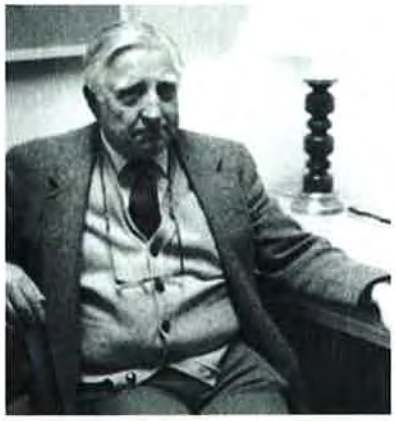
foundations from the Foundation, Spring 2013: *Wilbert Fordyce*

foundations from the Foundation for Rehabilitation Psychology…*building an endowment that supports student research, professional education and the advancement of Rehabilitation Psychology.*

Operant conditioning in the treatment of chronic pain. Fordyce W, Fowler W, Lehman J, Delateur B, Sand P, Trieschmann R, 1973. Arch Phys Med Rehabil, 54: 399-409.

The second selection for "*foundations* from the Foundation" comes from Wilbert "Bill" Fordyce, PhD (1923-2009). Bill received his PhD in clinical psychology at the University of Washington in 1953. After working at the Seattle VA hospital for several years, he joined the university's Department of Rehabilitation Medicine in 1959 as an assistant professor. He became full professor in 1970, and professor emeritus in 1993 He was a founding member of International Association for the Study of Pain and the American Pain Association, and a fellow of the American Psychological Association. He was President of Division 22, and served on the Boards and as President of many professional organizations.

Dr. Fordyce pioneered the use of behavioral psychological principles in the treatment of chronic pain and other chronic medical conditions. His book "Behavioral Methods in Chronic Pain and Illness" is still widely cited in the field of rehabilitation medicine. Dr. Fordyce's professional accomplishments were honored with innumerable awards, including the establishment of the annual American Pain Society "Wilbert E. Fordyce Clinical Award".



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Dr. Fordyce developed approaches to dealing with chronic pain that were groundbreaking at the time. He used behavioral principles to encourage chronic-pain patients to become active again and to cut back on the amount of pain medication used. His work led the way for the integration of psychological principles and psychologists into the care of people with chronic pain. In the early 1970's, Fordyce and his colleagues conducted a study that operant learning methods could be used to increase activity and reduce medication for people with chronic pain being treated on an inpatient admission. (Fordyce WE, Fowler RS Jr, Lehmann JF, Delateur BJ, Sand PL, Trieschmann RB. (1973). Operant conditioning in the treatment of chronic pain. *Arch Phys Med Rehabil.* 1973 Sep;54(9):399-408.)

These principles and work still serve as foundations for the care of persons with chronic pain.

KEY WORDS: Conditioning, operant; learning; pain

Operant Conditioning in the Treatment of Chronic Pain

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• The concept of chronic pain is analyzed from a learning point of view, leading to a treatment program based on learning principles. Selected patients with chronic pain were treated by an operant conditioning program. Treatment was designed to reduce medication and interference in activities because of pain and to increase performance in exercises, walking and general activity level. The significant improvement in the patients treated has implications for diagnosis and treatment of some problems of chronic pain.

Chronic pain is one of the most difficult and burdensome problems in medical practice. The patient suffers both physical discomfort and limitation in activities because of persisting pain. The physician in turn is faced with the frustrations of frequent failure of treatment to resolve the pain problem and by the patient's unremitting calls for help. The work reported in this paper suggests that some of the failures of traditional treatment approaches result from reliance on a too narrow conceptual model of pain.

The traditional approach to the diagnosis and treatment of chronic pain is based on a medical or disease conceptual model. Pain is viewed as a symptom which occurs as an automatic or reflex response to an afferent stimulus produced by some pathogenic factor. Diagnostic efforts seek to identify the presumed underlying pathogenic factor. Treatment is aimed, if possible, at removing the pathologic condition or stimulus so that the pain will no longer occur. That view of pain assumes the presence of an antecedent pathogenic stimulus. If the diagnostic process fails to reveal current and active pathologic change or if the amount of change appears insufficient to account for the amount of pain displayed by the patient, a second set of pathogenic factors may be inferred, focusing on emotional or personality problems. These are usually identified by such terms as "psychogenic pain," "conversion reaction," or some variation around the theme of hysterical over-reaction to modest amounts of pathologic change. The inference of emotional or personality pathology continues to assume that some intra-organism {tissue or psychic) pathologic change accounts for the pain which is observed or reported.

Examination of the observations by which physicians identify pain problem points to alternative ways of conceptualizing clinical pain. Sternbach[1] has said, "In order to describe pain, it is necessary to conceive of it as a set of responses . . . a person must do something . . . in order for us to determine that he is experiencing pain." Stated another way, the person must engage in some behavior identified by observers as indicative of pain, that is, he must engage in pain behavior.

Diagnostic inferences and treatment judgments about clinical pain are based predominantly on information from the patient in the form of his pain behavior. He says he hurts. He describes the pain experience. He grimaces, holds a painful body part, asks for analgesics or stops an activity to rest because of his pain. However, Lasagna[2] notes, ". . . The investigator who would study pain is at the mercy of the patient, upon whose ability and willingne to communicate he is dependent." Kast and Collmgs[3] stated, "In judging the intensity of pain by verbal exchange, one must be willing to accept the premie that the descriptive terms applied to degrees of pam refer to definite quantities. However, it is not known that these degrees of pain are elicited by the same sensory input in different individuals." Those statements point out how diagnostic inferenes about the nature and type of underlying pathogemc factors are subject to distortion because of potentially faulty patient-derived information.

