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INDIVIDUAL DIFFERENCES IN SUBJECTIVE EXPERIENCE

AND TASK SUCCESS DURING EEG-ALPHA FEEDBACK

by

LAURENCE R. LEWIS

A dissertation submitted to the Graduate Faculty in Psychology in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York.

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Abstract

INDIVIDUAL DIFFERENCES IN SUBJECTIVE EXPERIENCE AND TASK SUCCESS DURING EEG-ALPHA FEEDBACK

by

LAURENCE R. LEWIS

Adviser: Professor Gertrude Schmeidler

Fifty adults (26 M, 24 F; ages, 18 - 56) volunteered without pay for an alpha feedback experiment. No _Ss_ were excluded because of low alpha levels. From the occipital EEG were derived measures of alpha blocking, alpha variability and amount of feedback change in alpha (i.e., task success). These EEG measures underwent regression residual transformation to remove variance associated with individual differences in mean alpha level. Non-EEG measures were derived from the _16 PF_, from subjective reports of feedback experience and from Mood Adjective Check List ratings of changes in feeling state during feedback. Various inter-correlations among these EEG and Non-EEG variables were predicted on the basis of a new theory, namely, that alpha is associated with primary process thinking, beta with secondary process and that the alternation between the two types of activity is under homeostatic control.

Median split of the subjects into low and high alpha sub-groups revealed that correlations were typically opposite in direction in each sub-group whenever significant effects were present, that is, the effects were curvilinear over the group as a whole. The contrasting high alpha-low alpha correlations appeared to reflect processes functioning to keep alpha parameters at mid-range levels, and this supported the homeostatic part of the theory.

There was no hard evidence to support the other part of the theory, namely, the relationship between alpha and primary process thinking. Although the significant findings agreed with this hypothesis, these results were relatively few in number and could be interpreted in other ways. It was concluded that the theory might have merit, but that the design was too simple to deal with the complex and curvilinear interactions that appeared to be involved. The study's main contribution seemed to lie in the clarification of methodological problems related to these difficulties such as the problem of measuring alpha change. The usefulness of the regression transformation in scaling change scores was demonstrated, and certain contradictions in the alpha feedback literature were resolved. Alternative approaches to methodological problems that remain were discussed.

The markedly skewed distributions of many alpha and 16PF variables suggested that feedback volunteers come from a special population characterized by tendencies to give focussed attention to impersonal details in the external world rather than give relaxed attention to a spontaneous flow of internal feelings and fantasies.

High uniformity among Ss in amount of feedback alpha increase (after transformation of scores) indicated that feedback increases were largely determined by autonomous regulatory processes rather than by learned voluntary control. Some Ss primarily reported that alpha was associated with fantasizing; others, that it was associated with relaxation of attention. While these reports of experimental associates of the occurrence of alpha seemed valid, Ss' additional reports that they were causing the observed increases in average alpha level by persisting in the types of experience that seemed favorable to alpha appeared to be largely a matter of superstitious belief. Ss could exert some short term influence on alpha production; but such influence was not constant. Long term voluntary influence was minimal relative to other factors determining average alpha level.

Findings involving the fantasizing vs. relaxation experiential differences could be parsimoniously interpreted to depend on differences in the actual feedback Ss received. For example, Ss who were high in alpha blocking may have tended to be "relaxers" rather than "fantasizers" simply because of the salience of blocking effects in their alpha feedback. However, reasons were discussed for continuing to entertain the idea that both high alpha blocking and feedback "mind-blanking" reflect personality tendencies to avoid primary process thinking.

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Shelley Edelman has been a pleasing helper at road's end, efficiently and expertly typing the final draft with a sharp eye for my mistakes.

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CHAPTER I

PROBLEM

This research proposes and tests a new theory to explain the significance of the alternation between alpha and beta activity in the EEG. To the eye, this alternation is by far the single, most salient characteristic of the normal, waking, adult EEG. Bursts of high amplitude, smooth sinusoidal alpha waves, having a fairly steady frequency, alternate with stretches of low amplitude, irregular beta waves that look like noise. Although intermixing of the two types of wave activity occurs, there is a striking tendency for the EEG to shift quite rapidly from periods of predominance of one to the other. These sudden gross changes in the recording would seem to reflect changes in physiological function that are similarly gross.

The record of neuro-electric activity derived from an electrode on the scalp, with bone and tissue between it and the brain, can only detect summed potentials from areas of the brain; the recording technique is gross to begin with. Moreover, although alpha bursts do not occur with exact simultaneity in all areas of the brain and are present more in the rear of the head than the front, there is often a tendency towards approximate concurrence of bursts. Thus both the sheer size of the crudely recorded changes that constitute the alpha-beta alternation and the tendency for the alternation to have global pattern over different recording sites support the idea that the alternation has widespread physiological significance. Hence, it has been customary in alpha research to record only over the occipital cortex, where alpha is most present, yet speak of findings as if they referred to the brain in general. The practice is questionable, but will be continued here. Unless stated otherwise, the reader is to assume that all discussion herein refers to occipital recording.

If the alpha-beta alternation does reflect a fundamental process, grossly changing brain function, what is it all about? Commonly, it has been held that the alternation reflects fluctuations in arousal of the cortex. This idea has been largely based on the alpha blocking response. Ordinarily, the switches between alpha and beta occur with apparent, erratic spontaneity. The successive durations of each type of activity vary widely and irregularly although alpha bursts longer than a few seconds are relatively rare.

However, stimulation during an alpha burst usually causes a fairly immediate switch to beta activity. This blocking of alpha is thought to reflect cortical activity provoked by the stimulus. Alpha is associated with states of low cortical arousal, beta with high arousal. The stimulus initiates mental activity, this activation being reflected in the switch from alpha to beta.

A number of specific research findings raise questions about this interpretation, but it can also be generally criticized. Although it does seem to explain the simple alpha blocking response, what are we to think of all the other switches between alpha and beta that continuously and spontaneously occur? Are large portions of the cortex repeatedly fluctuating between states of relative idleness and high arousal? This is not likely. There is every reason to suppose that a variety of information processing in the brain continues without interruption in order to maintain the continuity and coherence of behavior. A flash of light (a typical stimulus that elicits alpha blocking) undoubtedly arouses some cortical activity, but it is difficult to believe that so simple a stimulus would appreciably alter the general amount of ongoing brain activity.

