in: J S Carlson, A R Seifert, N Birbaumer.
Clinical Applied Psychophysiology
Plenum Press, New York 1994

# CHAPTER 9

# *Significance of Breathing Awareness and Exercise Training for Recovery after Myocardial Infarction*

*Jan van Dixhoorn*

## *Introduction*

Experts state that cardiac rehabilitation should be comprehensive and "tailored to the individual" (Kellerman, 1981; Meyer, 1985). In actual practice, the main component of rehabilitation is physical exercise (Blodgett & Pekarik, 1987). It is assumed that exercise training will improve not only the patients' physical fitness but also their morale, enhance their return to normal activities, and reduce their risk of recurring cardiac events. It is becoming clear, however, that some patients will benefit from exercise, while others will not (Uniken Venema-Van Uden, Zoeteweij, & Erdman, 1989). This difference is one of the reasons that the effectiveness of exercise-rehabilitation is limited (Barr Taylor, Houston-Miller, Ahn, Haskell, & DeBusk, 1986) and the development of cardiac rehabilitation stagnates (Hellerstein, 1986).

In this chapter, another treatment modality for cardiac patients will be examined, consisting of teaching skills for self-regulation, in particular relaxation and breathing techniques. Although it would seem obvious that stress management is important for cardiac patients and although several authors recommend its use (Fardy, 1986; Hackett & Cassem, 1982), its effectiveness is scarcely documented. There is a large literature on relax-

*JAN VAN DIXHOORN* • St. Joannes de Deo Hospital, Haarlem, 2003 BR The Netherlands.

*Clinical Applied Psychophysiology*, edited by John G. Carlson, A. Ronald Seifert, and Niels Birbaumer. Plenum Press, New York, 1994.

ation effects in stress-related disorders, but relatively few studies have dealt with its application to cardiac patients. Polackova, Bockova, and Sedivec (1982) taught autogenic training to 48 patients and found substantial psychological improvement in comparison to controls. Progressive relaxation was taught by Bohacick (1982) to 18 patients, in addition to exercise training, and resulted in lower diastolic blood pressure. Relaxation was provided by Cunningham (1980) to 15 patients in the form of tape-recorded instructions. Compared to no treatment or exercise only, there was no effect on depression. Benson's relaxation response, in addition to exercise training, was taught to 27 patients by Munro, Creamer, Haggerty, & Cooper (1988) and was found to have an effect on diastolic blood pressure. A mixed program of muscle relaxation and self-suggestion was provided to 46 patients, in addition to regular rehabilitation, by Krampen and Ohm (1984) and later to 234 patients by Ohm (1987). The researchers found a higher sense of self-awareness and of control over patients' health, a better perceived physical status, and a higher physician's rating of general and cardiovascular health status. Moreover, the rehabilitation environment was perceived more positively. Langosch, Seer, Brodner, Kallinke, Kulick, and Heim (1982) compared such a treatment in 28 patients to behavior therapy and found that both treatments were more effective than no treatment with respect to self-report data. Patel, Marmot, and Terry (1985) taught a similar program, including breathing, to 99 subjects at high cardiovascular risk. At 4-year follow-up, there were significant reductions in blood pressure and even less cardiac morbidity. Finally, relaxation and breathing techniques were included in an intensive treatment package, focusing on diet, by Ornish and associates in two studies that documented reduced cardiovascular morbidity (Ornish, Brown, & Scherwitz, 1990; Ornish Scherwitz, Doody, Kesten, & McLanahan, 1983); these techniques were included in the Type A behavior modification program of Friedman and Thoresen, which reduced the occurrence of reinfarction (Thoresen, Friedman, Powell, Gill, & Ulmer, 1985). Thus, research to date suggests that relaxation techniques may reduce cardiac risk factors and morbidity, improve psychological well-being, and enhance the effectiveness of rehabilitation.

Relaxation therapy has been part of the cardiac rehabilitation program in St. Joannes de Deo Hospital, Haarlem, The Netherlands, since 1977. A variety of techniques have been experimented with. General relaxation, in the sense of quietening mind and body, was a basic procedure, and breathing was the key element that the patients remembered and used best (van Dixhoorn, 1984). The main focus of our approach was to increase awareness of bodily signs of tension and relaxation. Thus, in 1980, a protocol for "breathing awareness" was constructed, and its effectiveness was tested in a clinical trial. The purpose of teaching breaching awareness was to enable the patient to perceive and elicit a shift in the respiratory pattern toward an easier and more relaxed way of breathing (van Dixhoorn, 1984). The patients could apply this technique both during passive rest and during daily activities, while sitting or standing.

### *Breathing Awareness*

Respiration implies a movement of the body, which in general one is aware of only when breathing becomes difficult. Such a negative awareness occurs when the subject notices unpleasant changes: laborious, effortful, or restricted breathing. One complains of shortness of breath or dyspnea. By contrast, a positive awareness of breathing is the result of pleasant changes: easier, freer, and more effortless respiration. These changes can be elicited by way of exercises, imagery, instructions, or manual techniques. Thus, *breathing awareness*, in the context of this chapter, refers to perceptible changes in the respiratory movement, as a result of the aforementioned techniques. The procedure is as follows: The subject relaxes and notices his spontaneous breathing; he then applies a particular technique for a short while and stops the technique; again, the subject notices the spontaneous breathing movement and compares this to the experience before the technique was applied. In this way, the autonomous character of respiration is respected, yet the possibility for voluntary modification is recognized. Conscious breathing may not always result in pleasant sensations; one may also become aware of restrictions and tensions that previously remained unnoticed. Therefore, the patient is advised to practice when he or she is feeling relatively calm.

General relaxation is a precondition for breathing awareness, since relaxation of the body is necessary to breathe more easily and mental relaxation is necessary for passive attention and the perception of spontaneous breathing. Usually, the subject who practices some form of breathing technique tries to breathe in a particular way—for instance, slowly and abdominally. It is pointed out, however, that one should at first try not to do anything and simply focus attention on the actual tension state and breathing pattern of the body. Also, the subject is asked to do the technique in a "lazy" or indifferent, almost careless way. Afterward, one simply notices how the body responded to the particular technique. In time, the habitual breathing pattern may change, without the conscious effort of the subject to breathe "better." This attitude toward the body differs sharply from the usual view, as well as from the way the body is treated during exercise training. The point was made that one should respect and listen to physical signs and signals, and try to understand their meaning, rather than suppress unpleasant self-perceptions. This metacommunication seems to be important (Peper & Sandler, 1987). In order to relax, one must inevitably become aware of tension.

One of the techniques is to make the passage of air audible by slightly compressing the lips. As a result, one receives audible feedback on the actual breathing pattern. The increased resistance at the lips during exhalation, or during inhalation and exhalation, puts a load on the respiratory muscles. As a result, respiration tends to become slower and fuller, tidal volume increases, and respiratory excursion becomes more expansive and more clearly perceptible. One stops this after about five respiratory cycles and then notices how one's breathing continues by itself. This pattern is to be repeated two times or so, after which the changes in breathing pattern and in one's body sensations can be evaluated.