Beecher[4] notes:

> Many investigators seem grimly determined to establish-indeed too often there does not seem to have been any questio in their mind-that for a given stimulus there must be a given response; that is, for so much stimulation of nerve endings, so much pain will be experienced, and so on. This fundamental error has led to enormous waste . • . It is evident in work in our laboratory that there is no simple relationship between stimulus

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This project was supported in part by Grant No. 16-P-56818/0-10 from the Social and Rehabilitation Service, Department of Health, Education and Welfare. Washington, DC.
Submitted for publication October 12, 1972.

and subjective response. It is also made evident that the reason for this is the interposition of conditioning, of the processing component, of the psychic reaction. It is clear that this component merits and must have extensive consideration. It must be taken into account not only for pain but for all subjective responses.

The foregoing citations note that identification and measurement of pain is based on and inevitably filtered through something the patient says or does and that information from a patient about the nature and severity of his pain is subject to marked influence by factors which are independent of underlying pathogenesis.

How does conditioning interpose? Skinner's[5] work elucidating the principles of operant conditioning appears to be directly applicable. The pain behaviors of patients with chronic pain are for the most part what Skinner has termed, operants. Operant conditioning refers to the functional principles by which the rate, strength or frequency of occurrence of operants may be increased or decreased.

Operants, while capable of being elicited by antecedent stimuli, are also subject to influence by consequences. When an operant is followed by a positive consequence (for example, a reinforcer such as praise, attention from significant people, money, food) that behavior is more likely to occur in the future: that is, that behavior will be strengthened or increased in rate of occurrence. When an operant is followed by a negative consequence (for example, criticism, loss of valued rewards) , that behavior is likely to occur less frequently in the future or decrease in strength and behavior designed to remove the negative consequence or avoid it is likely to increase. When a behavior is followed by neither positive nor negative consequences, the behavior will tend to decrease in frequency, a process called extinction. These behavior-consequence relationships are basic elements of operant conditioning.

The behaviors making up most of the manifestations of pain, like other operants, may be elicited by antecedent stimuli, for example, by the noxious stimuli of pathologic changes in tissue. However, those very same operants making up pain behavior *may* come under the control of consequences. They may come to occur only because they are followed systematically by positive consequences.

Across the history of a patient's pain problem, his pain may have begun because of the presence of a noxious stimulus in the form of pathologic changes in tissue. If,however, his pain responses or behaviors (operants) were systematically reinforced during the early stages of his pain problem, it is possible those pain responses would continue to occur, if still being reinforced, even when the original noxious stimulus was no longer present or active-or was minimally active. Moreover, there is no inherent reason why the quality of the patient's pain responses would appear or sound discriminantly different to the diagnostician. Suppose further that a patient's activity or well behavior, as in work, exercise, or vigorous and active leisure pursuits, all operants, were no longer being systematically reinforced. Under these conditions, the rate of those well behaviors likely would diminish.

If it could be established in any given patient with pain that pain behaviors were systematically followed by favorable or reinforcing consequences and/or that well behaviors were no longer followed by reinforcement, it is possible that such a person would display much pain behavior and little well behavior even where there was no longer an active pathogenic factor.

The work reported here approaches selected problems of chronic clinical pain from the perspective of the principles of operant conditioning. It views pain responses in *selected* patients as learned behaviors subject to influence by consequences. Because the learning-based treatment approaches 'do not aim at modifying tissue or emotional pathology but instead are directed specifically toward pain responses or pain behaviors, the methods also stand as a partial test of the question of whether it is necessary to assume a patient's pain is under the control of antecedent stimuli in the form of tissue or emotional pathology. If a patient's pain responses or behaviors can be altered without attacking either the alleged antecedent noxious stimuli "causing" his pain, or alleged underlying emotional problems, the validity of the disease model of pain as the sole explanatory system must be questioned.

Method

When pain is treated as learned behavior, the focus is on the pain behaviors themselves. The measurement of treatment effects consists of measuring change in pain behaviors and "well" behaviors. A patient would be considered to have improved if he displayed a decrease in specifically defined pain behaviors and an increase in the "well" behaviors, which were the focus of treatment.

In the work reported here, the goals of the treatment program were as follows: to reduce medication intake; to decrease the avoidance of activities because of pain; to increase selected exercise tolerance; to increase walking; and to increase general social and work activities. Efforts were also made to reduce the patient's talking about or complaining about pain. Formal data about verbal pain behavior were not collected because of the difficulty in obtaining valid measures of such activity independent of specific elicitation of statements about pain from observers.

The data reported describe changes in a sample of patients with problems of chronic pain who were admitted to and who stayed in the program for four or more weeks of inpatient treatment, a period long

enough for minimum performance data to be obtained. The program evolved over several years of trial and error experience. Minor changes in criteria for admission, in treatment and in record-keeping systems from which to observe results occurred as experience accumulated.

Limitations on the inferences supported by these data will be discussed in more detail below. The frequency of what appear to be significant successes with the operant approach serves as our justification for describing results when so many factors could not be controlled or were loosely controlled in the procedures used.

