# THE EFFECTS OF FEEDBACK, REWARD, AND LOCUS OF CONTROL ON OCCIPITAL ALPHA ENHANCEMENT

JAY W. BROLUND

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## ABSTRACT

On the basis of Rotter's (1966) locus of control scale, 40 internals and 40 externals were each assigned to four separate groups: feedback, feedback plus reinforcement (money or extra experimental credit), control, and yoked control.

No differences in alpha production were found between internals and externals. The results indicated that all the groups, except the yoked control group, significantly enhanced their level of alpha production across trials. Only the feedback plus reinforcement group, however, demonstrated a significantly greater level of alpha enhancement than the control groups.

It was concluded that Rotter's locus of control scale may not be appropriate for alpha biofeedback experimentation; and the use of reward, in addition to feedback, was necessary to demonstrate an increase in alpha production.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

# CHAPTER I

# INTRODUCTION

## The EEG Alpha Rhythm

Research into the intrinsic rhythms of the human brain (eg. alpha, beta, theta and delta rhythms) has most particularly focused on the investigation of alpha activity. Alpha has been defined by the Terminology Committee of the International Federation for Electroencephalography and Clinical Neurophysiology as a "rhythm, usually with a frequency of 8-13 c/sec in adults, most prominent in the posterior areas, present most markedly when eyes are closed and attentuated during attention, especially visual." (Storm van Leevwen, Bickford, Brazier, Cobb, Dondey, Gastaut, Bloor, Henry, Hess, Knott, Kugler, Lairy, Loeb, Magnus, Daurelly, Petsche, Schwab, Walter & Widen, 1966 p. 306). The alpha wave is the most prominent human brain wave activity and comes in bursts of a few to many hundreds of waves (Kamiya, 1968). One of the most obvious features of the electroencephalogram (EEG) patterns is that they are not constant, but rather, alternating between alpha rhythm and little or no alpha (Davis & Davis, 1939; Lynch & Paskewitz, 1971; Mulholland, 1971, 1972; Hawkes & Prescott, 1973). In spite of this fact, the alpha activity for any given individual remains relatively stable over successive meas-

ures taken under uniform conditions (Davis & Davis, 1939; Rubin, 1938; Engel, Romano & Ferris, 1947; Johnson & Ulett, 1959).

Alpha Biofeedback

Evidence has been accumulating in recent years to suggest that human subjects can alter their EEG activity when they are given feedback indicating the level of activity in the frequency band (eg. alpha) which is to be enhanced or reduced (Kamiya, 1968; Green, Green & Walters, 1969; Peper & Mulholland, 1970; Brown, 1970; Nowlis & Kamiya, 1970; Beatty, 1971, 1972; Regestein, Pegram, Cook & Bradley, 1973; Beatty & Kornfeld, 1973; Travis, Kondo & Knott, 1973; Nowlis & Wortz, 1973). In the case of alpha, subjects are presented with auditory (eg. Kamiya, 1968) or visual cues (eg. Brown, 1970, 1971) which are indicative of the presence of alpha wave activity in their EEG. Successful self-control has apparently occurred in spite of the fact that visual imagery, associated with the visual feedback, has an initial suppressive effect on the presence of alpha (Short, 1953; Short & Walter, 1954; Walter & Yaeger, 1956; Slatter, 1960; Kamiya, 1968). When viewed from an operant conditioning perspective, this feedback is considered to operate as a reinforcer on a continuous schedule of reinforcement (eg. Beatty, 1971; Gaarder, 1971; Hord & Barber, 1971; Shapiro & Schwartz, 1972). This assumption about feedback being reinforcing, it should be noted, is perhaps only applicable when subjects are motivated to

control their EEG patterns (Beatty, 1971; Shapiro & Schwartz, 1972).

A wide range of subjective reports follow successful control of the alpha rhythm (Hord & Barber, 1971). Generally, however, the presence of alpha activity has most frequently been reported to be associated with an alert, non-drowsy, internally focused state, which is devoid of concrete visual imagery (eg. Kamiya, 1968; Green, Green & Walters, 1970, 1971; Nowlis & Kamiya, 1970; Brown, 1970, 1971). In addition, Kamiya (1969) claims that subjects learn to prefer an "alpha on", rather than an "alpha off" state, and therefore are more successful at facilitating than suppressing alpha. This may be because "relaxation and letting go" (associated with a high alpha state) is more preferred and/or reinforcing than intense concentration (associated with a low alpha state).

## Methodological Problems in Alpha Biofeedback Research

Although many studies have purported to demonstrate self-control of alpha waves, some investigators have seriously questioned how adequate the designs employed have been to unequivocally support the existence of the phenomenon.

Lynch and Paskewitz (1971) and Paskewitz and Orne (1973) have discussed many baseline problems associated with alpha conditioning and agree that it is very difficult to establish appropriate baseline conditions from which to

measure alpha increases or decreases. They suggest that any initial baseline will be contaminated by apprehensions about the experiment, the novelty of the situation, and so on. Any measure taken during the course of training may result simply from the decrease in these factors themselves and not from the training procedure. Even the use of frequent intermittent baseline determinations has been questioned by Kamiya (1969) who has stated that his subjects seem to prefer high alpha states and persist in such states during baseline conditions. In addition, Paskewitz and Orne (1973) have criticized the practice of using rest periods interspersed throughout the training session as baselines against which to compare the subject's performance. They suggest that defining a period as a rest period for the subjects may produce changes in motivation and arousal. Therefore, such a practice does not permit separation of the effects of feedback training, from those increases that are due to changes in arousal or motivation. Lynch and Paskewitz (1971) and Paskewitz and Orne (1973) have further criticized the use of reversals (keeping alpha on and keeping alpha off) in training for differential control of alpha density. They note that although differential control has been demonstrated in a number of studies (eg. Kamiya, 1968; Nowlis & Kamiya, 1970; Peper & Mulholland, 1970), some authors (Peper & Mulholland, 1970; Paskewitz, Lynch, Orne & Costello, 1970; Paskewitz & Orne, 1973) have noted that subjects can quickly learn to suppress alpha activity but

they have a much more difficult time enhancing it. Consequently, this is a demonstration of unidirectional rather than bidirectional control which only indicates that subjects can quickly put to use some of those factors which block alpha activity (eg. visual imagery). In order to differentiate true control, these authors feel that the subjects should increase their alpha density above that observed during optimal baseline conditions. As noted earlier, however, the problem of proper baseline conditions still exist. It is on the basis of such information that Lynch and Paskewitz have concluded that no proper controls have been established and consequently any conclusive demonstrations of alpha control are severely restricted.

In view of the literature on alpha control, such criticisms have some validity. One of the most obvious conclusions from reviewing this literature, is that the majority of studies fail to make use of any type of control group. Most investigators compare their subjects' final performance to their original baseline level (eg. Brown, 1970; Nowlis & Kamiya, 1970). Of the very few published studies that have made use of control groups, some have compared contingent feedback and no feedback groups (Hord & Barber, 1971; Pegram, Cook & Bradley, 1973). The results of both of these studies indicated that alpha control during feedback conditions was not significantly greater than no feedback control conditions. Both studies, however, have their limitations. Hord and Barber utilized only eleven

volunteers who served in eight different conditions. It appears from this study that the same subjects who served in a no feedback condition may have earlier received feedback. Similarly, in the study by Regestein, Pegram, Cook, and Bradley, it appears that all subjects were previously allowed to practice with the feedback tone. In addition, no data was included in their study. Consequently, any conclusions based on either of these two studies must be made with extreme caution.

Only one study (Beatty, 1972) reported in the literature demonstrated superior performance of the experimental group over the control group. In this study the experimental group was exposed to both feedback and an additional extrinsic reinforcer (extra experimental credit).

One study (Beatty, 1971) has compared contingent feedback (plus reward) and non-contingent feedback groups. The results denote that alpha control for the experimental group was significantly superior to that of the yoked control group. In view of this result, however, it should be noted that there has been controversy regarding the use of a true yoked control design (Church, 1964; Katkin & Murray, 1968; Katkin, Murray & Lachman, 1969; Crider, Schwartz & Shnidman, 1969). It has been pointed out that the use of such a design establishes an inherent bias against the control group on the basis of individual reactions to a reinforcer.

None of the studies reported above have used both a yoked control and a no feedback group. This, it is felt,

would allow one to assess any inherent bias against the yoked control groups by comparing their performance to the control group, and, in addition would allow one more accurately to assess the effects of feedback.

## Feedback Issues

Beyond seriously questioning any conclusive demonstration of alpha control on the basis of methodological problems, other investigators have disagreed with viewing the phenomenon in an operant theoretical framework. Particularly, viewing feedback as a reinforcing stimulus has been seriously questioned. Peper and Mulholland (1970), although they felt they succeeded in demonstrating alpha control when feedback alone was used, still argued that because there was no definite criterion for motivation, its status as a reinforcer was ambiguous. Therefore, they suggested that a reinforcer (eg. a monetary reward) should be scheduled in addition to the feedback. They further reasoned that extinction should occur when the reinforcement is withheld. Similarly from a reinforcement analysis, one would expect the rate of alpha occurance to be determined by the schedule of reinforcement and a greater resistance to extinction as a result of intermittent reinforcement. Peper and Mulholland felt that these suggestions would serve as a test to determine whether or not the use of feedback met the requirements of an operant conditioning procedure.

Some of their suggestions have been incorporated

directly or indirectly into other studies. Beatty (1971, 1972) and Beatty & Kornfeld (1972), for example, have provided both an auditory feedback signal and an extrinsic reward (money or double experimental credit) when the subjects succeeded in doubling alpha or beta activity. While the subjects significantly increased their amount of alpha and beta activity, it is not possible to say how much this was due to the reinforcement, since they all received the same option, and there was no comparison of these subjects to a group which received feedback alone. One study by Regestein, Pegram, Cook and Bradley (1973), however, attempted to make this comparison. In this study of extended feedback conditions, some of the subjects received a monetary reward of $2.50 for each hour they could produce alpha. Others received only feedback. Although the authors failed to report any comparisons of these groups in their results, they stated in their discussion that it apparently made no difference to their subjects whether they were paid or not. In the absence of any statistical analysis, however, one should be cautious about this conclusion. In addition, it should be noted that the subjects all volunteered. On the basis of this alone, it can be assumed that the subjects were motivated to participate and that an additional extrinsic reinforcer might have added little to their motivation.

Several other studies (eg. Brown, 1970, 1971; Peper, 1970, 1972; Nowlis & Kamiya, 1970), however, have reported

they have successfully demonstrated alpha control with human subjects when feedback alone was used. Given this information, it seems reasonable to assume that feedback functions as a reinforcer in much the same way as an extrinsic reinforcer, at least for some subjects. It cannot be assumed that feedback will necessarily be reinforcing for everyone (Gaarder, 1971; Shapiro & Schwartz, 1972). The addition of an extrinsic reinforcer such as money, however, involves making fewer of these assumptions. Peper and Mulholland's suggestion that a reinforcer be scheduled in addition to feedback may not be necessary, but, on the other hand, may contribute to the overall strength of the reinforcer, and, in turn, to the demonstration of alpha control. This suggestion is supported by the fact that Hord and Barber (1971) and Regestein, Pegram, Cook and Bradley (1973) failed to demonstrate any difference in alpha production between feedback and control groups. Beatty (1972), on the other hand, demonstrated superior performance of the feedback group over the control group when an additional reinforcer was scheduled with feedback.

