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Stress Management Techniques: Are They All Equivalent, or Do They Have Specific Effects?[1]

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This article evaluates the hypothesis that various stress management techniques have specific effects. Studies comparing various techniques are reviewed, as well as previous literature reviews evaluating the effects of individual techniques. There is evidence that cognitively oriented methods have specific cognitive effects, that specific autonomic effects result from autonomically oriented methods, and that specific muscular effects are produced by muscularly oriented methods. Muscle relaxation and/or EMG biofeedback have greater muscular effects and smaller autonomic effects than finger temperature biofeedback and/or autogenic training. EMG biofeedback produces greater effects on particular muscular groups than progressive relaxation, and thermal biofeedback has greater finger temperature effects than autogenic training. Disorders with a predominant muscular component (e.g., tension headaches) are treated more effectively by muscularly oriented methods, while disorders in which autonomic dysfunction predominates (e.g., hypertension, migraine headaches) are more effectively treated by techniques with a strong autonomic

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component. Anxiety and phobias tend to be most effectively treated by methods with both strong cognitive and behavioral components.

Descriptor Key Words: relaxation; biofeedback; autogenic training; meditation; stress management; cognitive therapy; anxiety; hypertension; headache.

The influence of stress on various diseases has become increasingly obvious in recent years (Dantzer, 1991; Lehrer, Isenberg, & Hochron, 1993; Niaura & Goldstein, 1992; Pelletier, 1992; Schmitz, 1992), and various stress management techniques are becoming accepted components in treatment programs. As part of their efforts to improve worker health and productivity, industries are becoming aware of deleterious effects of stress, and are turning to stress management educators to train their employees to reduce it. Thus, stress management is rapidly becoming a specialization within the mental health fields. The Biofeedback Certification Institute of America has even begun offering a certification program in stress management education. With the increasingly widespread professional application of stress management methods, it becomes increasingly necessary to document the effectiveness of various stress management techniques, and to delineate the array of methods that stress management therapists must learn in order to practice effectively.

The field of stress management conventionally employs a variety of stress management methods. Most prominently, these include progressive relaxation (PR), biofeedback, autogenic training (AT), various other Eastern or Westernized meditation methods, and various cognitive methods. Other procedures also have been used, but there are considerably fewer empirical data available to evaluate their relative effectiveness. These include listening to relaxing music, doing aerobic exercise, controlled breathing, postural relaxation methods (such as those described by Alexander and by Feldenkrais), etc. We recently have edited a book in which these techniques are described and evaluated (Lehrer & Woolfolk, 1993b). This article is an update and condensation of material presented in three chapters from that volume.

Specific Effects vs. the "Relaxation Response"

For almost two decades, an unresolved question for stress management practitioners has been whether these techniques all elicit a single "relaxation response," as proposed by Benson (1975). An alternative hypothesis is that they have specific effects, as proposed by Davidson and Schwartz (1976): specific cognitive effects for cognitively oriented methods,

autonomic effects for autonomically oriented methods, and muscular effects for muscularly oriented methods. Davidson and Schwartz hypothesize that muscle relaxation therapy might be expected to have predominantly somatic effects, because it emphasizes development of a muscular skill. AT (Linden, 1993), might be expected to generate both cognitive and somatic effects because it emphasizes achieving of body homeostasis through self-suggestion and it involves repeating internal verbal formulae (a cognitive process) that have specific somatic foci (e.g., "My arms are warm, "My forehead is cool," etc). There is evidence that AT particularly affects self-reports of various sensations that are specifically suggested during AT (such as heaviness and warmth in the limbs), and that the effects are greater than those produced by PR (Lehrer, Atthowe, & Weber, 1980; Shapiro & Lehrer, 1980). One study found that AT produced greater increases in the vividness of imagery and emotions (Borgeat, Stravynski, & Chaloult, 1983). These effects are consistent with AT's emphasis on imagining various visceral sensations and emotional states (e.g., through such commonly used autogenic formulas as "My mind is at peace"). PR only teaches the trainee to recognize muscular sensations.

Extrapolating from this argument, it also can be hypothesized that techniques using multiple modalities have a broader range of effects than more narrowly focused methods. Thus, PR may have effects that are differentiable from those of EMG biofeedback. The former technique uses verbal instruction, and some variants of the technique (e.g., Bernstein & Carlson, 1993) also employ a considerable amount of suggestion. EMG biofeedback has a more narrowly somatic focus.[3] If Benson was correct and all relaxation techniques are equivalent, then practitioners need not learn them all. Instead they could select only ones that they or their clients may particularly like or find simpler to use. If they are not equivalent, practitioners are obliged to learn them all. The choice of technique may depend upon multiple factors. These include the existence of a specifically strong effect in modifying a particular manifestation of stress, but may also involve such issues as compliance, cost-effectiveness, and adverse effects. We have reviewed these latter issues elsewhere (Lehrer & Woolfolk, 1993). The cur-

[3]It should be noted that Lazarus (1977) suggests that even biofeedback, the least cognitive of relaxation therapies, is mediated by cognition. He also theorizes that biofeedback occupies the client's attention with somatic processes, and thereby blocks stressful thoughts or events; and that the self-knowledge gained about stress responses and the events that produce it lead people to rethink the meaning of these events, and to change their behavior accordingly. A similar argument was made by Holroyd (1979). However, although cognitive processes may play some role in biofeedback, we nevertheless hypothesize a stronger somatic than cognitive effect for biofeedback, particularly in comparison with other techniques with a more obvious and direct cognitive focus.

rent article will focus on the existence of specific effects on various outcome measures and disorders.

In assessing specifically cognitive effects of various stress management techniques, the term "cognitive" requires definition. We use it broadly to denote focused attention on a particular object or thought. We also use the word to describe a specific interpretation of events as stressful or uncomfortable. The specific effects theory would predict greater effects for cognitively focused treatments on both types of cognitive activity. Meditation methods specifically target the first of these. They can also affect the latter, by providing an alternative activity through which the practitioner can block generic "worry" activity that could reinforce a negative or catastrophic interpretation of events. Mental focus on a verbal mantra, according to this hypothesis, might be expected to inhibit any other type of verbal activity, including worry. Mantra meditation's greatest and most direct effect might therefore be to reduce the quantity of verbal thought process. "Cognitive therapy" (Beck, 1993) is more specifically focused on modifying the *content* of cognitions. It therefore should be expected to have greater effect on this aspect of cognition than meditation therapy.

In this review we have drawn conclusions based on the weight of results across many studies. This approach assumes that the various methodological differences across studies tend to balance each other out. The reader is cautioned that this assumption may not always be valid. This is particularly true where the number of studies on a particular issue is small, and/or where most of them tend to come from one laboratory; and this is the case for almost all the issues that will be discussed below. Thus some conclusions we draw by this method may reflect methodological biases across multiple studies, and may be reversed in future research. Also, different outcome measures have been used across studies, many of which are noncomparable. To minimize the influence of differing methodologies used with particular methods, we included only articles in which a parametric *comparison* was made between or among two or more techniques. We tallied the number of such comparisons in each direction, where differential effects were significant at $p < .05$. In a separate category, we tallied published parametric studies finding nonsignificant effects. We also covered literature reviews by others of controlled parametric studies of individual methods. Where possible, we included papers in all languages. We did not examine relative effect sizes in these studies. Authorities do recommend this method for examining the relative effects of treatments across studies (Glass et al., 1981; Rosenthal, 1984), and it has the advantage of providing a quantitative estimate of relative effectiveness. However, it has the disadvantage of exaggerating the effects

of possible methodological biases in individual studies finding large effects. Previous reviews of relaxation studies, not restricted to *comparative* studies, have made use of this method (Eppley, et al., 1989; Holroyd & Penzien, 1986; Jacob et al., 1991; Linden & Chambers, 1994), and this method may profitably be used in future examination of the literature reviewed here. We mention the findings of these previous reviews, but, in the present review, we examined only the *consistency* of effects, rather than their size, and we gave equal weight to each study.

A criticism often applied to metaanalytic assessments of effect size is the overestimate of average effects. There is a tendency for studies with nonsignificant effects to remain unpublished, and therefore to be omitted in metaanalytic reviews, thereby inflating effect sizes. This "file drawer" effect (Rosenthal, 1979) might be expected to be minimized in the current review, because we are examining only *differences* between techniques. If *any* technique produces statistically significant results, there would ordinarily be no necessary barrier to publication. This would be true even for findings of no differential effects among treatments.

We have looked at the following possible specific effects: (1) The specific vs. general effects of muscle relaxation methods (vs. autonomically, behaviorally, or cognitively focused techniques) on reduction of muscle tension, autonomic, behavioral, and cognitive outcome measures; and (2) the effects of each of these modalities on various disorders that involve abnormalities that are focused in one of these areas. Also, where a sufficient body of literature exists, we covered the differences in effects of techniques that are more closely related to each other, but still are distinguishable: e.g., EMG biofeedback vs. PR training as methods for reducing muscle tension, AT vs. thermal biofeedback for reduction in autonomic reactivity. In our review we have included all outcome measures and disorders for which comparative studies are available. We have, however, restricted the review to disorders that, in the opinion of stress researchers, include an important stress component. Therefore, for example, although we have included such disorders as chronic pain, asthma, and hypertension, we have excluded most applications in orthopedics and neuromuscular reeducation.