Another technique consists of coupling or uncoupling a body movement and respiration. For instance, in the supine position, the subject flexes the feet during exhalation and stops flexing during inhalation. This combination is unusual, since one tends to inhale while making effort. In this exercise, inhaling while relaxing the feet and exhaling while pulling them up associates inhalation with relaxation and passivity. Moreover, the movement of the feet is related mechanically to the exhalation movement: The pelvis is tilted backward slightly, the abdomen flattens, and the spine is pushed up a little bit, which implies a relative downward motion of the ribs. After some time, the combination becomes easy and almost natural. When the movement is stopped, spontaneous respiration may be perceived as easier and more effortless.

An example of a manual technique is as follows: The subject is seated on a stool and the therapist sits (squats) behind and places a hand at either side of the lumbar spine. The subject is asked to pay attention to the hands and to notice whether any movement is perceptible with respiration. If one sits and breathes easily, one feels the hands spreading during inhalation and thereby perceives a sideways movement. Conversely, when one mentally follows the sideways spreading and contracting movement in the lumbar region, one tends to sit more relaxed and comfortable and to breathe more slowly, fully, and easily.

There are a number of such techniques to gradually involve the whole body in the respiratory movement, which enhances its efficiency. The perception of such "whole-body breathing" is an unmistakable and very pleasant experience.

### *Research Questions*

In order to assess the effect of breathing awareness, a program of exercise training was compared to a more comprehensive treatment, consisting of the same exercise training combined with individual relaxation and breathing therapy. Since myocardial infarction patients were randomly assigned to either of the two treatments, differences in outcome can be attributed to the difference in treatment. The significance of exercise training was assessed in another way. Since patients were referred for exercise-rehabilitation, they could not be assigned to a control group that received no exercise training. Therefore, a composite criterion, developed to determine the success of the exercise training, was used to stratify the patients into two groups: those for whom exercise training had been successful and those for whom training had not resulted in physical improvement. Rehabilitation outcome was compared between these two groups.

The questions to be answered were: (1) What is the effect of breathing awareness on the rehabilitation outcome? (2) Is training success associated with a positive rehabilitation outcome?

## *Patients and Methods*

### *Patients*

After discharge, cardiac patients from various hospitals were referred to the regional rehabilitation center at St. Joannes de Deo Hospital. A total of 156 myocardial infarction patients were admitted to the study and were randomly assigned to one of two treatment protocols. There were 147 men and 9 women. The median age was 56, the range from 36 to 76. Baseline characteristics of the study population have been described elsewhere (van Dixhoorn, Duivenvoorden, Staal, & Pool, 1989; van Dixhoorn, Duivenvoorden, Pool, & Verhage, 1990b) and are summarized in Table 1.

### *Procedure*

Clinical baseline data and medical history were obtained from the referring cardiologist. On entry, patients were interviewed to obtain psychosocial information and were asked to participate in the study. After providing informed consent, they completed additional psychological questionnaires on a separate occasion, when measurements of respiratory variables were also taken. These tests were repeated after rehabilitation and at a 3-month follow-up interview. On that occasion, roughly half a year after hospital discharge, data on daily activities and work were acquired. All patients participated in a 5-week daily physical conditioning program, starting approximately 4–5 weeks after hospital discharge. Graded exercise testing was performed on a bicycle ergometer before and after physi-

*Table 1. Baseline Clinical Data for the Two Treatments*[a]

| | Relaxation + exercise | Exercise only |
|---|---|---|
| Number of cases | 76 | 80 |
| Age (years) | 55 ± 8 | 56 ± 8 |
| Number of men (%) | 71 (93) | 76 (95) |
| Working (%) | 50 (66) | 51 (64) |
| Preinfarction angina pectoris (%) | 14 (18) | 12 (15) |
| Infarction | | |
| Large (%) | 25 (33) | 27 (34) |
| Anterior (%) | 29 (38) | 24 (30) |
| Complications (%) | 14 (18) | 13 (16) |
| Postinfarction | | |
| Start of training[b] | 4.8 ± 2.8 | 5.2 ± 2.1 |
| Work capacity[c] | 90 ± 15 | 87 ± 20 |
| Heart rate | 80 ± 16 | 80 ± 17 |
| Resting Watts = 60 | 103 ± 18 | 101 ± 18 |

[a]Data are reported as number of cases (percentages) or as means ± SD.
[b]Weeks after hospital discharge.
[c]Maximal work load (% of normal).

cal training, supervised by the cardiologist. Half the patients were randomly assigned to six sessions of individual breathing and relaxation therapy, additional to the exercise training. Long-term follow-up data on cardiac events were collected as follows: Patients received a postal questionnaire after 2 years, and the general practitioner was contacted in case of nonresponders. Medical records were searched in case of death or hospital readmission. Patients who were admitted in the early part of the study were invited for an interview.

### *Measurements*

Exercise testing was submaximal, with increasing workloads of 30 watts every 2 min until symptoms prevented the patient from continuing or until the physician terminated the test. The occurrence of angina pectoris, ST abnormalities, and arrhythmias was noted. ST abnormalities consisted mostly of ST depressions greater than 2 mm, horizontal or downsloping, occurring during or immediately after the test. A bipolar ECG (CM5) was taken during the last half minute before the work load was increased, and heart rate was read from this. Blood pressure was taken before the test and at maximum work load. The outcome of exercise training was assessed on the basis of changes in exercise testing. In order to obtain a single measure indicating the efficacy of physical training, these changes were integrated into a composite criterion for training benefit. The procedure is discussed in detail elsewhere (van Dixhoorn *et al.*, 1989; van Dixhoorn, Duivenvoorden, & Pool, 1990a). In short, the following measurements were ranked according to their clinical relevance: (1) exercise-induced signs of cardiac dysfunction (ST-abnormalities, angina pectoris, complex ventricular arrhythmias), (2) maximal work load, (3) heart rate, and (4) systolic blood pressure response. At each level, a patient could be assigned to success or failure when a substantial change in a particular measurement had taken place. Dropouts were classified on the basis of the reason for not completing the program. Thus, physical outcome could be assessed for all subjects as follows: (1) patients who experienced little or no change, (2) patients who improved (success), or (3) patients who deteriorated (failure). The criterion was an operationalization of the primary purpose of exercise training to improve physical fitness and lower the threshold for myocardial ischemia.

Psychological questionnaires included: (1) Heart Patients Psychological Questionnaire, for measuring the well-being of cardiac patients, consisting of four scales: (a) well-being, (b) feelings of invalidity, (c) displeasure, (d) social inhibition); (2) anxiety, measured by the State and Trait Anxiety Index in two modes: state and trait anxiety; (3) sleeping habits, consisting of questions about hours of sleep, daytime nap, and quality of sleep; (4) functional symptoms, consisting of physical complaints not typical of angina pectoris. In addition, two questionnaires referred to the preinfarction period: (5) the Jenkins Activity Scale for Type A behavior and (6) the Maastricht Questionnaire for vital exhaustion and depression (van Dixhoorn *et al.*, 1990b). At a 3-month follow-up, the patients' activity compared to preinfarction situation was rated by an interviewer, with respect to physical activity, daily affairs, and work, as a measure of social recovery.