Mediational Alternatives

Some investigators have suggested mediational alternatives (eg. oculomotor component, existential states) to the operant formulation of alpha self-control. Lynch and Paskewitz (1971), for example, have questioned the status of operant conditioning of autonomic systems on the basis

of a set of criteria proposed by Katkin and Murray (1968). According to these criteria, if a response is mediated (cognitively or physiologically) by another system, then it is this latter mediating system that is being conditioned. Given this orientation, Lynch and Paskewitz concluded that since alpha activity is mediated by a wide range of factors (as are all responses), it is impossible to demonstrate simple operant conditioning in any direct sense. It should be noted, however, that many operant conditioners would not be overly concerned with such a criticism on the basis of their interest in demonstrating a functional relationship. Such an analysis would concentrate on the link between alpha control and the precise conditions that control or determine it.

Other investigators have concerned themselves with the possibility that occipital alpha activity is mediated by an oculomotor component during feedback training. Mulholland (1968, 1969a, 1969b, 1971), Mulholland and Evans (1965, 1966), and Dewan (1967) hypothesized that, at least in some subjects, alpha rhythm is related to the position of the eye. Mulholland felt that alpha was facilitated when the eyes were moved to an extreme side or most notably to an up position. Lippold and Novotny (1970) have further hypothesized that alpha is not generated in the occipital cortex but rather by the tremor of the extraocular muscles. The literature, they felt, supported their contention to the extent that alpha rhythm and tremor tend to have the same frequency

and wave form in individuals. Furthermore, they stated that with increasing age, both tremor frequency and alpha frequency increase. They concluded that extraocular muscles, because of the intimate association between alpha rhythm and visual input, would be the most favorably related. The implication of such interpretations is that the subject can learn to control voluntary processes involving the oculomotor muscles that are conditioned. Several studies, as a result, have controlled for the Mulholland effect. Fenwick (1966) concluded that alpha was not significantly correlated to eye positions. He admitted, however, that a few subjects did show the hypothesized effect. Kamiya (1968) also investigated the possibility that eye position might be related to alpha activity. In spite of the fact that a burst of alpha occurred when the subjects raised their eyes, his subjects learned to control alpha with their eyes in either an up or down position. Brown (1970) similarly found that voluntary control of alpha activity occurred in the absence of eye movements. On the basis of this evidence, Nowlis and Kamiya (1970) concluded that although the Mulholland effect is not ruled out for all subjects, it does not seem to be widespread and is not characteristic of all subjects. Mulholland (1969a), himself, admits to the latter statement.

As another alternative mediational explanation of alpha control, Green, Green and Walters (1970) prefer to differentiate between voluntary control of internal states and conditioned control of central nervous system indicators.

They do not attempt to train subjects in alpha production, but rather train them in the voluntary control of certain existential states whose nervous system correlates are revealed by either the presence of alpha suppression, or facilitation.

Brown (1970, 1971) similarly is concerned with the identification of feeling states associated with the presence or absence of alpha activity. She characterizes the feedback procedure as being different from that of conditioning. Rather than viewing feedback as a reinforcer of the alpha response, Brown argues that the feedback signal is the response. Consequently the elements of response and reinforcement, according to her argument, cannot be separated. She fails to note, however, that this is true for a whole class of responses in operant orthodoxy (eg. consumatory responses such as eating, drinking, and sex). In addition, Brown (1970) notes that, unlike conditioning phenomenon, extinction of the response either does not occur or diminishes slowly over time. As has been noted earlier, however, there is at least some suggestion (Kamiya, 1969) that alpha production is inherently reinforcing, and therefore would account for this fact. Brown's statement, then, that at some point during training the external stimulus of the light no longer was necessary for the maintenance of alpha activity, may be interpreted as support for the contention that alpha is itself reinforcing. Consequently, alpha in itself may be able to maintain the behavior which does not seem to

extinguish, as do other operants.

New Directions

Although the status of the operant self-conditioning paradigm of alpha control has been criticized, it has not been discredited as a viable explanation. It is generally believed that feedback seems to be necessary for such learning to occur. Ray (1971) suggests that the researcher should no longer be satisfied with only reporting change in a given physiological system. Beyond demonstrating control, he recommends that the researcher should investigate both physiological and cognitive methods by which such change (or control) is achieved. Nowlis and Kamiya (1970) have further suggested that alpha conditioning provides the opportunity to explore the relationship between physiological and behavioral measures. They based this view on the evidence that there are differences in verbal reports of subjects regarding their mental activities during various conditions of alpha control. Other evidence has suggested that there are individual differences in subjects in gaining control over alpha activity (Peper & Mulholland, 1970; Kreitman & Shaw, 1965). Green, Green and Walters (1970) have hypothesized that inward-outward orientations may, in part, account for the interindividual differences of success in voluntary control of internal states. In view of this hypothesized relationship they have administered a number of tests in order to determine their subjects' inward-outward orientations (eg. introversion-extroversion, field-dependence and inde-

pendence). Unfortunately, however, Green et al. have not published any results regarding the relationship between inward-outward orientations and success in control of internal states.

## Internal-External Locus of Control

Among the measures utilized by Green et al. is Rotter's internal-external locus of control (I-E), a personality construct which has developed from social learning theory (Rotter, 1966). As a personality construct and a generalized expectancy, it refers to the difference in the extent to which individuals believe that reinforcement is primarily determined by their own behavior. When such a reinforcement is believed to be contingent upon one's behavior, internal control is said to exist. Conversely, when such reinforcements are believed to be the result of such environmental factors as fate, luck, chance or control by powerful others, external control is said to exist. The internal individual consequently feels that he has more control over himself and his environment.

Locus of control has been demonstrated to significantly differentiate between subjects in a variety of situations (for reviews see Rotter, 1966; Lefcourt, 1966a, 1966b, 1972; Joe, 1971). Several investigations have shown that internals exhibit more initiative and effort to control their environments and to attain goals than do externals (Seeman & Evans, 1962; Seeman, 1963; Phares, 1965). Internals have

also been shown to have a greater need for independence (Crowne & Liverant, 1963) and a stronger motivation in achievement situations (eg. Rotter & Mulry, 1965; Gurin, Gurin, Lao & Beattie, 1969; Lao, 1970). In addition, there has been some evidence that internals can control their own impulses better than externals. The evidence for this has, in part, been derived from studies by Straits and Sechrest (1963) and James, Woodruff and Werner (1965) who have found that smokers were more often externals and non-smokers were more often internals. Among those smokers who reported to believe the Surgeon General's report, more internals than externals did not return to smoking after they quit. To Joe (1971) this suggested that internals can control not only their environments, but also their impulses better than externals. Along this same line, Rotter (1966) has suggested that the feeling that one can control his own environment may be linked to the feeling that he can control himself. The internal individual should then function more effectively under conditions in which he has the most self-influence and can rely primarily on himself rather than on external influences. Investigations of performance in skilled and chance tasks (eg. Rotter & Mulry, 1965; Lefcourt, Lewis & Silverman, 1968; Julian & Katz, 1968) provides some support for this contention. The evidence, however, is not conclusive as the research has not been systematic, and the results have not been consistent.

Locus of Control and Biofeedback

A few authors (Fotopoulos, 1970; Ray, 1971) have published studies relating inward-outward orientations with biofeedback measures. Since Rotter's internal-external locus of control appeared to be an important generalized personality concept, Fotopoulos deemed it was reasonable to go beyond social behavior in its application and to apply it to a physiological process. Given this introduction, she designed a study to investigate the concept of control and its relationship to the physiological response of heart rate. The purpose of her study was to investigate the potential differences between internals and externals in controlling their own heart rates. She hypothesized that since internals relied more upon themselves and less on external influences, they should function more effectively under conditions where they have the most self-influence in determining their behavior. Since external individuals are more influenced by external environmental events, they should function more effectively under conditions in which influence stems from the environment. Most specifically, it was hypothesized that internals should function more effectively than externals when given no feedback, while externals could increase their heart rate more readily when given feedback.

The results of this study indicated that internals were significantly more capable of increasing their heart rate without external feedback (under a thinking condition). This significant group difference, however, did not occur

under the feedback condition. Under the feedback condition (information from the oscilloscope) and when the subjects received an additional reinforcement (defined by Fotopoulos as additional information as to when the subject successfully increased and kept increasing heart rate), reinforced externals increased their heart rate more than non-reinforced externals. Externals, in fact, demonstrated no ability to increase their heart rate without environmental influence (ie. feedback or reinforcement). When no reinforcement was given (ie. only feedback) internals were more able to increase their heart rate. When reinforcement was given under the feedback condition there tended to be no difference between internals and externals in their ability to increase heart rate.

Ray (1971) also investigated the differences between internals and externals in their ability to control heart rate. He investigated both increase and decrease in heart rate measures as being indicative of control. The results indicated that a significant interaction occurred between locus of control and the ability to control heart rate when given visual feedback. Internals were found to be better able to increase their heart rates, while externals were better able to decrease their heart rates from their initial baseline levels. He also found a significant difference between feedback and no-feedback conditions. In all conditions feedback had a facilitating effect on the magnitude of heart rate changes.

Ray explained the differential ability of internal and external subjects to produce changes in heart rate according to the different strategies they adopted. He found that external subjects looked significantly more at objects in the room than did internals on the decrease heart rate task. Moreover, a series of studies conducted by Lacey, Lacey and colleagues (for a review see Lacey & Lacey, 1974) provide support for Ray's conclusions. Essentially they have found that attention to external environmental events consistently produces bradycardia (decreased heart action), while simple cognitive work produces tachycardia (increased heart action). The studies by Lacey and Lacey have implications for the research of both Ray and Fotopoulos for the different strategies adopted by internals and externals may account for the results of these studies.

Present Goals and Rationale

The present study is concerned with investigating the effects of feedback and feedback plus an additional extrinsic reinforcement (ie. money or additional experimental credit) on the facilitation of alpha production. Moreover, this study is also concerned with investigating the relationship of locus of control to the biofeedback procedure. In this respect it is being questioned whether individuals with an internal orientation differ from individuals with an external orientation in their ability to control their EEG alpha waves. In addition, what effect does feedback plus an extrin-

sic reinforcement have on this ability?

