JOURNAL OF APPLIED BEHAVIOR ANALYSIS 1979, 12, 99-109 NUMBER 1 (SPRING 1979)

EVALUATION OF BIOFEEDBACK IN THE TREATMENT OF BORDERLINE ESSENTIAL HYPERTENSION[1]

EDWARD B. BLANCHARD, STEPHEN T. MILLER, GENE G. ABEL, MARY R. HAYNES, AND REBECCA WICKER

SUNY AT ALBANY AND UNIVERSITY OF TENNESSEE CENTER FOR THE HEALTH SCIENCES

Direct biofeedback of blood pressure was compared with frontal EMG biofeedback and with self-instructed relaxation for the treatment of essential hypertension in a controlled group outcome study. Patients were followed up for four months after the end of treatment. Generalization of treatment effects was assessed through pre- and posttreatment measurements of blood pressure under clinical conditions in a physician's office. There were no significant reductions in diastolic blood pressure. The systolic blood pressure (SBP) of the patients receiving blood pressure biofeedback decreased 8.1 mm mercury ($p = 0.07$) and the SBP of the patients in the relaxation condition decreased 9.5 mm mercury ($p = 0.05$). In the generalization measures, there were significant reductions in SBP for the relaxation group. The results are discussed in terms of the general lack of replicability within the area of biofeedback treatment of hypertension.

DESCRIPTORS: biofeedback, hypertension treatment, blood pressure, relaxation, humans

Since 1970, an increasing number of reports on the use of biofeedback of blood pressure (BP) to treat elevated BP, or hypertension, have appeared. However, a careful analysis of these reports reveals many problems in experimental design, methodology, and/or results, which seriously limit our ability to draw any definite conclusions about the efficacy or utility of BP biofeedback.

Among the problems are: (1) a lack of adequate control conditions (Blanchard, Young, and Haynes, 1975; Benson, Shapiro, Tursky, and Schwartz, 1971; Elder and Eustis, 1975; Goldman, Kleinman, Snow, Bidus, and Korol, 1975; Kristt and Engel, 1975); (2) lack of adequate baseline sessions before biofeedback training was begun (Elder and Eustis, 1975; Elder, Ruiz, Deabler, and Dillenkoffer, 1973; Goldman *et al.*, 1975); (3) lack of adequate followup (Benson *et al.*, 1971; Blanchard *et al.*, 1975; Elder *et al.*, 1973; Goldman *et al.*, 1975; Schwartz and Shapiro, 1973; Shoemaker and Tasto, 1975); and (4) failure to find any substantial BP lowering (Elder and Eustis, 1975; Schwartz and Shapiro, 1973; Shoemaker and Tasto, 1975).

Given the increasing number of studies in this area, it becomes important to resolve the issue of whether BP biofeedback has any true efficacy for the treatment of hypertension. To resolve this issue, a study should possess certain minimal features: (1) the study should be a controlled group outcome study, in which one group receives a form of BP biofeedback that has been shown to be effective and a second group receives some form of attention placebo treatment (Paul, 1969); (2) adequate baseline trials are conducted before treatment is introduced; (3) the subjects have been screened to determine if they are truly hypertensive; (4) some minimal followup data, at least two to

[1]This research was supported by a grant from the National Heart, Lung and Blood Institute, HL-18814. Reprints may be obtained from Edward B. Blanchard, Department of Psychology, SUNY-Albany, Albany, New York 12222.

three months, are obtained; and (5) some independent assessment of treatment effects is made.

A study designed to meet these minimal criteria is described below.

METHOD

Patients

All patients were paid volunteers who gave informed consent. Patients received $3 per session plus parking expenses, if any. Thirty-three patients (16 male and 17 female) ranging in age from 23 to 56 yr ($X = 39.5$) were started in the experiment. Twenty-eight completed the treatment and initial followup sessions. Dropouts were scattered among the three treatment conditions.

Inclusion criteria. To be included in the study, patients had to be diagnosed as suffering from essential hypertension with no end-organ damage by the consulting physician (S.T.M.), who performed pretreatment and posttreatment physical examinations but had no other contact with the patients. Furthermore, the patients had to have BP readings in the laboratory that averaged greater than 140 mm mercury systolic and/or greater than 90 mm mercury diastolic for the four baseline sessions. Patients on antihypertensive medication who still had BP readings within the hypertensive range were included. The 15 patients on medication were asked to keep the dosage stable. They were equally distributed among the conditions.