Respiratory variables were measured during a physiological test, which was presented to the patient as a test of the resting condition (van Dixhoorn & Duivenvoorden, 1989). Recordings were made of respiratory movement, using stretch-sensitive bands around the thorax and abdomen, and of beat-to-beat variation of the heart rate (Psychophysiograph, ZAK). Capnographic and spirometric recordings were taken, after which the patient was asked to remain quiet for 6 min. The patient's perception of the body's state was then assessed.

### *Treatments*

Physical exercise training consisted of 5 weeks of interval training on a bicycle ergometer, once a day, for half an hour. Training was given in groups of four patients, supervised by two physical therapists. Each patient was exercised up to 70–80% of the maximal heart rate (Karvonen method) attained at the pretraining exercise test. Relaxation therapy was given once a week in six individual 1-hr sessions. The therapy was provided by five experts and is discussed in the Introduction. The rehabilitation program did not have a structured form of patient education. At the patients' request, information was given and questions were answered by the rehabilitation staff.

## *Results*

### *Training Outcome*

In 139 patients, exercise testing results were available before and after training (van Dixhoorn *et al.*, 1989). Both treatments showed a clear but modest training response: Maximal work load increased and heart rate at a given work load decreased. Heart rate reduction was more pronounced for patients who participated in relaxation therapy. Exercise-induced signs of cardiac dysfunction remained relatively stable, except for a remarkable decrease in ST depression in patients who underwent relaxation therapy. The difference between treatments was statistically significant ($p < 0.02$). Seventeen patients (making a total of 156) did not complete their training, 9 of whom were classified as unsuccessful because of dropping out for cardiac problems and 6 of whom stopped for noncardiac reasons and were classified as unchanged. The other 2 patients stopped rehabilitation because they became fully active again; they were classified as successful. There was no significant change in medication during rehabilitation, probably because the program covered only a short period of time.

The results on the composite criterion are shown in Fig. 1. For 79 of the 156 patients (51%), training was successful, whereas for 42 patients (28%), the outcome was negative. There was a shift to a more positive outcome in the combined treatment. The difference in training failure was significant: The odds for failure were higher for exercise as a sole treatment (odds ratio: 2.07; 95% confidence interval 1.002–4.28; $p < 0.05$).

### *Psychological Changes*

Measurements were available for 137 patients (van Dixhoorn *et al.*, 1990b). Figure 2 summarizes the changes in four scales. The pre–post differences are expressed in Cohen's $d$ (Cohen, 1969). As a rule of thumb, $d$ less than 0.20 means no effect and d equals 0.5 means a medium effect.

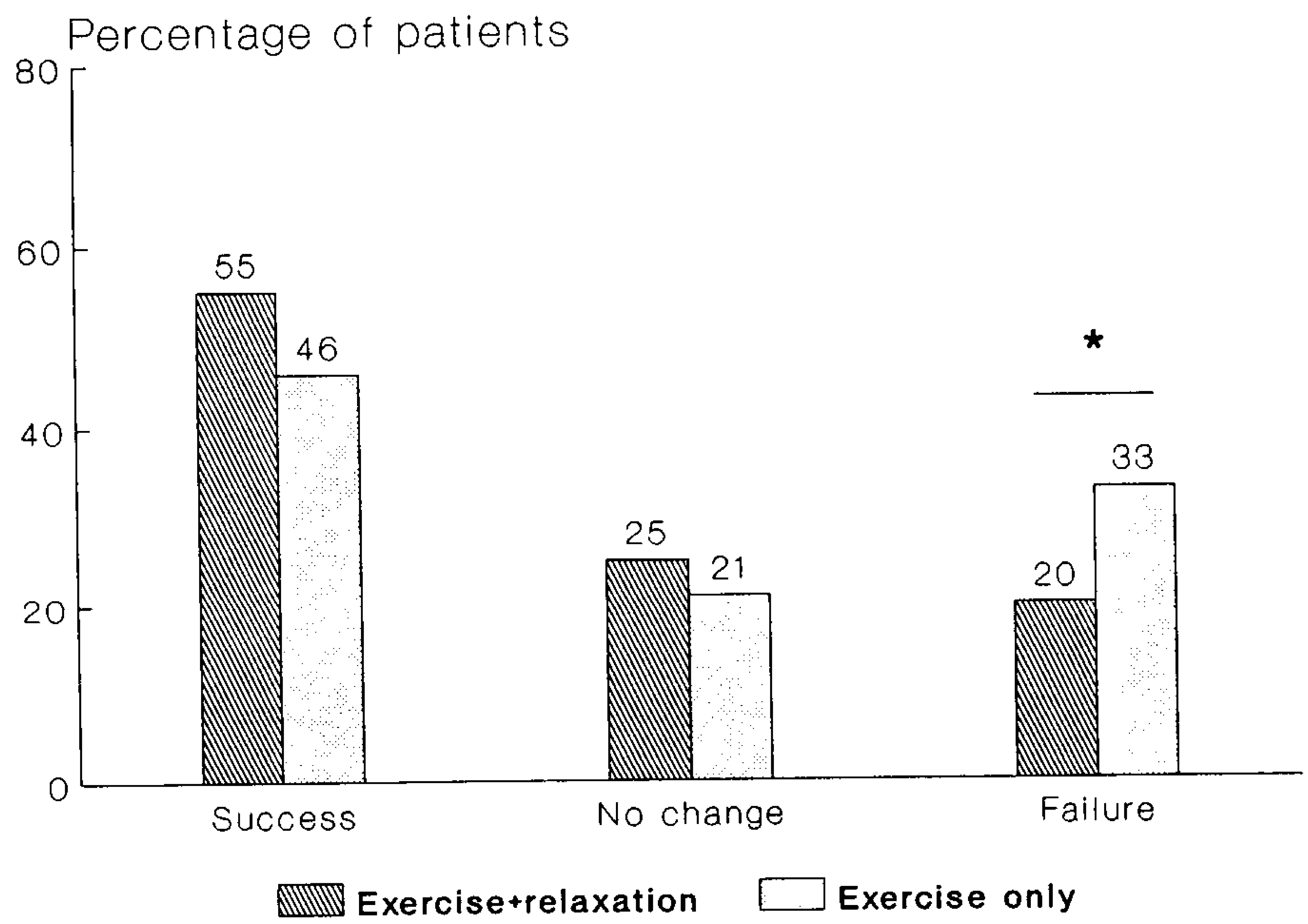


*Figure 1.* Success and failure of exercise training for two treatments. (*) $p < 0.05$.

It appeared that exercise training did not result in any psychological change, on the average. After relaxation therapy, patients improved in state-anxiety, well-being, and invalidity feelings. The difference between treatments was significant for well-being ($p < 0.001$).

