Locus of control and expectation of control in EMG biofeedback

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LOCUS OF CONTROL AND EXPECTATION OF CONTROL IN EMG BIOFEEDBACK

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THESIS

Submitted to the Faculty of Graduate Studies
Lakehead University
In Partial Fulfillment of the Requirements for
the Degree of Master of Arts.

Department of Psychology

June, 1983

ABSTRACT

This study examined the importance of cognitions in the feelings of self-control on task performance and on certain subjective states, via electromyographic (EMG) biofeedback training. Subjects in a "misled" EMG feedback group were led to believe that they had successfully reduced their EMG levels (induced cognition of self control); in actuality, the subjects in the misled group were yoked to subjects receiving feedback contingent on their own EMG levels; thus, the feedback received by the misled group was that of their contingent EMG feedback counterparts. The effects of this treatment were explored in relation to feelings of self control via Rotter's I-E scale, EMG task performance during two training trials, state-trait anxiety levels via the State-Trait Anxiety Inventory (STAI), and other subjective states via some self-report questionnaires. These data were compared to those of the EMG group receiving feedback contingent on their own EMG levels and to a control group which was also yoked to the contingent feedback group, but who were informed that this was the case.

Data on sixty normal subjects (thirty internals and thirty externals assigned equally to each of the three groups), indicated that the group receiving the contingent feedback evidenced significant ($p < .01$) decreases in EMG levels in comparison to the other two groups. The treatment × I-E data indicated that the mean EMG levels of the

informed control group internals were significantly higher than the EMG levels of the other groups ($p < .05$). A t test for mean EMG changes over sessions indicated that the misled group internals significantly increased their mean EMG levels ($p < .05$).

No significant differences were indicated by the post-pre I-E and STAI or the other questionnaire data. A Pearson r indicated a positive correlation ($r = .62$) between mean pre-post LOC score decreases (greater internality) and mean pre-post EMG level decreases for the three groups.

INTRODUCTION

The internal-external locus of control concept is a cognitive approach to the explanation of the effects of environmental reinforcement contingencies on behavior.

Rotter(1966) believes that the effects of reinforcement depend upon whether or not the individual perceives a causal relationship between his behavior and the reinforcement. It has been demonstrated that individuals learn differently in situations culturally labelled as skill versus chance-determined (Rotter 1966; 1972).

Of prime importance in Social Learning Theory is that the locus of control construct is an expectancy variable. A reinforcement is said to strengthen an expectancy that a particular behavior will be followed by that reinforcement in the future; when the individual perceives the reinforcement as being not contingent upon his own behavior, its occurrence will not increase an expectancy as much as when it is seen as contingent. These expectancies for reinforcement in a particular situation also have the capacity to generalize to other similar situations. It would stand to reason then that a generalized expectancy regarding control of reinforcers would develop from an individual's social learning experiences and reinforcement history.

The locus of control concept is thus regarded as a dimension of personality which reflects the extent to which an individual perceives reinforcing or punishing events to follow from or be contingent upon his own behavior or attributes. By definition, a person with a belief primarily in external control perceives reinforcing or punishing events to be a function of chance, as under the control of powerful others, or unpredictable due to the great complexity of forces acting upon him. A person with a belief primarily in internal control perceives reinforcers and punishers to be contingent upon his own behavior or his own relatively permanent characteristics (Rotter, 1966).

The adult Internal-External Locus of Control (I-E) Scale, along with a number of other tests, has been designed to assess individual differences with regard to the locus of control personality dimension (Rotter, 1966; Lefcourt, 1976). The I-E scale is a 29-item, forced-choice test including 6 filler items. Data on the I-E scale indicate a reasonably high internal consistency and an adequate test-retest reliability; discriminant validity is evidenced by low correlations with variables such as social desirability, intelligence and political liberalness (Rotter, 1966).

The locus of control concept has been utilized in a vast number of personality research studies and has been related to a variety of variables. Generally, the data suggest that in comparison to externals, internals are superior in coping with and in gaining control over their environment (Phares, 1976).