What it may do, however, is increase a type of mental activity that is oriented to the external world, reducing at the same time a type which is oriented to inner personal needs, feelings and memories. In short, the theory proposed here holds that the alpha blocking response represents a shift from primary to secondary process thinking (to borrow Freud's terminology); and that the alpha-beta alternation in general manifests shifts between these two modes of information processing.

What Freud called secondary process thinking has been characterized by others in agreement with him as being verbal, rational, perceptual and accessible to consciousness. Similarly, the other broad mode of mental activity that Freud referred to as the primary process has often been distinguished from the other mode because it tends to be imaginal, irrational, concerned with emotions and memories, and only fleetingly glimpsed as in fantasies or slips of the tongue. Because of these essential differences in nature between the two, it may be necessary, if each mode is to be productive, that each be provided with both time and processing space that is relatively free from opposing influences of the other mode. If so, and if it is further assumed that the individual must draw on both modes in his ongoing adaptation to the demands of both reality and inner needs, it would follow that large regions of the cortex would switch periodically between primary process-alpha and secondary process-beta.

The present theory does not assume that the content of behavior or conscious awareness at _a point in time_ necessarily corresponds to the state of the EEG. It is assumed, rather, that great portions of the output from both modes never receive direct expression in overt behavior or representation in consciousness. Instead, the continuity of behavior and experience is maintained by unknown mechanisms which integrate information from the two modes over time. (Also integrated, of course, are other kinds of information such as that pertaining to vegetative function or to the performance of well-learned, automatized behaviors). Thus, in the present view the alpha-beta alternation does not reflect processes immediately involved in behavioral output, but rather processes that are an important substrate to that output and which, when integrated over time, receive complex and transformed expression. Over _periods of time_, then, the theory would predict that the proportion of primary process to secondary process influence on behavior would be directly related to the relative amount of alpha activity in the EEG. If alpha activity has been relatively high for a period, then the amount of primary process activity would be relatively high. Similarly, an individual whose alpha-beta alternation is characterized by strong alpha activity would be one in whom primary process thinking is particularly strong. These last two statements give the general form of many of the specific hypotheses to be presented later.

In developing these hypotheses, various findings will be discussed that are compatible with the idea that alpha is associated with primary process thinking. Mention will be made first, however, of some other diverse sources of support for the present theory.

In a series of experiments studying EEG evoked responses and word associations to subliminal stimuli, the presence of alpha in the evoked response was found to be associated with the occurrence of "clang" word associates (Shevrin and Fritzler, 1968). The interpretation was that alpha is associated with primary process thinking.

Klinger, Gregoire and Banta (1973) have reported that six Ss had higher average alpha levels when fantasizing than when concentrating on mental problems. The small size of the sample weakens this finding and its meaning is not clear. The difference may have depended more on the alpha blocking effects of the concentration tasks than on an association between alpha and fantasizing which is claimed to explain the finding. The theory advanced in Klinger's research is very close to that advanced here, and it was heartening to encounter this publication while the present experiment was underway, although the data presented to support their theory were inconclusive.

In more general support of the present view is a recent trend in neurophysiology towards viewing brain wave patterns as carriers of information, rather than as reflecting processes of arousal (Adey, 1969; Pribram, 1971). Evidence has now accumulated which indicates that both storage and retrieval of information depends upon the structure of wave patterns coursing through the brain tissue, information being encoded in the wave patterns themselves. More specifically, in a book length study of the thalamic origins of alpha activity, Andersen and Andersson (1968, p. 212) reach the conclusion that alpha may act "as a device to impress information on the cortical system." In the past, it has often been speculated -- and with very little basis -- that primitive thought processes, pervaded with emotions, are largely sub-cortical in origin and that higher level thinking is cortical. To the degree that this might be true, the information that alpha might impress on the cortex would be particularly primary process in nature. There is nothing directly supporting such speculation in the neurophysiological research referred to here, but it becomes more reasonable to think about such questions now that there is reason to view the EEG as an informational, rather than an arousal phenomenon.

Studies of Alpha Blocking

Because both arousal theory and the one proposed here predict a decrease in alpha when external stimulation causes brain activity, many research findings shed no light on the relative validity of the two ideas. Moreover, findings that may seem to pose a difficulty for arousal theory can often be accounted for by post-hoc reformulations. For example, the uncommon but nonetheless repeated finding that stimulation can provoke alpha activity at times, instead of blocking it, has been integrated with arousal theory as follows. Early formulations held that alpha passively reflected brain inactivity. Alpha was thought to result from a synchronization of neuro-electric activity that maintained a basal level of brain function, like a motor idling; beta in turn was thought to result from the complex, out of phase neural impulses that occurred when information processing was in progress (Jasper, 1954). Later re-formulations have held, however, that alpha reflects an inhibitory activity, that it occurs when synchrony is being imposed on the cortical tissue in order to reduce excitation. In short, reformulations have held that alpha is the cause of cortical inactivity, not its result.

For example, anomalous alpha augmentation responses to stimulation occur particularly often when experimental conditions are emotion arousing or when the subject is in an emotional state (Darrow, 1947; Simonov and Mikihailova,1971). Hence, the authors cited have claimed stimulation provokes alpha in these conditions in order to keep activation level within adaptive limits, on the assumption that the subjects are in a state of hyperarousal. However, there are no supporting data to indicate that the subjects were in fact emotionally over-aroused, and it might equally be speculated that the emotions were associated with heightened primary process activity, hence, the unusual occurrence of alpha.

A study by Heinemann and Emrich (1970) involved subliminal presentation of words rated by the subject as being either neutral or emotional. There was significantly more alpha provoked by the emotional words than the neutral. (This experiment replicated work by Dixon, 1971, pp. 210-217.) The authors concluded that alpha reflected inhibitory processes, being specifically a matter of repression of mentation stimulated by the emotional words. But it might be asked whether alpha reflected the repressing or the repressed. In physiological terms, is alpha associated with inhibition that reduces excitation, or is it associated with the excitation that inhibition works against. In this case of course, the present view is that alpha is associated with the primary process activity being repressed or inhibited, but there is obviously no compelling reason not to make the opposite presumption.