Subjects

The 36 patients included in the study were selected from those referred between October 1967 and March 1971, either to the Pain Clinic (of which the first author (WEF) is a . member) , University of Washington School of Medicine and Hospital, or directly to the Department of Rehabilitation Medicine where the treatment procedures were carried out. All patients were adults and were selected on the basis of the following criteria:

1. having a diagnosis of a clinical pain problem of several months' duration which had failed to respond to surgical or conservative treatment,
2. having no clear indications for alternative medical or surgical treatment,
3. medically determined to have the physical capability of walking,
4. identified by interview with patient and spouse (where appropriate) as showing a systematic relationship between pain behavior and apparently positive environmental consequences,
5. identified by interview and observation as likely to be responsive to reinforcers controllable in the hospital setting,
6. identified by history as having previously engaged in activities which likely could be re-established or approximated in the patient's environment if treatment led to an appropriate activity level,
7. agreed to participate in the program.

Table 1: Personal Data and Pain History in 36 Patients Having Chronic Pain

Factor	Mean	Standard deviation	Range
Age, yr	41.75	8.9	22 - 62
Education, yr	12.15	2.5	6 - 20
Time since onset of pain, mo	92.70	85.6	4.5 - 396
Time since last fulltime employment,* mo	41.21	39.5	1 - 216
Major operations for pain,† no	2.69	2.6	0 - 13

*For housewives: months since began requiring help with housework.
†Major operations immediately related to referring pain problem.

Each of the 36 patients had an active and current pain problem and had failed in multiple treatment programs in the past.

Table 1 shows age, education, duration of illness and number of previous surgical procedures for pain in the 36 patients, and table 2 reports more detail regarding formal diagnoses by referring physicians. The modal group were those having some form of so-called mechanical back pain. It was commonly the case that the patient would present at least two pain problems (for example, back and neck or shoulder), though formal diagnoses mentioned only one. Patients were treated under the same general format and are considered as comparable in the data reported, regardless of site of pain or type of diagnosis.

Each patient was examined by a physiatrist who had access to medical data from the referring physician. The physician's screening examination included an interview, a physical examination, and where appropriate, radiographic examination and elect romyography. The physiatrist's examination searched particularly for discrepancies between pain behavior and observed or inferred pathology. A discrepancy is not a logical requirement of an operant approach but makes it more likely that pain behavior is under control of factors other than tissue pathology. The physiatric examination also served to define upper performance limits for the patient, that is, the amount, kind and rate of activities indicated as prudent at outset and at subsequent points throughout the program.

The patient was also evaluated by a psychologist, and frequently by a social worker, to explore for systematic relationships between pain behavior and what appeared to be reinforcing consequences in the patient's environment and to identify events which appeared to serve as reinforcers to the patient. It was necessary to identify reinforcers for each patient in order to determine whether the reinforcers available and controllable in the hospital setting could be used to increase the frequency of well behaviors and decrease the frequency of pain behaviors.

Screening interviews also served to determine whether the spouse would agree to participate in appropriate training sessions. Whenever possible, prior to admission, each patient was provided with two weeks of daily diary forms with which to record the distribution of daily activities among reclining, standing or walking, and sitting.

If the physiatrist and the psychologist concurred that the patient was an appropriate candidate, the rationale, treatment objectives and treatment procedures were explained in detail to patient and spouse together. In most cases, the spouse was required to come for twice weekly training sessions. Some patients were accepted with no spouse participation.

Table 2: Summary of Number of Operations and Diagnoses in 36 Patients Having Chronic Pain