Apparatus

The same measurement operations were performed on all patients at each session, regardless of treatment condition or phase of the experiment. All physiological measures were taken with a Grass Model 7 Polygraph.

Blood pressure. Blood pressure was measured once per minute using a Narco-Biosystems automatically cycling cuff pump connected to a standard inflatable arm cuff which was wrapped around the patient's upper left arm. A crystal microphone was mounted in the cuff and positioned over the brachial artery to detect Korotkoff sounds.

The pressure in the cuff was recorded on a 7P8 sphygnomanometer preamplifier of the polygraph. Signals from the microphone indicated onset and disappearance of Korotkoff sounds on the pressure reading, thus indicating systolic and diastolic BP, respectively. In this way, using an automatic recording of BP, the potential for experimenter bias in manual measurement of BP was reduced. The BP values can be read with an accuracy of ± 2.5 mm mercury with an obtained consistency interrater reliability of over 90%.

Cardiac rate. Heart rate (HR) was measured automatically. Electrodes for detecting the electrocardiogram (ECG) were attached to the right arm and left leg (Standard Lead II), with a reference attached to the right leg. The ECG and HR were recorded on the Grass polygraph using a 7P4 preamplifier. HR was counted automatically on a minute-to-minute basis by means of counters and timers triggered by the R-wave of the ECG.

Frontal electromyogram (EMG). Disc electrodes placed approximately 2.5 cm above each eye with a reference electrode attached to the center of the forehead recorded frontal EMG. A 7P3 preamplifier recorded the EMG signal and converted it into an averaged signal with an integrator. Finally, a 7P10 integrator preamplifier cumulated the raw EMG signal over a 1-min interval. The output of the 7P10, expressed as microvolt-seconds per minute, was the physiological variable recorded.

Blood pressure feedback. Feedback of BP was provided using the open-loop, visual, intermittent feedback system described by Blanchard *et al.* (1975). In this system, the experimenter read the systolic BP of the subject on a once-per-minute basis as it was recorded on the polygraph. He then plotted a point on a graph that was visible to the subject on closed-circuit television. The lag between when the Korotkoff sound, indicating systolic BP, occurred and

when the point was plotted on the graph was 4 to 5 sec. The patient thus had available the entire history of his/her BP throughout the experimental trial. Elder *et al.* (1973) also reported successful use of once-per-minute feedback of BP.

EMG feedback. Feedback of frontal EMG was provided by connecting the output of the integrator section of the 7P3 preamplifier to a voltage controlled audio oscillator that drove a speaker in the subject chamber. With this set up, the patient received a tone for which the frequency varied with level of frontal EMG, or analogue auditory feedback.

Procedure

Certain aspects of the procedure were common to all patients for all sessions. Each session lasted approximately 40 min. Each session had three parts: Adaptation—15 min; In-Session Baseline—5 min; Experimental trial—20 min. The first two portions were indistinguishable to the patient. Instructions regarding what was to happen in the experimental trial were given over an intercom between the In-session baseline and the Experimental trial. Data for analyses came from the In-session baseline and from the last 5 min of the Experimental trial for each session. During the Adaptation and In-session baseline portions of sessions, patients were instructed to sit quietly.

There were three phases of the experiment: pretreatment baseline, treatment, and followup. The instructions to the patients for the Experimental trial of each session varied from phase to phase, as did the number of sessions.

Pretreatment Baseline. This phase lasted for four sessions over a two- to three-week time span. During this phase, patients were instructed to try to continue to sit quietly.

Patients were matched into triads based on average systolic BP during the four sessions of the pretreatment baseline phase and randomly assigned to one of the three treatment conditions.

Treatment. This phase lasted for 12 sessions over six to 10 weeks. Before the first Experimental trial began, the patients were given different instructions, depending on treatment condition. For the *BP feedback* group, it was explained that the points on graph visible on the television screen in front on them represented their BP on a minute-by-minute basis. They were told to try to lower their BP using the feedback to help them to discover a mental strategy that would work for them. In the *EMG feedback* group, it was explained that the sound that varied in pitch represented their level of forehead muscle tension. They were told to try to use the feedback signal to help them to relax deeply. They were further told that relaxing would help them to lower their BP. Patients in the *Relaxation* group were told to try to relax as deeply as they could. They were also told that relaxing would help them to lower their BP. These instructions, in abbreviated form, were repeated before each Experimental trial. The relaxation condition was initially included as an attention-placebo control group. However, as the Results section shows, this condition proved to be as "active" as the other two conditions.