Either theoretical view can be criticized for being at too great a remove from the phenomena being explained. The use of vague constructs that are assumed to work opposite to one another is particularly hazardous. Psychoanalysis has been rightfully criticized in this respect for the apparent ease with which it can explain most any behavior in terms of the assumed opposition between conscious and unconscious processes, but vague use of the physiological terms excitation and inhibition is equally questionable.

Harris (1952), a psychoanalyst, has noted that patients in analysis sometimes avoid fantasies by opening their eyes. Putting this observation together with the fact that eye closure elevates alpha activity, he concluded that alpha was associated with fantasy activity and that beta, therefore, must reflect the process of repression. His speculations are noted here simply because they illustrate how easy it is to fit a bi-polar theory to a bi-polar phenomenon however one wishes, regardless of whatever way the data fall!

These considerations apply as well to reformulations of alpha arousal theory that have attempted to explain anomalous augmentation responses to non-emotional stimuli such as a simple flash of light. Morrell (1966), noting as have others (Mulholland and Runnals, 1962; Kreitman and Shaw, 1965) that these atypical responses occur more often during latter stages of an experiment, argued that habituation to the experimental conditions reduces the arousal potential of stimuli which then are more likely to provoke inhibitory processes. However, it might be asked what is being inhibited when stimuli have lost their excitatory properties, and we encounter again a failure to adequately specify what is involved. An equally plausible speculation is that with habituation, one might expect that cognitive activity not directly related to the reality of the experiment becomes more probable.

There are also a number of alpha blocking studies that have yielded results which do not jibe well with alpha arousal theory and whose authors have not attempted to reconcile the discrepancies. Thus, stimulus provoked alpha augmentation has been observed during vigilance tasks that require a high degree of sustained visual attention (Beyn, Zhirmunskaya and Volkov, 1967; Mulholland and Runnals, 1962). Alpha augmentation has been observed when S is given mental arithmetic tasks to perform which presumably require intense mental activity (Brown, 1966; Kreitman and Shaw, 1962; Mundy-Castle, 1957). Moreover, manipulation of the difficulty of such tasks has not produced differences in the amount of alpha blocking elicited (Glanzer, Chapman, Clark and Bragdon, 1964; Glass, 1964). Theoretical speculation could easily bring any of these findings to accord with arousal theory, and one can only decide for himself whether such speculation is more or less plausible than similar lines of thought that could align the data with the theory here proposed. For example, tactile stimulation elicits alpha augmentation particularly readily (Bagchi, 1937; Kreitman and Shaw, 1962; Loomis, Harvey and Hobart, 1937). Is cortical activity apt to subside when the body is touched, or does the touch stimulate primary process thinking? Those who think the body image is at the core of personality and that a touch is a powerful emotional stimulus would be apt to choose the latter interpretation; but the available research data here allow no firm conclusion.

Although it is presently felt that all these discrepant findings weigh against arousal theory, it is clear that they do not conclusively destroy the validity of arousal theory nor conclusively establish the validity of the theory that has been advanced here. One of the reasons for this is that in all of the studies cited only a single variable was used to measure "arousal", and one has as much reason to accept this labelling of the single measure as one would any other interpretation it might be given. Because of the necessary vagueness and high generality of concepts such as arousal or primary vs. secondary process, it would seem advisable to measure such constructs in a variety of ways in a single study in the hope that converging findings will provide definitive support for the theoretical interpretation one favors. Hence, the general strategy of the present research is to cross-correlate a variety of both EEG and non-EEG measures thought to reflect individual differences in the relationship between primary and secondary process thinking. Among these variables are measures of alpha blocking responsiveness, and we turn next to the methodological issues in measuring alpha blocking.

Methodology of Measuring Alpha Blocking

Alpha blocking has usually been studied by presenting stimuli repetitively to the subject and measuring the depression in alpha activity that occurs with each stimulus presentation. In this approach, each instance of alpha blocking is treated as a discrete, independent event; and observations of a number of such events are pooled together to provide a data base. A problem exists, however, in that alpha blocking shows strong habituation effects. Because of these the amount of blocking in any one instance is not independent of that in other instances near in sequence; and the simple pooling of data from these mutually related events becomes hazardous.

Another problem with the approach is that the immediate effects of stimulation on the EEG are highly dependent on the nature of the brain wave activity that was present just prior to the stimulation. If a strong alpha burst is present, the probability of marked alpha blocking occurring is high; if beta activity is present, the probability of an anomalous alpha augmentation response occuring is high (Morrell, 1966).

This circumstance creates a particularly difficult problem for studies of individual differences in alpha blocking. Either one presents stimuli on the same schedule to all Ss or one presents stimuli to each S only when he is exhibiting a particular wave pattern, e.g. an alpha burst. In the first case, all Ss receive the same temporal procedure; but because of wide individual differences in average alpha level, some Ss will be stimulated more often while an alpha burst is present than will others. The alternative procedure tends to equate Ss in terms of being stimulated in the same brain wave state; but again, because of the differences in average alpha, the overall rate of stimulation -- if not the duration of the experiment itself -- will be different for different Ss. For example, if E has decided to present stimuli during alpha bursts, he will have to wait much longer to present each stimulus for a low alpha S than for a high alpha S. (In addition there is the technical problem of deciding on-line when to stimulate; doing it by eye and hand is unreliable; doing it by machine involves establishing criteria that cannot be the same for each S. Also, what should be done with individuals who do not have alpha bursts?) In short, either procedure introduces non-uniformities that could seriously contaminate the scaling of individual differences in alpha blocking. A way out of this dilemma, presented below, is suggested by a closer look at the habituation effects mentioned earlier.

These effects have been particularly studied in connection with a controversy (reviewed by Wells, 1963) among researchers studying Pavlovian conditioning of the alpha blocking response. In the typical conditioning experiment, blocking to a tone was first habituated out, thus making the tone a potential CS. Then the tone was presented a number of times in pair with a light, the UCS. In a third step, the tone was again presented alone, and was observed to elicit alpha blocking again, apparently as a result of its paired presentation with the light. This interpretation, however, came under devastating attack when two things became apparent. First, although blocking occurs more readily to a light than to a tone, blocking to the light will habituate (contrary to what early workers in this field had thought), and thus there is no clear distinction between the tone and the light in terms of one being a CS, the other a UCS (Wells, 1962). Secondly, the reinstitution of blocking to the tone in the third step of the paradigm occurs primarily as a response to the change in experimental conditions, rather than as a response to the tone itself. Whether the tone or the light is presented separately -- or both together -- blocking invariably occurs to the initial presentations in a series, with a diminishing of the response thereafter if sufficient trials are given (Escover et al., 1964; Stern et al., 1961).