Method

We only included studies if they involved a parametric comparison among two or more stress-management methods. Also, we examined systematic literature reviews about the methods and/or disorders covered in

this article. We examined papers whose references were obtainable from searches of *Index Medicus* and *Psychological Abstracts*. We also included papers cited in this literature, where they met the above criteria.

DIFFERENTIAL EFFECTS OF VARIOUS RELAXATION THERAPIES ON SPECIFIC PHYSIOLOGICAL MEASURES

Progressive Relaxation vs. EMG Biofeedback: Effects on EMG

EMG biofeedback appears to be more powerful than live instructions in PR for producing changes in EMG (4 studies to 1 in the opposite direction, in Table I). The literature also suggests that EMG biofeedback may produce greater reduction in other forms of physiological arousal. In one study each EMG biofeedback produced greater increases than PR in

Table I. Comparisons Between EMG Biofeedback and Progressive Relaxation: Effects on Surface EMG

Study	Results
Live Progressive Relaxation Training	
Kravitz (1977)	bfk + PR > PR
Beiman et al. (1978)	PR > bfk
LeBoeuf and Lodge (1980)	bfk > PR
Scandrett et al. (1986)	bfk > PR
Pharr and Coursey (1989)	bfk > PR
Taped Progressive Relaxation Training	
Haynes et al. (1975)	bfk > PR
Reinking and Kohl (1975)	bfk > PR
Hutchings and Reinking (1976)	bfk > PR
Sheridan et al. (1977)	PR > bfk
Sime and DeGood (1977)	bfk > PR
Fee and Girdano (1978)	bfk > PR
DeBerry (1979)	bfk > PR

Note: In this and following tables, ">" denotes a greater effect in producing changes in the direction of greater relaxation. The following abbreviations are used in all tables: AT, autogenic training; CT, cognitive therapy; EMG bfk, EMG biofeedback; HR bfk, heart rate biofeedback; SC bfk, skin conductance biofeedback; RR, respiration rate; PR, progressive muscle relaxation; RT, relaxation therapy (generic); SD, systematic desensitization; TBFK, thermal biofeedback; DBP, SBP, diastolic, systolic blood pressure.

peak expiratory flow rate (among asthmatics) (Davis, Saunders, Creer, & Chai, 1973), and heart rate (Rawson, Bhatnagar, & Schneider, 1985).

Taped PR tends to be less powerful than live (see reviews in Lehrer, 1982; Lehrer & Woolfolk, 1984; Lehrer, Woolfolk, & Goldman, 1986), but does produce significant physiological effects *during training sessions*. Six of seven studies in Table I show greater effects for EMG biofeedback than for taped PR in reducing EMG during training sessions. For self-reported symptoms of various stress-related disorders, the results are mixed, but tend to favor EMG biofeedback over taped relaxation.

These results are consistent with the interpretation that PR provides less direct physiological training than EMG biofeedback. However we should caution that there are several varieties of PR training. Some [like Jacobson's original technique (McGuigan, 1993)] are much more physiologically oriented than others (e.g., the more commonly used abbreviated method of PR training described by Bernstein and Carlson, 1993). The specific differences between these two approaches have been described elsewhere (Lehrer, Woolfolk, & Goldman, 1986). Jacobson's method emphasizes muscle training and refrains from using suggestion or direct cognitive interventions. The revised methods make considerable use of such components, and almost all studies in the research literature use this method. Thus, their effects might be expected to be more cognitive and less physiological than Jacobson's, according to the "specific effects" theory.

Comparison Between Muscle Relaxation and Mantra Meditation

Davidson and Schwartz modified their "specific effects" hypothesis in an article describing a study involving mantra meditation. Mantra meditation involves repeating a word to oneself silently (Carrington, 1993). Although the practitioner is advised to relax and sit quietly, specific training in somatic relaxation skills is not necessarily offered.[4] Meditation was hypothesized to have stronger cognitive than somatic effects (Schwartz, Davison, & Goleman, 1978).

The pattern of effects on autonomic measures is not clear. For blood pressure, one study found greater effects for meditation than for PR (Parker et al., 1978), and one found the opposite (English & Baker, 1983). PR tends to have a greater effect in reducing heart rate (2 studies to 1 finding equal effects, Table II). However, following meditation training, two studies from our laboratory found greater increases in heart rate decelera-

[4]Some more complex meditation techniques do combine specific training in somatic relaxation with mantra meditation. This is particularly the case among various Eastern meditative disciplines (e.g., Patel, 1993).

Table II. Mantra Meditation vs. Muscle-Focused Treatments: Effects on Physiological Measures

Study	Results	Outcome measure
	Heart Rate Effects	
Warrenburg et al. (1980)	PR > MED	HR
Lehrer et al. (1980)	PR > MED	HR
Curtis and Wessberg (1980)	PR = MED	HR
Lehrer et al. (1980, 1983)	MED > PR	Incr. HR decel to noxious stimuli
	Other Autonomic Effects	
Curtis and Wessberg (1980)	PR = MED	SC, RR
Keller and Seraganian (1984)	Exerc > MED	Electrodermal activity
	Literature Reviews on EEG Effects	
Woolfolk (1975)	MED > PR	EEG alpha and thera
West (1980)	MED > PR	EEG alpha and theta
Delmonte (1984)	MED > PR	EEG alpha an theta
	Literature Reviews on EMG Effects	
Fee and Girdano (1978)	MED = EMG bfk	EMG
Zaichkowsky and Kamen (1978)	MED = EMG bfk	EMG
Lehrer et al. (1980)	PR > MED	EMG
Carlson et al. (1988)	MED > PR	EMG

Note: See footnote to Table I.

tions elicited by loud tones during meditation than during PR. For other autonomic functions, two studies give the edge to PR or exercise (another muscular technique), one to meditation and one found equal effects (Table II).

For EMG effects, the specific effects hypothesis would predict that muscular relaxation should have greater effects than meditation. However, thus far, the two methods show equivalent effects. One study listed in Table II favors meditation, one favors PR, and two show equal effects. This is discrepant from the specific effects hypothesis. It is possible that these studies found no consistent differences because all were performed on normal subjects. Research from our laboratory (Lehrer, 1978) has found a consistent "floor" effect for relaxation in this population. This could minimize differences in effectiveness among techniques.

Three literature reviews conclude that meditation produces greater increases in EEG alpha and theta than PR (Table II). This is consistent with the specific effects theory only if EEG activity reflects cognitive, more than somatic, arousal. Biofeedback-produced increases in EEG alpha and theta have been described in terms of state of consciousness: "relaxed"

Table III. Autonomically Focused Techniques vs. Others

Study	Results	Outcome measure
	Muscular Effects	
Staples et al. (1975)	PR, EMG bfk > AT	EMG
Schneider et al. (1987)	EMG bfk > AT	EMG
Gamble and Elder (1983)	EMG bfk > TBFK	EMG
Reading (1983)	EMG bfk > TBFK, SC bfk	EMG
	Autonomic Effects	
Muscular vs. autonomic techniques		
Gamble and Elder (1983)	TBFK > EMG bfk, PR	Forehead cooling
Lehrer et al. (1980)	AT > PR	HR decreases
Blanchard et al. (1988b)	PR > TBFK	HR reactivity
Meditation vs. autonomic techniques		
Cuthbert et al. (1981)	MED > HR bfk	HR, SC
Pollard and Ashton (1982)	MED > HR bfk	HR
Gallois et al. (1984a,b)	MED > AT	Lower cortisol and prolactin
Zeier (1985)	MED + AT > AT	HR, RR, phys index
Autogenic training vs. finger temperature biofeedback		
Kluger et al. (1985)	TBFK = AT	Finger temperature (normal subjects)
Freedman and Ianni (1983); Freedman (1989)	TBFK > AT, EMG bfk	Finger temperature
Kelson and Bryson-Brockmann (1985)	TBFK > AT	Hand warming in people with cold hands
Freedman et al. (1993)	TBFK > AT	Finger temperature (normal subjects). Heart rate systolic BP were higher for TBFK

Note: See footnote to Table I.

alertness for alpha (Brown, 1970; Kamiya, 1969) and somnolescence for theta (Bell, 1979); however, others have raised questions about the relationship between biofeedback-induced changes in EEG rhythms and any specific mood or cognitive states (Beyerstein, 1990; Cott et al., 1981; Plotkin, 1979).

Autonomically Focused Relaxation Techniques vs. Meditation and Muscle Relaxation

The techniques classified in this article as having a predominant autonomic focus include AT and biofeedback of autonomic variables. AT is

included in this category because it contains a preponderance of autonomically focused suggestions. Comparisons between these techniques and more muscularly oriented techniques appear in Table III.

Muscular Effects. For effects on surface EMG, four of four studies show greater effects for PR or EMG biofeedback than for AT or thermal biofeedback (Table III).

Autonomic Effects. Most of the literature on autonomic effects of self-regulation techniques describes clinical studies, particularly on hypertension, Raynaud's disease, and migraine headaches. These studies will be reviewed below, where we discuss differential clinical effects of the various methods. In this section, our review is restricted to nonclinical studies. Two of three studies in Table III show greater autonomic effects for AT or thermal biofeedback than for PR or EMG biofeedback. One study shows the opposite effect.