The psychological significance of exercise training was further investigated by differentiating patients with and without psychological improvement, according to training outcome. Two composite scores were constructed on the basis of changes in six questionnaires: psychic improvement, reflecting changes in state- and trait-anxiety and depression; somatic improvement, reflecting changes in sleeping quality, feelings of invalidity, and functional complaints (van Dixhoorn *et al.*, 1990b). Since some patients did not complete all the questionnaires, the composite scores were available for a smaller number of patients. Improvement on the scale "well-being" was considered separately. Table 2 shows the results. The odds ratios in the rightmost column indicate the effect of relaxation therapy; the odds ratios in the two middle columns indicate the effect of training success for the two treatments separately.

Psychic improvement occurred in 89 patients (69%), whereas 40

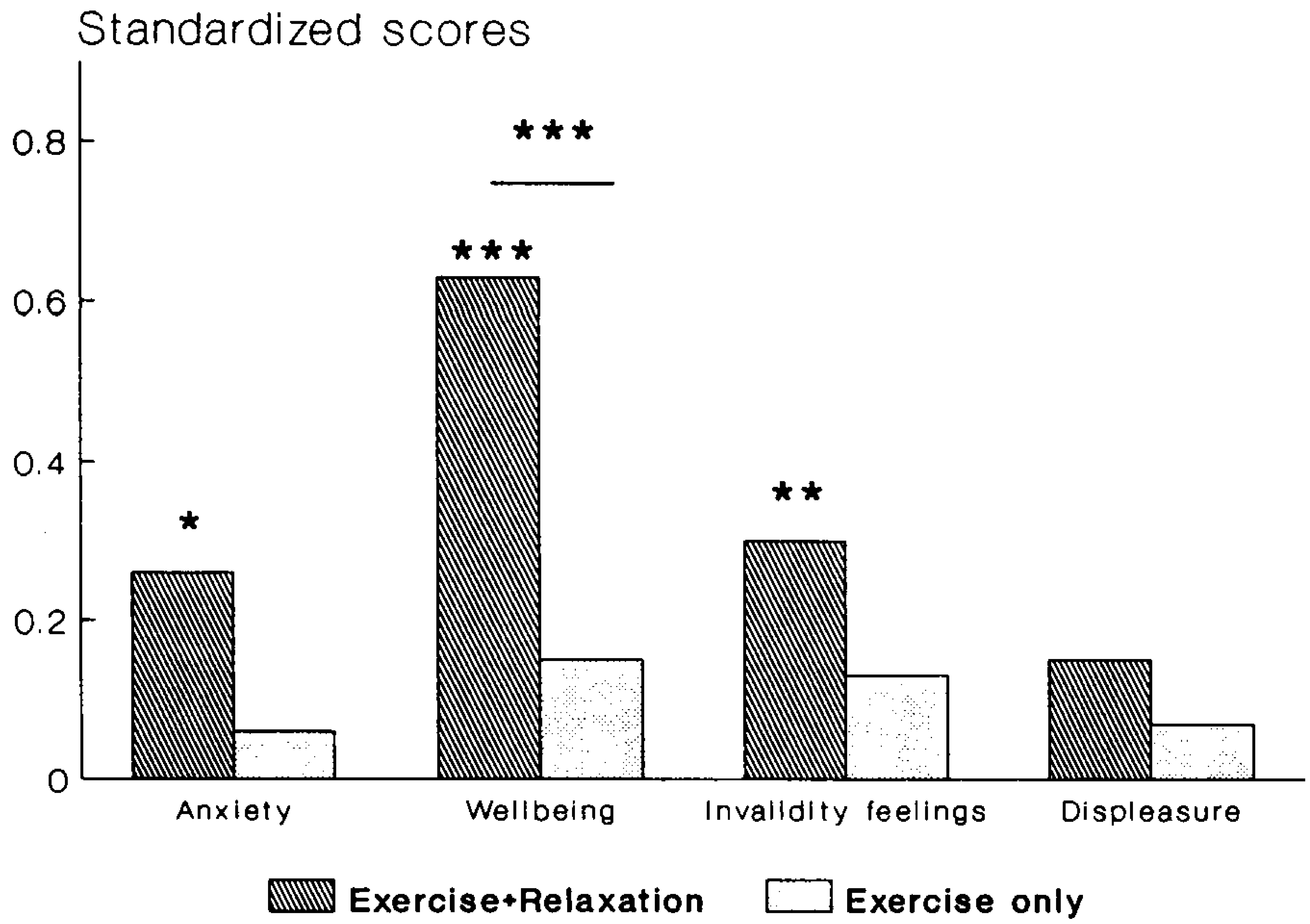


*Figure 2.* Psychological changes after rehabilitation for two treatments. (*) $p < 0.05$; (**) $p < 0.01$; (***) $p < 0.001$.

patients did not improve. Thus, the odds for improvement were greater than 2 in both treatments (odds ratio: 1.03). They were slightly lower for patients whose training was successful, particularly after relaxation therapy, compared to the odds of patients without training success (odds ratio: 0.64 and 0.83, respectively), although statistically not significant. Thus, the composite score for psychic improvement was not influenced by breathing and relaxation therapy or by training outcome.

Somatic improvement occurred in 80 patients (64%), whereas 46 patients did not improve. The odds for somatic benefit were slightly higher after relaxation therapy than after exercise training only (odds ratio: 1.37). Interestingly, the association between training success and somatic benefit showed a different pattern for the two treatments: For exercise as the sole treatment, the odds for improvement were *higher* for successful patients than for unsuccessful patients, although statistically not significant (odds ratio: 2.07). For the combined treatment, the odds for somatic improvement were significant *lower* in patients with training success than in unsuccessful patients (odds ratio: 0.32).

Consequently, in unsuccessful patients, the odds for improvement

*Table 2. Psychological Benefit for the Two Treatments, in Relation to Training Success (TS)*

| | Exercise + relaxation therapy | | | Exercise training only | | | Odds ratio | |
|---|---|---|---|---|---|---|---|---|
| Question | Yes | No | Odds | Yes | No | Odds | (95% CI)[a] | |
| Psychic improvement? | | | | | | | | |
| Total | 43 | 19 | 2.26 | 46 | 21 | 2.19 | 1.03 | (0.49–2.2) |
| TS + | 25 | 13 | 1.92 | 22 | 11 | 2.0 | 0.96 | (0.36–2.6) |
| TS − | 18 | 6 | 3.0 | 24 | 10 | 2.40 | 1.25 | (0.38–4.1) |
| Odds ratio (TS +/−) | 0.64 | (0.20–2.0) | | 0.83 | (0.30–2.34) | | | |
| Somatic improvement? | | | | | | | | |
| Total | 41 | 20 | 2.05 | 39 | 26 | 1.50 | 1.37 | (0.66–2.8) |
| TS + | 20 | 15 | 1.3 | 22 | 10 | 2.20 | 0.61 | (0.22–1.7) |
| TS − | 21 | 5 | 4.2 | 17 | 16 | 1.06 | 4.0 | (1.2–13.0) |
| Odds ratio (TS +/−) | 0.32 | (0.10–1.0) | | 2.07 | (0.75–5.7) | | | |
| Well-being improved? | | | | | | | | |
| Total | 57 | 9 | 6.3 | 47 | 24 | 1.96 | 3.2 | (1.4–7.6) |
| TS + | 34 | 4 | 8.5 | 19 | 16 | 1.2 | 7.2 | (2.1–24.5) |
| TS − | 23 | 5 | 4.6 | 28 | 8 | 3.5 | 1.3 | (0.38–4.6) |
| Odds ratio (TS +/−) | 1.85 | (0.45–7.6) | | 0.34 | (0.12–0.95) | | | |

[a](CI) confidence interval.

were significantly higher after relaxation therapy compared to exercise only (odds ratio: 4.0). Thus, relaxation and breathing therapy had a beneficial effect on the score for somatic improvement for patients who did not benefit physically from training.