Many of the studies presented earlier (Seeman & Evans, 1962; Seeman, 1963; Straits & Sechrest, 1963; Phares, 1965; Rotter & Mulry, 1965; Rotter, 1966; James, Woodruff & Werner, 1965; Lao, 1970; Fotopoulos, 1970; Joe, 1971; Ray, 1971) tend to support the hypothesis that internals show more initiative and effort in controlling their own environments, as well as themselves, when compared to externals. As Joe (1971) has concluded, internals, in contrast to externals, show a greater tendency to seek information and adopt behaviors which facilitate personal control. Given this evidence, it is therefore reasonable to assume that, when receiving feedback alone, internals will be more motivated to be in control. During alpha training the subjects are told that they are to be given an opportunity to control their own brain waves. For internals (more than externals) the feedback will serve as a strong reinforcement and indication of their success. A further study by Baron and Ganz (1972) adds support to the logic presented in formulating this hypothesis. They designed an experiment to examine the effects of variations in locus of control on the effectiveness of intrinsic and extrinsic types of feedback in a discrimination task. The major difference between their feedback conditions was whether the subjects had to depend directly on the experimenter's personal praise (extrinsic reinforcement), or whether they could directly observe the success of their performance (intrinsic rein-

forcement). A combined condition consisting of both extrinsic and intrinsic feedback was also used. They reasoned that since externals are highly responsive to external social reinforcement (Heilbrun, 1970), they would achieve superior task performance in the extrinsic feedback condition. On the other hand, since internals are better able to regulate their behavior by self-reinforcement (Heilbrun & Norver, 1970; Weiner, Frieze, Kukla, Reed, Rest, & Rosenbaum, 1971), they would perform better in the intrinsic condition. The results of the study supported their hypothesis. Concomitantly they found that locus of control did not differentiate performance effects under the combined feedback condition. Baron, Cowan, Ganz and McDonald (1974) have replicated and extended these results across sample (lower-class white, lower-class black, and college samples) and across the measurement of locus of control (Rotter's I-E scale and the Intellectual Achievement Responsibility Questionnaire).

Applied to the present study the results of Baron and Ganz (1973) and Baron et al. (1974) support the contention that internals would perform better than externals, given feedback alone, as feedback alone conforms to their definition of an intrinsic reinforcer. The use of an additional concrete reinforcer (ie. money or extra experimental credit), however, may be more likened to an extrinsic type of feedback. This would make available an external source of motivation for the externally oriented subjects. Since internals are strongly motivated to control themselves, an extrinsic

incentive would add little to their motivation. Externals, however, would be expected to increase their performance under this condition, as compared to their performance under the feedback condition. Under the combined feedback condition (feedback plus extrinsic reinforcement), internal and external subjects would not be expected to perform differently.

Before specifically stating the hypotheses of the present experiment, it is necessary to investigate another relationship which, it is felt, will affect the outcome and form the basis for another hypothesis.

The general consensus of the I-E literature is that externals do tend to report and reveal in their performance more anxiety than internals (eg. Bialer, 1961; Lowe, 1961; Butterfield, 1964; Ray & Katahn, 1968). In view of the fact that Slatter (1960), Shagrass (1972), and Paskewitz & Orne (1973) emphasize that alpha activity is blocked or suppressed by anxiety, it seems very likely that a difference between the baseline levels of alpha activity for internals and externals will emerge. The relationship suggests that externals would have a smaller proportion of baseline alpha than internals. Indeed, this may have been an important factor in Fotopoulos' (1970) study, in which externals manifested a mean elevation of 5 beats per minute over the baseline rates of internals. This suggests that externals may have been initially more anxious than internals.

Statement of the Hypotheses

The present experiment attempts to test the following hypotheses suggested by the literature reviewed on alpha conditioning, reinforcement and locus of control:

1. As noted earlier, alpha activity is blocked by anxiety and externals tend to report and reveal more anxiety in their performance. In this context it is hypothesized that internals have a higher initial level of alpha activity than externals.

2. The previous review also indicates that internals demonstrate more initiative in controlling their own environment as well as themselves. Given the evidence that internals are more motivated to control themselves, it is reasonable to assume that feedback would serve as a strong reinforcer. When given contingent feedback, then, it is hypothesized that internal individuals demonstrate a greater increase in their alpha wave production than do externals in the same condition.

3. The literature also supports the contention that reinforcement in the form of an additional reward would provide an external source of motivation for the external subject. Since internals are strongly motivated to control themselves, an extrinsic incentive would add little to their motivation. Under the condition of feedback plus an extrinsic monetary reinforcement, then, externals increase their performance over that obtained in the feedback condition. Additionally, under this combined feedback condition inter-

nals and externals do not perform differently as internals do not differ significantly between feedback and feedback plus reinforcement conditions.

# CHAPTER II

## METHOD

### Subjects

Eighty-one male freshman psychology students from the University of Manitoba served as subjects.[1] Their participation in this experiment partially fulfilled the requirements of an introductory psychology course. The median score (11) on the Rotter Internal-External Locus of Control Scale was used to identify internal and external subjects. Those subjects scoring below the median were assigned to the internal groups, while those subjects scoring above the median, were assigned to the external groups. The subjects were not given detailed prior knowledge as to the exact nature of the experiment. They were simply told they would be participating in a study of brain wave activity.

### Experimental Design

The subjects were assigned to a 2x4x6 mixed factorial design with 10 subjects in each cell. The design consisted of two between subject variables of internal and external locus of control; four treatment conditions (feedback, feed-

[1] Only one subject was dropped from the experiment as equipment difficulties prevented him from receiving the taped instructions.

back plus extrinsic reinforcement, yoked control and control); and the within subject variable of six trials.

Electrode Placement

Using silver disc electrodes, the occipital EEG was recorded monopolarly from position $O_2$ of the 10-20 system (Jasper, 1958). A combination of both the right and left ears served as a reference. In order to eliminate the possibility that eye movements served as a mediating variable, they were recorded continuously using Beckman electrodes supraorbitally and at the external canthus of the right eye. A Beckman electrode placed on the right wrist served as a ground.

Apparatus

The subjects were seated in a quiet radio frequency shielded, dimly lit room. The EEG signal was recorded on and amplified by a Grass Model 5 6-channel polygraph (an AC preamplifier model). The EEG signal was then fed through an EEG filter system which was set to filter out a signal in the 8-13 Hz range. A BRS Foringer Audio Generator (Lehigh Valley Electronics 215-03; Model no. AU-902) provided the auditory feedback (frequency = 333 Hz. and intensity = 80 db.). The Hunter Klockounter (Model 120A) was used to record the amount of time alpha was present. The auditory feedback was recorded by a Sony Stereo Cassett Recorder (T-126) and was used later to provide identical auditory feedback for yoked subjects.

Measurement of Locus of Control

The internal-external locus of control factor was measured by Rotter's (1966) twenty-three item, forced-choice I-E scale (see Appendix A). The I-E scores range from a low of 0 (depicting extreme internality) to a high of 23 (depicting extreme externality). Six filler items have been added to the scale in an attempt to disguise the purpose of the test (Rotter, 1966).

Only a brief summary of the scale's characteristics will be discussed here, as a comprehensive review of its development, validity, and reliability have been reported by Rotter (1966) and Joe (1971).

Reliability measures have, for the most part, been consistent and satisfactory. Rotter's measure of test-retest reliability have ranged from .49-.83 for 1-2 month periods. Other investigators such as Hersch and Scheibe (1967) and Harrow and Ferrante (1969) have found comparable results. In addition, the scale has been demonstrated to have reasonably high internal consistency measures of reliability (Rotter, 1966) with nearly all correlations in the .70s.

Low correlations with such measures as intelligence ($r=.01$) (Hersch & Scheibe, 1967) and social-desirability ($r=-.07$ to $r=-.35$), as measured by the Marlowe-Crowne Social Desirability Scale, have demonstrated discriminant validity (Strickland, 1965; Tolor, 1967; Tolor & Jalowiec, 1968). Recent findings regarding the relationship between locus of control and social-desirability, however, suggest that it is

not as free of the social-desirability set as originally claimed by Rotter (1966). Feather (1967) and Altrocchi, Palmer, Hellmann and Davis (1968) have found significant relationships between I-E and the Crowne-Marlowe Social Desirability Scale (r=-.42 and r=-.34 respectively). Similarly, Cone (1961) and Berzins, Ross and Cohen (1970) have reported significant correlations between the I-E scale and Edwards' Social Desirability Scale (r=-.23).

The evidence for construct validity comes from predicted differences in behavior for internals and externals and correlations with behavioral criteria. Support has been found for the hypotheses that internals are generally more concerned with abilities, more resistive to subtle influences, take more steps to improve their environment, and place greater value on achievement reinforcements (Rotter, 1966).

The results of factor analysis reported by Rotter (1966) indicated that all items are loaded significantly on a general factor which accounts for 53% of the total variance. The results from other, more recent factor analyses, however, are far from being in agreement with this finding. For example, Mirels (1970) and Abrahamson, Schludermann and Schludermann (1973) have found two factors which account for much less of the total variance. One factor concerns the amount of control one believes he personally possesses, while the other concerns the extent to which one believes any individual can exert control over political and world

affairs. The results of these and other studies (eg. Gurin, Gurin, Lao & Beattie, 1969; Lao, 1970) suggest that the scale is not as factorally pure as was originally believed. In fact such results have provided the rationale for the development of another I-E scale (Levenson, 1972) which separates the I-E dimension into three dimensions (internals, powerful others and chance).

Procedure

Initially all subjects received the Rotter Internal-External Locus of Control Scale. In all but a few cases this scale was completed in class and was unrelated to the present experiment. On the basis of this scale, 40 internal and 40 external male subjects were chosen and then randomly assigned to one of four further groupings: a feedback group, a feedback plus extrinsic reinforcement group, a yoked control group, and a control group. Consequently, there was a total of eight groups: four internal groups and four identical external groups.

The subjects were initially told that they were participating in a study of brain wave activity. At this time, they were also told about the procedure of electrode placement. In addition, all pertinent information about the physical set-up (eg. the shielded room, the purposes of the electrodes,etc.) and the general procedure (eg. number of trials, post-experimental questionnaire, etc.) was explained to the subjects in order to alleviate any anxiety about the

novel situation. Moreover, any questions asked were answered when it was felt the answers would not reveal the specific purposes of the experiment.

After the recording electrodes were attached and the feedback system connected, the subjects were instructed to rest for a 4 minute period. Following this, the subjects were then asked to keep their eyes open and to refrain from moving for another 4 minute period. During this time their baseline level of alpha activity was reported. Immediately following this baseline condition, the subjects received their taped instructions. The instructions, where applicable, were patterned after those used by Beattie (1971). Preceding the instructions for each group the subjects were reminded that they had the option of refusing to participate at any point in the experiment without penalty, if they felt it constituted an invasion of privacy or a violation of personal rights. The specific instructions for each condition or group were as follows:

1. Feedback Condition:

> Today you are participating in a study of brain wave activity. While you have been sitting here, a measurement of your brain wave activity has been taken. Now you have the opportunity to learn to control your own brain waves. Although there are many different patterns of brain wave activity, we have only selected one for today's study. A tone that you will hear is turned on by that brain wave, and your job is to learn to produce the kind of wave that will keep that tone on as long as you possibly can. You will be instructed when to do so. As before, keep your eyes open, refrain from moving, do not move your eyes, nor clench your jaw.

2. Feedback plus Reinforcement Condition:

> Today you are participating in a study of brain wave activity. While you have been sitting here a measurement of your brain wave activity has been taken. Now you have the opportunity to learn to control your own brain waves. Although there are many patterns of brain wave activity, we have only selected one for today's study. A tone that you will hear is turned on by that brain wave, and your job is to learn to produce the kind of wave that will keep that tone on as long as you possibly can. You will be instructed when to do so. If in the last session you can succeed in increasing that brain wave activity one and one-half times your original baseline, you will receive either an extra hour of experimental credit or one dollar. The choice is yours. As before, keep your eyes open, refrain from moving, do not move your eyes, nor clench your jaw.