Meditation vs. Autonomically Focused Techniques. Inconsistent with the specific effects theory, meditation seems to have greater effects than heart rate biofeedback or AT in reducing both autonomic arousal and various self-reported symptoms. These findings suggest that mantra meditation may altogether be a more powerful intervention than AT, and may show greater generalization than the latter, beyond its specific focus. However, this conclusion requires more study. The studies on which it is based were done on diverse populations, using diverse outcome measures. (See Table III.)

Finger Temperature Biofeedback vs. Autogenic Training. AT and thermal biofeedback both focus on autonomic effects. However, the specific effects theory would predict a greater cognitive component for AT, because of its use of mental focus on specific formulas. Thermal biofeedback might be expected to have greater effects on blood flow to the skin, and related measures. With its more exclusive somatic focus, thermal biofeedback might be expected to have greater autonomic effects. Moreover, Freedman and his colleagues (Freedman, 1989, 1991; Freedman & Ianni, 1983) have shown that different physiological processes occur in the two techniques. AT tends to function more as a relaxation technique, producing general decreases in sympathetic arousal. Digital thermal biofeedback, however, may have specific effects in reducing alpha sympathetic activity, but may have the opposite effect on nonneural beta sympathetic arousal. In fact, decreases in beta sympathetic arousal can produce *decreases* in peripheral blood flow. Table III shows stronger effects for thermal biofeedback than for AT in producing increases in digital temperature (3 studies, vs. 1 study finding no differences). Digital temperature is a close reflection of peripheral blood flow. Freedman and his colleagues (Freedman, Keegan, Rodriguez, & Galloway, 1993) recently demonstrated that

thermal biofeedback produced increases in heart rate (a beta sympathetic stimulating effect) along with increases in finger temperature, while AT produced lower heart rate and systolic blood pressure than thermal biofeedback (possible relaxation-mediated beta-blocking effects), but lower finger temperature.

COMPARATIVE TREATMENT EFFECTS IN CLINICAL OUTCOME STUDIES

Conclusions about specific effects of techniques on diseases tend to be less definitive than those regarding such effects on particular physiological outcome measures. In almost all cases there is disagreement among experts about etiological factors, and there is great variability among studies in the types of outcome measures used. Therefore, this section should be interpreted more impressionistically than the preceding one. Nevertheless, communalities among studies do suggest heuristic hypotheses regarding behavioral treatment strategies for these disorders.

SOMATIC DISORDERS

Blood Pressure and Hypertension

Literature Reviews

Most of the literature reviews listed in Table IV show equivalent effects for various relaxation, biofeedback, and stress management methods in treating hypertension. Drug therapies tend to be more effective than behavioral methods. However, several reviews conclude that stress-management methods can be effective for people with milder hypertension, and that they can cut the dosage of antihypertensive medications that may be needed. Lichstein (1988) noted decreases of at least 10 mm Hg systolic and 5 mm Hg diastolic in moderate hypertensives. Changes of this magnitude are generally considered clinically important (Health & Public Policy Committee, American College of Physicians, 1985). Further, Barr and Benson (1984) concluded that these changes are greater than those produced by placebos, that they generalize to nontreatment settings, and that they are maintained well over time. More recently, Goldstein and Niaura (1992) reviewed studies on psychotherapy, relaxation, and biofeedback and concluded that monitoring of blood pressure and relaxation procedures provided additive benefits when combined with pharmacologic treatments.

Table IV. Blood Pressure

Study	Results
Conclusions of Literature Reviews of Stress-Management Techniques	
Agras and Jacob (1979)	BP biofeedback = PR = various forms of RT
Frumkin et al. (1978)	BP biofeedback = PR = various forms of RT
Seer (1979)	BP biofeedback = PR = various forms of RT
Tarler-Benlolo (1978)	BP biofeedback = PR = various forms of RT
Wadden et al. (1984)	Drug therapy > behavior therapy > no treatment, attention-placebo
Kaufmann et al. (1988)	Self-regulation procedures = control conditions, no differences among self-regulation procedures
Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure (1988)	RT useful adjunct to medication in severe hypertension, RT indicated in mild hypertension
Jacob et al. (1991)	Multicomponent programs > EMG FB > TBFK > RT
Relaxation vs. Blood Pressure Monitoring	
Goldstein et al. (1982)	RT > BP monitoring
Glasgow et al. (1982)	RT > BP monitoring
Agras et al. (1987)	RT > BP monitoring
Jacob et al. (1985)	BP monitoring > RT
Chesney et al. (1987)	BP monitoring > RT
Self-Regulation Therapies vs. Drug Therapies	
Studies finding stronger effects for stress-management methods	
Patel et al. (1981, 1985)	GSR FB + PR + meditation + stress education > standard medical treatment
Richter-Heinrich et al. (1984)	RT + BP feedback + BP monitoring + physical exercise + psychoeducation > drug therapy with beta-receptor blockers
Goldstein et al. (1984)	Drug therapy + RT + or EMG FB > drug therapy, nondrug therapy
Studies finding stronger effects for drugs	
Luborsky et al. (1980)	Drug therapy > AT or drug therapy + AT
Andrews et al. (1982)	Drug therapy > weight reduction, yoga, PR > meditation, exercise training, BP feedback and salt restriction = placebo
Goldstein et al. (1982)	Drug therapy > RT, BP feedback, self-monitoring
Luborsky et al. (1982)	Drug therapy > metronome-conditioned relaxation, BFB, physical exercise control procedures
Jacob et al. (1986)	Drug therapy (beta-blocker + diuretic) > PR, AT
Autonomic vs. Muscle Techniques	
Reviews	
Frumkin et al. (1978)	BP bfk = PR = AT
Tarler-Benlolo (1978)	BP bfk = PR = AT
Agras and Jacob (1979)	BP bfk = PR = AT
Seer (1979)	BP bfk = PR = AT
Goldstein (1982)	BP bfk = PR = AT
Kaufmann et al. (1988)	BP bfk = EMG bfk =TBFK = RT (DBP) (no significant effect for any at follow-up)

Table IV. Continued

Study	Results
Jacob et al. (1991)	Stress management > EMG bfk > TBFK > RT > MED > BP bfk
Comparative studies	
Fray (1975)	AT > EMG bfk
Longo (1984)	Deep breathing > PR
Blanchard et al. (1984, 1986)	TBFK > PR
McCoy et al. (1988)	TBFK > PR
McCoy et al. (1988); Aivazyan et al. (1988)	TBFK > breathing-retraining + PR
Blanchard et al. (1988b)	PR > TBFK
Aivazyan et al. (1988)	TBFK = PR + breathing-medit > AT
Thermal Biofeedback vs. Autogenic Training	
Blanchard et al. (1986)	TBFK > AT
Aivazyan et al. (1988)	TBFK > AT
Blanchard et al. (1988a)	TBFK = AT
Blood Pressure Biofeedback vs. Other Techniques	
Goldstein et al. (1982)	BP Feedback > RT, self-monitoring
Glasgow et al. (1982)	RT + BP feedback > RT, BP feedback
Meditation vs. Muscular and Autonomic-Focused Techniques	
Parker et al. (1978)	MED > PR (nonhypertensive alcoholics)
Sedlacek et al. (1979)	EMG + TMP bfk > MED
Hafner (1982)	MED + EMG-or-SC-BFK > MED
Cohen and Sedlacek (1983)	AT + PR + EMG and TBFK > MED
English and Baker (1983)	PR > MED (SBP)
Cognitive vs. Relaxation Therapies	
Lustman and Sowa (1983)	EMG bfk > stress inoculation training
Agras et al. (1983)	RT = anxiety management training > NT, delayed treatment, WL
Longo (1984)	Breathing retraining or PR > guided imagery (DBP) Deep breathing > guided imagery (SBP)
Chesney et al. (1987)	CT + RT > RT
Achmon et al. (1989)	HR bfk > CT for anger control
Relaxation vs. Dietary Therapies	
Lasser et al. (1987)	PR = Diet control (reduced sodium, weight reduction) > standard medical treatment

Note: See footnote to Table I.

Biofeedback as a singular technique did not add anything to the practice of relaxation. Overall, they concluded that these interventions may allow individuals to decrease their medication dosage.

However, the widely cited conclusions of NIH's Hypertension Pooling Project (Kaufman et al., 1988) were quite negative about the effects of stress management therapies in treating hypertension. Jacob et al. (1991) pointed out that the various relaxation/meditation/biofeedback therapies produce the greatest blood pressure reductions among patients who are "new" to the particular treatment situation, and who are not given extensive baseline testing. They therefore conclude that these therapies have their greatest effect in reducing the pressor effect generated by the testing situation, but that their effects on blood pressure *in general* are small. On the other hand, based on a metaanalysis, they note that some methods of treatment (particularly multifaceted stress management methods) have better effects than others (particularly meditation and blood pressure biofeedback).

