating Pennebaker [16] — more studies on the perception and processing of bodily sensations, especially with chronic pain patients, are badly needed.

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