The locus of control concept has also been applied in research studies investigating performance in bodily self-control tasks. Since biofeedback concerns itself with the self-control of physiological responses, it is amenable to the study of the locus of control concept. Results of an increasing number of research studies have indicated that an internal orientation is facilitative of the biofeedback task. Internals have been shown to be more effective than externals in controlling EMG activity (Reinking, Morgret, & Tamayo, 1976; Carlson, 1977; Stern & Berrenberg, 1977; and Kappes & Michaud, 1978), alpha production (Greer, 1974; Goesling, May, Lavond, Barnes & Carreira, 1974; Johnson & Meyer, 1974), heart rate speeding (Ray & Lamb, 1974; Blankstein & Egner, 1977; Schneider, Sobol, Herrman, & Cousins, 1978), and GSR (Wagner, Bourgeois, Levenson, & Denton, 1974). These data indicate that internals will make more attempts at controlling their internal, as well as their physical environments.

There has also been a growing preoccupation with attempts at modifying externality, via biofeedback task performance. Because feedback provides cues which can be utilized to regulate responses, a person may actually learn that control is self-regulated. In essence, this process can be seen as one of achieving an enhanced belief in internal locus of control (Carlson, 1977). Contingent feedback, - particularly EMG feedback, - has been indicated to be facilitative of the enhancement of one's general sense of control. The results of a number of studies indicate that the actual reduction of EMG levels can produce locus of control shifts in the internal direction (Stern & Berrenberg, 1977; Carlson, 1977; and Carlson & Feld, 1978). Goldfried (1971) notes that the concept of self-control is playing an increasingly significant role in the understanding and modification of various maladaptive behaviors. And as there is substantial evidence in the literature suggesting a link between externality and certain negative factors such as greater anxiety, depression, and more severe psychopathology (Himle & Barcy, 1975; Organ, 1976; Patton & Freitag, 1977; Calhoun, Cheney, & Dawes, 1974; Hanes & Wild, 1977; Shybut, 1968; Levenson, 1973), it would seem that attempts at modifying externality would be justified.

In light of these data, an interesting question to raise is what a mere belief that an individual has achieved some self control (i.e. by believing that he has successfully reduced his EMG level), - without actually having done so, - would have on personal I-E and task performance. How much of a contribution do cognitive factors alone have on feelings of self-control? Valins (1966, 1967) found that subjects who received bogus heart-rate feedback were significantly influenced in the labelling of opposite-sexed figures. These findings are supportive of Schachter's (1964) emphasis of the importance of the cognitive (labelling) effects of internal events. Glass & Singer (1972) noted relatively consistent findings that aversive events are experienced in accord with the degree of control that subjects believe they can exercise over those events. Apparently, the **mere** knowledge that one can exert control can alter the impact of an aversive event (Lefcourt, 1976). There is also considerable theoretical agreement with, and empirical support for, the assumption that the experience of emotion is basically an interpretation of behavior. Bem's (1972) "self-perception theory" explains emotional and other private events as self-observations of overt behaviors. Emotional syndromes have also been explained as transitory social roles (e.g. Segall, 1976; Harre & Secord, 1973). All these data lend support to the important role cognitions play in the labelling of internal events.

The present study was designed to explore the importance of cognitions in the feelings of self-control, as well as on task performance itself, via EMG biofeedback training. Biofeedback and relaxation training naive subjects in a "misled" EMG feedback group were told that they had successfully reduced their EMG levels (induced cognition of self control); in actuality, the subjects in the misled group were yoked to subjects receiving feedback contingent on their own EMG levels. [1] This group should be distinguished from the "false feedback", "uninformed" control groups in the literature; these groups usually receive a prerecorded random feedback tone but are simply told that the presence of this tone should help them to relax. They are not led to believe that the feedback is their own. Thus, the feedback received by the misled group in this study was that of their contingent EMG feedback counterparts; but unlike these other "misled" or "false feedback" groups, they were purposely told that the feedback was their own. The effects of this treatment were explored in relation to feelings of self control via Rotter's I-E scale, EMG task performance during two training trials, state-trait anxiety levels via the State Trait Anxiety Inventory (STAI), and other subjective states via some self-report questionnaires. These data were compared to those of the EMG group who received feedback contingent on their own EMG levels and to a control group which was also yoked to the contingent EMG group, - but who were informed that this was the case.