3. Yoked Control Condition:

The yoked control subjects received exactly the same instructions as the feedback group.

4. Control Condition:

> Today you are participating in a study of brain wave activity. While you have been sitting here a measurement of your brain wave activity has been taken. Today we are interested in studying the effect of a tone that you will hear on one of your brain wave patterns. You will be instructed when we are doing so. As before, keep your eyes open, refrain from moving, do not move your eyes, nor clench your jaw.

This instructional period was immediately followed by a 2 minute rest period. Following this the subjects were given a total of five 4-minute experimental periods and four 2-minute interspersed rest periods. The feedback system accompanied all rhythmic activity in the 8-13 Hz range only during the experimental periods. The subjects were requested

to keep their eyes open and to move as little as possible during the experimental periods. The total procedure was designed to take approximately one hour including electrode placement and final debriefing.

The control subjects received intermittent auditory stimuli which served as feedback in the feedback condition. The control subjects were matched individually with the feedback subjects on both locus of control and baseline level of alpha production. In order to be matched on baseline level of alpha production, the total amount of time that alpha was present during the baseline condition for the control subject, had to be within 6 seconds of the total amount of time that alpha was present during the same condition for the experimental subject (in the feedback condition). The purpose of this condition was, as stated, simply to test the effect of such stimulation on alpha production. Its importance lies in the fact that auditory stimuli have been said to produce an increase in alpha activity on occasions, especially with barely audible stimuli (Durup & Fessard, 1935; Kreitman & Shaw, 1965).

The yoked control subjects were treated in exactly the same manner as subjects in the feedback condition except that their pattern of feedback was not contingent upon their EEG alpha production. As well as being matched on their locus of control orientations, they were matched on the basis of their baseline data with the experimental (feedback) subjects. The same matching criterion was used for both control

and yoked control subjects. The yoked subjects received the same feedback pattern as their matched experimental subject.

In the feedback, feedback plus reinforcement, and yoked control conditions all the subjects were told after each experimental session how their performance compared to their original baseline level of alpha production in terms of per cent increases or decreases. The yoked control subjects were given the same information that their matched experimental subjects had received. All subjects, including the control subjects, were again reminded to keep their eyes open and to refrain from moving when the next experimental session began.

All subjects completed a post-experimental questionnaire (see Appendix B) after which they were debriefed as to the purpose of the experiment.

# CHAPTER III

# RESULTS

## Locus of Control

The distribution of I-E scores was slightly skewed (-.04495) toward the external end of the distribution. The mean was 10.8 and the standard deviation was 4.6. The median was 11, as all subjects included in this study either scored above or below this point. The median, it should be noted, had previously been determined on the basis of a distribution of 800 introductory psychology students at the University of Manitoba.

In order to insure that random sampling had occurred and to confirm that all treatment groups within the internal factor and within the external factor were comparable in terms of their mean I-E scores, an analysis of variance of the I-E scores per group was computed. As may be seen from Table 1, there were no significant differences between internal groups nor no significant differences between external groups, on the basis of their mean I-E scores. There was, of course, a significant I-E difference between internal and external groups.

The results of the mean performances across trials of the feedback, feedback plus extrinsic reinforcement, yoked control, and control groups for both internals and

TABLE 1

The Analysis of Variance of I-E Scores per Group

| Source | df | MS | F |
|---|---|---|---|
| Locus of Control (A) | 1 | 1224.61 | 218.63* |
| Treatment Conditions (B) | 3 | 10.55 | 1.88 |
| A x B | 3 | 3.55 | 0.63 |
| Within Cells | 72 | 5.60 | |

*$p < .001$

externals are presented graphically in Figure 1. An analysis of variance of the initial (baseline) scores per group served as a test of the first hypothesis. The results are depicted in Table 2. Hypothesis I was not supported as internals and externals did not differ on the basis of initial level of alpha production. Similarly, there were no differences in baseline measures found for the training groups (feedback, feedback plus reinforcement, yoked control and control) or for the interaction of locus of control and training.

In order to assess the effects of locus of control, treatments, and trials on alpha production, a repeated measures analysis of variance was performed. The results, as presented in Table 3, indicated that there was no significant effect for locus of control. Moreover, there were no significant differences found between internals and externals across trials or across treatments. Similarly, there was no interaction found for locus of control by treatments by trials.

The results of the same analysis also indicated that there was no significant effect for treatment. A significant effect for trials, however, was found. This in turn relected a greater probability of alpha production at the end opposed to the beginning of training. In addition, a significant interaction of trials by training signified that the effects of treatment increased with trials.

Although the analysis of variance for the initial

MEAN PERFORMANCE FOR INTERNALS AND EXTERNALS ACROSS TRIALS AND ACROSS TREATMENTS

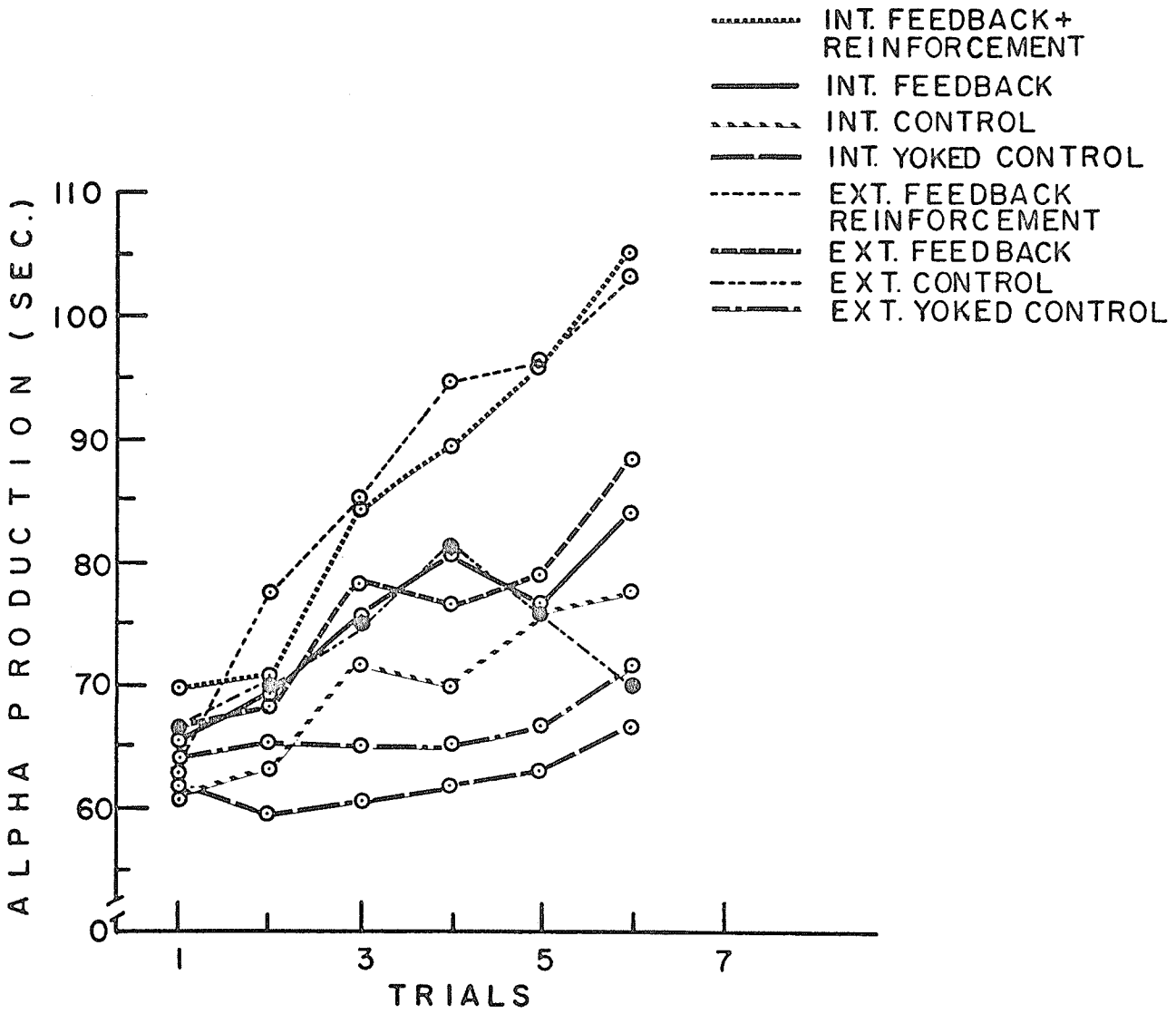


TABLE 2

The Analysis of Variance of Baseline Scores

| Source | df | MS | F |
|---|---|---|---|
| Locus of Control (A) | 1 | 288.80 | 0.0 |
| Treatment Conditions (B) | 3 | 6,115.65 | 0.13 |
| A x B | 3 | 11,562,25 | 0.13 |
| Within Cells | 72 | 48,392.00 | 0.24 |

TABLE 3

Repeated Measures Analysis of Variance

| Source | df | MS | F |
|---|---|---|---|
| Locus of Control (A) | 1 | 599.65 | 0.15 |
| Treatment Conditions (B) | 3 | 9791.84 | 2.39 |
| A x B | 3 | 101.99 | 0.03 |
| Error 1 | 72 | 4082.33 | |
| Trials (C) | 5 | 3767.42 | 26.80** |
| A x C | 5 | 76.52 | 0.54 |
| B x C | 15 | 597.77 | 4.25* |
| A x B x C | 15 | 102.61 | 0.73 |
| Error 2 | 360 | 140.60 | |

*$p < .001$
**$p < .0001$

scores (Table 2) indicated that there was no significant baseline differences, Figure 1 signified that the baseline scores do not fall on the same point. In order to partial out any initial baseline differences between the groups and to adjust the means of the final scores accordingly, an analysis of covariance was performed on the final scores, using the initial scores as covariants. The results of this analysis are presented in Table 4. Once again, there were no significant differences found between internals and externals, nor between internal and external treatment conditions. A significant effect for treatment, however, was found.