In a metaanalysis of 165 studies on the clinical effectiveness of various treatments for hypertension, Linden and Chambers (1994) conclude that nondrug therapies may be more effective than commonly believed. This is particularly true after controlling for differences in pretreatment blood pressure levels. They found that adjustment of differences in initial pressure levels led to increased effects for nondrug therapies. For systolic blood pressure, the size of the antihypertensive effect produced by individual psychotherapy approximately matched that produced by drug therapies. The effect size on blood pressure for drug therapy was larger than that for weight reduction, physical exercise, decreased sodium and alcohol intake, potassium supplements, and standard relaxation training. However, weight reduction, physical exercise, and individualized cognitive-behavioral therapy were particularly effective. The raw effect sizes of these treatments on systolic blood pressure did not differ from drug therapy. Calcium supplements were the least effective.

It is possible that self-regulation therapies may have other positive benefits on the lives of hypertensives than their specific effects on blood pressure. Shapiro et al. (1982) note that there have been common reports of psychological benefits and improved quality of life. Muldoon, Shapiro, Manuck, and Waldstein (1991), however, note that there is still little research on this topic.

Comparative Studies

Among comparative studies, as can be seen in Table IV, we found evidence that various relaxation therapies are marginally more effective than home monitoring of blood pressure (3 of 5 studies showing an advantage for self-regulation therapies). However, they were less effective

than drug therapies (5 studies favoring drug therapies, 3 favoring self-regulation). One study found equivalent findings for dietary regulation and relaxation therapy.

Among self-regulation therapies, there is evidence (Table IV) that autonomically focused therapies may be marginally more powerful than muscle relaxation or meditation for treating hypertension. In making this conclusion, "deep breathing" was characterized as an autonomic intervention, because of the strong direct effects of slow, deep breathing on increasing vagal tone (Sargunaraj, Lehrer, & Hochron, 1992). Similarly, combinations of autonomic and muscular measures appear to have greater antihypertensive effects than mantra meditation. This is consistent with conclusions of reviews by Delmonte (1986) and by Patel and Carruthers (1979) of studies on the effects of individual techniques. Thermal biofeedback may have stronger effects than AT. In addition, it appears that thermal biofeedback has greater effects than AT, although both have an autonomic focus. The specific vasodilation effects of thermal biofeedback may contribute a specific advantage. Similarly, one study (Goldstein et al., 1982) found an advantage of blood pressure biofeedback over relaxation therapy, but another found that the combination of blood pressure biofeedback and relaxation therapy was more effective than either technique alone (Glasgow et al., 1982).

Table IV also shows that meditation has smaller effects than other relaxation therapies (4 studies to 1), and that somatically oriented self-regulation therapies have greater effects than methods emphasizing cognitive changes and imagery.

Resolving the discrepancy between our findings and the metaanalysis conclusions reached by Jacob et al. (1991) requires further research. They indicated that stress management training is superior to relaxation training, with EMG biofeedback and thermal biofeedback training having intermediate effects; but we conclude that there is an advantage to using autonomic over muscular methods, and that cognitive therapies have little effect. We point out that the paper by Jacob et al. did not differentiate between muscle relaxation and AT. Also, in our review, only one comparative study (Chesney et al. 1987) found an advantage of stress management training (including cognitive components) over relaxation and biofeedback methods. Because of the many methodological differences among studies reviewed in the Jacob et al. article it is possible that the direct comparisons may give a more accurate reflection of actual differences between treatment methods. We suggest that further research be done comparing autonomically based relaxation/thermal biofeedback therapies with a comprehensive stress management program.

Raynaud's Disease

Raynaud's disease involves spasms in the blood vessels of the hands and feet. At its worst it deprives these regions of sufficient blood supply, and can result in gangrene, and loss of extremities. Attacks of Raynaud's disease can be precipitated both by cold stimulus and by stress.

Behavioral interventions with Raynaud's disease are an attractive alternative to invasive medical interventions such as surgery or medication. Most behavioral research on this disease has focused on biofeedback and relaxation strategies. Early reviews of these techniques (Blanchard, 1979; Pickerton, Hughes, & Wenrich, 1982; Sappington, Florito & Brehony, 1979; Surwit, 1982) suggested that relaxation and finger temperature biofeedback training were almost equally effective in treating Raynaud's disease. However, Kelson and Bryson-Brockmann (1985) demonstrated an advantage for temperature biofeedback training in producing consistent finger temperature increases among subjects with chronically cold hands. Rose and Carlson (1987) reported that a combination of temperature biofeedback during exposure to a cold stressor seems superior to thermal biofeedback or AT alone. These differences are not consistent across studies, however. It does appear, though, that several methods of biofeedback and relaxation training are superior to no treatment.

Two studies on classical conditioning (Jobe, Sampson, Roberts, & Beetham, 1982; Jobe, Sampson, Roberts, & Kelly, 1986) found that it was superior to EMG digital temperature and biofeedback as indicated by the one-year follow-up data.

Studies by Freedman and his co-workers have consistently shown an advantage for finger temperature biofeedback. The technique's efficiency was enhanced when cold stress was used in the training (Freedman, Lynn, Ianni, & Hale, 1981; Freedman, Ianni, & Wenig, 1983, 1985). It is possible that the specific effect of temperature biofeedback was due to an increase in the effects of circulating beta-catecholamines. This is the reverse of the direction of change produced by relaxation techniques (Freedman, 1985).

The consensus in the literature indicates that various stress management and self-regulation techniques are useful in the treatment of Raynaud's disease. Temperature biofeedback has the greatest effects. These are potentiated by training subjects with a cold stress technique. Classical conditioning procedures may be useful adjuncts to relaxation or biofeedback techniques, but this requires further evaluation. The comparative or additive affects of drug and nondrug treatments have not yet been studied.

Other Disorders with a Predominant Autonomic Focus

Dysmenorrhea

Empirical research on a variety of stress reduction procedures has shown positive results. Comparative studies have found few significant differences among nonpharmacological techniques, including systematic desensitization (SD) with PR, PR alone, EMG biofeedback, thermal biofeedback, cognitive restructuring, time scheduling and nondirective therapy (Balick, Elfner, May, & Moore, 1982; Bennink, Hulst, & Benthem, 1982; Duson, 1976, 1977; Rosenthal, 1978; Sigmon & Nelson, 1988).

Stress management strategies such as PR or a combined PR-SD procedure appear to be more effective with spasmodic than with congestive dysmenorrhea (Chesney & Tasto, 1975; Amodei, Nelson, Jarrett, & Sigmon, 1987). Anxiety management training was found to improve both kinds of symptoms, compared to a no-treatment control group (Quillen & Denny, 1982). The series of studies by Heczey (1977, 1978, 1980) strongly indicates that vaginal temperature biofeedback combined with AT is superior to either used alone and to a no-treatment control.

Also, as shown in Table V, thermal biofeedback seems to have greater effects than AT in treating dysmenorrhea (2 studies). This is consistent with the involvement of vascular engorgement in producing symptoms of dysmenorrhea, and with the view that thermal biofeedback has greater effects on the vascular system than AT.

Literature reviews of nondrug treatments for dysmenorrhea indicate that SD is an effective treatment, though its exact mechanism of action is unclear (Denney & Gerrard, 1981; Lewis, Wasserman, Denney & Gerrard, 1983). Two alternate hypotheses suggest that it may act directly on the pain sensation or may indirectly affect it by reducing tension that might exacerbate it (Denney & Gerrard, 1981).

The reviews highlight several needs and problems in the literature on psychological treatments of dysmenorrhea. Some women have symptoms of both congestive and spasmodic dysmenorrhea; there is a need for studies on women who show this mix of symptoms. Furthermore, careful screening and selection of research subjects are necessary. Eliminating subjects who use intrauterine devices or hormonal medication is essential because of the effects of these on dysmenorrhea and the consequent bias introduced into descriptive and treatment research. Also, researchers have tended to rely on subject populations who are already receiving various kinds of therapy or on college students. Both these groups are nonrepresentative of women in general. Lewis, Wasserman, Denney, and Gerrard (1983) suggest the

Table V. Disorders with a Predominant Autonomic Focus

Study	Results
	Raynaud's Disease
Surwit et al. (1978)	TBFK = TBFK + AT
Freedman et al. (1983); Freedman (1987)	TBFK > AT, EMG bfk
	Dysmenorrhea
Duson (1976/77)	PT + SD = CT > control
Heczey (1977/1978)	Vaginal TBFK > AT
Rosenthal (1978)	PR = SD = nondirected therapy
Heczey (1980)	Vaginal-TBFK + AT > AT
Bennink (1982)	PR + EMG bfk > PR = waiting list
Sigmon and Nelson (1988)	PR = contingency management > WL
	Asthma
Lehrer et al. (1993)	EMG bfk > PR (review)
Davis et al. (1973)	EMG bfk > PR

Note: See footnote to Table I.

use of physiological measures such as intrauterine pressure data in addition to self-report measures of outcome.

Asthma

EMG biofeedback may be more powerful than PR in treating asthma. Work by Kotses and his colleagues (Glaus & Kotses, 1983; Harver & Kotses, 1984; Kotses & Glaus, 1981; Kotses, Harver, Segreto, Glaus, Creer, & Young, 1991) have suggested that, through action of a vagal/trigeminal reflex, specific relaxation of muscles in the facial area may produce bronchodilation. There is reason to think that more *general* relaxation may *worsen* asthma, at least temporarily, through a decrease in sympathetic activity or an increase in vagal tone. (Sympathetic stimulation produces bronchodilation, and vagal stimulation bronchoconstriction.) Such findings have been obtained in two studies from our laboratory (Lehrer, Hochron, McCann, Swartzman, & Reba, 1986; Lehrer, Hochron, Mayne, Isenberg, Carlson, Lasoski, Gilchrist, & Rausch, 1994). EMG biofeedback to the frontal area may produce specific relaxation in the facial area than more general PR training. The latter emphasizes facial relaxation less and general relaxation more. It may be counterproductive in asthma, at least in the short run.