[1] See also Discussion, pp. 20, 21.

The hypothesis generated were as follows:

1. The contingent and misled EMG feedback groups should show lower frontalis EMG readings than the control group, and

2. the greatest increases in internality should be evidenced in the contingent and misled EMG treatment groups.

METHOD

Subject Selection

Sixty introductory psychology students were selected based on scores on the Rotter (1966) Locus of Control Scale (LOC), which was administered to approximately two hundred students in introductory psychology classes. The selection criterion for internal subjects was a LOC score of seven or below, and for external subjects a score of thirteen or above; (this method of selection would assure two widely separated distributions should data analyses reveal any LOC × treatment effects.) The subjects were largely naive of any form of relaxation training; (subjects usually knew "biofeedback" by name, but never had the equipment demonstrated to them). At LOC pretest, the subjects were asked to indicate whether they had any experience with biofeedback or relaxation training, - under the pretense that it was not important whether they had any training but rather that the experimenter wanted to know so that experimental training procedures would be adjusted accordingly; any discrepancies regarding relaxation training naivete were again checked prior to the commencement of the first session.

Conditions

An equal number of internals and externals, and approximately an equal number of males and females were assigned randomly to one of the following conditions (a total of twenty subjects per group). Subjects in the contingent EMG feedback group (BF_1) and the misled EMG feedback group (BF_2) were told that they will hear a tone, the pitch of which will be determined by their own level of bodily muscular tension. These subjects were told that their main task was to relax as much as possible and that this would be achieved by using the tone as muscle tension information (i.e. lower pitch represents greater relaxation). Subjects in the control group (C_1) were also told that their main task was to relax as much as possible and that the presence of the tone they would hear, -(which they were asked to attend to as much as possible),- should help them to relax. The BF_1 group received feedback contingent upon their own EMG level. The feedback received by BF_2 and C_1 subjects were tape-recorded EMG feedback signals generated by their yoked BF_1 counterparts and played back to the BF_2 and C_1 subjects. Yoking was based on LOC scores, so that yoked BF_1-BF_2 and BF_1-C_1 pairs had highly similar, if not identical, LOC scores. Each BF_2 and C_1 subject was yoked to the same BF_1 subject throughout both training sessions; a new tape of each BF_1 subject's feedback signals was made in each of the two training sessions, so that the BF_2 and C_1 subject heard the feedback generated in the corresponding BF_1 session. The subjects in the C_1 group were informed that they would be receiving feedback taped from group members receiving contingent EMG feedback.

Apparatus

Two bi-polar reference electrodes and one ground electrode were attached to the subjects' foreheads. The bi-polar electrodes were secured approximately two centimeters above each eyebrow and five centimeters on either side of the midline; the ground electrode was secured between the bi-polar electrodes on the midline; Spectra 360 Electrode Gel was used as the conducting medium. (Frontalis muscle control was used here as the most appropriate target response as it is presumed to be one of the most difficult muscles to relax (Stoyva & Budzynski, 1974; Balshan, 1962). The electrodes were connected to a Cyborg EMG J33 preamplifier which was in line with a Cyborg BL900 RMS Dual Processor. The EMG feedback signals were emitted through a pair of headphones which were attached to the processor; the EMG signals from the BF_1 group subjects were taped by a Sony TC-110 B cassette recorder.

The equipment was housed in a quiet dimly-lit room. The room was equipped with a padded armchair; and in order to keep visual cues to a minimum, a metal screen was positioned to separate the subject from the experimenter and the equipment.