These findings suggested that habituation occurred in relation to the experimental conditions as a whole rather than in relation to the repetitively presented stimuli within conditions. This conclusion received firm support from Wells (1962) who used the same repetitively presented blocking stimulus in two conditions that differed only in that Ss wore earphones presenting white noise in one, and wore no earphones in the other. The order of the two conditions was counterbalanced. After habituation of the blocking response had occurred in the first condition, blocking was reinstituted and again habituated in the second. Since the blocking stimulus itself had not changed over conditions, it seemed clear that the changing strength of the blocking response had little to do with that stimulus taken by itself. Such stimuli have very little informational value to begin with. The strength of the blocking response depended on S's habituation to the experimental condition as a whole rather than to the blocking stimulus itself.

The habituation curves plotted in the experiments just cited all have the same negatively decelerated shape. That is, blocking diminishes less and less with time as the asymptote of no blocking at all is approached. Curves of this shape have also appeared in the work of Mulholland who has studied changes in alpha level during conditions that did not include repetitively presented blocking stimuli. Ss were asked simply to close their eyes, gaze at a spot or gaze at a projected slide, each for a couple of minutes or more. Alpha levels dropped at the start of each of these conditions and then rose with negative deceleration to baseline level (Mulholland and Gascon, 1972). It thus seems that average alpha level and the alpha blocking response both react in the same way to changes in experimental conditions. Although both of these EEG behaviors have not been measured simultaneously in any experiment that the writer knows of, it seems likely that a unitary process underlies their common pattern.

If beta activity is associated with reality oriented attention (as both arousal theory and the theory proposed here maintain), it is quite understandable that the onset of a new experimental condition would be associated with heightened alpha blocking and diminished alpha level. As S becomes familiarized with a condition, habituation develops. Alpha levels rise and the blocking response disappears since a high degree of beta alertness to the environment is no longer needed. Morrell (1966) has noted that anomalous alpha augmentation responses to stimuli occur more often in latter stages of experimental conditions when alpha levels have risen. This observation further indicates that the strength of blocking observed at any point during a condition (i.e., the amount of alpha observed after the presentation of a blocking stimulus) may be closely related to how much average alpha level has recovered its baseline level at that point.

From this point of view the transient alpha blocking to trivial, repetitive stimuli in an experimental condition is just one aspect of the more general blocking of alpha activity that occurs in response to meaningful changes in experimental conditions. If so, it would seem advisable to study the more basic phenomenon, i.e. changes in average alpha level as conditions are changed. In such an approach, there would be no need to present repetitive blocking stimuli, hence the difficulties involved in the dilemma described earlier would simply be bypassed. Instead of having to eliminate the confounding effects of habituation on the discrete blocking response, one can study different characteristics of the habituation process itself as representing different aspects of S's total EEG response to external input.

Mulholland and Gascon (1972) have shown that the pattern of loss and recovery of alpha during a condition is so regular that the data of as few as 7 Ss can be pooled to define an alpha recovery function that can be quite precisely described by simple mathematical formulae. This encourages the hope that individual Ss will each exhibit the characteristic, negatively decelerated, curve of alpha recovery, differences among Ss lying in small variations in the precise path each curve takes. In the present experiment, it was planned to measure such variations in three different ways, as follows. An alpha recovery function for each S was plotted by averaging changes in alpha level over a series of conditions, each condition being defined by the presentation of a slide projected landscape view that S gazed at for at least a minute. (Each condition had this minimum length since both Mulholland's data and the data in the discrete alpha blocking experiments cited earlier indicated that habituation neared asymptote within a minute's time.) The three measures planned then consisted of the average drop in alpha level at the onset of conditions, the average amount of recovery of alpha at the end of a minute, and the length of time it took for alpha to recover 63.2% of asymptotic value.

On the basis of the theorized association between alpha and primary process thinking, it was assumed that Ss who were relatively more oriented towards the primary process than were other Ss would show less of an initial drop in alpha, a greater recovery of alpha within a minute's time, and a more rapid recovery of alpha. In other words, in three different ways it was expected that such Ss would show less blocking or loss of alpha activity than would other Ss who were more involved in the reality oriented secondary process.

It was an open question whether individual differences in these respects reliably existed since these methods had not been experimentally tried. For that matter individual differences in alpha blocking have been little explored using other methods. Mulholland's work is aimed at detecting differences among clinical groups which is probably a less subtle problem than differences among individual Ss in a single normal group. On the other hand, individual differences in tendency to give anomalous augmentation responses have often been noted, although not systematically explored (Brown, 1966; Creutzfeldt et al., 1969; Gruenwald et al., 1968; Kreitman and Shaw, 1965; Morrell, 1966; Mulholland and Runnals, 1962; Toman, 1943). Although no attempt was made in this present research to elicit augmentation responses, the apparent commonness of individual differences in this type of response was encouraging since it seemed likely that alpha augmenters would be the kind of person to show strong and rapid recovery of alpha levels under the procedure here.

A number of authorities have reported that individual differences in discrete alpha blocking are significantly reliable in both test-retest and alternate test conditions (Fenton and Scotton, 1967; Visser, 1961; Wells, 1962). These findings cannot be taken at face value, however. Measurement of alpha blocking invariably involves taking some kind of difference score. Alpha activity after stimulation is compared to pre-stimulus or baseline levels. Unfortunately, alpha difference scores are always highly correlated with measures of average alpha level (see full discussion below). Hence, these reliability findings offer only minimal encouragement of the present research plan. The apparent reliability of alpha blocking measurement in these studies may have been chiefly a matter of the reliability of measurement of individual differences in average alpha level.

Alpha Level

Correlation between alpha level and difference measures would not be so unwanted if there was reason to think that individual differences in alpha level have psychological significance. Many researchers have attempted to find correlates of alpha level. Sisson and Ellingson (1955), Ellingson (1956) and Walters (1964) have reviewed this unproductive and now generally abandoned research area. One finding that has received some replication is that alpha level is inversely correlated with trait and/or state anxiety, but this has not always appeared, and statistically the relationship appears to be a weak one. However, it has been used to bolster alpha-arousal theory by assuming that trait and/or state anxiety involves heightened cortical arousal. Anxiety can also involve wary alterness to the environment and avoidance of primary process thinking; hence, a plug can again be made for a non-arousal view of the matter.