Case	Sex	Age, yr	Operations	Diagnosis*
1	F	22	0	Chronic low back strain; transitional lumbosacral vertebra on left.
2	F	45	1	Lumbosacral strain 4 years PTA. SPO L4 through S1 fusion, unstable.
3	F	38	0	Postelectric shock neck pain.
4	F	37	4	Chronic (18 yr) back pain; SPO 4 back surgeries including lumbar laminectomies and L5-S1 fusion, solid; adhesive arachnoiditis; obesity.
5	F	35	0	Chronic (3 yr) low back and cervical pain; chronic herniated intervertebral disc L5-S1 on right; S1 radiculopathy.
6	F	37	2	Herniated disc; SPO two surgeries L4-S1 fusion and lumbar laminectomy; sympathetic dsystrophy, right lower extremity; passive-aggressive personality
7	F	47	0	Right hip, buttock and shoulder pain; partial fusion of posterior elements of C7 and T1 associated with slight cervical scoliosis; no other objective findings.
8	F	35	9	Old (32 yr PTA) fracture right elbow; chronic elbow pain; ulnar nerve irritation; SPO ulnar translocation and cervical sympathectomy.
9	F	52	4	Multiple sacral cysts; 4 laminectomies; arachnoiditis; sacral nerve deficits
10	F	53	3	Herniated disc; chronic (6 yr) low back pain; SPO multiple surgeries including larninectomy, cordotomy and sympathectomy.
11	F	38	3	Chronic (9 yr) back pain; SPO 1 laminectomy and 2 spinal fusions: L4-5, L5-S1 stable; arachnoiditis with L5 nerve root irritation
12	F	31	3	Lower back pain intermittent for 6 yr; SPO laminectomy; SPO fusion L4 to sacrum; repeat back surgery, type unknown; old healed compression fractures of T12 and L1; repeat laminectomy and fusion of L4-5.
13	F	28	2	Chronic (6 yr) low back pain; discectomy and 2 fusions; second stable.
14	F	32	0	Chronic (2½ yr) back pain; lumbar scoliosis; no nerve deficit; tension state.
15	F	47	4	Chronic (11 yr) lower back pain; L4-5 herniated disc; SPO 3 lumbar laminectomies; chronic S1 radiculopathy.
16	F	35	2	Lower back pain with history of herniated lumbar disc; SPO lumbar laminectomy.
17	F	33	6	Right midback pain; T9-10 radiculopathy; SPO gastric resection, vagotomy and pyloroplasty; dumping syndrome.
18	F	53	3	Chronic (5 yr) lower back pain; SPO 2 laminectomies; SPO spinal fusion
19	F	46	4	Chronic back pain (19 yr); SPO 3 lumbar fusions and 1 lumbosacral fusion; possible L3-4 pseudoarthrosis.
20	F	41	2	Laminectomy and fusion; L5-S1 arachnoiditis with low back pain.
21	M	48		Chronic (4 yr) lower back pain; prior disc syndrome; SPO laminectomy and fusion L5-S1.
22	M	47	0	Chronic (3 yr) back pain, chronic sprain, lumbar spine; osteoarthritis of spine; **chronic schizophrenia.**
23	M	51	2	Chronic (3 yr) back pain; herniated nucleus pulposus; SPO two laminectomies and discectomies; arachnoiditis.
24	M	55	2	Chronic (6 yr) cervical and upper back pain; SPO ant C4-5 and C5-6 discectomies and interbody fusion 5 yr PTA; SPO C6-7 discectomy and interbody fusion, 1 year PTA.
25	M	34		Chronic (5 yr) lower back pain; SPO L5-S1 laminectomy, discectomy and fusion.
26	M	35	2	Chronic (4 yr) back pain; laminectomy and fusion; pseudoarthrosis; obesity.
27	M	46	3	Chronic (8 yr) lower back pain; herniated lumbosacral disc; SPO laminectomy and L5-S1 fusion, SPO L4-5 laminectomy and fusion; refusion of pseudoarthrosis; foraminotomies (L) L5-S2; bilateral lumbar sympathectomy.
28	F	46	5	After slipping on ice in 1964, chronic pain problem secondary to probable nerve root scar, chronic depression and barbituate narcotic addiction; four operations between 1964 and 1965: first was laminectomy and three others fusions; another laminectomy and exploration of nerve roots in 1969.
29	F	34	3	**Lower back pain secondary to depression, chronic, severe; no evidence of disc** disease; not suffering from sciatica; Believe problem of pain due to muscle spasm; Operations: 1965-laminectomy and discectomy, 1966-<liscectomy. 1967-discectomy and fusion.
30	M	48	13	Fall with back injury; 13 subsequent operations including 4 laminectomies and 5 cordotomies; developed spastic bladder and impotence in 1968 with a cordotomy; always pain in low back and legs worsening 6 mo ago.
31	M	51		Chronic lower back pain; left ulnar neuropathy; injured back in lifting in 1964; in 1968 underwent lumbar laminectomy and fusion of L5 and S1; pain showed **no improvement.**
32	M	36	0	Neck, back and leg pain and spasm after struck by Jog and fall on ship
33	F	62	6	Chronic backache; three laminectomies and fusion of L3 and S1; hysterectomy and oophorectomy (1965).
34	F	30	3	Auto accident and L5 compression fracture followed by multiple surgeries for relief of low back and extremities pain; operations: 3/68-L4 to S1 laminectomy and L4-5 discectomy, 10/68-bilateral L4-5 S1 fusion, 4/69-bilateral L2-L3-L4 discectomy with fusion of L2 and sacrum.
35	F	53	3	Lower back pain, chronic with apparent mild weakness of right foot and the dorsiflexors with considerable emotional overlay.
36	F	43		Low back strain caused by automobile accident and fracture of fifth lumbar vertebra: pain continued despite 1967 laminectomy at L4, laminectomy in 1969 and in 1970 manipulation under anesthesia.

*SPO, status postoperative. PTA, previous to admission.

Treatment

Treatment was carried out in a hospital-based comprehensive medical rehabilitation center and a 30-bed nursing ward housing patients with a variety of physical disabilities. There were usually to pain patients in the inpatient phase at any one time. Although the duration and details of treatment varied with each patient, the general approach was the same. The duration varied according to rate and amount of progress plus a variety of logistical and financial considerations. Each patient received a minimum of four weeks of inpatient care. The maximum was 12 weeks. A longer program generally was related to slow progress or no progress at all. In some instances, however, extension of the inpatient phase related to need to complete further steps in working with the patient's home environment before returning the patient to that environment. The data reported here are based on changes from the first to the last inpatient week.

Table 3 shows the mean number of weeks of inpatient and outpatient treatment, and of follow-up contacts. The data in table 3 show that some patients received no outpatient treatment, while others continued for as long as 24 weeks. Patients continued to keep diary records throughout the outpaient period and for varying intervals thereafter. Diary' records were kept on a decreasing schedule until finally terminated. Periodic diary records beyond the inpatient and outpatient phases of treatment were collected to study the durability of the increases in activity level established during the formal treatment phase.

The specific pain behaviors to be reduced or extinguished varied with each patient. The pain behaviors most frequently displayed were taking medication, moaning, gasping, or verbalizing the prsence of pain, communicating the presence of pam by gesture or facial expression, walking in a guarded, protective manner, and interrupting or curtailing activities to recline or sit to ease pain.