At the end of each of the first few treatment sessions, patients were asked to begin to practise what they had learned in the laboratory on their own at home once per day. In the BP group they were told to try to practise relaxing and trying to lower their BP.

Followup. This phase lasted for eight sessions spread over four months. Patients were seen approximately twice per week for two weeks, then at four weeks posttreatment, and then at 2, 3, and 4 months posttreatment.

These sessions were like Pretreatment Baseline sessions, in that no feedback was available. However, the sessions were somewhat different in that subjects were instructed to try to continue lowering their BP by the same means they had used during the treatment phase. They were also reminded to continue practicing daily relaxation and/or BP lowering at home.

Pretreatment and Posttreatment Physical Examinations

All patients received a pretreatment physical examination before the Treatment phase began. It took place any time between two weeks before the beginning of the Pretreatment Baseline phase to after the third Baseline phase session. The posttreatment examination took place within four weeks of the end of the Treatment phase and usually within two weeks.

Blood pressure was measured by ascultation using a sphygnomanometer while the patient was in three positions: standing, sitting, and recumbent. The physician was kept uninformed as to treatment condition for the posttreatment examinations.

At the pretreatment examination, a clinical ECG, chest X-ray, and several routine laboratory tests were done to help to rule out hypertensives who were not suffering from essential hypertension and to exclude patients suffering from end-organ damage.

RESULTS

The principal data for this study were the physiological measures recorded during the In-session Baseline and the last 5 min of the Experimental trial for each session. Each of the four physiological variables, systolic BP, diastolic BP, HR, and frontal EMG, was subjected to a three-way analysis of variance (Treatment Group × Session × Period within session, the two 5-min data gathering periods) in which there were unequal *n*'s (BP feedback = 10, EMG feedback = 9, Relaxation = 9). All 28 patients were available for the first four followup sessions. Thereafter, the number in each group varied so that the data from the latter four followup sessions were analyzed separately. The results of all of these analyses are summarized in Table 1.

The results of primary interest, systolic BP and diastolic BP, are presented in Figures 1 and 2, respectively. The points represent the average value for the group for the session from the last 5 min of the Experimental trial.

Systolic Blood Pressure

Table 1 shows that there were only two significant sources of variance in the analysis of systolic BP data: regardless of treatment condition or session of the experiment, there

Table 1
Summary of Analyses of Variance of Physiological Measures

		F *Values*			
		Physiological Variables			
Source	df	*Systolic BP*	*Diastolic BP*	*HR*	*Frontal EMG*
Treatment groups (A)	2	<1.0	8.55***		<1.0
Error A	25			1.18	
Sessions (B)	19	<1.0	<1.0	<1.0	1.80**
A × B	38	1.21*	<1.0	1.57**	1.19
Error B	475				
Period (C)	1	5.88**	6.53**	1.22	2.19
A × C	2	1.24	2.61*	<1.0	<1.0
Error C	25				
B × C	19	1.74**	<1.0	<1.0	1.22
A × B × C	38	<1.0	<1.0	<1.0	1.19
Error BC	451				