Another pattern that has turned up is for high alpha level to be associated with passive, receptive attitudes; low alpha level with independent, active attitudes (Gastaut, 1954; Henry, 1965; Mundy-Castle, 1958). Like the "anxiety" relationship, this pattern has only appeared weakly in some but not all data. It also shares with the "anxiety" finding equal interpretability under either of the two theories under discussion.

One of the reasons why findings relating to alpha level have been so few and so weak may be that there are many different factors determining average alpha level. Distinct personality traits like anxiety or activity/passivity may just be a small part of this universe of factors. Whether we view alpha as reflecting general cortical arousal level or the general proportion of primary to secondary process thinking, it is clear than an enormous number of influences would share in determining the normal adaptive alpha level for each S. If the alpha-beta alternation does reflect a fundamental and gross aspect of brain function, it is expected that the factors involved in determining the mean level of this function are exceedingly great in number and exceedingly complex in their organization.

In addition to the complex multitude of psychological factors that are likely involved, there are physical factors as well which determine how alpha appears in scalp recordings. For example, skull thickness reduces the recorded amplitude of alpha activity (Leissner et a., 1970). Hence, no predictions were made about differences in alpha level in this study. Instead, the focus is on the size of changes in alpha over short periods of time. An individual's trait alpha level is a product of his entire history, but changes in that level are apt to have a strong relationship to the immediate conditions in which they are observed. Hence, changes in alpha level would seem to be more amenable to experimental exploration than would trait alpha level.

But the problem remains of the correlation between alpha level and the size of changes observed. In general, EEG records characterized by low amounts of alpha activity show relatively small short term changes in level whatever the change in condition. At the other extreme, the records of individuals who have a large average amount of alpha activity also show relatively large variations in level over short periods of time. It seems to be a matter of the way the alpha-beta alternation is organized, and it becomes necessary to remove the effects of this relationship from data. If we are to have measures of alpha change that are comparable across individuals, these measures should be free of differences in mean alpha level. As discussed later, regression techniques are used for this purpose; but their value depends on having good estimates of mean alpha level to begin with.

Estimating Mean Alpha Level

In general, changes in level of alpha activity within subjects are much smaller in range than the differences in mean level among subjects. This is true even for high alpha subjects who show relatively large variations in amount of alpha activity. This circumstance is in keeping with the idea that the alpha-beta alternation reflects a homeostatic regulatory mechanism that tends to keep alpha as well as beta activity within adaptive limits for the person, a point that will be returned to again as different, systematic ways that alpha level fluctuates are reviewed.

In addition to the short term blocking and recovery of alpha level that occurs when stimulus conditions change, alpha levels tend to rise gradually throughout an experiment as a whole. This has created a controversy in alpha feedback research, because the amount of increase in alpha exhibited by Ss given feedback is often not significantly different from that exhibited by Ss given no or false feedback (Engstrom et a., 1970; Lynch and Paskewitz, 1971; Paskewitz et al., 1969). However, differences are sometimes obtained (Travis et al., 1972). If an experiment involves different sessions, mean alpha levels on the second day are apt to be higher than on the first. In other words, systematic changes in the alpha-beta alternation in response to changes in stimulus conditions within an experiment are superimposed on a changing response to the experiment as a whole.

In addition, if subjects are allowed to remain within a condition long enough, regular oscillations in alpha level may also be observed. That is, the frequency of alpha bursts emitted shows a regular waxing and waning, full cycles of such oscillations having period lengths that vary from 1 to 5 minutes (Morrell and Morrell, 1962; Morrell, 1966; Mulholland, 1964). This author has noted that these oscillations in amount of alpha activity are paralleled by simultaneous oscillations in ESP performance (Lewis, 1971). The alpha fluctuations may also be related to regular oscillations in the amplitude of evoked responses (Bogacz et al., 1960). Whether "fluctuations in attention" (Morrell and Morrell, 1962) or fluctuations in the balance between primary and secondary process thinking are involved, these findings strengthen the idea that the alpha-beta alternation reflects a homeostatic regulatory mechanism.

Because there are a number of ways that alpha activity systematically varies, estimation of a single value for the mean level around which such variations occur becomes hazardous. Much of the variation related to S's response to the experiment as a whole can be eliminated by having a first session that gives S̲s a chance to become accustomed to the situation, collecting the data of major interest on a second day. This was done in the present research. It is likely that measures of both alpha change and alpha level will be more stabilized at second testing than at first.

The other kinds of variations in level are handled by averaging alpha level across as much time as possible. Commonly, base-line alpha level has been measured by recording the subject in a resting condition where he has to do nothing but sit or lie quietly. The assumption is that this creates a uniform condition for all subjects, one where, in the absence of applied stimulation, basal levels of alpha will be exhibited. Such an assumption makes sense if one tends to think that behavior is primarily determined by stimulus input. Physiologists, at least in the past, may have been particularly prone to think this way. However, if one accepts that behavior has important internal, self-generated determinants as well, there is then no reason to think that resting conditions would be more uniform for S̲s than would stimulating conditions. In fact, the contrary might be expected -- greater variations in response to the resting condition since S̲s might be freer to act each in his own way when stimulating constraints are absent.

Thus, the plan here is to record alpha level over a variety of conditions and assume that the mean value obtained over all conditions is the best estimate of the level around which an individual's alpha homeostatically fluctuates. In addition, this approach provides a broad data base in line with the general principle that reliability increases with the number of observations.

Alpha Variability

When homeostasis is maintained by a negative feedback system, the quality of the control is reflected in the oscillations the system exhibits. Failure or near failure of control is often manifest in wildly erratic fluctuations, but with the exception of such extreme, usually catastrophic circumstances, it is generally the case that the smaller the fluctuations, the poorer the quality of control.

For example, when a person is learning to ride a bike, he tends to ride as straight a line as possible since he has not yet acquired the skill of converting the perception that he is falling to one side into steering action that would cancel the fall (i.e., the negative feedback loop has not been completed). When skill comes, he can swoop from side to side although if he should happen to swoop too far and fall, he may ride the straight and narrow again for a while.