Treatment Conditions

Given that there were no significant differences found between internals and externals across treatments or trials, the data for internals and externals in each group was combined and presented graphically in Figure 2. Consequently, the design became a 4x6 mixed factorial design with 20 subjects in each cell, consisting of four treatment conditions, and the within subject variable of six trials. In order to correct for error introduced by the inclusion of the locus of control between subjects variable in the original repeated measures analysis (Table 3), the repeated measures analysis of variance was computed once again. Consequently, the second repeated measures analysis of variance was based on the combined groups and the 4x6 mixed

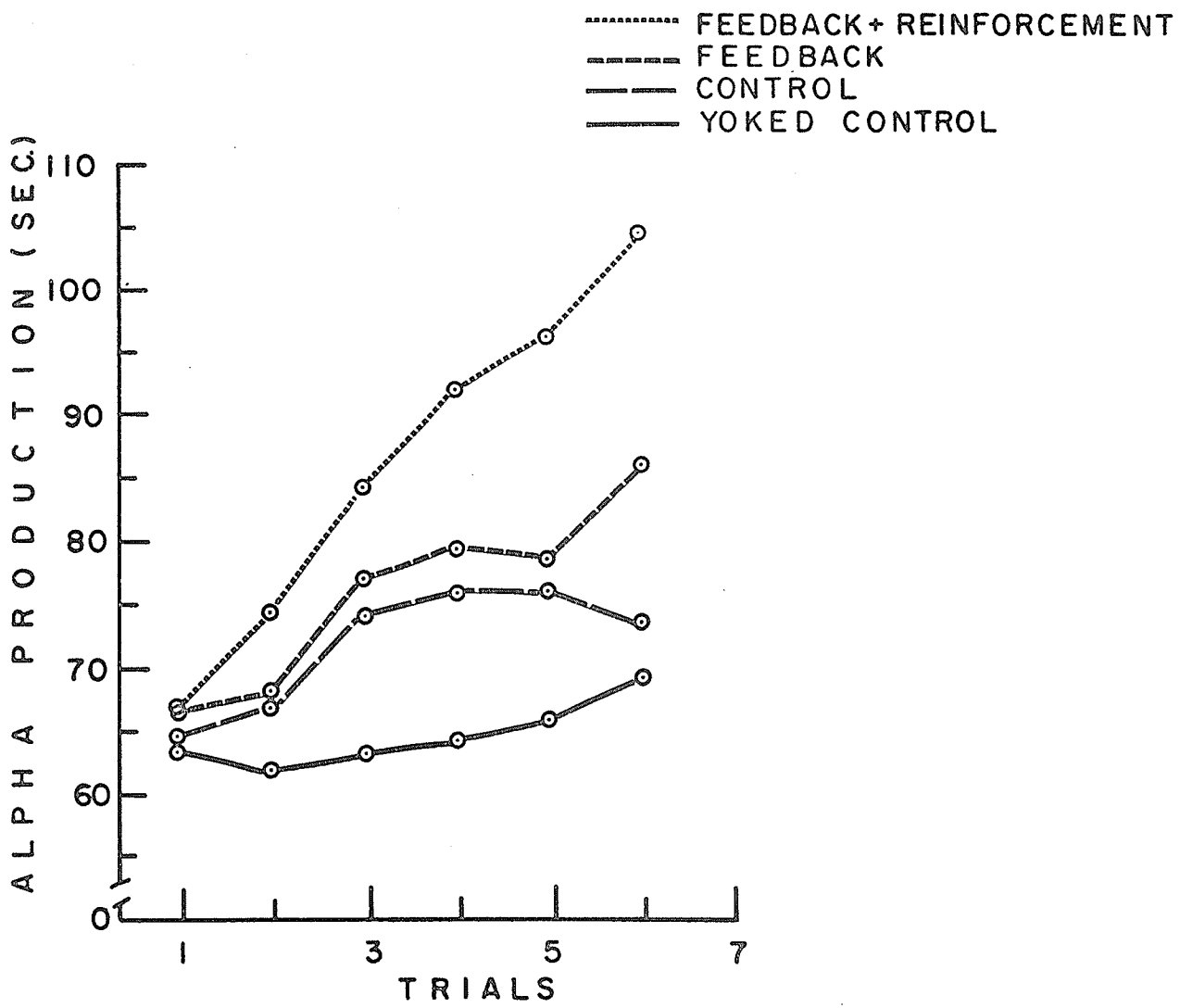
TABLE 4

Analysis of Covariance on the Final Scores: Using the Initial Scores as Covariates

| Source | df | MS | F |
|---|---|---|---|
| Locus of Control (A) | 1 | 2.62 | 0.0 |
| Treatment Conditions (B) | 3 | 3852.49 | 3.80* |
| A x B | 3 | 364.72 | 0.36 |
| Error | 71 | 1014.66 | |

*$p < .025$

MEAN PERFORMANCE ACROSS TRIALS AND ACROSS TREATMENTS:
INTERNALS AND EXTERNALS COMBINED



factorial design. As noted from Table 5 the results are very similar to those presented in Table 3. Once again, a significant trials effect and a significant trials by training effect was found. No significant training effect was found.

Given the fact that no significant training effects but a significant trials by training interaction was found, further analysis was performed to investigate the interaction effect. The simple effects analysis of variance (Kirk, 1968) was used for this purpose. As depicted in Table 6, the results of this analysis indicate that significant treatment effects occurred only at trials 4,5, and 6. In addition, it should be noted that these treatment effects became more apparent (ie. significant) toward the end of training (ie. trial 6). This is also discernible from visual observation of Figure 2.

Post-hoc analysis, utilizing Tukey's Ratio (Kirk, 1968) served to supplement the investigation of treatment effects occurring at trials 4,5 and 6. The results (Table 7) indicate that a significant difference was found between the feedback plus reinforcement and the feedback groups at both trial 5 and trial 6. A further examination of Figure 2 indicated that it was obvious that significant differences would also be found between the feedback plus reinforcement group and both control groups on trials 5 and 6. None of the other group comparisons (ie, feedback versus control, feedback versus yoked control and control versus yoked control) were significant at trials 5 or 6. The significant treatment

TABLE 5

Repeated Measures Analysis of Variance: For Combined Groups and 4 x 6 Mixed Factorial Design

| Source | df | MS | F |
|---|---|---|---|
| Treatment (A) | 3 | 9791.66 | 2.52 |
| Error 1 | 76 | 3886.01 | |
| Trials (B) | 5 | 3767.33 | 27.25** |
| A x B | 15 | 597.78 | 4.32* |
| Error 2 | 380 | 138.26 | |

*$p < .001$
**$p < .0001$

TABLE 6

Test for Simple Effects:
Analysis of Variance Summary Table

| Source | df | MS | F |
|---|---|---|---|
| Between Subjects | | | |
| 1. Between treatments at trial 1 | 3 | 62.89 | .08 |
| 2. Between treatments at trial 2 | 3 | 517.37 | .68 |
| 3. Between treatments at trial 3 | 3 | 1560.34 | 2.05 |
| 4. Between treatments at trial 4 | 3 | 2676.19 | 3.51* |
| 5. Between treatments at trial 5 | 3 | 3153.50 | 4.13** |
| 6. Between treatments at trial 6 | 3 | 4819.49 | 6.32***** |
| Within cell | 456 | 762.88 | |
| Within Subjects | | | |
| 1. Between trials at treatment 1 (feedback + reinforcement) | 5 | 3888.12 | 28.12****** |
| 2. Between trials at treatment 2 (feedback) | 5 | 1007.86 | 7.29***** |
| 3. Between trials at treatment 3 (control) | 5 | 529.68 | 3.83*** |
| 4. Between trials at treatment 4 (yoked control) | 5 | 143.50 | 1.04 |
| Treatments x Trials | 15 | 597.78 | 4.32**** |
| Trials x Subject within groups | 380 | 138.26 | |

*p < .05
**p < .01
***p < .005
****p < .001
*****p < .0005
******p < .0001

TABLE 7

Post-hoc Analysis:
Tukey's Ratio

| Comparison | Trial | q |
|---|---|---|
| Feedback + Reinforcement vs Feedback | 6 | 2.94* |
| Feedback + Reinforcement vs Feedback | 5 | 2.91* |
| Feedback + Reinforcement vs Feedback | 4 | 2.13 |
| Feedback + Reinforcement vs Control | 4 | 2.58 |
| Feedback vs Control | 6 | 1.98 |
| Feedback vs Yoked Control | 6 | 2.66 |
| Feedback vs Yoked Control | 5 | 1.98 |
| Feedback vs Yoked Control | 4 | 2.43 |
| Yoked Control vs Control | 5 | 1.68 |

critical q'=2.83
*$p < .05$

effect occurring at trial 4 was accounted for by the difference in performance between the feedback plus reinforcement group and the yoked control group.

The simple effects analysis of variance also served to analyse the significant trials effect and the significant trials by training interaction. As noted from Table 6, a significant trials effect was found for the feedback plus reinforcement, feedback, and control conditions. The yoked control subjects did not significantly increase their level of alpha production over trials.

In order to further investigate and compare the trials effect across treatments a post-hoc test for the differences between slopes (linear component) was used (Edwards, 1967). The results (Table 8) indicate that the performance slope for the feedback plus reinforcement group was significantly greater than that of the feedback and control groups and obviously (see Figure 2) greater than that of the yoked control group. Furthermore, the performance slope for the feedback condition was significantly steeper than that of the yoked control group. The slopes for the feedback versus control conditions, however, were not significantly different. It is also interesting to note that the difference between the control group and the yoked control group was not significant, when the test for differences in the linear component of the slopes was calculated. Observation of Figure 2, however, suggested that it may not be appropriate to assume linearity in this case. A test for the difference

TABLE 8

Test for Differences Between Slopes:
Post-hoc Comparisons

| Comparison | df | F |
|---|---|---|
| Feedback + Reinforcement vs Feedback | 1,190 | 15.04** |
| Feedback + Reinforcement vs Control | 1,190 | 25.19** |
| Feedback vs Control | 1,190 | 2.31 |
| Feedback vs. Yoked Control | 1,190 | 10.96* |
| Control vs Yoked Control | 1,190 | 1.95 |

*$p < .001$
**$p < .0005$

in curvature of the quadratic component (Edwards, 1967) supported this assumption. The results revealed that there was a significant difference ($F=7.92$; $df=1,190$; $p < .005$) in the curvature of the means between the control and yoked control groups.

Post-Experimental Questionnaire

Chi-square analyses of the subjects' responses to the post-experimental questionnaire (see Appendix B) revealed very little in the way of significant group differences. No differences were found between internals and externals in their responses to any of the questions.

Combining the data for internals and externals and analysing the group performances again, revealed only one difference. A significantly greater number of subjects in the feedback plus reinforcement and the feedback groups ($x^2=8.91$; $df=3$; $p < .05$) felt they had control over the presence and absence of the tone when compared to control and yoked control groups. Further investigation of the data via the analysis of variance per group revealed that a relationship was found between perceived self-control and actual control for only one group. The subjects (internal and externals combined) in the feedback plus reinforcement group who responded in the affirmative to this question, tended to have significantly higher increases in scores ($F = 4.66$; $df = 1,16$; $p < .05$) than those subjects who felt they had no control over the presence or absence of the tone.

The other responses, across internal and external subjects, and across the various treatment groups were remarkably similar. This is especially surprising in view of the strategies that the subjects reported they used to keep the tone on. The major strategies utilized by those subjects (n=50) who felt they had control over the tone were: thinking about something (n=16), concentration (n=16), focusing on an object (n=5), relaxation (n=4), controlling breathing or heart rate (n=3), daydreaming (n=2), moving (n=2) and keeping still (n=2). What is most surprising about these strategies was that they were declared as strategies for all groups. Both yoked control and control subjects, as well as the feedback groups, declared the use of variants of thinking, concentrating, etc. The strategies, then, did not serve to differentiate the groups.

# CHAPTER IV

# DISCUSSION

## Alpha Enhancement

The results of the present experiment constitute several interesting, and in some cases, unexpected findings. Furthermore, the results serve to emphasize and to illustrate the importance of many of the methodological and theoretical problems associated with the literature on alpha control.

Methodological issues. Several of the results of the present research are especially applicable in view of the methodological problems previously discussed in this paper. As may be noted from Figure 2 and the analyses presented in Tables 5 and 6, a significant main effect for trials occurred across all treatment groups, with the exception of the yoked control group. This, in turn, reflected the greater probability of alpha production at the end, as opposed to the beginning of the experimental session. Also of interest is the finding that the feedback group and the control group did not differ in their ability to enhance alpha (see Tables 7 and 8). The feedback group, however, was able to enhance alpha slightly more than did the yoked control subjects (see Table 8). In addition, the difference in curvature of

the means between the control and yoked control group, suggested a difference in performance for these two groups.