Improvement in "well-being" occurred in 104 of 137 patients (76%). The odds for improvement were significantly higher for patients who had followed breathing and relaxation therapy (odds ratio: 3.2). Remarkably, the pattern of association with training success differed again between the treatments, but contrary to the association of somatic benefit. Training success tended to be positively associated with increased feelings of well-being for the combined treatment (odds ratio: 1.85), but was negatively associated for exercise as a sole treatment (odds ratio: 0.34). As a result, the effect of relaxation therapy was particularly clear for patients with training success (odds ratio: 7.2), whereas for unsuccessful patients, the addition of relaxation therapy did not make a difference (odds ratio: 1.3).

## *Respiration and Body Sensation*

The average respiration frequency before rehabilitation was 14.7 cycles/min for the combined treatment and 15.2 cycles/min for exercise

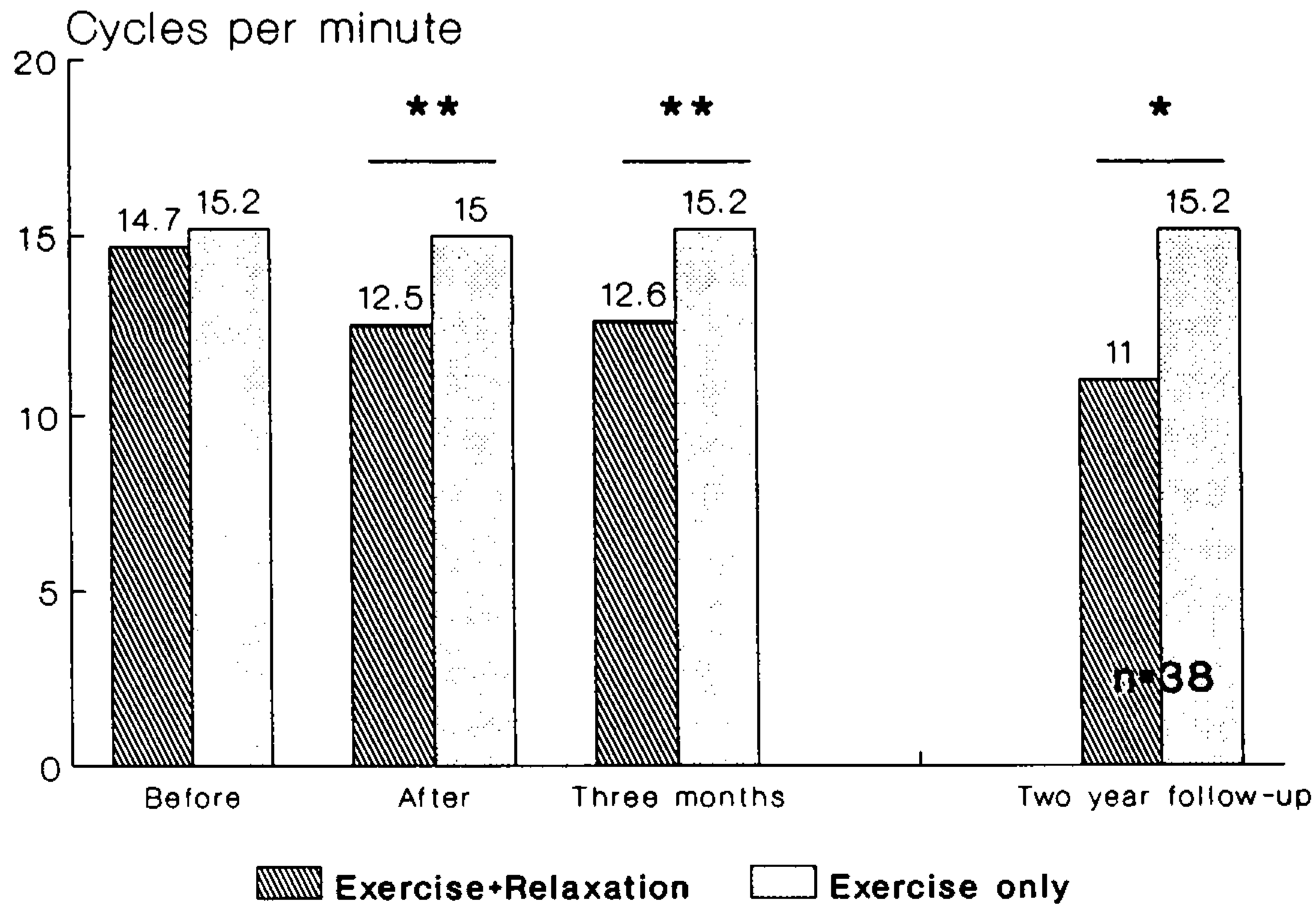


*Figure 3.* Respiration rate before and after rehabilitation, at 3-month follow-up, and at 2-year follow-up for two treatments. (*) $p < 0.01$; (**) $p < 0.001$.

training only (van Dixhoorn & Duivenvoorden, 1989). Figure 3 shows that after rehabilitation, and at the 3-month follow-up, respiration rate remained the same for the single treatment (15.0 and 15.2, respectively), but dropped significantly for the combined treatment (12.5 and 12.6, respectively). The difference between treatments was highly significant ($p < 0.0001$). A fine-grain analysis on a subset of the population ($N = 48$) confirmed the idea that a lower respiration rate implied a larger tidal volume (van Dixhoorn & Duivenvoorden, 1989). Thus, after relaxation and breathing therapy, patients were breathing more slowly and more fully, but minute volume was unchanged. After exercise training, tidal volume decreased slightly, implying that patients tended to breathe more superficially. The fine-grain analysis also revealed that heart rate variability during breathing at a fixed rate of 6 cycles/min, an indicator of cardiac vagal tone, increased after relaxation therapy, but remained the same after exercise training only. The differences between treatments were significant for both tidal volume ($p < 0.05$) and heart rate variability ($p < 0.05$). At 2-year follow-up, respiratory measurements were taken in 38 patients. It appeared that patients who had participated in relaxation and breathing therapy were still breathing more slowly (see Fig. 3). The difference between treatments was even greater and highly significant ($p < 0.01$).