Other specific biofeedback procedures have been proposed for treating asthma, but await further validation. These include Peper's technique of trapezius EMG biofeedback for thoracic relaxation, combined with biofeedback training to increase inspiratory air flow (Peper, Smith, & Waddell, 1987; Tibbetts & Peper, 1989), controlled breathing (Hibbert & Pilsbury, 1988), decreased vagal tone (Harding & Maher, 1982), trachea noise biofeedback (Mussell & Hartley, 1988), and biofeedback of respiratory resistance (Janson-Bjerklie & Clark, 1982; Steptoe, Phillips, & Harling, 1981). Of these, it should be noted that, strictly speaking, the latter two methods are not "stress management" methods, and that decreases in vagal tone tend to be associated with *increases* in the fight-or-flight reaction.

Peptic Ulcer

Although clinical case reports and the results of several research studies all suggest that stress management training may be a useful adjunct to ulcer treatment, few controlled studies have yet been done, and no comparative studies. In an early study, Chappel, Stefano, Rogerson, and Pike (1936) applied six weeks of didactic training. This included education about the etiology, relaxation training and training in the use of positive self-statements. Subjects receiving this intervention showed greater reduction in ulcer symptoms than did a group receiving only dietary and drug treatment. The treatment gains persisted at a one-year follow-up. Jacobson (1938) provided well-documented case study material showing improvement in ulcers following training in PR. In summarizing the results of an uncontrolled study, Beaty (1976) suggested that, when taught as a stress management technique, relaxation training can reduce or eliminate the symptoms of peptic ulcer. At a 30-month follow-up, Brooks and Richardson (1980) found fewer recurrences of ulcerative symptoms among subjects receiving assertiveness training and relaxation, compared with untreated controls. In their literature review, Whitehead and Basmajian (1982) concluded that there is a need for a large extended trial comparing relaxation training to medical management with antacids and cimetidine, using x-rays and endoscopy as outcome measures. This need still prevails.

Irritable Bowel Syndrome

Early case material presented by Jacobson (1938) showed symptom improvement x-ray evidence of decreased colonic spasms following PR. More recently, Hislop (1980) found that brief psychotherapy aimed at increasing insight and self-reliance resulted in symptom remission for 50%

of a sample of unmedicated IBS sufferers. The one-year follow-up indicated an improvement in anxiety, fatigue, insomnia, mood, diarrhea, and nausea. Abdominal pain was less responsive. Svedlund (1983) found that a combination of psychotherapy and medical treatment resulted in significant decreases in abdominal pain, depression, anxiety, and bowel dysfunction.

Interventions with a specific focus appear to be more effective than general psychotherapy. Whorwell, Prior, and Faragher (1984) found hypnotherapy aimed at general relaxation and control of intestinal motility to be more effective than supportive psychotherapy. Lynch and Zamble (1987) reported significant decreases in symptoms following a combination of relaxation, assertiveness training, and cognitive restructuring. A combination of PR, thermal biofeedback, educational information and cognitive stress coping strategies was successful in decreasing abdominal pain and diarrhea (Blanchard & Schwarz, 1987; Neff & Blanchard, 1987). The clients classified as "successes" reported improvement in depression, state anxiety, and psychosomatic symptoms, and the "failures" did not deteriorate on any of the measures (Blanchard, Radnitz, Schwarz, Neff, & Gerardi, 1987). The treatment gains persisted at a two-year follow-up (Blanchard & Schwarz, 1988). In a later study, Blanchard et al. (1992) found a nonsignificant tendency for a multicomponent treatment (relaxation, thermal biofeedback, and cognitive therapy), but not cognitive therapy, to reduce symptoms of irritable bowel syndrome more than an attention placebo; but, in an additional study reported in the same paper, no such differential improvement occurred. All subjects (including those in an attention placebo condition) showed significant and enduring improvement. These results are sufficiently strong to warrant further investigation.

Headaches

Several literature reviews have concluded that various stress management techniques are effective for tension and migraine headaches (Table VI). There is also evidence that muscularly oriented therapies (EMG biofeedback and PR) are more effective for tension headaches than thermal biofeedback and/or AT, and that the reverse is true for migraine headaches (Table VI). Janssen and Neutgens (1986) found PR to be more effective than AT for treating tension headaches. Three studies found thermal biofeedback to be more effective than EMG biofeedback or PR for migraines. Cott et al. (1992) studied two groups of headache subjects, one with muscle contraction headaches and one with mixed headaches. There were no significant differences across headache groups. However, averaged across headache groups (with most subjects experiencing some tension headache

Table VI. Headaches

Study	Results	Type of HA
	Relaxation vs. EMG Biofeedback Therapies	
Reviews		
Beaty and Haynes (1979)	bfk = PR	Tension
Holroyd and Penzien (1986)	bfk = PR	Tension
Andrasik and Blanchard (1987)	bfk = PR	Tension
Blanchard et al. (1987)	PR > EMG bfk	Migraine
Comparative studies		
Chesney and Shelton (1976)	PR > PR + BFK > bfk	Tension
Hutchings and Reinking (1976)	bfk > PR	Tension
Blanchard et al. (1982)	bfk helps after PR fails	Mixed
	Muscle vs. Autonomic Relaxation	
Cohen et al. (1980)	TBFK = EMG bfk = EEG alpha bfk = temporal artery blood flow bfk	Migraine
Lacroix et al. (1983)	TBFK > PR, EMG bfk	Migraine
Daly et al. (1983)	TBFK > PR	Mixed
Reading (1983)	EMG bfk = TBFK = SC bfk	Migraine
Blanchard et al. (1985)	PR	Tension > migraine
	TBFK	Migraine > tension
Janssen and Neutgens (1986)	PR > AT	Tension
	PR = AT	Migraine
Sargent et al. (1986)	TBFK > AT, EMG bfk	Migraine
Cott et al. (1992)	AT + EMG bfk > AT, AT + TBFK	Average across tension and mixed headache groups
	Cognitive vs. Relaxation/Biofeedback Therapies (Migraine Headaches)	
Mitchell and Mitchell (1971)	PR + SD + assert tr > PR	Migraine
Comer (1977)	Applied relaxation = PR	Migraine
Huber and Huber (1979)	Rational emotive therapy + AT produces improvements for people previously treated with RT	Migraine
Knapp (1982)	CT = temporal artery flow bfk	Migraine
Sorbi and Tellegen (1986); Sorbi et al. (1989)	AT = cognitive behavioral therapy	Migraine
Hoag (1988)	PR + EMG bfk + pain behavior management = PR + pain behavior management	Migraine
Blanchard et al. (1990)	CT + TBFK = TBFK	Migraine
	Cognitive vs. Relaxation/Biofeedback Therapies (Tension Headaches)	
Kremsdor et al. (1981)	CT > EMG bfk	Tension
	EMG bfk > CT	EMG
Holroyd and Andrasik (1982); Tobin (1986); Murphy et al. (1990)	CT > EMG-bfk + PR	Tension
Tobin et al. (1988)	CT + RT + bfk > RT + bfk	Tension
Zitman et al. (1992)	Future-oriented hypnotic imagery > AT	Tension
Spinhoven et al. (1993)	AT = self-hypnosis	Tension

Note: See footnote to Table I.

symptoms), they found that the combination of AT and EMG biofeedback produced better results than AT alone or the combination of AT and thermal biofeedback. Blanchard (1985) found PR to be more effective for tension than migraine headaches, and thermal biofeedback to be more effective with migraines. Three studies found equivalent effects, but none found the reverse.

Although the specific clinical effects of muscularly oriented vs. autonomically self-regulation strategies for tension and migraine headaches (respectively) are clear, it is not certain that these results provide evidence supporting the more general theory of specific muscular vs. autonomic effects. There is considerable evidence that both autonomic and muscular components exist in both types of headaches, and that improvement in headaches is not related to the degree of physiological control achieved (Andrasik, Blanchard, Arena, Teders, Teevan, & Rodichok, 1982; Bakal, 1975; Drummond & Lance, 1984; Morley, 1977; Pikoff, 1983; Silberstein, 1992; Thompson & Figueroa, 1983). One comparative study found greater improvements in symptoms of tension headaches using cognitive therapy than EMG biofeedback (Kremsdorf et al., 1981). Nevertheless, some recent research tends to validate the classification of tension headaches as having a primarily muscular component and migraines a predominantly vascular component (Cohen, Williamson, Monguillot, Hutchinson, Gottlieb, & Waters, 1983; Martin, Marie, & Nathan, 1992), and this classification is still currently accepted medically (Rapoport, 1992). Nevertheless evidence from headache studies provides only tentative evidence for conclusions regarding the specific effects theory.

The relative effectiveness of using biofeedback technology (thermal or EMG) or nonbiofeedback relaxation strategies (PR or AT) to achieve self-regulation of headaches is not clear. The results, across studies, are mixed (Table VI), suggesting that both methods have advantages for some patients. Blanchard et al. (1982) found that biofeedback helped some individuals after treatment failure with preliminary relaxation therapy. No study has yet tested the effects of relaxation therapy following failure with biofeedback.