In a similar fashion, the repeated finding that schizophrenics have less alpha variability than normals (Goldstein and Pfeiffer, 1969; Goldstein et al., 1965; Marjerrison et al., 1968; Murphree and Schultz, 1969) has been interpreted to reflect disturbances in homeostatic control of arousal level in the abnormal subjects. It has also been noted in these studies that alpha variability increases as a person recovers from a schizophrenic breakdown, and that variability is particularly reduced while the schizophrenic is in an hallucinatory state.

From the present theoretical viewpoint, these findings of reduced alpha variability in schizophrenics could also be interpreted as reflecting poor integration of primary and secondary process thinking. In other words, the schizophrenic counteracts his difficulty in maintaining an adaptive alternation between the two modes by reducing the size of fluctuations in alpha and beta activity. One might even speculate that the schizophrenic has to be particularly wary of falling off his bike on the primary process side, as it were, i.e. of becoming overwhelmed by hallucinations.

Thus, these alpha variability findings may have some relevance to the theory advanced in the present research;

and on this basis measures of alpha variability were included in this study. The findings cited above have been well replicated and statistically the relationships found have been strong. This is a rare situation in alpha research and it recommends further study of this alpha parameter.

In the studies cited alpha variability has usually been measured by sectioning the recording into 20 second segments, and measuring the amount of alpha within each segment by integrating the EEG after it has gone through a band-pass filter set to the alpha frequency range of 8-13Hz. The standard deviation of the set of alpha scores thus derived is then divided by the mean of the set to yield the "coefficient of variation" (CV), a measure that is supposedly free of variance associated with individual differences in mean level. The problem the CV attempts to solve is the same one discussed earlier in connection with alpha difference scores. Like them, the straight standard deviation is highly correlated with mean alpha level. The higher one's alpha level, the bigger are both difference scores and standard deviations. Indeed, one might expect that the size of the difference between alpha level at any two points in time would be related in part to the average size of standard deviation. However, the CV method of removing variance associated with mean level in a group of subjects can only be effective if the ratio of the standard deviation to the mean tends to a constant value throughout the entire range of average alpha scores. As we shall see, this does not seem to be the case; hence, regression techniques are used here again. The CV measure is also included in the study, however, because it has been used in the literature.

A minor departure from the usual approach to measuring CV in this study is that EEGs here are divided into 15 second segments, rather than 20. It has been found (Goldstein et al., 1965) that CV measures show essentially the same correlations with other variables whether segment lengths of 1, 5, 10, 20 or 60 seconds are used.

Alpha Feedback

Although alpha feedback is not new (Adrian and Matthews, 1934), it was not until Kamiya's reports (1969) that much interest in the subject arose. Kamiya argued that subjects could learn to increase their alpha activity and in doing this they altered their state of consciousness. Subjects commonly reported that being "in alpha" was associated with relaxation of conscious mental activity and with states of mental tranquility. These findings when coupled with other reports of markedly elevated alpha activity in Yoga and Zen adepts during deep meditation (Bagchi and Wenger, 1959; Kasamatsu and Hirai, 1966) seemed to suggest that alpha feedback provided a new road to nirvana, and interest in alpha feedback boomed.

For a number of reasons such interest now seems to have been unwarranted. In the first place, feedback subjects do not obtain levels of alpha activity as high as those of deep meditation. As already mentioned, it is difficult to show that the increases in alpha observed during the feedback experiment are any different from those normally and gradually appearing in any EEG experiment. Lynch and Paskewitz (1971) in their review of the area concluded that during feedback, alpha production rarely rises "above alpha levels which naturally occur under optimal conditions."

Secondly, while changes towards states of mental tranquility do occur, there is little reason to think that these states are like meditation or that they are related to the small changes in alpha level that occur. Brown (1970) found no relationship between the tendency to report such experimental changes and increases in alpha level. Instead, the reports seem to be related to the alpha blocking phenomena.

During feedback it is common for subjects to notice that the interested attention they give to the feedback stimulus, when it appears, causes it to rapidly disappear. Hence, they often adopt the strategy of reducing their attentiveness in order to minimize the alpha blocking they are observing. They become more mentally relaxed and alpha blocking may in fact become reduced. However, even if alpha bursts begin to last longer at some moments because of this strategy, the effect on average level of alpha activity over time may be quite small. As we have seen, average alpha level is predominantly constrained by the regulatory process reflected in the alpha-beta alternation. This process functions to gradually increase alpha over time. Subjects perceive the increase and think their mental relaxation is responsible for it, but to a very great degree, this conclusion may rest on illusion.

In short, the feedback situation provides ample opportunity for superstitious learning. Because alpha blocking commonly occurs, subjective experience of feedback has commonly been of the sort just described. It is perhaps because people differ in their blocking responsiveness as well that differences in subjective reports do occur. Peper and Mulholland (1970) reported that half of one experimental group learned to tense themselves to enhance alpha. Brown

(1969, 1970a, 1970b) systematically analyzed Ss' forced choice sorting of words and phrases to describe alpha. In addition to the descriptors significantly associated with alpha which connoted calmness, relaxation and tranquility, there were other significantly associated descriptors such as "association of ideas", "remembering", "intense", and "talkative". Nowlis and Kamiya (1970) report a study where a few Ss relaxed and let their minds wander to turn alpha off, although again the majority of Ss in the sample reported doing this to turn alpha on. In short, when experimenters have troubled to examine the variety of experiences reported, there invariably seem some subjective reports that differ markedly from the relaxation reports commonly given. Superstitious learning may account for all of this variety; and the only conclusion would be that there is very little direct connection between the EEG and conscious experience, as the theory proposed here has argued.

Supporting this view is one of Kamiya's earliest experiments (1970) in which subjects merely had to say whether or not alpha was present when given a signal by the experimenter. Feedback simply consisted of being informed when correct. Some subjects learned to be correct nearly 100% of the time, but could not state the basis for their discrimination. Thus, in the absence of feedback coming straight from the EEG, the common type of report described above did not arise, and subjects could only develop the vaguest awareness of what alpha was about. However, some awareness was present since near perfect discrimination rates were achieved. If shifts between primary and secondary process activity are involved in the alpha-beta alternation it seems likely that awareness of the changes would be borderline. There need be no particular consistent pattern in what the subject was thinking about at such times, but there might be some background awareness that the quality of mental activity was somehow different.