Before rehabilitation, 28% of the patients in both treatments had a pleasant body sensation after resting supine during the physiological test. For exercise as a sole treatment, this percentage remained stable after rehabilitation and at the 3-month follow-up (33% and 28%, respectively). The majority felt nothing in particular, and a minority had unpleasant sensations (7%, 12%, and 12%, respectively, before rehabilitation, after rehabilitation, and at the 3-month follow-up). After rehabilitation through exercise and relaxation therapy, 60% had a pleasant sensation during rest, and 59% reported this at follow-up as well. The increase in pleasant sensations was highly significant ($p < 0.001$), and the difference between treatments was significant as well ($p < 0.01$). A minority felt physically uncomfortable during rest before and after rehabilitation and at follow-up (10%, 8%, and 9%, respectively).

### *Social Recovery Three Months Later*

Data on physical activity level at the 3-month follow-up were available for 130 patients, 53 of whom (41%) had become physically more active and only 25 of whom (19%) had become less active than they were before infarction. Information on daily activities was elicited at a later phase of the study and was available for 82 patients. Half of them (51%) had become as busy in daily life as they were before infarction, whereas only 3 (4%) had become busier. Almost half of them (45%) had become less busy than before. Coping style had changed for 44%, usually meaning that they said "No" to requests more easily and were taking things more lightly. Thus, compared to preinfarction, the most common changes were that patients became less busy but physically more active. Before infarction, 101 patients had been working and an additional 2 patients had been on sick leave. Of the 103 patients, 68 had returned to work about 6 months after hospital discharge (66%), either part-time (47%) or full-time (19%). Information on changes in behavioral style at the workplace was available on 60 patients who had resumed work, 48% of whom said they were doing things differently now. Again, this usually meant they took things easier and delegated responsibility more than had been their habit previously.

The effect of relaxation therapy can be deduced from the odds ratios in the rightmost column of Table 3. It appeared that the odds for increased physical activity did not differ between the treatments (odds ratio: 0.96), whereas the odds for fewer daily activities were higher in the combined treatment (odds ratio: 2.16), although statistically not significant. Also, the odds for a changed coping style in daily life were more than twice as high

*Table 3. Resumption of Activities, Three Months after Rehabilitation, for the Two Treatments and in Relation to Training Success (TS)*

| | Exercise + relaxation therapy | | | Exercise training only | | | Odds ratio | |
|---|---|---|---|---|---|---|---|---|
| Question | Yes | No | Odds | Yes | No | Odds | (95% CI)[a] | |
| More physical activity? | | | | | | | | |
| Total | 27 | 40 | 0.68 | 26 | 37 | 0.70 | 0.96 | (0.48–1.9) |
| TS + | 17 | 21 | 0.80 | 16 | 16 | 1.0 | 0.81 | (0.32–2.1) |
| TS − | 10 | 19 | 0.52 | 10 | 21 | 0.48 | 1.10 | (0.38–3.2) |
| Odds ratio (TS +/−) | 1.5 | (0.57–4.2) | | 2.1 | (0.76–5.8) | | | |
| Less daily activities? | | | | | | | | |
| Total | 21 | 17 | 1.24 | 16 | 28 | 0.57 | 2.16 | (0.89–5.3) |
| TS + | 12 | 10 | 1.20 | 8 | 15 | 0.53 | 2.25 | (0.68–7.5) |
| TS − | 9 | 7 | 1.26 | 8 | 13 | 0.62 | 2.10 | (0.56–7.9) |
| Odds ratio (TS +/−) | 0.93 | (0.26–3.4) | | 0.87 | (0.25–2.97) | | | |
| Coping differently (daily life)? | | | | | | | | |
| Total | 21 | 17 | 1.24 | 15 | 28 | 0.54 | 2.30 | (0.94–5.6) |
| TS + | 12 | 10 | 1.20 | 7 | 15 | 0.46 | 2.57 | (0.75–8.8) |
| TS − | 9 | 7 | 1.26 | 8 | 13 | 0.62 | 2.10 | (0.56–7.9) |
| Odds ratio (TS +/−) | 0.93 | (0.26–3.4) | | 0.76 | (0.22–2.67) | | | |
| Return to work? | | | | | | | | |
| Total | 37 | 13 | 2.85 | 31 | 21 | 1.48 | 1.79 | (0.78–4.1) |
| TS + | 21 | 12 | 1.75 | 18 | 10 | 1.8 | 0.97 | (0.34–2.8) |
| TS − | 16 | 2 | 8.0 | 13 | 11 | 1.18 | 6.78 | (1.3–36.1) |
| Odds ratio (TS +/−) | 0.22 | (0.04–1.12) | | 1.5 | (0.5–4.6) | | | |
| Coping differently (work)? | | | | | | | | |
| Total | 20 | 11 | 1.82 | 9 | 20 | 0.45 | 4.04 | (1.4–11.9) |
| TS + | 13 | 7 | 1.86 | 6 | 11 | 0.55 | 3.4 | (0.88–13.2) |
| TS − | 7 | 4 | 1.75 | 3 | 9 | 0.33 | 5.3 | (0.87–31.6) |
| Odds ratio (TS +/−) | 1.06 | (0.23–4.9) | | 1.64 | (0.32–8.45) | | | |

[a](CI) Confidence interval.

(odds ratio: 2.3) in the combined treatment, approaching significance. The odds for work resumption were greater than 1 in both treatments, but tended to be higher in the combined treatment (odds ratio: 1.79). There was a significant difference with respect to coping style at work. The odds for such a change were almost 2 in the combined treatment, but less than 0.5 in the single treatment. Thus, patients in the combined treatment changed their behavior 4 times more often than patients in the single treatment (odds ratio: 4.04).

The significance of training success can be seen from the odds ratios in the two middle columns of Table 3. The odds for increased physical activity were greater than 1 for both treatments, implying that patients with training success tended to be physically more active. However, the association was statistically not significant in either of the treatments or for the total population. The odds for fewer daily activities did not differ between patients with and without training success, in either of the treatments, nor was there a difference in the odds for changed behavior in daily life. Thus, training outcome did not affect daily life at all. Interestingly, the association of training outcome with work resumption showed an opposite pattern for the two treatments. In the combined treatment, the odds for work resumption were much lower for successful patients then for unsuccessful patients, largely because almost all patients without training success returned to work (odds ratio: 0.22). In the single treatment, the odds for work resumption were somewhat higher in successful patients (odds ratio: 1.5). Neither of the two associations was statistically significant, but their opposite direction resulted in the fact that relaxation therapy significantly enhanced return to work among unsuccessful patients (odds ratio: 6.78). By contrast, relaxation therapy had no effect at all among patients who benefited physically from training (odds ratio: 0.97). Finally, the odds for an easier coping style at the workplace were not greater in successful patients compared to unsuccessful patients. Thus, training outcome did not influence coping behavior.