More definitive results were obtained for comparisons between cognitive and relaxation/biofeedback therapies. For tension headaches, four studies (Table VI) found cognitive therapy to be more effective than EMG biofeedback (with or without an additional component of PR training). No studies found the opposite results; and Tobin et al. (1988) found that adding cognitive therapy to the combination of relaxation and biofeedback therapies produced significantly augmented results. For migraine headaches cognitive therapy is of more doubtful advantage. Mitchell and Mitchell (1971) found that adding systematic desensitization

and assertion therapy to progressive relaxation significantly improved results; and Huber and Huber (1979) that the combination of AT and rational emotive therapy produced significant improvements among headache patients previously treated by PR. However, 4 studies (Table VI) found no differences between relaxation/biofeedback strategies and methods that included greater cognitive components ("applied relaxation therapy," cognitive behavior therapy, and self-hypnosis) and 2 studies found no differences between CT and relaxation/biofeedack therapies.

Other Sources of Chronic Pain

Table VII lists two studies showing a greater therapeutic effect for CT or a mixture of relaxation with CT than for relaxation therapy alone in the treatment of chronic pain. Consistent with the notion that the pain experience has a major cognitive component (Turk, Meichenbaum, & Genest, 1983), the contribution of stress-management techniques to pain reduction appears to be through cognitive processes involved in the pain experience. In addition, one study found that EMG biofeedback did not produce incremental benefit over PR alone in the treatment of chronic back pain. This also is consistent with the notion that cognitive components of therapy are important in the treatment of pain.

BEHAVIORAL DISORDERS

Insomnia

As can be seen in Table VIII, there are no reliable differences among relaxation therapies for treatment of insomnia. All are more effective than placebos. However, these techniques tend not to be as strong as cognitive or behavioral strategies. Three reviews conclude that there is greater improvement with a stimulus control program than with PR; although one study found equivalent effects. In the stimulus control program, an attempt

Table VII. Other Pain Conditions

Turner (1982)	CT > RT	Back pain
Achterberg et al. (1988)	Guided imagery + PR + breathing instr > PR + breathing instr	Pain among burn patients
Kravitz (1977)	bfk + PR = PR	Back pain

Note: See footnote to Table I.

Table VIII. Insomnia

Study	Results
Differences among Relaxation/Biofeedback Strategies	
Nicassio and Bootzin (1974)	PR = AT
Woolfolk et al. (1976)	MED = PR
Haynes et al. (1977)	PR > bfk
Coursey et al. (1980)	AT = EMG bfk
Hauri (1981)	EMG bfk + EEG theta bfk = EMG bfk = sensorimotor rhythm EEG bfk = control. Subjects whose problems "matched" the method improved; others did not
Nicassio et al. (1982)	PR = bfk
Relaxation vs. Stimulus Control Therapy	
Reviews	
Borkovec (1982)	Stimulus control > RT
Lichstewin and Fischer (1985)	Stimulus control > RT
Lacks (1987)	Stimulus control > RT
Lacks and Morin (1992)	Stimulus control + RT = stimulus control
Turner and Ascher (1979)	PR = stimulus control
Espie (1987)	Stimulus control > PR for EEG sleep measures PR > stimulus control for sleep satisfaction
Relaxation vs. Cognitive Therapies	
Gershman and Clouser (1974); Steinmark and Borkovec (1974)	PR = systematic desensitization
Mitchell and White (1977)	Mental-relax + PR > PR
Turner and Ascher (1979)	PR = paradoxical intent
Woolfolk and McNulty (1983)	Cognitive RT > somatic RT

Note: See footnote to Table I.

is made to render the bed situation a conditional stimulus for sleep. The client refrains from tossing and turning in bed, and gets up after a predetermined period of attempting sleep; and no daytime naps are allowed. One study found PR to be more helpful than the stimulus control program in improving clients' satisfaction with sleep, but less helpful in altering EEG sleep parameters. There is also some evidence that CT is more effective than relaxation therapy for this problem, but these data are more equivocal (2 studies, versus 3 with equivalent results). Espie (1987) found greater improvements in sleep satisfaction with PR.

Lacks and Morin (1992) recently reviewed the treatment outcome literature on insomnia from the past decade. There were 683 subjects included in a total of 32 different studies. Excluding waiting list subjects, mean percent improvement at posttreatment ranged from 26% (sleep hygiene instruction, 1 study, $N = 21$) to 59% (sleep restriction, a procedure

similar to stimulus control but with a more direct focus on excessive time in bed; 2 studies, total $N = 45$). In this review, stimulus control averaged a 55% improvement across 8 studies ($N = 100$). Lacks and Morin (1992) reviewed a variety of cognitive-behavioral strategies that target maladaptive sleep habits (e.g., sleep restriction, stimulus control, or with and without CT or PR). They concluded that these methods are effective for most insomnia sufferers. However, studies published over the past decade has witnessed a declining rate of improvement for those receiving PR.

Lacks et al. (1992) recommend evaluating the outcomes of newer, single component interventions by the standard of those achieved by stimulus control; however, they also encourage the pursuit of multicomponent interventions. Thus far, such combined approaches have not fared better than stimulus control alone. For further evaluation of multicomponent treatments, they advise that it be "administered in a sequential, stepwise order with sufficient time to learn each one [component] before a new one is introduced" (Lacks et al., 1992, p. 592).

A review by Gillin, Spinweber, and Johnson (1989) concluded that rebound insomnia is very likely following discontinuation of benzodiazepines that have a short half-life. In addition to rebound insomnia, a review of behavioral and pharmacological treatments for insomnia by Morin and Kwentus (1988) points to other adverse effects of drug therapy: daytime sedation, tolerance, dependence, interference with REM, psychomotor impairment, daytime sedation, and drug "hangover" (p. 93). Their recommendation is that pharmacotherapy be used judiciously and on only a short-term or adjunctive basis; treatment by alternate nondrug interventions was strongly urged. Finally, the review by Morin and Kwentus (1988) concludes by recommending a combination of education (e.g., sleep hygiene), cognitive restructuring (targeting unrealistic expectations or misappraisals of the problem), and behavioral strategies.

Anxiety and Anxiety Disorders

Panic Disorder

Margraf, Barlow, Clark, and Telch (1993) provide a summary of work-in-progress on several techniques aimed specifically at panic attacks. They reviewed comparisons of breathing retraining, exposure (internal and external), PR, and cognitive restructuring, as well as combinations thereof. The reviewed studies adhered to strict research methodology (e.g., control groups, random assignment, multimethod assessment, large sample sizes,

active panic disorder, etc.). The studies were conducted in several different laboratories in the United States and in Europe.

In general, combinations of these techniques fare extremely well relative to waiting lists, to PR alone, and to imipramine. No single technique proved more effectual than another; for example, pure CT versus pure exposure (e.g., Margraf & Schneider, 1991). The authors discourage the use of PR as a primary intervention, because its effects appear to be weaker than cognitive and exposure therapies; however, neither exposure nor cognitive restructuring has yet emerged as a necessary component to successful treatment outcome. Nonetheless, there is consistent evidence that cognitive changes are significantly associated with treatment success. This is true even in treatment combinations that exclude a cognitive component (e.g., exposure only) (Margraf & Schneider, 1991). Furthermore, Clark and colleagues (Clark, Salkovskis, Hackman, & Gelder, 1991) found that measures of misinterpretations of bodily sensations at posttreatment were predictive of follow-up symptom status, independent of posttreatment symptom status. Thus, therapists treating panic disorder should pay close attention to cognitions—formally assessing anxiety sensitivity, fear of body sensations—even when cognitions are not directly targeted (e.g., pharmacotherapy, exposure, breathing retraining). Ignoring such panicogenic cognitions may lead to premature termination with a higher risk of relapse.

Generalized Anxiety Disorder

A recent, waiting list controlled study by Barlow, Rapee, and Brown (1992) evaluated the relative and combined effects of PR and CT in a sample of 65 patients with generalized anxiety disorder (GAD). The active treatments (PR, CT, and PR-CT) demonstrated significant gains, which were maintained through 6-, 12-, and 24-month follow-up assessments. Although subjects continued to report substantial residual anxiety symptoms, each intervention significantly affected worry, a core feature of generalized anxiety disorder. Moreover, reports of anxiolytic medication usage declined throughout the 2-year follow-up.

It should be noted that drop-out rates across treatments varied considerably, but nonsignificantly, with a high of 38% from PR and a low of 8% from the combined intervention (PR-CT). A composite measure defined a priori to reflect high end-state functioning across several areas indicated that more than twice the proportion of PR subjects met these criteria (56%) as did CT subjects (25%). None of the waiting list subjects and 36% of the PR-CT subjects met high end-state functioning criteria.

Evaluation of Specific Effects

Most forms of anxiety (e.g., avoidance, worry, physical symptoms) are assessed by cognitive methods (self-report, interview). Even where DSM-III-R diagnoses of particular anxiety disorders require somatic symptoms (e.g., diagnosis of panic disorder), it is rare that physiological measures are actually obtained, even in research settings. Thus, inevitably, treatment outcome measures for the anxiety disorders are primarily cognitive. Therefore, the specific effects theory would predict a relatively greater effect for cognitive than for somatic interventions.