*$p < 0.10$
**$p < 0.05$
***$p < 0.01$

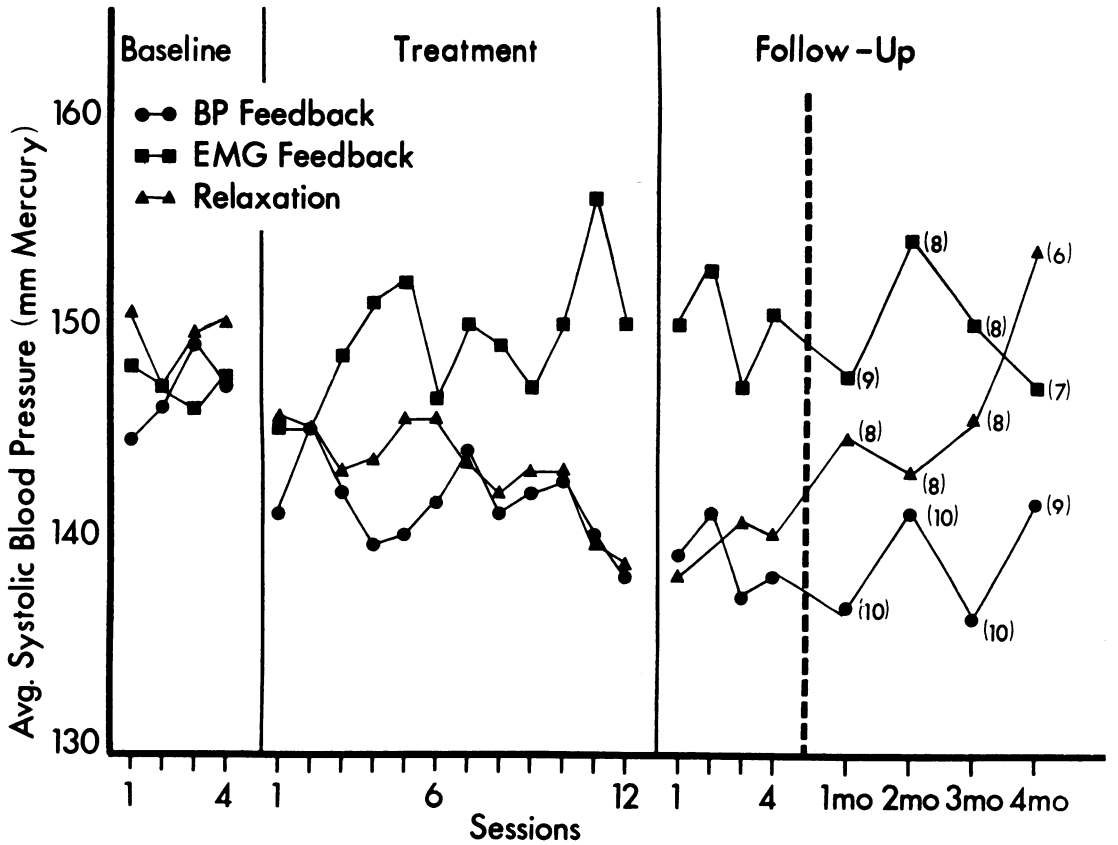

Fig. 1. Average systolic blood pressure for each treatment group at each session of the study.

was a significant ($p < 0.02$) decrease in systolic BP from the in-session baseline to the last 5 min of the experimental trial. The average value of this decrease was 1.4 mm mercury. There was also a significant ($p < 0.05$) interaction of session with period of session during which BP was measured, indicating differential within-session decreases in different sessions. Further analysis revealed no readily interpretable pattern of differences across sessions.

Because there was a trend ($p < 0.10$) for the groups to show differential changes in systolic BP across sessions, and because examining such differences was a main point in the study, further individual comparisons were made. For each treatment group, the average systolic BP from the last 5 min of the four pretreatment baseline sessions was compared with the average systolic from the last 5 min of the first four followup sessions, as comparing these two phases when no feedback was available seemed the best test of any treatment effect. These analyses revealed an average decrease in systolic BP of 8.1 mm mercury for the BP feedback condition ($t = 1.49$, $p = 0.07$), and 9.5 mm mercury for the relaxation condition ($t = 1.66$, $p = 0.05$), while there was an average *increase* of 1.4 mm mercury for the EMG Feedback condition ($t = 0.26$, n.s.).

Between-group comparisons yielded no differences among the three treatment conditions during Pretreatment baseline; furthermore, there were no significant differences among the three treatment conditions at the end of treatment, despite the appearance of differences on Figure 1. The latter finding, and perhaps the former, was due in part to the large degree of variability in the data.