Procedure

All subjects participated in two 20-minute sessions, with both sessions being held on the same day; there was a 10-15 minute break between the two sessions. Each of the two sessions consisted of a baseline trial of 5 minutes without feedback for all groups followed by a 15-minute period of either contingent (group BF_1) or taped (groups BF_2 and C_1) feedback. To make the conditions more comparable to clinical training situations, subjects in each of the three groups were given 5 minutes of muscle tensing and relaxing exercises adapted from Jacobsen (1938) immediately prior to the first session; each subject was introduced to the biofeedback equipment as: "The biofeedback equipment will pick up electrical activity from you body through sensors which will be attached to your forehead; and it will convert this electrical activity into audio signals which you will later hear through a pair of headphones. As your body becomes more tense, the pitch of the signal will get higher; as you relax more and more, the pitch will get lower and lower." To ensure that the meaning of pitch was understood, a taped signal of high and low pitch was demonstrated to all three groups. The C_1 group was informed that they will receive taped feedback. All subjects were asked to sit as comfortably and as relaxed as possible in the arm chair with hands at sides and eyes closed. Communication between subject and experimenter was kept to a minimum and no praise or verbal reinforcement of any kind was given to subjects regarding their performance during the experiment. At the start of the first session, the volume of the tone was adjusted to a comfortable level for each subject. After all the testing was completed, all subjects were debriefed on the procedural details of the experiment. The BF_2 group was offered a "real" session in EMG training if desired.

Experimental Design

For the EMG data, the design was a 3X2X2X2 factorial. The factors were Treatment Conditions (BF_1, BF_2 or C_1), Personal Locus of Control (I or E), Sex (M or F), and Sessions (1 or 2). The criterion measure was the average EMG level in microvolts measured peak-to-peak obtained during each session; EMG levels were recorded by hand at 60-second intervals. A similar 3X2X2X2 analysis was performed on the two baseline periods. Again, the factors were Treatment Conditions (BF_1, BF_2 or C_1), LOC (I or E), Sex (M or F), and Sessions (1 or 2).

For the personal I-E and STAI change data, the design was a 3X2X2 factorial; the factors were Treatment Conditions (BF_1, BF_2 or C_1), Locus of Control (I or E), and Sex (M or F). For the LOC data, the criterion measure was the posttest minus the pretest I-E scores (from the entire I-E scale); and for the STAI data, the criterion measure was the posttest minus the pretest STAI scores. A similar 3X2X2 analysis was performed on each of the postsession questionnaires. A Pearson Product-Moment Correlation Coefficient (r) was performed in order to determine the relationship between mean pre-post LOC and STAI (State and Trait) scores and mean pre-post EMG levels.

Pre and Post Tests

In order to relate respective treatment experiences to subjective experience, all three groups were given the following subjective measures prior to and after the experiment:

(1) Rotter's (1966) I-E scale, and

(2) The State-Trait Anxiety Inventory (STAI).

Postsession Questionnaires[2]

At the conclusion of each 20-minute session, each subject rated to what extent his/her performance was affected by:

1. one's own efforts,
2. ease or difficulty of the task,
3. visual cues,
4. the experimenter.

The 7-point scale was anchored at three points: "not at all", "moderately", "very much" (from Stern & Berrenberg, 1977).

Each subject was also asked to rate his/her subjective feelings of relaxation, as compared to: (a) prior to the attending session, (b) the previous session.
The 7-point ratings were anchored at three points: "less relaxed", "about the same", "more relaxed".

[2]These questionnaires are included in the Appendix as Fig. 1 and Fig. 2.

At the conclusion of each session, each subject was also asked to rate to what extent he felt the audio signal aided him in his efforts to relax. This was a 7-point scale anchored at three points: "not at all", "moderately", "very much".

RESULTS

EMG Data

The 3X2X2X2 Anova performed on the two baseline periods revealed no significant differences.

The 3X2X2X2 Anova on mean EMG levels revealed a significant main effect of treatment conditions ($F(2,48)=5.18$, $p<.01$). A subsequent Neuman-Keuls analysis indicated that the BF_1 group had reduced their EMG levels significantly more ($p<.01$) than the BF_2 or C_1 groups in both sessions. There were no significant differences between sessions 1 and 2; there were no significant differences in mean EMG reduction between the 2nd and 3rd groups in either session. Table 1 indicates group mean EMG levels at the first base period, and those attained by the end of the second session (last three minutes).