The activities to be increased (well behaviors) also were specific to the individual patient. They can be grouped into certain classes common to all patients: one or more prescribed exercises in physical therapy, physically demanding tasks in occupational therapy (for example, weaving, operating a weighted hand printing press), walking laps of a measured course, and time in a work assignment at a job station within the hospital or nearby university buildings.

Table 3: Weeks of Treatment and Follow-up in 36 Patients Having Chronic Pain

Period of observation	Mean	Standard deviation	Range
Inpatient treatment	7.17	2.8	4 - 19
Outpatient treatment*	3.13	5.2	0 - 24
Outpatient follow-upt	76.17	46.8	5 - 174.9

*Regular schedule in physical and occupational therap..
tContact maintained by correspondence and/or chmc follow-up Yisits.

Efforts to modify the natural environment of patients to encourage maintenance of treatment gains may be summarized under two general categories. The first category encompassed efforts to modify the spouse's response to pain and well behavior. The spouse was helped in interview training sessions to identify the patient's pain behavior, to identify his reactions to the patient's behavior (consequences to the patient), to identify well behaviors and his reactions to those, and to change his responses to those events in the desired and appropriate manner. The objective was to insure that the patient continued to be reinforced for well behavior with a minimum of reinforcement for pain behavior. The second category included efforts to modify further the natural environment through facilitating the patient's reentry into activities which had appeared to be reinforcing prior to onset of the pain problem..For example, if employment was the target, the patient was assigned to a related job station during treatment and assisted in job placement or training after the program. If socializing was the target, socializing activities were developed which the spouse would encourage and participate in with the patient. The umber of these activities was gradually increased durmg the course of the program. In all cases the goal after several weeks of treatment was for as full as possible a set of reinforcing activities to be available to the patient (and, where appropriate, reinforcement by spouse attention and approval).

Extinction of Pain Behavior

TAKING MEDICATION

Most patients with chronic pain use m ication to control pain. Medication is usually amm1ste ed. on a pm (take when needed) basis, with restnct10ns as to the total amount to be taken each day. The patient hurts and then asks for or takes medication. In that sequence, the immediate and systematic consequences to asking for or taking medication are chemotherapeutic relief and, if given by another, the attention of the person giving it. Relief and attention are both potentially powerful reinforcers. . .

Pain medication was shifted from a pam-contmgent to a time-contingent basis to encourage etinction. Medication was delivered at fixed tune mtervals whether or not the patient expressed a need for it. On admission, the patient's rate (kind, dosage and time) of taking medication was observed directly, or by his report, to establish a baseline. The daily amount was then divided among dosages, delivered

at fixed time intervals shorter than the patient's demonstrated pattern. Medications were delivered in a color- and taste-masking vehicle, usualiy either glycenyl guaiacolate or cherry syrup. Dosages were gradually reduced, eventually reaching or nearing zero in approximately seven weeks in virtually all cases.

EXERCISE AND PHYSICAL ACTIVITY

When pain behavior occurs, people in the presence of the patient usually take action designed to relieve the patient's pain. The spouse may fetch water or take over and complete the task underway when the pain began. The physician or nurse may express concern. Such ministering behaviors may function as favorable consequences for reinforcers to the pain signal by reducing pain, by distracting the patient or by evoking pleasant feelings associated with having the attention and regard of a valued or prestige figure.

Withdrawing attention as a reinforcer proceeded by encouraging all personnel having contact with the patient to be as socially nonresponsive to pain behavior as seemed appropriate.[6,7] The point was not to let the attention of the professional be contingent upon pain behavior.

The role of rest as a reinforcer becomes clearer when it is recognized that a common consequence to a pain signal is to stop the activity underway when the pain occurred and to recline so that the pain will abate. This is the analog of working to tolerance. Rest is contingent upon pain.

Programming rest as a reinforcer for activity rather than for pain behavior proceeded first by establishing the patient's tolerance limit for each treatment activity, that is, the amount the patient could complete before he began to signal pain behavior. After that baseline was established, an initial quota was set for the patient to do *less* than his tolerance limits. He was then allowed to rest before the next activity. The immediate consequence to completion of a performance quota in occupational therapy or physical therapy was attention by the therapist. The performance was recorded and a period of rest was offered. Quotas were then gradually increased at rates defined by therapist judgment as to the patient's increased tolerance. Rest and attention were in this manner made contingent upon performance of treatment tasks.

Failure to meet quotas, a rare event, was reacted to in a socially nonresponsive way. Performance was recorded matter-of-factly. No effort was made to encourage further performance at that time to insure that therapist attention remained contingent upon performance, not nonperformance.

Increases in the amounts of exercise or activity patients could achieve from initially observed tolerance limits without being stopped because of pain

Results

ACTIVITY LEVEL

Each patient was provided with the same kind of diary forms he had completed during the preadmission period on which to record the amount of time each day spent reclining, standing or walking, and sitting. Totals were calculated and recorded by a member of the treatment team. The values for the standing-walking and the sitting categories were summed and recorded as "uptime" or nonreclining time. Table 4 gives mean uptime hours per week for patients at preadmission, first inpatient week, last inpatient week and last contact week. The data in table 4 show that the preadmission diary data corresponded quite closely to the values obtained during the first week of inpatient treatment when the patient was under direct staff observation. The mean weekly total uptime values in the preadmission period correlated 0.82 with mean weekly uptime totals during the first week of inpatient treatment, giving further evidence to show diary data are a reliable index of patient activity level in or out of the hospital.