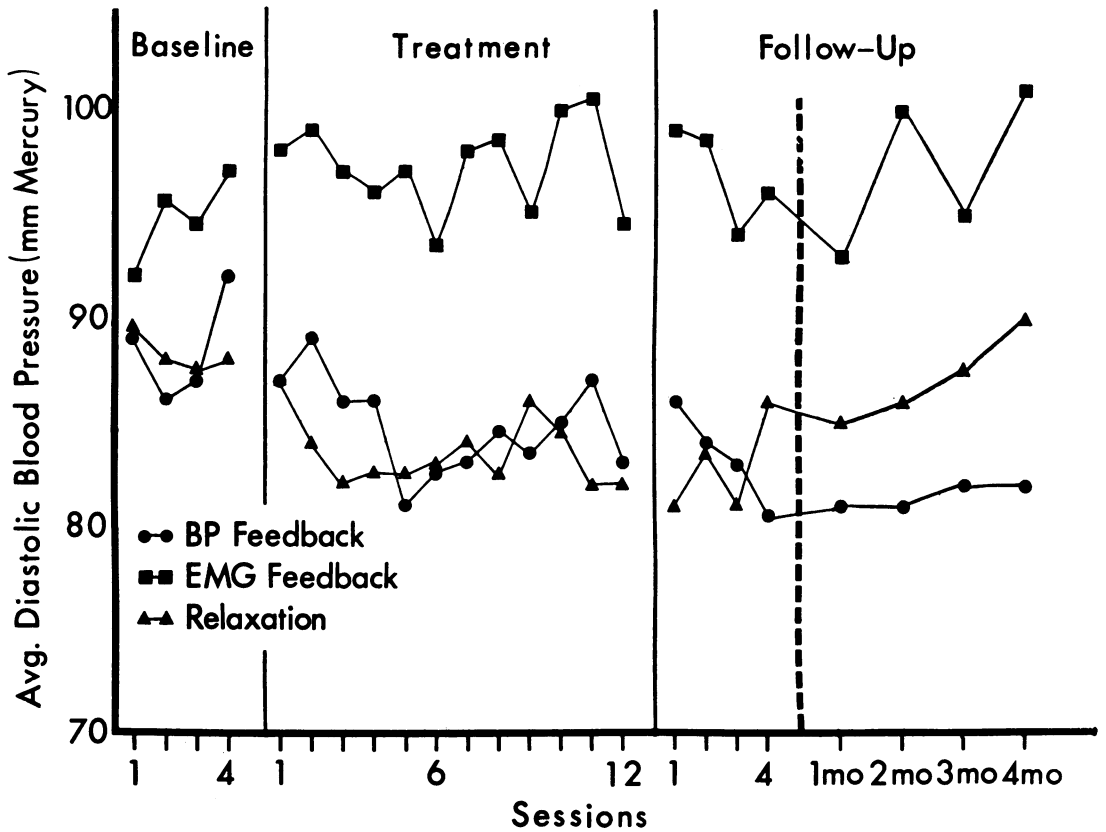

Fig. 2. Average diastolic blood pressure for each treatment group at each session of the study.

Diastolic Blood Pressure

There were two main effects in the analysis of the results with diastolic BP: the three groups differed significantly ($p < 0.002$) regardless of stage of the experiment. In fact, the subjects in the EMG feedback condition were significantly higher on diastolic BP at the start of the experiment and remained higher throughout. This unfortunate confound resulted from matching patients and assigning them to conditions solely on the basis of systolic BP.

As with systolic BP, there was a significant ($p < 0.02$) decrease in diastolic BP from the In-session Baseline to the last 5 min of the Experimental trial regardless of treatment condition and of session of the experiment. There was also an interaction of treatment condition with phase of session ($p < 0.10$). This resulted from an increase within the session of the diastolic BP of the subjects in the EMG feedback condition ($\Delta = +2.1$ mm mercury) while those in the BP feedback and relaxation groups decreased slightly ($\Delta = -1.4$ and -1.3 mm mercury, respectively).

None of the changes in diastolic BP from pretreatment baseline to the first four followups was significant. They were: for BP feedback, a decrease of 1.9 mm mercury; for EMG feedback, an increase of 1.2 mm mercury; and for relaxation, a decrease of 2.8 mm mercury.

Heart Rate

For cardiac rate, the only significant source of variance was the differential response of the three groups across sessions. Within-group analyses showed a trend ($p < 0.10$) for the HR of the relaxation group to decrease from pretreatment to followup ($\Delta = -5.2$ BPM) but no change for the other two groups.

Table 2

Summary of Analyses of Followup Data on Systolic and Diastolic Blood Pressure

	Systolic BP				*Diastolic BP*			
Analysis	*1 mo.*	*2 mo.*	*3 mo.*	*4 mo.*	*1 mo.*	*2 mo.*	*3 mo.*	*4 mo.*
Overall analysis (*F*)	1.68	1.11	2.56*	<1.0	2.13	6.05***	4.10**	5.18**
Individual comparison (*t*)								
BP *vs.* EMG	1.67*	1.38	2.24**	0.65	2.09**	3.37***	2.91**	3.37***
BP *vs.* Relax	1.55*	0.14	1.59*	1.42	0.80	2.50***	1.32	1.35
EMG *vs.* Relax	0.05	1.23	0.61	0.75	1.23	0.74	1.51*	1.78*

*$p < 0.10$
**$p < 0.05$
***$p < 0.01$

EMG

For frontal EMG, there was a significant effect of sessions, regardless of treatment condition or phase of session. In particular, there was a decrease from 12.4 microvolt-seconds/minute to 10.1 microvolt-seconds/minute from pretreatment to followup ($p < 0.05$). Although there was no significant interaction of treatment condition by session, the EMG feedback group did show the lowest average EMG at the end of treatment (average for the last two treatment sessions was 8.4 microvolt-seconds/minute) and during the first four followups (X = 9.4 microvolt-seconds/minute).