These results, for the most part, were unpredicted for it was not expected that the feedback group and the control group would perform in a similar fashion. In addition, it was not expected that the control group would demonstrate an increase in alpha production over trials.

Such unexpected results seriously question the demonstration of alpha enhancement in many experiments, despite the fact that the increasing number of studies suggest that the amount of alpha activity can be either increased or decreased through appropriate feedback conditions (Kamiya, 1968; Green, Green & Walters, 1969, 1970, 1971; Peper & Mulholland, 1970; Brown, 1970; Nowlis & Kamiya, 1970; Beatty, 1971, 1972; Regestein, Pegram, Cook & Bradley, 1973; Beatty & Kornfeld, 1973; Travis, Kondo & Knott, 1973).

A review of the literature relevant to the control of alpha, indicates that very few studies make use of controls. This has occurred in spite of the fact that the use of control groups has been emphasized (eg. Katkin & Murray, 1968; Lynch & Paskewitz, 1971) in order to assess the observed changes in the experimental group. Without such control groups it is impossible to ascertain whether the changes in the treatment group were a result of the training itself, or the result of natural occurances such as habituation to the situation, decrease in anxiety, etc. Alpha control cannot be demonstrated unless the increase and decrease of alpha

production in the feedback group, is significantly greater than the increase or decrease of alpha production occurring with the control group. The results of the present study emphasize this point nicely. If a control group had not been included, the increasing production of alpha across trials would suggest that feedback training was having its effect. Many studies have suggested this conclusion in spite of the absence of control groups (Kamiya, 1968, 1969; Peper, 1970; Peper & Mulholland, 1970; Brown, 1970; Nowlis & Kamiya, 1970; Beatty & Kornfeld, 1972; Nowlis & Wortz, 1973; Paskewitz & Orne, 1973: Travis, Kondo & Knott, 1973). By incorporating a control group, however, the present results indicate that alpha enhancement over and above the control group did not occur with feedback training alone. The results, it should be noted, are in agreement with the conclusions of two previous studies whose limitations have been noted earlier (Hord & Barber, 1971; Regestein, Pegram, Cook & Bradley, 1973). These studies also suggested that there were no significant differences in alpha control between those subjects who received feedback and those who did not receive feedback. These findings suggest that serious caution must be used in interpreting the results of many existing studies which have failed to make use of control groups.

In addition to having implications for the general use of control groups, the present results also provide some evidence for the methodological problem surrounding the use of the yoked control design.

Although there are no published studies of alpha control which have compared feedback and non-contingent feedback groups (yoked controls), Paskewitz, Lynch, Orne and Costello (1970) indicate that they have compared the learning curves of feedback groups in other studies with the learning curves of yoked control subjects. They report that such learning curves are essentially similar. In the present study, however, slope analysis revealed a significantly greater increase in alpha production over trials for the feedback group. Furthermore, the results of the present experiment revealed that there was a significant difference in the curvature of the means between the control and yoked control groups. The difference between the control and yoked control groups was also supported by the fact that the yoked control group was the only group for which a significant trials effect was not obtained. Given the level of significance of the main trials effect ($p < .0001$) this result is particularly interesting. It suggests that some factor or factors were operating to inhibit this group's performance over trials. There are several possibilities.

One possibility is that the yoked feedback may have served to reinforce non production of alpha rhythm. Another is that the yoked control subjects may have become anxious about their inability to control the tone. Anxiety, as noted earlier, has a suppressive effect on alpha production. A third possibility is that the yoked control design established an inherent bias against the control group (Church, 1964;

Katkin & Murray, 1968; Katkin, Murray & Lachman, 1969). Church (1964) originally pointed out that individual reactions to an event, or stimulus, or reinforcer may be enough to favor the experimental group over its yoked controls. For example, if one considers the feedback tone in the present study to be only effective or ineffective (eg. contributing to motivation, relaxation, etc.), there are four possible ways in which an experimental and yoked control subject may be paired in terms of differences in the effectiveness of the tone. In one case the tone may be effective for both subjects. In another case it may be ineffective for both subjects. In both of the cases the reinforcer (tone) induces an equal level of motivation (or relaxation, etc.). There is no biasing effect. In another case the tone may be effective for the experimental subject but ineffective for the yoked-control. Since in this case it is expected that the reinforcer induces a greater level of motivation,etc., there is a biasing effect in favor of the experimental subject. He would be expected to produce a greater number of alpha responses. In the last case, the tone may be ineffective for the experimental subject, but effective for the yoked subject. Although in this case, one would expect a bias in favor of the yoked control subject, this is not the case, as the reinforcer is ineffective for the experimental subject and consequently he will make few responses. Since the reinforcements which the yoked subject receives are contingent upon the behavior of the experimental subject,

the yoked subject will be prevented from being exposed to a situation which is effective for inducing motivation (etc.) for him.

Such individual differences in response to the feedback tone may, in part, have accounted for differences between the control and yoked control conditions and the feedback and yoked control conditions in the present experiment.

Another outcome of the present study serves to introduce a third methodological issue. The finding that all treatment groups (excluding the yoked control group) significantly enhanced their level of alpha production across trials illustrates the baseline problems associated with alpha conditioning.

A review of the literature indicates that the effects of feedback training have usually been demonstrated in one of three ways: by comparison to an initial baseline, by comparison to frequent baseline measures taken throughout the training procedure, and by comparison of "alpha on" to "alpha off" conditions. As has been noted earlier in this paper, all of these methods contain inherent methodological shortcomings. The present research serves to illustrate the problems of comparing the effects of training to an initial baseline.

As has also been noted earlier, such a baseline may be contaminated by initial apprehensions about the experiment, the novelty of the situation, etc. Any measure taken during

the course of training may result simply from a decrease in the effect of such factors rather than from the training procedure itself (Lynch & Paskewitz, 1970; Paskewitz & Orne, 1973). The increasing trials effect found for the control group in the present research provides support for this hypothesis. Consequently, it seems reasonable to conclude that the increase in alpha production across trials for the feedback group, the control group, and to some extent, for the feedback plus reinforcement group, may have resulted from the dissipation of initial anxiety or apprehension. The fact that almost one-half of the subjects reported feeling anxious initially lends support to such a conclusion. Paskewitz and Orne (1973), however, suggest another possible reason. In a series of studies designed to investigate alpha enhancement with auditory feedback, they found that subjects under conditions of dim ambient illumination were able to systematically increase their level of alpha production. In total darkness, however, the subjects, given the same procedure, were not able to significantly enhance their alpha levels. They concluded that the light allowed the subjects to engage in visual scanning which in turn had an initial suppressive effect on alpha production. In addition, they concluded that alpha feedback training can lead to significant changes in alpha production only when the conditions have lowered alpha densities below the level occurring under optimal (eyes-closed) conditions. Anxiety, apprehension, and visual scanning may all have this initial suppressive effect.

Although dim lighting was used in the present research, it does not seem feasible to conclude that visual scanning was responsible for any initial suppressive effect. In the present experiment, all subjects were instructed to refrain from moving their eyes (ie. as would occur in visual scanning). Furthermore, eye movements were continually monitored. No subjects were eliminated on the basis of excessive eye movements at any point in the experiment. Consequently, the increase in alpha production across trials for the feedback and control group, and in part for the feedback plus reinforcement group, may most likely have occurred as a result of a decrease in anxiety, apprehension, etc. The fact that the yoked control group did not demonstrate such an enhancement effect, again supports the hypothesis that some factor (eg. the inherent bias associated with the yoked control design) may have been operating to prevent this increase.

Such conclusions point out the possibility of baseline problems contaminating the results of many studies which have relied on an initial baseline measure and have not used control groups (eg. Brown, 1970; Nowlis & Kamiya, 1970; Peper, 1970). The use of a control group provides a solution to the problem in that it allows one to separate the effects of training from the effects of dissipation of initial anxiety, visual scanning, etc. Although it may be possible to eliminate these effects (eg. anxiety or visual

scanning) by specific techniques (eg. extended pre-baseline rest period, or by conducting the procedure in darkness), the use of a control group remains paramount. It is always possible that there may be other contaminants, the presence of which may be detected by employing a control group.

Feedback issues. Another interesting result which emerged from the present experiment involved the differences between treatment groups. As evidenced from the analysis of slopes of the mean performances of the four treatment groups (Table 8), the slope for the feedback plus reinforcement group's performance was significantly steeper than that of any other group. Of the significant treatment effects that emerged in the last three trials, those occurring on trials 5 and 6 were in part accounted for by significant differences between the feedback and feedback plus reinforcement conditions (see Table 7). Consequently, the group receiving an additional extrinsic reward in the form of one dollar or one additional hour of experimental credit demonstrated a significantly greater increase in alpha production on trials 5 and 6 than did any other group. Since this group's performance was superior to either control conditions on those same trials, it was the only group for which training can most confidently be said to have been truly effective. Feedback alone was not sufficient to produce a desired enhancement effect vis-a-vis the control group.

Thus, these results seriously question the status of

feedback as a sufficient reinforcing stimulus for alpha enhancement. Consequently, they serve to introduce the major theoretical issue discussed earlier. Peper and Mulholland, as noted earlier, particularly question the status of feedback as a reinforcer. In view of the fact that there was no definite criterion for the level of motivation in their own, or other experiments they reviewed, Peper and Mulholland concluded that the status of feedback as a reinforcer was ambiguous. In addition, they concluded that it was not clear whether feedback was of informational value, reinforcing value, or both. In order to compare the effects of feedback to that of a reinforcer, they suggested that future research should make use of an additional reward to accompany feedback, partial reinforcement, and extinction procedures.

While the present experiment did not incorporate all of Peper and Mulholland's suggestions, it did incorporate the initial one. As was noted earlier, the use of an additional reward was necessary to produce the desired enhancement effect; feedback by itself was not sufficient for such a demonstration of learning to occur. Other experimenters have also made use of an additional reinforcer. Beatty(1971, 1972) and Beatty and Kornfeld (1972) offered feedback plus an additional extrinsic reinforcer (extra hour of experimental credit), if their subjects were able to double their production of alpha or beta waves on demand. Unfortunately, since this group was not compared to a group receiving feedback alone, it is not possible to assess the effects of the

additional reinforcer. It should be noted, however, that the two studies that utilized controls demonstrated quite reliable and reasonably large training effects when compared to yoked controls (Beatty, 1971) and controls (Beatty, 1972), in spite of their short training periods. This, it is felt, may provide some evidence for the effect of the additional reward.

Only one study (Regestein, Pegram, Cook & Bradley, 1973) reported in the literature attempted to compare feedback and feedback plus reinforcement conditions. As was noted earlier, however, this study failed to report any comparisons of these groups in their results. They only stated in their discussion that it apparently made no difference whether or not their subjects received the additional monetary reward for producing alpha. It should also be noted that the subjects for this study of extended feedback conditions (5 hours) were all volunteers. On this basis alone, it might be assumed that the additional extrinsic reinforcer would add little to the motivation of this group.