Table 1

Group Mean EMG Levels (In Microvolts)

Group	Initial Base Level	End of 2nd Session
BF_1	4.68	2.55
BF_2	4.43	3.88
C_1	4.55	4.46

The Anova also indicated a significant treatment X I-E interaction ($F(2,48)=3.23$, $p<.05$); a subsequent Neuman-Keuls analysis indicated that the mean EMG levels of the C_1 Internals (averaged over the two sessions) were significantly higher than the other groups ($p<.05$). Table 2 indicates treatmentXI-E data for the two sessions.

Table 2

Mean EMG Levels for TreatmentXI-E Data (In Microvolts)

	Session 1		Session 2	
	Locus of Control		Locus of Control	
Group	I	E	I	E
BF_1	2.52	3.04	2.34	2.80
BF_2	3.31	4.08	4.29	3.76
C_1	5.18	3.55	5.50	3.56

An analysis of mean EMG changes over sessions indicated that there was a significant increase in mean EMG levels for the BF_2 Internals from the first to the second sessions, two-tailed $t(33)=2.26$, $p<.05$.

Subjective Measures

Table 3 indicates that all groups became more internal in their LOC post scores, - except for the C_1 Internals who became more external. The 3X2X2 Anova, however, indicated that these results were not significent. The Pearson r indicated a positive correlation (r=.62) between the mean pre-post change in LOC scores and the mean pre-post change in EMG levels (first base level-last three minutes of second session). Therefore, generally, as mean EMG levels decreased, the LOC scores also decreased (became more internal).

The posttest scores of the STAI in Table 4 indicate that all groups reduced their State anxiety levels; and the pre-post Trait anxiety scores remained quite constant. The 3x2x2 Anova indicated that these results were also not significant. The Pearson r did not reveal any significant correlations.

Table 3

Mean Pre- and Posttest Internal-External

Locus of Control Scores

Group	Mean Pre Score	Mean Post Score
BF_1I	5.2	4.4
BF_1E	16.5	15.8
BF_2I	4.6	4.3
BF_2E	16.2	15.7
C_1I	4.8	6.3
C_1E	15.5	14.1

Note. I=Internals
E=Externals

Table 4

Mean Pre- and Posttest State-Trait Anxiety Inventory Scores

Group	Pretest	Posttest
	Mean State Scores	
BF_1I	34.7	29.6
BF_1E	42.9	39.7
BF_2I	34.8	30.1
BF_2E	44.3	39.8
C_1I	32.0	28.3
C_1E	37.1	32.6
	Mean Trait Scores	
BF_1I	36.8	34.8
BF_1E	47.2	47.4
BF_2I	37.6	37.8
BF_2E	47.9	46.8
C_1I	34.3	34.4
C_1E	38.8	38.2

Note. I=Internals
E=Externals

DISCUSSION

Consistent with the literature, subjects in the contingent feedback treatment condition (BF_1) evidenced significant reductions in EMG levels in comparison to their noncontingent feedback group counterparts.

The EMG biofeedback literature also indicates a lack of consistency in the type of control conditions utilized. As mentioned earlier, a popular type of control condition is the "random" or "false" feedback one (group receiving noncontingent prerecorded feedback); here, the group is either informed or not regarding their feedback condition (Kappes & Michaud, 1978; Budzinski et al., 1973; Reed & Saslow, 1980). However, "uninformed" subjects are usually simply told that the feedback they are to receive should help them to relax. They are not purposely told that the feedback they are to receive is contingent on their own EMG levels; the rationale behind not purposely "misleading" the subjects is that they would easily detect that the feedback they were receiving was not their own, anyway. However, if subjects are relaxation training naive, and have never been shown how the feedback signal actually interacts with bodily tension/relaxation, naiveté regarding the true feedback condition could be established for a certain period of time. (Most relaxation training naive subjects do not even realize when they are bodily relaxed or tense.)