Extended Followup Results

As was described above, after the first four followup sessions, patients were seen four more times over the next 3.5 months. Some patients were lost during this phase of the study. Figure 1 depicts the number of patients available in each group at each followup point. Because of this differential drop-out rate, the data at each of the latter four followup points were analyzed separately with one-way analyses of variance across treatment conditions. The results of these analyses, along with the comparisons between pairs of groups, are presented in Table 2 for both systolic BP and diastolic BP.

For systolic BP there were no differences among the groups at two months or four months. At one month and three months there were trends for the BP feedback group to have a lower systolic BP than the other two groups. On a group basis, subjects in the two biofeedback groups tended to remain at the systolic BP levels they showed during the initial stage of followup, while the relaxation group showed a steady trend toward returning to pretreatment levels of systolic BP. The last point on the graph is somewhat spurious due to the loss of subjects, however.

With diastolic BP, a slightly different pattern of results emerged during followup: the diastolic pressures from the biofeedback group tended to remain at the levels achieved at the end of treatment and were significantly lower than the diastolic pressures of the EMG group, which also tended to remain at the levels achieved at the end of treatment. The pressures for the relaxation group fell in between these two.

Overall, it appears that the slight benefits the BP feedback group received from treatment were maintained up to four months after the treatment ended. For the relaxation group, however, there was a tendency for the BP's to return over the four months to pretreatment levels. The BPs of the EMG feedback group never dropped and remained at the elevated levels during followup.

Generalization Results
(Physician's Office Measures)

The measure of generalization used in this study was the BP obtained in the physician's

Table 3

Summary of Physician's Measurements of Blood Pressure
(In mm mercury)

Treatment Group	Sit		Lie		Stand	
	Pre	Post	Pre	Post	Pre	Post
			DIASTOLIC			
BP feedback	94.4	90.0	89.2	86.4	91.8	88.2
EMG feedback	103.4	100.8	98.1	96.6	102.1	105.0
Relaxation	88.5	81.4**	85.4	82.6	88.0	84.9
			SYSTOLIC			
BP feedback	141.2	137.6*	135.6	134.8	135.2	133.2
EMG feedback	152.0	146.5	145.0	141.0	143.3	145.8
Relaxation	145.4	135.7**	142.0	134.6	148.9	132.6**

*Difference significant by t test ($df = 22$) at 0.10
**Difference significant by t test ($df = 22$) at 0.05

office at the posttreatment physical examination. Although this measurement may not be representative of the patient's average BP, in a sense it is the most important measurement, as it influences changes in medication and other aspects of the treatment regimen.

Table 3 lists the mean BP values for the three determinations of BP for each group at each visit. Separate two-way analyses of variance were performed on systolic BP and diastolic BP for each of the three determinations. (Posttreatment physical examinations were not obtained on one patient in each of the EMG feedback and relaxation groups.) The results of these six analyses are summarized in Table 4.

The values in Table 3 show that the average BPs obtained in the physician's office were slightly higher at the pretest than those obtained in the laboratory. This was particularly true of the diastolic BP of the subjects in the EMG feedback group. Table 3 also shows that for the relaxation group there was a significant decrease from pretreatment to posttreatment in both systolic and diastolic BP, when taken in the sitting position, and there was a trend for the systolic BP of the BP feedback group to be lower in the sitting position.

The analyses summarized in Table 4 show no significant variance accounted for in systolic BP by any source utilized. For diastolic BP, there was a significant group effect for all three determinations, due to the consistently higher values for the patients in the EMG feedback group.