In spite of the fact that feedback was not sufficient to produce the desired effect in the present experiment, it may still constitute a sufficient reinforcer in other situations. The major factor which appears to differentiate reinforcement from other feedback tends to lie in its motivational value to the subject. Gaarder (1971) noted that in typical feedback situations the information is usually presented to the subject in the neutral form of a dial, tone,

or other display. In operant conditioning, on the other hand, the information is usually presented to the subject in the form of a compelling reward or punishment. Gaarder contends that although it may be true that the subject in the ordinary feedback experiment may be influenced either by his own motivation to succeed at the task or by approval from the experimenter, these influences lack the compelling quality of an electrical shock or food for the hungry subject.

Other experimenters (eg. Miller, 1969; Shapiro & Schwartz, 1972; Schwartz, 1973) suggest that feedback may be all that is necessary for controlling the function in question. This, they state, is especially applicable when producing a state which may be in itself rewarding, such as has been reported for alpha enhancement (Kamiya, 1969). They suggest, however, that as the novelty of the situation wears off, additional rewards (eg. money) seem to be necessary.

In summary, the major difference between reinforcement and feedback tends to be with the assumptions of motivation. It cannot be assumed that feedback will necessarily be reinforcing for everyone. Using an extrinsic reinforcer, such as money, in addition to the feedback, involves making fewer of these assumptions. It seems reasonable to assume that in some of the studies reported in the literature, feedback did function as a reinforcer. Peper and Mulholland's (1970) suggestion that a reinforcer (eg. money) be scheduled in addition to feedback, may not be necessary. The present experiment and the research presented, however, suggest that

the use of such an additional reward may contribute to the overall strength of the reinforcer and consequently enhance the desired effect.

Conclusions: Alpha enhancement. The results of the present research have illustrated and, in some cases, assessed some prominent theoretical and methodological problems associated with alpha conditioning. Above all, the present results have demonstrated both the need for and the utility of the inclusion of control groups. Since control groups were used in this study, it was possible to demonstrate that feedback alone was not sufficient to account for alpha enhancement. Similarly, it was possible to illustrate that the addition of an extrinsic reinforcer to the feedback procedure was necessary for alpha enhancement to occur toward the end of training. Finally, the present research serves to illustrate the problems associated with using the initial baseline for comparison with later performance. The use of control groups made it possible to assess the effect of baseline contaminants when an initial baseline was used . Similarly it is felt, that the use of control groups are not only useful, but also necessary for demonstrating the effect of alpha training when using reversals.

## Locus of Control

One of the most obvious conclusions of the present study is that internals and externals did not differ in their performance across treatments or trials (Table 3 and

Figure 1). Consequently, all of the hypotheses based upon predicted differences received no support. Although internals and externals in the control groups and in the feedback plus reinforcement groups were not expected to differ (and did not differ) in their performance, they were predicted to perform differentially on their original baseline measure and in the feedback condition. As may be noted from the results presented in table 2, however, internals did not have a higher initial level of alpha activity than externals. This suggests several possibilities. One possibility is that initial anxiety may have been minimal or absent. In this case, internals and externals would not be expected to perform differently. Indeed, this point is relevant to the present study as measures were taken to reduce the subjects' initial anxiety by providing them with a four minute rest period prior to taking baseline measures, and providing them initially with a general explanation of the setting and the procedure. This may have accounted for the fact that less than half (34) of the subjects reported feeling anxious initially. Of these 34 subjects, 17 were internals and 17 were externals. This, in turn, may suggest that the above procedure was more effective for externals than internals, or that internals and externals may have reacted to this situation in an equally anxious way. The results also indicate that internals and externals performed in a similar way when given feedback alone. These unexpected findings require an examination of the theory and measurement of locus of control.

Theoretical considerations. According to social learning theory (Rotter, 1954, 1966, 1967; Levy, 1970; Rotter, Chance & Phares, 1972) expectancy is the probability held by the individual that a particular reinforcement, or group of reinforcements will occur in any given situation or situations. Expectancy is considered to be a function of an individual's past history of reinforcement in a given situation and generalized expectancies from other situations perceived as similar by the individual. In Rotter's theory, such generalized expectancies account for transfer of learning from one situation to another, and, at the same time, account for stability in a given individual's behavior across situations (Rotter, 1967). Although such generalized expectancies have been deemed as functionally similar to generalized traits (eg. Mischel, 1973), they differ from traits because they rely upon an individual's perception of a given situation and its similarity to previously experienced situations. Generalized expectancies may also be conceived as different from traits because it is felt that the relevance of expectancies to a situation varies inversely with the amount of experience an individual has in a given situation (Levy, 1970). Consequently, an individual's behavior will be guided less in a given situation by generalized expectancies from other situations, as his exposure to that given situation increases and he develops expectancies specific to that given situation. This point has been well illustrated in a study by Mischel and Staub (1965) which examined

some of the conditions determining the interaction of situations and individual differences in expectancies. The results of their experiment demonstrated that presituational expectancies significantly affected choice behavior in the absence of situational information concerning the outcome of their behavior. However, when the subjects were exposed to new information regarding behavior-outcome relations specific to that situation (ie. success or failure), the highly specific situational expectancies quickly became more dominant influences on their behavior.

Other authors have also emphasized the effect that situations may have on locus of control orientations. It has been noted (eg. Rotter, 1954; Levy, 1970) that although expectancies for locus of control of reinforcement are conceived of as generalized and relatively stable, they may vary in their effect from one situation to another. These situational effects may depend upon a variety of factors. In some cases, it is possible for these situational effects to override the effects of individual locus of control expectancies. Rotter, for example, suggests that highly structured academic situations may override the effects of individual expectancies. If things are so clearly defined in terms of what must be done to obtain a specific grade, even an externally oriented subject might realize that chance plays a small role in determining his grade. Similarly it is possible for an internal individual to experience a certain situation in which he feels the outcome is beyond

his control (eg. Gorman, 1968; McArthur, 1970). This latter point may be relevant to the present experiment. Evidence for this hypothesis is provided by the post-experimental questionnaire. Although approximately three quarters (28 of 40) of the subjects in the feedback and feedback plus reinforcement groups (who were told that their task was to increase the amount of alpha present) stated that they felt they had some control over the tone, an equal number of internal and external individuals responded in the affirmative to this question. This finding particularly suggests that the situational effects may have overridden the effects of individual locus of control expectancies.

Measurement considerations. The I-E scale (Rotter, 1966) is not without its limitations. For example, it has been noted (eg. Coan, 1966) that the I-E scale samples from and favors items dealing with social and political events. Coan (1966) suggests that since the I-E scale does not sample items regarding personal habits, traits, goals and other interpersonal and intrapersonal concerns, it does not tap all major aspects of personal control. Consequently, the range of applicability has been restricted (Crandall, Katkovsky & Crandall, 1965; Coan, 1966; Dies, 1968). Coan (1966) and Sarason and Smith (1971) have further suggested that the scale could be improved if research was to concentrate on the development of situation-specific I-E measures (eg. social, academic, experimental), so that the strength of a

given expectancy may be expressed, not in absolute terms, but in relation to the strength of other expectancies. Indeed, it has been such limitations that has spurred some researchers (eg. Crandall, Katkovsky & Crandall, 1965) to develop other I-E scales which sample from specific situations (eg. intellectual-academic achievement situations).

The results of several most recent studies tend to support this line of reasoning. Although the I-E scale was designed to measure generalized expectancies regarding locus of control, those studies investigating the factor structure of the scale indicate that the assumption of unidimensionality is no longer tenable (Joe & Jahn, 1973; Kleiber, Veldman & Menaker, 1973; Reid & Ware, 1973, 1974; Collins, 1974). The results of these studies in combination with many previously mentioned (eg. Gurin, Gurin, Lao & Beattie, 1969; Lao, 1970; Mirel, 1970; Abrahamson, Schludermann & Schludermann, 1973) seriously suggest that the I-E scale is not a very generalizable unidimensional measure, but rather it is a much more complex scale dealing with a multidimensional construct, which is perhaps more relevant to specific situations. Such serious criticisms of the I-E scale have direct connotations for the results of the present study. It may be precisely because the scale does not sample items of relevance (eg. self-control) that its application to the present study was inappropriate. Although it would be possible to develop such a scale, the fact remains that, in its present form, the I-E scale may not be useful for predicting

self-control.

Of particular relevance to the present paper is the study by Reid and Ware (1974) which questions the use of Rotter's scale to predict self-control behavior. They note that although a number of I-E studies introduce the concept of self-control of impulses, desires, emotional behavior, etc. (eg. Straits & Sechrest, 1963; James, Woodruff & Werner, 1965; Keutzer, 1968; Williams & Nickels, 1969; Goss & Morosko, 1970; Berzins & Ross, 1973), an inspection of the items on the Rotter I-E scale indicate that none of them are directly worded in terms of self-control. This, they felt, may account for some of the inconsistent results in this area. In addition, they note, that although Rotter (1966) suggests that the feeling one has about controlling his environment may be related to a feeling he can control himself, Rotter's theory does not predict that internals would have a strong belief in self-control. In order to test out such assumptions Reid and Ware (1974) designed a study to determine whether self-control was part of the present two-factor structure of the I-E scale (fatalism--luck, fate or chance and social system control--social-political influence) or whether self-control added an additional dimension. In order to do so they developed a scale which additionally sampled from areas of self-control.

The results of their study indicated that belief in self-control differed from both belief in chance and expectations of control by social-political forces. Essentially,

this signifies that an individual may be very external on both fatalism and social system control, and at the same time, retain a strong internal sense of self-control.

Reid and Ware's results have direct application to the present study. It may be concluded that since Rotter's scale measures fatalism and social system control rather than self-control, the use of this scale to predict self-control behavior is not profitable. The use of a scale which would sample items from the area of self-control, such as impulses, emotions, and especially internal physiological events, would be particularly applicable to the present study. Such items, it is felt, might allow one to fruitfully predict behavior involving biofeedback training.

Conclusions: Locus of control. In summary, it has been suggested that the predicted differences between internals and externals were not obtained because the situational effects may have overridden the effects of individual locus of control expectancies. Furthermore, it was concluded that the present form of the I-E scale may not be appropriate for predicting behavior involved in biofeedback training. The development of an appropriate scale, which would sample items relevant to self-control and internal physiological events, it is felt, would enhance the predictive validity of the I-E dimension and serve as a more appropriate test of the present hypotheses. Perhaps one of the most appropriate overall measures of I-E would utilize multiple

regression predictions based on a series of reliable subscales, each of which are homogeneous and situation specific (Reid and Ware, 1973). Such a regression model would allow an investigator to calculate scores on each factor separately and establish a multiple regression prediction of criterion scores. Those factors which were particularly useful in predicting the criterion score could then be ascertained (by examining the regression weights). Reid and Ware (1973) and Sarason and Smith (1970) suggest that the use of such a model would enhance predictive validity of the I-E dimension as well as encourage further investigations of the more complex aspects of the I-E construct.