This lack of consistency in control conditions creates unequal psychological conditions, - i.e. expectations for success, - between the contingent and control conditions. As these factors are of upmost importance to any study, this research project involved both types of control groups. To create a more equivocal condition to the contingent group, therefore, the BF_2 group was purposely told that the signal they were receiving was contingent on their own level of bodily tension/relaxation.

In light of these factors, it is meaningful to note certain outcomes of the I-E data. Table 2 indicates that Internals attained the lowest EMG levels in the contingent group, and the highest levels in the informed control condition (C_1). According to the literature, externals will feel more threatened in a skill versus a chance situation, - one which demands mastery behaviors. Internals, on the other hand, will tend to prefer to master the skill situation (Lefcourt, Lewis, & Silverman, 1968; Liverant & Scodel, 1960). Therefore, we can say that the contingent (BF_1) condition, - a skill situation, - prompted the Internals to act on their generalized expectancy and therefore reduce EMG levels substantially. By the same logic, the informed control condition (C_1) did not warrant mastery behaviors and therefore did not prompt the Internals to attempt to reduce EMG levels, - as evidenced by the high EMG levels throughout both sessions.

It is also meaningful to note that the misled group (BF_2) Internals attained substantially lower EMG levels in the first session in comparison to the second session. Cognitions of control, thus, perhaps play a more important role in task performance than we realize. But to draw such a conclusion, it would be expected that the misled group Externals would have evidenced similar results.

When discussing the concept of externality-internality features of the task, - i.e. task difficulty, - should be given more consideration. Since the subjects utilized in this study were all "normals", the task of relaxing would not be difficult; and the presence of feedback cues would simplify the task even more. In the misled condition, however, the task was obviously an impossible one; and during the first session when naiveté and expectancy for success were at their peak, this task could have been interpreted as a very difficult one. Thus, acting on a generalized expectancy, the misled group Internals can be regarded as having been more determined than the externals in their efforts to master their internal environment; this is evidenced by the relatively more substantial reductions in their EMG levels in the first session.

Over all, Table 2 indicates that the Internals' EMG data evidenced more substantial differences among the three treatment conditions than the Externals' data. Thus, we can say that the generalized expectations and task features had more of an effect on the Internals in the different treatment conditions. Perhaps the very nature of the relaxation procedure inhibits the threatening nature of the skill situation; and perhaps the mastery of skill situations is more of an important issue to the Internals than is realized.

One must not interpret the EMG data as an indication of the lack of utility for the feedback signal. It should be remembered that this study dealt with subjects who were relatively low in bodily tension to begin with; and, as such, the task of learning to relax did not warrant the need for biofeedback instrumentation.

That there were no significant between group differences for the post-pre LOC or STAI scores can more than likely be attributed to the short training period. However, it is obvious that to have made the training period longer would have done nothing for the enhancement of the purpose of the study; the misled group would have better understood the true nature of the feedback signal as well as being unecessarily frustrated by deception.

With regards to the subjective data, it is meaningful to note that there is a positive relationship between pre-post LOC score decreases (greater internality) and pre-post decreases in mean EMG levels. In other words, the degree to which subjects shifted in the direction of internality was associated with how much they reduced their EMG levels. This finding is supported by the literature which reports that decreases in EMG levels are associated with increases in internality (Stern & Berrenberg, 1977; Carlson, 1977; and Carlson & Feld, 1978).

It is noteworthy that the different treatment groups did not show discriminating performance in the questionnaires asking the subjects to rate how relaxed they felt, and how much they felt the biofeedback signal aided them in their efforts to relax. In other words, the different treatment conditions did not affect how relaxed the subjects felt. And despite differences in EMG reduction, all subjects reported feeling equally relaxed. This finding is supported by Alexander (1975), who reported no significant differences in subjective reports of relaxation between a group receiving EMG biofeedback and a control condition; and Tarler-Benlolo (1978) notes that the weight of the evidence for the relationship between subjective reports of feeling relaxed and physiological measures are low and negative correlations. These data make one question the validity of subjective reports with regards to relaxation data.