Table 4

Summary of Analyses of Physician's Measurement of Blood Pressure

Source	df	F Values					
		Systolic			Diastolic		
		Sit	Lie	Stand	Sit	Lie	Stand
Groups (A)	2	2.11	<1.0	1.68	9.79***	7.14**	10.84***
Error between	22						
Pre-Post (B)	1	1.36	1.19	1.82	7.13**	2.04	<1.0
A × B	2	1.46	<1.0	1.92	<1.0	<1.0	<1.0
Error within	22						

*$p < 0.01$
**$p < 0.001$

DISCUSSION

The results of this study are, with one exception, somewhat difficult to interpret. The one clear-cut finding was the consistent lack of any effect of EMG biofeedback training on blood pressure, even when the frontal EMG values decreased from before to after treatment.

The results for the BP feedback and relaxation groups can be summarized as follows. First, the decrease in systolic BP of the subjects treated with BP biofeedback did not reach the usually accepted level of statistical significance; moreover, there was little change on the measure of generalization. However, the small change did appear to be stable over the period of followup. Second, the decrease in systolic BP of the subjects in the relaxation condition did reach the usually accepted level of statistical significance and also did show a significantly significant decrease on the measure of generalization. However, these results dissipated fairly rapidly during followup. Finally, there was, nevertheless, no significant difference in amount of decrease between the BP biofeedback treatment condition and the relaxation condition.

At the most general level, we are forced to conclude that none of the treatments was a success because of: (1) no obtained effect in the EMG feedback group, (2) failure to generalize (BP biofeedback), (3) failure to lead to significant reduction in BP (BP biofeedback), and (4) failure to remain stable during even brief followup (relaxation). Moreover, there was very little change in diastolic BP in any condition.

If one extrapolates the small decreases in systolic BP achieved by either BP biofeedback or relaxation to large populations, and if the life insurance data were directly applicable in calculating a decreased risk of death produced by a lower blood pressure in a large population, the decrease in mortality ratios associated with the experimental reduction in systolic BP would be approximately 15% (Lew, 1973). This is a small clinical change when compared to the 67% reduction of mortality ratios of drugs for diastolic BP of 90 through 114 mm mercury (Veterans Administration Cooperative Study Group, 1970).

If data from the Framingham study of cardiovascular disease (Kannel and Gordon, 1974) were directly applicable to the decreased risk of cardiovascular disease produced by the observed reduction in BP in our experiment, the annual incidence rates of cardiovascular disease in large populations of the same age and sex distribution might decrease from 97 new problems/10,000 persons per year to 80 new problems/10,000 persons per year. This small effect, although potentially substantial when applied to large populations, seems unlikely to be of great value in the clinical management of small groups of hypertensive patients.

The best conclusion seems to be that the present results are suggestive but far from definitive. A study very similar to the present one was published after completion of the present experiment. Surwit, Shapiro, and Good (1978) compared EMG biofeedback, instruction in Benson's (1975) "relaxation response" form of passive relaxation, and biofeedback of a combination of systolic BP and HR which had previously been found to be effective in lowering the systolic BP of normotensives. No significant reductions in BP were found from baseline to end of treatment (eight sessions) or six-week followup. Small, but significant, reductions in systolic BP ($\Delta = 3.4$ mm mercury) within treatment sessions were found. No differential treatment effects were found. Thus, with the exception of the significant reduction in systolic BP of the relaxation group in the present study, the results seem identical.

The present results and conclusions, coupled with those of Surwit *et al.* (1978), raise an important issue in this field: the lack of replicability of meaningful effects of direct BP biofeedback on the blood pressure of hypertensive patients. When one surveys the literature on biofeedback treatment of hypertension (Blan-

chard, 1978; Blanchard and Miller, 1977), the major conclusion one must draw is that good initial results appear not to hold up upon replication. For example, Benson *et al.* (1971) obtained an average decrease in systolic BP of 16.5 mm mercury for their seven patients; in a systematic replication by Schwartz and Shapiro (1973), no overall decrease was found. Miller (1972) reported a decrease of 21 mm mercury in diastolic BP for his first patient. In over 20 consecutive new cases, however, no significant decreases were found (Miller, 1975). Elder *et al.* (1973) obtained significant decreases in diastolic BP (to 80% of baseline) in the first study. In a later study, Elder and Eustis (1975) found decreases in only 40% of the patients and an average decrease of only 6 mm mercury. In our own laboratory, our first study yielded an average decrease of 26 mm mercury systolic in four patients. In the present study, the average was about 8 mm mercury. Goldman *et al.* (1975) and Kristt and Engel (1975) reported good initial results but no replication as of yet. Thus, the rule seems to be the lack of replicability of results when direct feedback of BP is used, regardless of feedback system.