The data in table 4 also show a significant increase in the amount of uptime or nonreclining time from admission to last contact. That was true whether one compares preadmission activity levels with values obtained during the last week of inpatient treatment ($t = -4.247$, $p = <0.001$) or the last week of follow-up diary data ($t = -5.552$, $p = <0.001$) or compares changes between the first and last inpatient treatment weeks ($t = 5.167$, $p = <0.001$). It is of interest to note that there tended to be an increase in recorded uptime after the patient left the hospital. That is to be expected because the routine of home daily living tends naturally to call for more activity than does life in a hospital. The post-hospital increase, however, suggests that uptime gains in the treatment program were not simply a result of increased demands made on the patient by staff.

A slight but nonsignificant decrease in uptime occurred from preadmission to first inpatient week. This probably resulted from limited treatment schedules during the first few inpatient days.

Preadmission to Last Contact in 36 Patients Having Chronic

Table 4: Hours Per Week of Uptime (Nonreclining). From Pain

	Hours per week*	
Period of observation	Mean	Standard deviation
Preadmission		
First inpatient week		

Last inpatient week ..... Last week of contact	59.2	24.8
	88.9	23.4
	94.9	17.4

*Recorded by patients on diary forms.

or fatigue constitute one of the clearest measures of effects of this program.

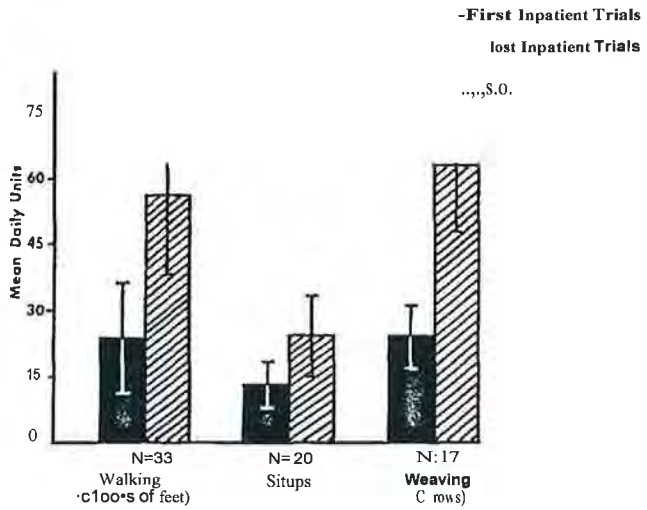

fig I-Changes in performa nce of most frequ ently prescribed activities d u ring in patient t reatment.

EXERCISE TOLERANCE

The number of units completed of each prescribed exercise or activity during each treatment session was recorded. Comparisons were then made between the number of units of each treatment procedure performed at the outset (tolerance limits) and during the last week of inpatient treatment.

Figure 1 compares the first and last inpatient treatment weeks for the three most frequently prescribed treatment activities, walking and situps in physical therapy and weaving with weights attached to the loom in occupational therapy. Figure 1 shows highly significant increases in each of these activities across four weeks of treatment. All differences were significant at the p = <0.001 level. The differences shown are actually underestimates of the distances patients could have walked or exercises which could have been completed during the last inpatient treatment week without having to stop becau e of pain or fatigue. When a patient had reached performance levels judged as adequate for treatment purposes, quotas were either limited at that point, even when the patient felt ready to go further, or were reduced in order to free the patient's time to engage in other treatment activities.

MEASUREMENT OF RESULTS

The kind and amount of medication taken daily was recorded and compared between the first and last inpatient weeks.

Medications taken by patients varied so that comparisons across patients required a general classification system. Medications were classified into narcotic analgesics, analgesics, sedatives and hypnotics. A unit potency value, defined as an average effective dose, was calculated for each of these four classes of medications.s-11 Unit potency values for sedatives and hypnotics were considered comparable and those two classes were pooled. Table 5 specifies the drug equivalents for analgesics and describes the sedative and hypnotic values.

Figure 2 compares the unit potency values for each class of medication during the first and last inpatient weeks. It is evident from figure 2 that marked reductions in medication intake occurred in the patients treated. Statistical comparisons using paired t-tests were statistically significant. Comparisons of means for the summed value of all medications indicated difference significant at the p = <0.001 level of confidence. Virtually every patient who remained in the program beyond the inpatient phase continued to reduce his medication intake. The amount of reduction shown in figure 2, then, describes only how far the reduction process had progressed at the time of discharge to outpatient treatment.

The data in figure 2 indicate clearly that increases in patient activity levels cannot be accounted for in terms of pain having been masked by increased medication. These data also lend support to the appropriateness of the kind of learning-extinctin approch used here as an effective method for reducmg medication habituation.

FOLLOW-UP

The fact that approximately half of the patients came from areas several hundreds of miles away and most of the others were beyond easy commuting distance to the hospital complicated long term follow-up. There were no funds or manpower avilable with which to make direct follow-up observations of patient performance. The necessary compromise was reliance on a questionnaire.