With regards to the subjective data, it should also be noted that the "misled" (BF_2) group was not formally asked whether they were actually "fooled" into believing that the feedback was their own. It was felt that because there were no significant differences between the groups in their ratings of how much they felt the signal aided them to relax, that this reflected the validity of the deception. However, it could be that the random tone somehow aided relaxation for some other reasons. That this was not further explored is a shortcoming of this study; to have done so perhaps might have shed more light on the experiment.

In conclusion, it should be mentioned that Phares (1976) emphasizes the importance of situation-specific as well as generalized expectancies in well-defined versus ambiguous task performance situations. In light of these data, - when relating the LOC variable to EMG task performance, - the fine interplay of task characteristics with the locus of control variable should be given more consideration. As well, when interpreting data, it is also important to consider the type of subject sample utilized. These will enable better understanding of the utility of the biofeedback procedure as well as of the locus of control variable.

A P P E N D I X

FIG. 1

Circle the response which you feel to be the most appropriate.

As compared to prior to this biofeedback session, I feel:

LESS RELAXED			ABOUT THE SAME			MUCH MORE RELAXED
1	2	3	4	5	6	7

I feel that my performance in this biofeedback session was affected by:

	NOT AT ALL			MODERATELY SO			VERY MUCH SO
1. my own efforts	1	2	3	4	5	6	7
2. ease or difficulty of the task	1	2	3	4	5	6	7
3. visual cues	1	2	3	4	5	6	7
4. the experimenter	1	2	3	4	5	6	7

I feel that the feedback signal aided me in my efforts to relax:

NOT AT ALL			MODERATELY SO			VERY MUCH SO
1	2	3	4	5	6	7

FIG. 2

Circle the response which you feel to be the most appropriate.

I feel that my performance in this biofeedback session was affected by:

	NOT AT ALL			MODERATELY SO			VERY MUCH SO
1. my own efforts	1	2	3	4	5	6	7
2. ease or difficulty of the task	1	2	3	4	5	6	7
3. visual cues	1	2	3	4	5	6	7
4. the experimenter	1	2	3	4	5	6	7

As compared to the previous biofeedback session, I feel:

LESS RELAXED			ABOUT THE SAME			MUCH MORE RELAXED
1	2	3	4	5	6	7

I feel that the feedback signal aided me in my efforts to relax:

NOT AT ALL			MODERATELY SO			VERY MUCH SO
1	2	3	4	5	6	7

FIG. 3.1

RAW DATA

Group BF_1

*$\overline{S}$	1st Base	1st Sess.	2nd Base	2nd Sess.	LOC Pre	LOC Post	STAI State Pre	STAI State Post	STAI Trait Pre	STAI Trait Post
1	3.84	2.29	3.74	2.65	5	5	34	28	38	34
2	2.80	1.55	2.98	1.43	6	8	26	23	22	22
3	5.36	2.42	5.58	2.30	7	6	25	25	25	25
4	4.94	2.71	4.12	2.32	7	5	23	23	39	34
5	5.14	2.34	5.14	1.52	3	3	36	40	41	42
6	4.46	1.96	4.76	2.01	1	2	53	30	53	48
7	6.10	3.05	6.08	3.31	6	4	37	27	45	43
8	4.20	3.51	4.56	3.48	7	2	43	42	32	32
9	2.90	2.28	2.46	1.96	3	3	36	28	40	38
10	6.60	3.13	6.60	2.36	5	4	34	30	33	30
11	2.68	1.88	2.78	2.14	14	12	38	36	50	52
12	4.04	2.63	3.98	2.10	22	23	72	54	69	67
13	4.08	2.21	3.18	2.20	14	12	42	40	46	44
14	5.04	3.74	5.00	2.94	13	12	37	29	54	58
15	3.56	2.46	2.60	2.44	15	13	53	36	43	38
16	3.88	2.29	3.14	1.87	23	23	41	35	50	46
17	5.56	3.12	5.36	3.28	17	17	36	47	42	44
18	5.76	3.81	5.62	3.47	13	13	37	32	34	37
19	5.96	3.73	5.84	3.18	19	18	34	45	39	41
20	6.40	4.53	6.96	4.39	15	15	39	43	45	47