A final point arises from the examination of data from individual subjects: despite the overall poor results of all treatments, there were some successful subjects. Two patients in the BP feedback conditions had average decreases in BP of at least 20 mm mercury and two in the EMG feedback condition had average decreases of 12 and 15 mm mercury, respectively. In the relaxation condition, four patients had decreases that ranged from 15 to 40 mm mercury. Thus, either form of biofeedback or relaxation may be useful for some hypertensive patients.

To date, there has been no systematic attempt to match a particular behavioral, or nonpharmacological, treatment of hypertension to a particular hypertensive patient. Work in this direction could bring some order to this area and might help explain the variability of results and the lack of overall replicability.

REFERENCES

Benson, H. *The relaxation response.* New York: William Morrow, 1975.

Benson, H., Shapiro, D., Tursky, B., and Schwartz, G. E. Decreased systolic blood pressure through operant conditioning techniques in patients with essential hypertension. *Science,* 1971, **173,** 742-742.

Blanchard, E. B. Biofeedback: To whom, by whom and for what purpose?. In J. P. Brady and H. K. H. Brodie (Eds), *Controversy in psychiatry.* Philadelphia: W. B. Saunders, 1978.

Blanchard, E. B. and Miller, S. T. Psychological treatment of cardiovascular disease. *Archives of General Psychiatry,* 1977, **34,** 1402-1413.

Blanchard, E. B., Young, L. D., and Haynes, M. R. A simple feedback system for the treatment of elevated blood pressure. *Behavior Therapy,* 1975, **6,** 241-245.

Elder, S. T. and Eustis, N. K. Instrumental blood pressure conditioning in outpatient hypertensives. *Behaviour Research and Therapy,* 1975, **13,** 185-188.

Elder, S. T., Ruiz, Z. B., Deabler, H. L., and Dillenkoffer, R. L. Instrumental conditioning of diastolic blood pressure in essential hypertensive patients. *Journal of Applied Behavior Analysis,* 1973, **6,** 377-382.

Goldman, H., Kleinman, K. M., Snow, M. Y., Bidus, D. R., and Korol, B. Relationship between essential hypertension and cognitive functioning: Effects of biofeedback. *Psychophysiology,* 1975, **12,** 569-573.

Kannel, W. B. and Gordon, T. *The Framingham Study: An epidemiological investigation of cardiovascular disease.* Section 30. Some characteristics related to the incidence of cardiovascular disease and death. DHEW Publication No. (NIH) 74-559. Washington, D.C. 1974.

Kristt, D. A. and Engel, B. T. Learned control of blood pressure in patients with high blood pressure. *Circulation,* 1975, **51,** 370-378.

Lew, E. A. High blood pressure, other risk factors and congenity: The insurance viewpoint. *American Journal of Medicine,* 1973, **55,** 381-294.

Miller, N. E. Clinical applications of biofeedback: Voluntary control of heart rate, rhythm, and blood pressure. In H. I. Russek (Ed), *New horizons in cardiovascular practice.* Baltimore: University Park Press, 1975. Pp. 245-246.

Miller, N. E. Postscript. In D. Singh and C. T. Morgan (Eds), *Current status of physiological psychology: Readings.* Monterey, California: Brooks-Cole, 1972.

Paul, G. L. Behavior modification research: Design and tactics. In C. M. Franks (Ed), *Behavior therapy: appraisal and status.* New York: McGraw-Hill, 1969.

Schwartz, G. E. and Shapiro, D. Biofeedback and essential hypertension: Current findings and theoretical concerns. In L. Birk (Ed), *Biofeedback: behavioral medicine.* New York: Grune & Stratton, 1973.

Shoemaker, J. E. and Tasto, D. L. The effects of muscle relaxation on blood pressure of essential hypertensives. *Behaviour Research and Therapy,* 1975, **13,** 29-43.

Surwit, R. S., Shapiro, D., and Good, M. I. Comparison of cardiovascular biofeedback, neuromuscular biofeedback, and meditation in the treatment of borderline essential hypertension. *Journal of Consulting and Clinical Psychology,* 1978, **46,** 252-263.

Veterans Administration Cooperative Study Group on Anti-Hypertensive Agents. Effects of treatment on morbidity in hypertension: II. Results in patients with diastolic pressure averaging 90 through 114 mm Hg. *Journal of American Medical Association,* 1970, **213,** 1143-1152.

Received 20 March 1978.
(*Final Acceptance 11 September 1978.*)