None of these considerations, however, need rule out the possibility that direct relationships between experience and alpha activity may occur at certain times. Indeed, the writer has recorded some feedback subjects who focused on emotionally-charged imagery to enhance alpha, some of whom stated that sexual fantasies were particularly effective. A heightening of primary process activity may have been involved in these relatively rare reports. These subjects tended to engage in fantasy for extended periods, and it seemed that when they said the fantasies enhanced alpha, they were talking about an increase in average alpha over time rather than the occurrence of fantasy-associated, specific alpha bursts. We have already seen that when subjects are asked, as in Kamiya's early experiment, to say what is going on when an alpha burst is present, there is little they can say. We have also seen in the more standard type of experiment that illusions develop when subjects become concerned with the blocking of specific alpha bursts. Hence, it is perhaps only when subjects try to grasp experiential correlates of alpha over periods of time that valid and meaningful observations may be made.

In the present study, inquiry and measurement of subjective experience was designed to orient the subject towards reporting his observations for periods of time rather than for the moments associated with alpha bursts. Three specific measures were developed. One was designed to tap the degree to which the subject found relaxation of attention to be associated with periods of heightened alpha activity during feedback. A second was concerned with the degree to which such periods were characterized by mental content of the primary-process sort, i.e. memories, fantasies, imagery. The third measure was concerned with how much the subject liked his feedback experience as a whole. The writer had encountered a few subjects in the past who developed an aversion to feedback. It was theorized that such aversion may have been a defense against contact with alpha-associated fantasies.

Central to the predictions made for these three variables was the idea that feedback experience would reflect characteristics of the person's alpha-beta alternation. For example, a person with mild alpha blocking or high alpha variability, who presumably shifts easily between primary and secondary process modes of thinking, would tend not to find that the occurrence of alpha during feedback was a matter of slackening of attention. Moreover, such subjects would tend to report a high amount of alpha-associated primary process content during feedback, and would tend to like the feedback experience itself, since the primary process mode would be more accessible and less threatening to them.

Measuring Feedback Success

Although there appears to be no two feedback studies in the literature that have used exactly the same procedure and method, two general research paradigms have evolved. In one (Kamiya, 1969, for example), subjects are given a series of brief feedback periods and are asked to alternately increase and decrease alpha production. Sometimes resting periods without feedback are interspersed between the "on" and "off" periods. The main concern of this type of research has been to demonstrate that subjects can control their alpha activity.

In the other paradigm (Brown, 1970, for example), subjects are exposed to feedback for relatively long, uninterrupted periods, and are simply asked to increase alpha as much as possible. The long exposure is provided to give subjects optimal opportunity to increase alpha level and a main concern of this type of research has been to study whether changes in psychological state accompany the rise in alpha which the procedure is designed to elicit. Both paradigms are included in this research.

It is perhaps a misnomer to refer to rises in alpha exhibited in either paradigm as representing "success" at the feedback task because it appears that subjects are not able in either to increase alpha above optimal baseline levels. Where rises in alpha are observed, they appear to depend largely on prior decreases in alpha below baseline level (Lynch and Paskewitz, 1971). Nevertheless, the term feedback success has validity from the subject's point of view; he experiences alpha increases. Hence, the term feedback success will be used to refer to measures of alpha change during feedback.

Feedback success in the "on-off" control procedure will be measured in accordance with common practice by taking the difference between "on" and "off" alpha levels. Feedback success in the other feedback procedure will be assessed in a number of ways.

One difficulty in measuring alpha increases while subjects are given free exposure to feedback for a long period is that there is no experimental control that insures that subjects will work steadily at the feedback task during the entire period or that alpha levels will increase steadily. One approach to this problem would be to assume that whenever higher alpha levels occur, the more they occur, the higher will be the person's average level of alpha for the entire period. Hence, comparison of mean feedback level with mean waiting level would be one measure of feedback success. However, the feedback success of subjects who may have registered high alpha levels only for a brief period of time would be underestimated by this method. Another approach which aims to avoid this is to find actual maximum level of alpha that the person registers during feedback and compare it to a similarly derived maximal base-line level. Alpha level tends in some subjects to fluctuate spontaneously; the peak to peak measurement is employed to cancel out variance arising from this source.

While data analysis was in progress here, it was decided to include one other feedback success measure. None of the measures originally proposed took into account the subject's view of the experiment. From the experimenter's point of view, feedback success is a matter of how much the subject is able to exceed non-feedback levels. But the subject never learns what his non-feedback level is and his experience of success depends only on how alpha changes during the feedback period itself. Hence, it was decided to include a feedback success measure that dealt only with the amount of alpha increase during feedback.

Mood Changes During Feedback

While there is little reason to think that changes in alpha level during a feedback experiment are associated with marked changes in feeling state, such as occur with deep meditation, smaller changes in state may occur. If alpha primarily reflects arousal level, one would expect increases in alpha to be associated with a decrease in feelings of arousal. On the other hand, if alpha is associated with primary process thinking, it would be doubtful that changes in this largely unconscious activity would have any predict-able relationship with changes in feeling. Hence, some insight into the relative validity of the two theories might be provided by attempting to establish correlations between changes in alpha level and changes in feeling state. One study (Brown, 1970a) that attempted to deal with this type of question found no relationship between amount of change in alpha and the degree to which alpha was reported to be quiescent in nature. However, in this study subjects were asked to describe what alpha felt like, instead of being asked simply to describe how they felt. As discussed above, the feedback situation tends to create an illusion that alpha is a blank stillness. This effect depends on the existence of alpha blocking, not on the size of changes in average alpha level that occur. Thus Brown's negative finding may be due to inadequacy of method. To study whether changes in feeling state are associated with changes in alpha level, each should be measured as independently of the other as possible. The subject should assess his general feeling state directly without being asked to refer to his experience of alpha. False perceptions of the nature of alpha must color the way the subject feels, but effort should be made to minimize this effect.

Thayer (1967, 1970) has developed a research paradigm that meets this objective. He has studied changes in feeling state associated with changes in non-EEG physiological measures of arousal. His method is to administer a Mood Adjective Check List (MACL) both before and after an experimental manipulation designed to change level of arousal. Difference scores between these pre and post tests are then correlated with difference scores derived from physiological parameters; significant positive correlations have often resulted.