*$\overline{S}$=Subject

FIG. 3.2

RAW DATA

Group BF_2

					LOC		STAI			
							State		Trait	
*$\overline{S}$	1st Base	1st Sess.	2nd Base	2nd Sess.	Pre	Post	Pre	Post	Pre	Post
21	5.96	4.57	6.48	7.69	5	5	44	30	44	45
22	4.46	3.75	4.40	5.08	7	7	34	33	44	49
23	4.30	3.47	4.42	3.95	2	2	35	30	35	31
24	2.70	1.52	2.96	1.72	6	4	28	25	35	30
25	4.42	2.56	4.42	1.95	6	8	34	30	38	40
26	3.50	2.64	3.22	2.77	6	7	40	32	34	38
27	4.26	2.04	4.50	2.55	5	2	38	40	43	46
28	5.18	5.52	5.38	5.45	0	0	35	30	39	37
29	4.14	4.92	4.36	4.76	6	6	31	29	33	33
30	5.40	4.37	5.40	4.62	3	2	31	22	31	29
31	3.66	2.40	3.02	2.45	18	16	61	51	63	57
32	4.50	5.23	4.52	4.00	16	16	42	42	50	46
33	3.40	2.69	3.58	2.67	22	22	39	36	56	59
34	4.38	4.97	4.98	3.96	14	13	43	42	39	38
35	3.36	3.08	3.34	2.84	16	16	33	28	39	39
36	4.88	3.63	4.52	4.23	13	13	42	38	38	36
37	5.34	3.70	5.30	2.93	16	15	44	42	31	32
38	3.20	3.82	3.62	4.59	16	18	54	49	51	53
39	4.76	4.67	4.72	4.13	15	15	46	44	57	54
40	5.94	6.63	6.46	5.77	16	13	39	26	55	54

*$\overline{S}$=Subject

RAW DATA

Group C_1

*$\bar{S}$	1st Base	1st Sess.	2nd Base	2nd Sess.	LOC Pre	LOC Post	STAI State Pre	STAI State Post	STAI Trait Pre	STAI Trait Post
41	5.62	5.72	5.74	5.95	6	7	27	24	45	42
42	2.74	3.86	2.40	3.37	2	2	29	28	28	28
43	3.68	2.19	3.72	3.34	2	12	41	26	30	31
44	3.92	2.57	3.90	4.51	3	6	28	27	27	31
45	8.90	13.79	8.90	11.35	7	6	35	24	32	32
46	4.30	3.58	3.72	3.38	6	4	25	30	37	39
47	4.14	5.48	4.18	8.03	6	7	37	38	36	35
48	4.52	4.73	4.20	4.83	6	5	39	33	40	36
49	4.22	3.49	4.44	3.59	5	8	37	29	41	41
50	5.54	6.40	5.32	6.67	5	6	22	24	27	29
51	4.30	3.94	4.04	3.11	13	12	33	29	35	36
52	4.56	5.05	4.56	3.66	16	10	36	30	32	32
53	3.88	3.11	3.60	2.96	18	17	61	48	60	59
54	3.32	2.29	2.80	4.73	13	14	37	37	46	46
55	4.64	4.67	5.26	5.05	14	12	32	25	32	33
56	2.80	2.15	2.46	2.46	14	13	28	24	35	35
57	3.02	3.52	3.14	2.40	15	13	30	27	35	32
58	3.78	3.72	4.08	4.74	20	18	35	26	36	33
59	4.18	2.53	4.24	3.59	17	16	33	34	38	36
60	3.14	4.50	3.32	2.89	15	16	46	46	39	40

*$\bar{S}$=Subject

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