### *Cardiac Events*

Data on cardiac events during 2 years after infarction were available for the patients admitted in the first years of the study, 43 in the combined and 47 in the single treatment (van Dixhoorn, Duivenvoorden, Staal, Pool, & Verhage, 1987). Of these 90 patients, 2 were lost to follow-up, 1 in each treatment. Further, 2 patients had died for cardiac reasons, both in the single treatment, and 9 had a recurrent infarction, 4 in the combined and 5 in the single treatment. Coronary bypass graft surgery was undergone by 6 patients, only 1 of whom was in the combined treatment. There were 15 readmissions to hospital for cardiac reasons, mostly unstable angina pectoris, 3 in the combined treatment and 12 in the single treatment. Thus, there was a total of 8 events in 7 patients (17%) after relaxation therapy, and there were 24 events in 17 patients (37%) after exercise training only. The odds for an event were higher for exercise as a single treatment than for relaxation therapy (odds ratio: 2.9; 95% confidence interval: 1.07–8.04).

## *Discussion*

### *Effect of Breathing Awareness*

The study had been designed primarily as a clinical trial of breathing and relaxation therapy in cardiac rehabilitation. It turned out that the outcome of rehabilitation was positively influenced by the addition of this therapy individually to a regular exercise program. It resulted in a stable effect on respiratory pattern, which became more efficient, slower, and fuller, even after 2 years. Also, more patients felt pleasant after taking a rest. These effects may be taken as the direct result of the techniques for breathing and body awareness and indicate that, on average, the therapy had been successful. More important, however, are the wider effects on traditional rehabilitation-outcome measures. The literature, reviewed in the Introduction, indicated that physical, psychological, and behavioral effects could be expected. It turned out that effects were found in each of these dimensions, but the physical effects were the most striking. Breathing and relaxation therapy reduced the incidence of deterioration after training (training failure), reduced the occurrence of exercise-induced signs of myocardial ischemia (ST depressions), increased cardiac vagal tone (heart rate variability), and reduced the occurrence of cardiac events in a 2-year follow-up period. Thus, the conclusion of Ohm (1987), that relaxation therapy enhances the general effectiveness of rehabilitation, is supported by this study.

Obviously, teaching awareness of respiration and of bodily tension is quite different from exercise training. It involves a learning process and skills training, rather than physical conditioning. Also, the attitude toward the body is one of respecting and listening to bodily signs with receptive attention. When a subject actually adopts this attitude and applies the techniques, it can be expected that behavioral patterns (habits) will be influenced and show lasting effects. The available data suggest that behavioral changes did indeed take place. On the physiological level, breathing habits were changed even 2 years later. Coping style had changed 3 months after rehabilitation, almost exclusively in the combined treatment. An interesting phenomenon was that breathing awareness influenced the effect of the exercise sessions. The association of training success with psychological and social outcome measures differed between the two treatments. As a result, breathing and relaxation therapy were particularly beneficial for patients who did not benefit physically from exercise training: It improved somatic aspects of psychological benefit (feelings of invalidity, sleeping quality, and functional complaints), and it promoted return to work.

### *Training Outcome*

Although the value of exercise-rehabilitation depends to a large degree on its contribution to social recovery and secondary prevention, the immediate purpose is to improve the patients' physical fitness and morale. The composite criterion for physical outcome, integrating the major measurements of exercise testing, was meant as an operationalization of the primary purpose of exercise training, to improve fitness and raise the threshold for myocardial ischemia. The fact that only half the patients actually reached this aim and benefited from exercise training is therefore most remarkable. Even more important is the fact that about one quarter had a negative outcome. Only a few authors evaluated the outcome of training in terms of success and failure instead of average changes in exercise testing parameters. Hammond, Kelly, Froelicher, and Pewen (1985) found that the percentage of patients showing at least 5% improvement in a training response, after 1 year of training, three times a week, was 44% for resting heart rate and thallium ischemia, 58% for heart rate at low work level, and 52% for measured maximal oxygen uptake. Uniken Venema-Van Uden and associates (Uniken Venema-Van Uden *et al.*, 1989) used a composite criterion derived from the one used in this study on 370 cardiac patients, rehabilitated in three centers with programs of differing length (6–12 weeks) and intensity (2–5 times a week) of training. On the whole, 54% improved after training and 16% deteriorated. Unlike the criterion in this study, dropouts (13%) were not included in the outcome, which may be a reason there were fewer failures. Thus, it seems realistic to say that exercise training is really appropriate only for about half of cardiac patients referred for rehabilitation. This questions the very basis of present-day rehabilitation, in which exercise is the main component (Blodgett & Pekarik, 1987; Hellerstein, 1986).

The significance of exercise training for recovery is unclear. In general, postinfarction patients are very enthusiastic about exercise, and the majority are convinced that it is extremely helpful in convalescence. The results of this study do not support this idea and confirm the conclusion of one recent review (Langosch, 1988), that the evidence of a psychological effect of exercise is weak. We did not find an improvement on any psychological questionnaire after exercise training was given. Moreover, patients with a positive training outcome did not improve psychologically any more than patients without physical benefit. With respect to social recovery, at 3 months follow-up, there was a weak association of training success with an increased level of physical activity. Daily activity level, return to work, and coping style were not associated. Thus, there was little evidence for the assumed significance of exercise training for the recovery and well-being of cardiac patients.

*Rehabilitation Policy*

These results question the one-sided reliance of rehabilitation on physical exercise as well as the idea of increasing fitness as a main purpose of exercise sessions. Cardiac rehabilitation should indeed be comprehensive and tailored to the individual. It means that more than one treatment modality should be employed and that subjects should be assigned to the treatment or treatment combination that seems to be best. This study indicates that such a differentiated program will have a higher overall effect than exercise training alone.

It should be noted that the results do not necessarily invalidate the utility of all physical exercise. Increasing aerobic power may be important for some patients, while for others the context of exercise sessions may be more meaningful. For some, increasing work loads may even be detrimental, and training is therefore not appropriate. It appears that if the staff were to take a more comprehensive attitude, rather than urge the "dogged repetition of mindless exercise," as Nixon, Al-Abbasi, King, and Freeman (1986) put it, the program would become an "arena for interchange and education" (Fletcher, Lloyd, & Fletcher, 1988) and probably more effective, physically, mentally, and socially.

Several authors stated that integration of relaxation exercises and body awareness into the exercise sessions would make them more interesting and more effective (Fardy, 1986; Sime, 1980). It should be emphasized, however, that group sessions may not be sufficient to actually learn self-regulation skills and to acquire awareness of personally relevant strategies for relaxation and tension control. In this study, therefore, individual sessions were utilized. At present, in our hospital, relaxation and breathing therapy are still implemented individually in about 40% of the rehabilitation patients. All the patients receive group instruction in addition to the exercise program. The individual treatments are retained for two reasons: A substantial number of patients require personal contact and guidance, verbally or manually, to be able to sense concrete differences in bodily tension, which is necessary for practice at home and in the group. For some of them, the sessions also have a counseling nature, and for a few they are the main treatment. Second, the individual therapy requires fine-tuning of skill and sensitivity on the therapists' part. Since the therapists are mainly physiotherapists who conduct the group sessions as well, this attitude will carry over into the style and quality of the group sessions. Actually, incorporating the individual therapy appears to influence the attitude of the entire rehabilitation staff.