Meditation vs. Muscular Methods

Studies comparing muscle relaxation with mantra meditation have yielded results consistent with the specific effects theory. As predicted by Schwartz et al.'s revised version of the theory, meditation tends to have greater effects in reducing self-reported anxiety than does PR (one review, one comparative study). Meditation and aerobic exercise—the latter having a muscle relaxation component—may have equivalent effects, however. Exercise may produce greater cognitive effects than does PR because of its greater complexity and, like meditation, because it requires more concentration, which may promote cognitive relaxation. Two studies cited in Table IX found improvements in self-reported cognitive anxiety symptoms that were stronger with meditation than with muscular methods. Improvements in self-reported somatic symptoms were stronger with muscular methods than with meditation. One study found equivalent effects.

Relaxation vs. Cognitive Therapy

Combining cognitive components with relaxation (including Wolpe's technique of SD, which some have considered a cognitive strategy because it specifically involves directed thought [Bandura, 1977; Breger & McGaugh, 1965; Kazdin & Wilcoxon, 1976]) tends to have greater effects than does relaxation training alone. For phobias, systematic desensitization is consistently more effective than relaxation training (although exposure therapy seems to have better effects than SD). Similarly, "packages" of anxiety management techniques (such as "anxiety management training" [Suinn, 1990] and "applied relaxation training" [Chang-Liang & Denney, 1976]), which include components of CT and relaxation, tend to have stronger anxiolytic effects than does relaxation training alone. One study of nonclinical subjects (Dogariu, 1991) found no differences in cognitive

Table IX. Anxiety and Stress Symptoms

Study	Results	Measure
	Meditation vs. Muscle-Focused Methods	
Schwartz et al. (1978)	MED > exercise	Cognitive anxiety symptoms among regular exercisers
	exercise > MED	Somatic anxiety symptoms among regular meditators
Norton and Johnson (1983)	MED > PR	Cognitive snake anxiety
	PR > MED	Somatic snake anxiety
Berger et al. (1988)	Exerc = MED	Stress symptoms
Carlson et al. (1988)	MED > PR	Anxiety (college students)
Long and Haney (1988)	Excerc = MED	Perceived stress and coping (stressed working women)
Eppley et al. (1989) (review)	MED > PR	Trait anxiety
Steptoe and Kearsley (1990)	Exerc = MED	Cognitive and somatic anxiety among normal athletes, recreational exercisers, and meditators
	Relaxation vs. Cognitive Therapies	
Shoemaker (1976)	Anxiety management training > PR	Anxiety neurosis
Goldfried and Trier (1974)	Applied RT > PR	Public speaking anxiety
Kroner et al. (1982)	AT + systematic desensitization > AT	Test anxiety
Lippincott (1991)	PR = quieting reflex training	Cognitive and somatic anxiety (normal subjects)
Öst (1988)	Applied relaxation training > PR	STAI State and Trait, Hamilton Anxiety and Depression Inventories, percent panic-free (panic disorder patients)
Barlow et al. (1989) Craske et al. (1991)	CT + exposure > PR	Panic disorder (percent pain free)
Muncy (1990)	EMG bfk = rational emotive therapy	Self-reported anxiety in panic disorder population
Clark et al. (1991)	CT > Applied relaxation training	Panic disorder
Öst (1991)	CT = Applied relaxation training	Panic disorder
Barlow et al. (1992)	PR > CT waiting list	Generalized anxiety disorder
	Relxation vs. Desensitization for Phobias	
Aponte and Aponte (1971)	SD > PR	Phobias
Cooke (1968)	SD > PR	Phobias
Freeling and Shemberg (1970)	SD > PR	Phobias
Johnson and Sechrest (1968)	SD > PR	Phobias
	Relaxation vs. Exposure Therapy	
Marks (1981, 1987) (reviews)	Exposure > PR	Anxiety/phobias
Michelson, Mavissakalian, et al. (1988)	Exposure > PR	Phobias
Michelson, Mavissakalian, et al. (1986)	Exposure + PR > exposure	Willingness to expose (phobic anxiety)
Michelson et al. (1985)	PR = exposure	Agoraphobia
Michelson, Marchione, et al. (1988)	Exposure = PR	Phobias
Alstrom et al. (1984)	Exposure > PR	Social phiobia

Table IX. Continued

Study	Results	Measure
	Relaxation vs. Cognitive/Exposure Therapies	
Michelson et al. (1985, 1989)	CT + exposure > PR + exposure	Panic disorder
Barlow et al. (1989)	CT + exposure > PR PR > CT, exposure	Panic General anxiety in panic disorder population
Dogariu (1991)	CT + study skill training > SD, study skill training	Academic performance (medical students)
	Autonomic vs. Muscular vs. Meditation Methods	
Detrick (1977)	PR + EMG bfk > TBFK + AT	Anxiety in tension headache sufferers
Lehrer et al. (1980) Shapiro and Lehrer (1980)	AT = PMR	Anxiety
Cuthbert et al. (1981)	MED > HR bfk	Anxiety in normal young men
Sun et al. (1986)	AT + EMG bfk > EMG bfk	Test anxiety
Yang et al. (1987)	AT + EMG bfk = EMG bfk	Anxiety in pregnant women
	Cognitive vs. Exposure Therapy	
Margraf and Schneider (1991)	CT = exposure = combination	Panic disorder
de Ruiter et al. (1989)	Breathing retraining + CT = exposure = combination	Panic disorder
	Progressive Relaxation vs. EMG Biofeedback	
Bernthal (1977)	PR = bfk	Test anxiety
Turner (1978)	PR = bfk	Anxiety (college students)
Beiman et al. (1978)	PR > bfk	Anxiety in respondents to an ad offering free therapy
DeBerry (1979)	bfk > PR	Anxiety in college students
LeBoeuf and Lodge (1980)	bfk > PR	Chronic anxiety
Reed and Saslow (1980)	bfk + PR > PR	Test anxiety
Hurwitz et al. (1986)	bfk = PR	Test anxiety
Scandrett et al. (1986)	PR > bfk	Anxiety in psychiatric patients

Note: See footnote to Table I.

or somatic symptoms of anxiety after training in PR or in Stroebel's "quieting reflex training." The latter method involves focusing attention on anxiety-producing events and situations while using imagery to achieve a state of relaxation. It is possible, however, that a "flow effect" was present in this study. Table IX shows advantages for CT over relaxation training for treating panic disorder. Similarly, Houston (1989) compared a treatment package that had a greater somatic than cognitive emphasis (applied relaxation training) with one that had greater cognitive and behavioral components (multimodal stress management); the latter produced greater effects on self-reported stress and Type A characteristics. Contrary to the specific effects theory, however, the one study comparing CT and PR for

treating generalized anxiety disorder yielded results favoring PR (Barlow, et al., 1992).

Exposure

For most anxiety disorders, cognitive and behavioral techniques have stronger effects than does relaxation, and exposure appears to be more potent than cognitive techniques. Exposure tends to be more effective than PR (one review and four studies), although three studies found equivalent effects for the two techniques. Results of one study indicate that relaxation training may enable phobics to expose themselves more willingly to phobic objects. (See Table IX.)

For panic disorder, the combination of cognitive and exposure therapies appears to have greater effects than either PR or exposure alone. PR may have a specific effect in treating the symptoms of generalized anxiety that often accompany panic disorder.

EMG Biofeedback vs. PR

Table IX lists two studies favoring PR, two favoring biofeedback, and three showing no differences. One study showed greater effects for a combination of PR and biofeedback than for PR alone. These findings appear to reject the hypothesis that PR training should have greater effects on self-reported anxiety than biofeedback. This may reflect one of several possibilities: cognitive/somatic equivalence (i.e., disconfirmation of the specific effects theory), a particularly salient physiological component in anxiety, or specific cognitive components in the EMG biofeedback procedures used in these studies. Data presented later will suggest that either the second or third of these possibilities provides the best explanation of these results.

Anger and Aggressive Behavior

For anger and aggressive behavior, cognitive and behavior therapies (the latter mostly social skills training) tend to be marginally more effective than relaxation training. Of studies reported in Table X, 4 studies favored a cognitive and/or behavioral therapy, 1 favored a relaxation therapy, and 3 found no differences. An additional study found better effects with meditation than with muscle relaxation. However, relaxation therapy does appear to be an effective treatment component. One study found greater effects for it than for CT (Amerikaner & Summerlin, 1982); one study

Table X. Anger and Aggressive Behavior

Study	Results	Outcome measure
Bott (1979)	Coping strategy training > PR	Aggressiveness
Palmari (1980)	Cue contr RT + CT > CT	Aggressiveness and attentiveness in hyperactive children
Amerikaner and Summerlin (1982)	RT > social skills training	Acting out behavior, distractibility
Woolfolk et al. (1982)	MED > PR	Self-directed hostility
Deffenbacher et al. (1986)	RT = CT	Self-reported anger (angry college students)
Hazaleus and Deffenbacher (1986)	Social skills training > RT	Self-concept (angry undergraduate)
Cain (1987)	Cognitive behavioral therapy > RT	Self-reported anger (adult women)
Deffenbacher (1988); Deffenbacher et al. (1987)	Cognitive RT = social skills training	Anger among healthy undergraduates
Achmon et al. (1989)	CT > HR bfk	Anger among hypertensives

Note: See footnote to Table I.

found advantages to combining cue-controlled relaxation and cognitive therapies, compared with CT alone (Palmari, 1980).