Post-Experimental Questionnaire

Although the subjects' responses to the post-experimental questionnaire were similar when internals were compared to externals, some interesting results emerged when the data was combined for internals and externals. It was found that a significantly greater number of subjects in the feedback and feedback plus reinforcement groups felt they had control over the presence and absence of the tone, when compared to control and yoked control groups. This result, it should be noted, makes sense in view of the initial instructions given to the groups and in view of the demonstrated alpha enhancement effect for the feedback plus reinforcement group. It is also interesting to note that only for the feedback plus reinforcement group was the relation-

ship between self-reported self-control and actual control significant. Again, this makes sense, in view of the fact that this group had the largest alpha enhancement effect.

What is a most surprising result, however, was found when examining the major strategies utilized by those subjects who felt they had control over the tone. Both yoked control and control groups, as well as the feedback groups declared the use of the same strategies. The specific strategies used by the subjects (eg. variants of thinking, concentrating, daydreaming, visual focusing) are those most often declared by other researchers (eg. Kamiya, 1968, 1960; Nowlis & Kamiya, 1970; Brown, 1970; Nowlis & Wortz, 1973) as strategies reported after successful alpha control. What is most interesting in the present experiment is that the subjects in both control groups also reported the use of such strategies. As Kamiya (1969) has noted, however, the area of alpha control may be particularly susceptible to superstitious learning that tends to occur when subjects attend to the tone and take note of their behavior. The results of the present experiment suggest that this may indeed be the case. The implications are that those studies reporting that their subjects utilized specific strategies must not be accepted readily. This is especially the case when such strategies have not been compared to those of a control group, as in the preceding studies (Kamiya, 1968, 1969; Nowlis & Kamiya, 1970; Brown, 1970, Nowlis & Wortz, 1973).

Conclusions

The results of this study suggest several conclusions.

1. The use of feedback alone cannot necessarily be assumed to be sufficient to account for alpha enhancement. The addition of an extrinsic reinforcer to the feedback procedure, in the present study, was necessary for alpha enhancement to occur. Consequently, feedback alone cannot necessarily be assumed to be reinforcing for everyone. However, utilizing an extrinsic reinforcer in addition to the feedback involved making fewer assumptions of reinforcing or motivational value.

2. Only the inclusion of control conditions made it possible to assess the effect of baseline contaminants associated with using an initial baseline for comparison with later performance. The enhancement effect that occurred for subjects under the feedback condition also occurred for control subjects. Consequently, the use of a control condition made it possible to separate the effects of training from the effects of dissipation of initial anxiety, apprehension, etc. and made it possible to conclude that the desired alpha enhancement effect occurred only for the feedback plus reinforcement condition.

3. Internals and externals did not differ in their performance across treatments or across trials. It was suggested that the predicted differences in internals and externals were not obtained because of the limitations of the present form of the I-E scale (Rotter, 1966) for predicting

behavior involved in biofeedback training. It was concluded that the development of another scale which would sample items relevant to self-control and physiological functioning might enhance the predictive validity of the I-E dimension and serve as a more appropriate test of the present hypotheses.

4. This study also has many implications for past and future research. Since this study served to illustrate and assess several methodological problems associated with the alpha control literature (eg. baseline problems, lack of controls), it must be conluded that the results of the bulk of existing literature must be interpreted with great caution. Chiefly because control groups have not been used in most of the research in this area, it is not possible to clearly assess whether or not alpha control was illustrated.

This study also has implications for future research. Above all, it is absolutely necessary that the results of the present study be replicated, especially in view of the fact that it has serious implications for both past and future research. It should be replicated in all aspects and extended to include an I-E measure which would include items relevant to self-control and physiological functioning. In addition, it should be extended over time so as to include a longer training session and allow for a more reliable test of the effects of various treatments. Such an extension would make it possible to determine if the trend of the various treatments used in this experiment continued over time.

Other implications for future research primarily involve the use of control groups to accurately assess the effect of the training procedure.

# CHAPTER V

## SUMMARY

The present study was designed to investigate the effects of feedback, reward, and locus of control on the facilitation of alpha production through a biofeedback training procedure. Predictions were based on a review of the respective literatures which suggested that alpha activity was suppressed by anxiety, externals tend to report and reveal more anxiety in their performance, and internals tend to be more motivated to control themselves. Consequently, it was hypothesized that internals would have a higher initial baseline level of alpha activity than externals. Also, since they were more motivated to control themselves, internals would demonstrate a greater increase in their alpha wave production when given auditory feedback indicating the level of alpha activity. In addition, it was suggested that an additional reward would provide an external source of motivation which would allow externals to increase alpha production over and above the level obtained when given feedback alone. Under the combined conditions, internals and externals were not expected to differ.

On the basis of the Rotter's (1966) locus of control scale, 40 internals and 40 externals were assigned to a

2x4x6 mixed factorial design with 10 subjects in each cell. The design consisted of two between subject variables of internal and external locus of control; four treatment conditions (feedback, feedback plus reinforcement, yoked control, and control); and the within subjects variable of six trials. Under the feedback condition, an auditory stimulus accompanied the presence of alpha. Under the feedback plus reinforcement condition, the subjects were additionally offered a reward (the choice of one dollar or one extra hour of experimental credit) which they received if they were able to increase their alpha production one and one-half times their original baseline level. A yoked control, which received non-contingent feedback, and a no-feedback control group were also used.

The obtained results did not support the predicted differences between internals and externals regarding alpha production. They did not differ in their performance across treatments or across trials. It was suggested that the predicted differences were not obtained because the locus of control scale did not sample items relevant to self-control and physiological functioning.

The results also indicated that all the groups, with the exception of the yoked control group, significantly enhanced their level of alpha production across trials. Only the group receiving the additional reinforcement, however, demonstrated a significantly greater degree of alpha facilitation vis-a-vis the control groups. Consequently, it was

concluded that feedback alone cannot necessarily be assumed to be sufficient to account for alpha enhancement as it may not be reinforcing for everyone. Using an additional extrinsic reinforcer (eg. money) involved making fewer assumptions of reinforcing or motivational value. It was concluded that the use of a control condition made it possible to separate the effects of training from the effects of dissipation of initial anxiety, apprehension, etc. and made it possible to demonstrate that the desired enhancement effect occurred only for the feedback plus reinforcement condition.

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# APPENDIX A

## ROTTER I-E SCALE

# SOCIAL OPINION SURVEY

Note: The external responses are underlined. The IE score is the number of underlined items chosen.

Please select the one statement in each pair of statements which you more strongly believe to be the case (as far as you personally are concerned). Be sure to select the one YOU BELIEVE TO BE CLOSER TO THE TRUTH rather than the one you think you should choose or the one you would like to be true. This is a measure of personal belief: obviously there are no right or wrong answers. (Remember, mark one and only one statement in each pair).

USE IBM SHEET: #1 = a
#2 = b

I more strongly believe that:

1. a. Children get into trouble because their parents punish them too much.

   b. The trouble with most children nowadays is that their parents are too easy with them.

2. a. Many of the unhappy things in people's lives are partly due to bad luck.

   b. People's misfortunes result from the mistake they make.

3. a. One of the major reasons why we have wars is because people don't take enough interest in politics.

   b. There will always be wars, no matter how hard people try to prevent them.

4. a. In the long run people get the respect they deserve in this world.

   b. Unfortunately, an individual's worth often passes unrecognized no matter how hard he tries.

5. a. The idea that teachers are unfair to students is nonsense.

   b. Most students don't realize the extent to which their grades are influenced by accidental happenings.

6. a. Without the right breaks one cannot be an effective leader.

   b. Capable people who fail to become leaders have not taken advantage of their opportunities.

7. a. No matter how hard you try some people just don't like you.

   b. People who can't get others to like them don't understand how to get along with others.

8. a. Heredity plays the major role in determining one's personality.

   b. It is one's experiences in life which determine what they're like.

9. a. I have often found that what is going to happen will happen.

   b. Trusting to fate has never turned out as well for me as making a decision to take a definite course of action.

10. a. In the case of the well prepared student, there is rarely, if ever, such a thing as an unfair test.

    b. Many times exam questions tend to be so unrelated to course work, that studying really is useless.

11. a. Becoming a success is a matter of hard work, luck has little or nothing to do with it.

    b. Getting a good job depends mainly on being in the right place at the right time.

12. a. The average citizen can have an influence in government decisions.

    b. This world is run by the few people in power, and there is not much the little guy can do about it.

13. a. When I make plans, I am almost certain that I can make them work.

    b. It is not always wise to plan too far ahead because many things turn out to be a matter of good or bad fortune anyhow.

14. a. There are certain people who are just no good.

    b. There is some good in everybody.

15. a. In my case, getting what I want has little or nothing to do with luck.

    b. Many times we might just as well decide what to do by flipping a coin.

16. a. Who gets to be the boss often depends on who was lucky enough to be in the right place first.

    b. Getting people to do the right thing depends upon ability, luck has little or nothing to do with it.

17. a. As far as world affairs are concerned, most of us are the victims of forces we can neither understand nor control.

    b. By taking an active part in political and social affairs the people can control world events.

18. a. Most people don't realize the extent to which their lives are controlled by accidental happenings.

    b. There really is no such thing as "luck".

19. a. One should always be willing to admit his mistakes.

    b. It is usually best to cover up one's mistakes.

20. a. It is hard to know whether or not a person really likes you.

    b. How many friends you have depends upon how nice a person you are.

21. a. In the long run, the bad things that happen to us are balanced by the good ones.

    b. Most misfortunes are the result of lack of ability, ignorance, laziness or all three.

22. a. With enough effort we can wipe out political corruption.

    b. It is difficult for people to have much control over the things politicians do in office.

23. a. Sometimes I can't understand how teachers arrive at the grades they give.

    b. There is a direct connection between how hard I study and the grades I get.

24. a. A good leader expects people to decide for themselves what they should do.

    b. A good leader makes it clear to everybody what their jobs are.

25. a. Many times I feel that I have little influence over the things that happen to me.

    b. It is impossible for me to believe that chance or luck plays an important role in my life.

26. a. People are lonely because they don't try to be friendly.

    b. There's not much use in trying too hard to please people, if they like you, they like you.

27. a. There is too much emphasis on athletics in high school.

    b. Team sports are an excellent way to build character.

28. a. What happens to me is my own doing.

    b. Sometimes I feel that I don't have enough control over the direction my life is taking.

29. a. Most of the time I can't understand why politicians behave the way they do.

    b. In the long run, the people are responsible for bad government on a national as well as on a local level.

# APPENDIX B

# POST-EXPERIMENTAL QUESTIONNAIRE

POST-EXPERIMENTAL QUESTIONNAIRE

1. What did you feel this study was about? Please explain:

_____

_____

_____

2. Did you experience any particular feeling while the tone was on? YES _____ NO _____.

   If so, how would you describe it? _____

_____

3. Did you feel you had any influence over the presence or absence of the tone? YES _____ NO _____

   If so, how did you feel you could influence it?

   a. _____

   b. _____

   c. _____

4. Did you feel you had any incentive or incentives to participate in this experiment? YES _____ NO _____

   If so, what motivated you to participate in this experiment? Please rank in order of importance with (a) being most important:

   a. _____

   b. _____

   c. _____

5. Did you feel you were fairly treated in this experiment?
   YES _____ NO _____

6. Were you frustrated by this experiment?
   YES _____ NO _____

7. Did you feel anxious at any time during this experiment?
YES _____ NO _____

If yes, when?

a. initially _____

b. throughout _____

c. other _____