A second complicating factor in carrying out follow-up derives from the very nature of the concept of pain at the core of the program. The program assumes that verbal report and other visible/ audible signals of pain are not by themselves reiable indictors of either the presence or the seventy of a pam

Table 5: Drug Equivalents for Analgesics

Drug	Potency (morphine = 1)*	Average effective dose
Morphine	1	10 mg every 4 hr
Codeine	1/6	60 mg every 4 hr
Meperidine (Demerol)t	1/10	100 mg every 3 hr
Percodant		1tab every 6 .hr
Darvon§	1/6	65 mg every 4 hr
Talwin ll	1/3	30 mg every 4 hr
Aspirin (acetylsalicylic acid) salicylate	5 cc = 600 mg	600 mg every 4 hr 5 cc every 4 hr
Choline (Arthropan) Tl	acetylsalicylic acid in potency	

*Morphine, in an average effective dosage (10 mg every 4 hr), is used as the standard of potency and frequency.
tWinthrop Laboratories, New York, NY.
tEndo Laboratories, Richmond Rill, NY.
§Eli Lilly and Co, Indianapolis, IN.
ll Winthrop Laboratories, New York, NY.
nPurdue-Frederick Company, Norwalk, CT.

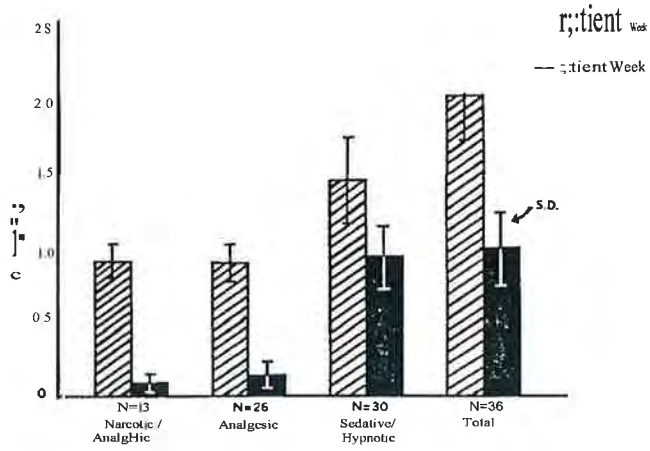

Fig 2-Changes in medications during inpatient treatment.

problem. From the operant perspective, to ask a patient how much pain he has is to beg the question. A more relevant measure would be direct observation of what he is doing. Since that was not possible except in a small proportion of the patients, the questionnaire method was again used. Of the 36 patients studied, 31 could be located for completion of the follow-up questionnaire. The average interval between termination of outpatient treatment and completion of the follow-up questionnaire was 22 months.

Patients were asked to rate on a ten-point scale the amount of pain they remembered themselves as having had at the time of admission and discharge from the program and at the time of completing the follow-up questionnaire.

Zero on the scale represented no pain whereas 10 equalled maximal pain. The average ratings of pain intensity were: upon admission 8.57 ± 1.33, at discharge 6.03 ± 2.34, at follow-up 6.17 ± 3.00 ($n = 30$). Although at the time of follow-up, patients still claimed considerable pain they recall a statistically significant decrease in pain intensity between admission to the program and discharge ($t = 5.09$, $p = <0.001$). They reported no significant change since discharge.

Patients were also asked to rate on a ten-point scale the degree of interference in activities from pain at the time of admission, discharge and follow-up. Again 0 equalled no interference and 10 equalled maximal interference. The average ratings were: At admission 7.76 ± 2.63, at discharge 4.83 ± 3.23, at

day's normal uptime hours (7:00 am to 10 pm) for the preceding two weeks. In the 17 subjects responding completely to this item, the average estimate of hours of uptime received at follow-up was 12.55 ± 2.71. These same patients had recorded an average of 10.27 hours ± 3.04 uptime between the hours of 7:00 am and 10:00 pm prior to admission. The increase in uptime between preadmission and follow-up was significant ($t = 3.40$, $p < 0.01$).

Such measures as how many were working fulltime or parttime, or, in the case of the housewife, how much help was required to complete tasks are not measures of change for several reasons unrelated or tangentially related to the program. For example, several patients had permanent irreversible functional impairment resulting from the operations they had undergone for their pain problems, thereby precluding return to work. Others had already received permanent medical retirement, including assistance in housekeeping. Still others were prevented from returning to employment by restrictions placed on employers with regard to future medical liability in hiring long-disabled workers who have potentially recurring conditions, particularly those who have undergone multiple operations, as had nearly all of this group.

Patients were also asked to list the medications they were presently taking, if any, but the more than 50% omission rate in responding to that item did not permit discrimination between those who were not taking medication from those who either overlooked the item or chose not to respond. Frequency of omission may indicate resumption of frequent use of medication.

Discussion

The data reported show a significant decrease in medication taken per day and a significant increase in distance walked and number of hours per week engaged in activities involving either sitting or standing-walking (that is, a significant decrease in redining time) without having to stop because of pain or fatigue. The data indicate corresponding increases in activity units performed in physical therapy and occupational therapy.

It has not been proven here that the changes in patient performance can be accounted for only by the operant methods used. It is possible that any one

follow-up 5.00 ± 3.35 (n = 29). Patients still claim some interference in activity because of pain but the decrease from admission to discharge represented a significant improvement ($t = 5.44$, $p = <0.001$). There were no significant changes in interference from pain from discharge to follow-up.