Depression

Although relaxation therapies are not recommended as the sole intervention for those suffering from depression, it is interesting to note the role of chronic stress, particularly when it occurs early in life, as an important predisposing factor. A review of Gold, Goodwin, and Chrousos (1988) implicates chronic stress in various neurobiological disturbances related to major depression. Further, this article suggests that stress management therapies could serve as a critical preventive intervention for depression.

Evidence accumulated thus far suggests approximately equivalent effects for CT, relaxation therapy, aerobic exercise, and meditation (Table XI). One study found an advantage for exercise over relaxation (Roth, 1986), and one each found an advantage for relaxation over meditation (Gilbert et al., 1978), and meditation over relaxation (Lehrer et al., 1983). All of these effects tend to be greater than those generated by placebos and/or waiting list conditions. These findings are surprising, in light of some evidence that relaxation therapy is contraindicated for depression (Ford,

Table XI. Depression

Gilbert et al. (1978)	RT > MED
Shapiro and Lehrer (1980)	AT = RT
Woolfolk et al. (1982)	MED = RT
Lehrer et al. (1983)	MED > RT
Epstein (1987)	Exercise = CT
Roth (1986)	Exercise > RT
Fremont and Craighead (1987)	Exercise = RT
Martinsen (1987) review	Exercise = RT
Kahn et al. (1990)	RT = CT

Note: See footnote to Table I.

Stroebel, Strong, & Szarek, 1982). However, most studies finding a significant effect for relaxation therapy on depression have been done on subjects for whom depression is a secondary symptom of another disorder. Further evidence is necessary to determine whether it is an effective treatment for a primary problem of depression. The lack of consistent differences in effects of various treatment methods may reflect the multidimensional nature of depression.

Substance Abuse

There is evidence that relaxation and stress management methods may lead to less alcohol and drug abuse at least among some abusers. Feely (1978) found a better relapse rate after narcotic detoxification for the combination of taped PR and biofeedback than for biofeedback alone, despite the lack of between-group differences in the initial response to treatment.

Significant decreases in anxiety and tension have been found among substance abusers after exposure to relaxation therapies. Page and Schaub (1978) compared taped PR plus frontalis EMG biofeedback with music as a control. Within the experimental group, clients with chronic tension and anxiety reduced their muscle tension levels significantly. However, mood state improved with time for all subjects. A series of studies (Gilbert et al., 1978; Parker & Gilbert, 1978; Parker, Gilbert & Thoreson, 1978) compared PR, meditation and a "quiet rest" control. All the groups manifested a significant uniform decrease in state anxiety over time. Roszell and Chaney (1982) used AT with opiate-dependent and polydrug-dependent individuals and reported a 52% improvement in symptoms with 11 patients.

Stress reduction methods appear to be most effective among alcoholics or drug abusers who are particularly anxious and/or who use the substances specifically to manage stress/anxiety. Rosenberg (1979/1980) found

greater reduction in state anxiety at posttreatment in a biofeedback-assisted relaxation group than in an alcohol-education control group. At a two-month follow-up, experimental subjects who initially reported high anxiety related to drinking indicated that they were abstinent significantly more often than control subjects who did not report this association. Also, subjects who reported practicing relaxation 7 to 21 times per week during the follow-up period reported abstinence significantly more often than those with infrequent practice.

Research on coping skill deficits as a probable reason for excessive alcohol use suggests that stress management training may be one of many coping skills that are useful in treatment. There is considerable evidence to suggest that broad-spectrum coping skills training (Hedberg & Campbell, 1974; Monti, Abrams, & Binkoff, 1990) may have advantages over particular relaxation or biofeedback techniques. The evidence reviewed here suggests that there are no differences in relative individual effectiveness among the various relaxation and self-management techniques.

Schizophrenia

Most clinicians consider schizophrenics to be unresponsive to these methods (Fuller, 1977; Gardner & Montogomery, 1977). Although the major disorganization of thought and behavior that characterizes schizophrenia is not helped by stress management therapies, there is evidence that many schizophrenics can learn these techniques, and that many of the secondary symptoms of schizophrenia are ameliorated by them. Nigel and Jackson (1979) concluded that severely impaired schizophrenics can learn to reduce muscle tension without an increase in psychotic symptomatology and that EMG biofeedback training can interact positively with major tranquilizers to enhance relaxation. Van Hessel, Bloom, and Gonzalez (1982) reported a significant decrease in general anxiety after anxiety management training and applied relaxation training as compared to a waiting-list control group. Also, significant positive changes were reported by the outpatient therapists on anxiety, ability to work effectively in therapy, manage anger appropriately, and to achieve personal goals. Pharr and Coursey (1989) reported reductions in muscle tension with EMG biofeedback and relaxation training, compared to an attention-placebo control group. There was no increase in psychopathology and social competence increased in the EMG biofeedback group.

There is some evidence that schizophrenics whose symptomatology includes high manifest anxiety may benefit particularly from relaxation therapies. Hawkins, Doell, Lindseth, Jeffers, and Skaggs (1980) identified a subgroup of "anxious" schizophrenics characterized by high state and trait

anxiety, low emotional withdrawal and conceptual disorganization. These individuals showed a substantial decrease in anxiety following treatment with thermal biofeedback and relaxation.

In general, this population has received little attention from behavioral researchers. We have found only one comparative study in the literature. Glueck and Stroebel (1975) observed that the limited attention span of schizophrenics rendered biofeedback and AT ineffective, although Transcendental Meditation could be effectively used by some. Adler and Morrisey-Adler (1983) discussed the possibility of increased hallucinations with biofeedback training.

SUMMARY AND CONCLUSION

This review provides suggestive evidence for specificity of effects for various stress management strategies. The conclusions must be interpreted cautiously, in view of the methodological considerations discussed above regarding interpretation of metaanalytic data.

Distinctions between effectiveness of various self-regulation techniques are clearest where the differences in emphasis of these techniques are clearest: e.g., PR is clearly more cognitive than EMG biofeedback, and CT is clearly more cognitive than PR; PR and EMG biofeedback are clearly more muscular and less autonomic than thermal biofeedback and AT; thermal biofeedback is more physiologically oriented than AT; etc. When neither of two techniques directly pinpoints the system being assessed at outcome, the results tend to be equivocal (e.g., for meditation and PR, when assessing autonomic measures). The greatest muscular effects are achieved by EMG biofeedback, followed by PR. Both of these methods appear to produce greater effects than AT or thermal biofeedback. The greatest effects on finger temperature are delivered by thermal biofeedback. Although mantra meditation appears to have equivalent or superior effects in lowering heart rate, compared with AT or heart rate biofeedback, mantra meditation appears to have weaker antihypertensive effects than various combinations of PR, AT, EMG biofeedback, and thermal biofeedback. All methods do tend to produce a generalized relaxation response, however. As originally proposed by Schwartz et al. (1986), the various techniques appear to have specific effects that are superimposed on this response.

Specific effects of various methods also are seen in clinical applications. Again, differences between techniques are clearest where differences between disorders are clearest (e.g., autonomic techniques with migraine headaches vs. muscular techniques with tension headaches, etc.). Where disorders involve several response systems, or where none of the methods specifically

target the focal problem area, there are fewer differences between techniques in effectiveness (e.g., depression, substance abuse, muscular vs. autonomic techniques for anxiety, etc.). Cognitive interventions appear to have some advantages for disorders in which self-report and interpretation of symptoms is the major method for assessing improvement (e.g., pain conditions, anxiety, insomnia, anger). There is inconsistent evidence that meditation may have superior results to other relaxation methods for treating the latter problems. It is possible that this occurs because of the relatively greater cognitive components in mantra meditation. Perhaps because of prominent behavioral components in these disorders, treatments of anxiety, anger, and insomnia that focus on overt behavior tend to show greater effectiveness than treatments that omit the behavioral focus. However, all stress management methods appear to have some beneficial effects for all these problems.

Although these results suggest the existence of specific clinical and experimental effects for various stress-management methods, they should not be used as an absolute guide to clinical practice. Although statistically significant, the relative differences among treatments in specific effects may, ultimately, be outweighed by such other considerations as cost, therapists' expertise with specific treatments, and/or differential treatment effects on client motivation and compliance (Lehrer & Woolfolk, 1993a). At present, therefore, choice of method in specific clinical situations must remain more in the domain of clinical art than of hard science. Nevertheless, these results do suggest that, other considerations being equal, the clinician might be advised to consider the possible specific effects of various methods.

Also, at present, although several replications and near-replications have been done for headache, anxiety, hypertension, and Raynaud's disease, comparative treatment effects on other disorders have been evaluated in relatively few studies from relatively few laboratories in each case, increasing the risk of findings due to sampling error and/or experimental bias. Nevertheless, the weight of evidence on specific effects suggests that, while awaiting greater clarification of experimental results, stress management clinicians might be advised to develop competency in a wide variety of stress management techniques. These particularly include PR, AT, temperature and thermal biofeedback, some meditative disciplines, and some cognitive stress management interventions.

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