To conclude, individual breathing and relaxation therapy is a treatment modality on its own, and its addition to a rehabilitation program is a worthwhile effort that will enhance the effect of cardiac rehabilitation in a number of ways.

ACKNOWLEDGMENT. This study was supported by a grant from the Dutch Heart Foundation, The Hague.

## *References*

Barr Taylor, C., Houston-Miller, N., Ahn, D., Haskell, W., & DeBusk, R. (1986). The effects of exercise training programs on psychosocial improvement in uncomplicated postmyocardial infarction patients. *Journal of Psychosomatic Research, 30,* 581–587.

Blodgett, C., & Pekarik, G. (1987). Program evaluation in cardiac rehabilitation I–IV. *Journal of Cardiopulmonary Rehabilitation, 7,* 316–323, 374–382, 410–414, 466–474.

Bohachick, P. A. (1982). Progressive relaxation training in cardiac rehabilitation: Effect on physiological and psychological variables. *Dissertation Abstracts International, 42,* 3191.

Cohen, J. (1969). *Statistical power analysis for behavioral sciences.* New York: Academic Press.

Cunningham, J. (1980). The effects of exercise and relaxation training upon psychological variables in coronary heart patients. *Dissertation Abstracts International, 41,* 2313–2314.

Fardy, P. (1986). Cardiac rehabilitation for the outpatient: A hospital-based program. In M. L. Pollock, D. H. Schmidt, & D. T. Mason (Eds.), *Heart disease and rehabilitation* (pp. 423–435). New York: John Wiley.

Fletcher, B. J., Lloyd, A., & Fletcher, G. F. (1988). Outpatient rehabilitative training in patients with cardiovascular disease: Emphasis on training method. *Heart and Lung, 17,* 199–205.

Hackett, T. P., & Cassem, N. H. (1982). Coping with cardiac disease. In J. J. Kellerman (Ed.), *Comprehensive cardiac rehabilitation* (pp. 212–217). Basel: Karger.

Hammond, H., Kelly, T., Froelicher, V., & Pewen, W. (1985). Use of clinical data in predicting improvement in exercise capacity after cardiac rehabilitation. *Journal of the American College of Cardiology, 6,* 19–26.

Hellerstein, H. K. (1986). Cardiac rehabilitation: A retrospective view. In M. L. Pollock & D. H. Schmidt (Eds.), *Heart disease and rehabilitation* (pp. 701–711). New York: John Wiley.

Kellerman, J. J. (1981). *Comprehensive cardiac rehabilitation.* Basel: Karger.

Krampen, G., & Ohm, D. (1984). Effects of relaxation training during rehabilitation of myocardial infarction patients. *International Journal of Rehabilitation Research, 7,* 68–69.

Langosch, W. (1988). Psychological effects of training in coronary patients: A critical review of the literature. *European Heart Journal, 9,* 37–42.

Langosch, W., Seer, P., Brodner, G., Kallinke, D., Kulick, B., & Heim, F. (1982). Behavior therapy with coronary heart disease patients: Results of a comparative study. *Journal of Psychosomatic Research, 24,* 475–484.

Meyer, G. C. (1985). Cardiovascular rehabilitation: A discipline in need of a new direction? *Journal of Cardiopulmonary Rehabilitation, 5,* 507–509.

Munro, B. H., Creamer, A. M., Haggerty, M. R., & Cooper, F. S. (1988). Effect of relaxation therapy on post-myocardial infarction patients' rehabilitation. *Nursing Research, 37,* 231–235.

Nixon, P. G. F., Al-Abbasi, A. H., King, J., & Freeman, L. J. (1986). Hyperventilation in cardiac rehabilitation. *Holistic Medicine, 1,* 5–13.

Ohm, D. (1987). *Entspannungstraining und Hypnose bei Patienten mit koronaren Herzkrankheit in der stationären Rehabilitation.* Regensburg: Roderer Verlag.

Ornish, D., Scherwitz, L. W., Doody, R. S., Kesten, D., & McLanahan, S. M. (1983). Effects of stress management training and dietary changes in treating ischemic heart disease. *Journal of the American Medical Association, 249*, 54–59.

Ornish, D., Brown, S. E., & Scherwitz, L. W. (1990). Can lifestyle changes reverse coronary heart disease? *The Lancet, 336*, 129–133.

Patel, C., Marmot, M., & Terry, D. (1985). Trial of relaxation in reducing coronary risk: Four year follow up. *British Medical Journal, 290*, 1103–1106.

Peper, E., & Sandler, L. S. (1987). The metacommunications underlying biofeedback training. *Clinical Biofeedback and Health, 10*, 37–42.

Polackova, J., Bockova, E., & Sedivec, V. (1982). Autogenic training: Application in secondary prevention of myocardial infarction. *Active Nerve Supplement, 24*, 178–180.

Sime, W. E. (1980). Emotional stress testing and relaxation in cardiac rehabilitation. In F. J. McGuigan, W. E. Sime, & J. Macdonald Wallace (Eds.), *Stress and tension control* (pp. 41–48). New York: Plenum Press.

Thoresen, C., Friedman, M., Powell, L., Gill, J., & Ulmer, D. (1985). Altering the Type A behavior pattern in postinfarction patients. *Journal of Cardiopulmonary Rehabilitation, 5*, 258–266.

Uniken Venema-Van Uden, M. M. A. T., Zoeteweij, M, W., & Erdman, R. A. M. (1989). Medical, social and psychological recovery after cardiac rehabilitation. *Journal of Psychosomatic Research, 33*, 651–656.

van Dixhoorn, J. (1984). Body awareness: The proper application of relaxation and breathing technique. *Gedrag, 12*, 31–45.

van Dixhoorn, J., & Duivenvoorden, H. J. (1989). Breathing awareness as a relaxation method in cardiac rehabilitation. In F. J. McGuigan, W. E. Sime, & J. M. Wallace (Eds.), *Stress and tension control 3*, (pp. 19–36). New York: Plenum Press.

van Dixhoorn, J., Duivenvoorden, H. J., Staal, J. A., Pool, J., & Verhage, F. (1987). Cardiac events after myocardial infarction: Possible effect of relaxation therapy. *European Heart Journal, 8*, 1210–1214.

van Dixhoorn, J., Duivenvoorden, H. J., Staal, H. A., & Pool, J. (1989). Physical training and relaxation therapy in cardiac rehabilitation assessed through a composite criterion for training outcome. *American Heart Journal, 118*, 545–552.

van Dixhoorn, J., Duivenvoorden, H. J., & Pool, J. (1990a). Success and failure of exercise training after myocardial infarction: Is the outcome predictable? *Journal of the American College of Cardiology, 15*, 974–982.

van Dixhoorn, J., Duivenvoorden, H. J., Pool, J., & Verhage, F. (1990b). Psychic effects of physical training and relaxation therapy after myocardial infarction. *Journal of Psychosomatic Research, 34*, 327–337.