Patients were also asked to indicate the number of hours spent reclining and nonreclining during the

or more of the physical therapy or occupational therapy procedures produced the results reported without the programming of reinforcers playing a significant role. The final test of that question would be to submit comparable groups of patients to each of the treatment modalities used but with rest and attention contingent not upon performance but upon pain behavior. That is not possible in our setting at

present. The treatment team is geared to the contingency arrangements described and could not be relied upon to relinquish them systematically without shutting off the flow of patients through the operant program at the same time. Moreover, even if it were judged ethically and financially feasible to treat such a control group in that fashion, past experience with patients having chronic pain leads us to expect patients would not stay in the program for comparable periods.

An alternative control study would be to subject each patient to intervals within the program in which the contingency arrangements were removed or reversed to see if performance records were influenced. The weakness of that approach in this instance is that once the patient has attained a greater level of activity he can no longer be considered comparable to what he was like at admission in such characteristics as general bodily tones.

Inconsidering possible alternative explanations for the results reported, it is important to remember that each patient in this program had previously received one or more treatment approaches without resolution of the pain problem. The fairly consistent improvements noted here seem to be in obvious contrast to the outcomes these patients had experienced previously.

The relative consistency of improvement across behavioral parameters, across patients, and across a range of therapists of every profession involved, some of whom were skeptical and even hostile to the program at the outset, further suggests that the results obtained are related to the methods used.

The question may be raised as to whether each of these patients had some form of psychogenic pain and that, somehow, the operant program produced the changes noted because of psychological factors. That may be a difficult argument to disprove depending upon the definition of the concept of psychogenic pain. If what is meant by the term is that the pain behavior observed had come to be under the control of factors other than tissue pathology to a significant degree in a number of the patients treated in this program, there is no argument. That is exactly the position taken here. The treatment program was designed to modify consequences to pain and well behaviors so that their respective rates would change in the desired direction. If what is meant by the concept of psychogenic pain is that, for example, some intrapsychic conflict or conversion mechanism is the causal factor in the pain problem, these data indicate otherwise. Such a position is committed to the hypothesis that res0lution of the problem can come only by resolution of the conflict or restructuring of the personality. It should be evident that the operant program focused on behavior-consequence relationships, not on conflict resolution or personality change. If the methods used produced conflict resolution or personality change, so much the better, though our data suggest that focus on constructs of conflict resolution or personality change are neither necessary nor sufficient to account for the results observed.

Perhaps the most difficult question of all is whether there has been any change in the amount of pain experienced by the patients treated. The only true test of that question would require a measure of pain which was entirely or substantially independent of any operant process treated here. Verbal report in any form would not suffice. Although the patients reported a reduction in pain after treatment, they still claimed considerable pain. It could be argued that the pain was the same and the change was only in verbal behavior in response to the withdrawal of social reinforcers to verbal complaints of pain. Conversely, if the patient stated there was no change in his pain, even when there were significant changes in other behavioral parameters, it could be argued that verbal pain behavior did not change at the same rate as performance measures because it continued to be intermittently reinforced by people around the patient over whose behavior the treatment program exercised no influence, for example, hospital visitors. The obvious performance alternatives to verbal report as measures of pain status show significant changes, as noted. The question hinges upon whether pain is conceived of as a neurophysiological phenomenon and a set of responses, or as the responses themselves. The program described here was directed toward modification of pain responses or pain behavior. The data reported indicate the methods used resulted in significant change in the desired direction in selected pain responses or pain behavior. The question is moot as to whether pain, defined independently of the pain behaviors measured, was changed.

More work is needed to identify in more detail the factors which indicate a patient's pain behavior is under control of environmental consequences rather than of tissue pathology. Furthermore, there needs to be more exploration of the methods by which frequency of pain and well behaviors can best be modified. There needs to be more follow-up work to identify more closely the factors which serve either to maintain and improve treatment gains in the patient's natural environment or to reduce or eliminate them. The principles of generalization govern durability of the treatment gains made in programs such as this one. They are well understood [12] but the tactical steps by which to apply these principles need much more work.

Given these limitations, two general implications appear to be supported by the findings reported. One is that the diagnostic process in problems of chronic pain must take into account effects of learning. The phenomena from which diagnostic inferences are

drawn are themselves subject to influence by learning factors. There is no reason to expect that pain behavior under the control of environmental consequences would necessarily look or sound differently from pain behavior under control of tissue pathology. The diagnostic process should therefore examine for relationships between the pain behavior or pain phenomena and *both* pathogenic factors and systematic environmental consequences. Stated another way, the diagnostic process should utilize both disease and learning conceptual models in approaching problems of chronic pain.

A second inference supported by these results is that the treatment of patients with chronic pain problems may be advanced by addition of learning systems to treatment programs. It should be apparent that the specific methods used here could be applied only with the looseness inherent in working in a complex multidisciplinary setting in juxtaposition to a variety of treatment programs for different kinds of physical disability problems. Nonetheless, the consistency of improvement in this sample of patients supports the inference that these methods can make usef ul contributions to patient well-being in problems of chronic pain when the treatment staff is adequately prepared to use them.

Acknowledgment: A particular note of gratitude is expressed to Paeli; Holden, *B.A.!* statistician, for her assistance in data organization and a1J-alys1s. Acknowledgment is alw given to the treatment and nursmg staff of the Department of Rehabilitation Medicine, University of Washington, School of Medicine for the many months of dedicated efforts in setting up and carrying out this program.

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