Thayer's work with the MACL method is an offshoot of that of Nowlis (1965, 1970). Both workers have used factor analysis to identify the word items that define a number of different dimensions of self-reported feeling state. Of the dozen dimensions well established by Nowlis, four are closely related to the dimensions of self-reported arousal that Thayer has established (Anxiety, Fatigue, Vigor and Nonchalance); there is considerable overlap between Thayer's and Nowlis' word lists defining each of these; and in measuring self-reported feeling states on each in the present study, word lists employed were derived from both Nowlis and Thayer.

In addition to these four, eight other lists were employed, based on Nowlis' work. Two of these eight other dimensions -- aggression and concentration -- could be viewed as related to arousal. The six remaining dimensions --

Surgency, Elation, Sadness, Egotism, Social Affection and Skepticism -- were included for exploratory purposes.

It was predicted that the amount of lowering of reported arousal on each of the six dimensions would be positively correlated with the amount of increase in alpha during feedback. Confirmation of this prediction would support alpha-arousal theory. Hence confirmation was not expected.

<u>Personality Correlates of Alpha Changes</u>

If personality traits are involved in the postulated association between the alpha-beta alternation and primary vs. secondary process thinking, they would appear, in general, to be a matter of how well the person can change the proportion of the two types of activity in adapting to circumstances. It has been argued earlier that this general ability is reflected in part by the amount of alpha variability. Individuals who can swing readily from one mode to the other would take maximum advantage of the contribution each mode can make to adaptation. It has also been argued that this ability is reflected in the size of shifts in balance between the two modes when circumstances warrant a heightening of either primary or secondary process activity. This general ability is labelled Primary Process Integration (PPI) because in normal individuals the ability would seem to depend in large measure on the accessibility of the mode which is not socially reinforced.

The different ways that this general ability may be expressed in alpha behaviour have been described. Similarly, there may be a number of different specific personality traits involved. In psychoanalytic terminology, the strength of ego defenses, the harshness of the superego, and the intensity of id drives can each play a role in determining the way that primary process thinking is integrated in behaviour. Hence, it seemed advisable to search broadly for personality correlates that would validate theory here.

Cattell's Sixteen Personality Factor Inventory (16PF) purports to measure the "majority of primary personality factors . . . covered by existing research on the total human personality sphere" (Cattell, Eber and Tatsuoka, 1970), that is, the dimensions that have been found by factor analysis to be, as it were, the main building blocks of personality. Some of the 16PF dimensions would seem to be related to the broad concept of Primary Process Integration, and rationales for certain specific relationships will shortly be presented. But first a caveat.

In earlier discussion it was pointed out how easily one may reach two opposite conclusions when attempting to connect two generalized, bi-polar constructs. Cattell describes his 16PF factors in bi-polar terms and bi-polarity is inherent in the notion of Primary Process Integration as well. Hence, the reader may easily think of reasons why some of the relationships proposed might be precisely opposite in direction to that stated. No lengthy argument will be made here concerning the validity of the interpretations that are advanced. Instead, the writer merely gives the rationales that seemed suggestive to him when he reviewed Cattell's factor descriptions. These admittedly speculative rationales provide the basis for what should be viewed as working hypotheses.

Factor A, "Sizothymia v. Affectothymia", is described by Cattell as reflecting a flat vs. a full emotional life. Since inhibition of feelings can sometimes occur with defensiveness against the primary process, (e.g., when intellectualization is heavily used), there is reason to think that Primary Process Integration (PPI) would be positively related to factor A.

Factor C is interpreted to reflect ego strength. Cattell reports that low scorers on C tend to exhibit impulsiveness or other signs of emotional conflict, both of which can be interpreted as a failure in integration of primary process thinking. Hence, a positive relationship between PPI and C is proposed.

Factor G, "Low vs. High Superego Strength", taps the tendency to bind drives by rigid adherence to moral values. This factor, then, would appear to involve a particular kind of defense against the primary process. Hence, it seems that PPI and G would be negatively related.

Factor L, "Alaxaia vs. Protension", reflects relaxed acceptance of self vs. jealous suspiciousness. In other words, high scorers on L tend to rely heavily on projective defenses; and on this basis a negative relationship between PPI and L would be predicted.

Factor M, "Praxemia vs. Autia", has been associated with conventional practicality vs. absorbtion in imaginative ideas. Artists score high on M, and the ability to draw upon fantasy life may be involved in this factor. Thus, there are indications that PPI and M would be positively related.

Factor Q_4 is defined as "Low Ergic Tension vs. High Ergic Tension". Cattell states that this factor taps levels of "id energy excited in excess of the ego strength capacity to discharge it." Thus, this factor would seem to be negatively related to PPI.

In the factor analyses which yielded the 16 basic factors, Cattell used oblique rotations. Hence, the factors themselves could be re-submitted to a second analysis from which have emerged four second-stratum source traits. One of these, Q_{II}, has been identified as an anxiety dimension. Factors C and Q_4 load heavily on this dimension in directions supporting the interpretation that would be made here in any case, namely, that high trait anxiety is associated with poor PPI.

Factors A and M, argued above to be positively associated with PPI load negatively on second order factor Q_{III}, "Pathemia vs. Cortertia". Cortertia means cortical arousal. Alpha arousal theory would associate high Q_{III} sccres with alpha behaviors that have been interpreted here to reflect low PPI. Hence, there is an agreement here between the two alpha theories in predicting that Q_{III} and PPI would be negatively related.

In sum, 6 of the basic 16 factors on the 16PF, and two of the major second-stratum factors are thought to be associated with PPI. Correlates of the other 16PF dimensions were also examined in this study on an exploratory basis.

Statement of Hypotheses

The broad concept of Primary Process Integration (PPI) was theorized to have a positive relationship to some 16PF variables and negative to others. (Hereafter, when the term _16PF PPI_ is encountered, the reader should assume reversal of the negatively related 16PF scales. Reversal should not be assumed when Cattell's labels for the scales are employed.) Primary Process Integration has also been theorized to have a positive relationship to measures of alpha variability, feedback success, reported primary process content during feedback (RC) and reported liking of feedback (RL). Measures of alpha blocking and reported relaxation of attention during feedback (RA) have been theorized to have a negative relationship to PPI. On the assumption that PPI would be a dominant factor underlying all inter-correlations among these various variables, the following hypotheses were generated:

I: _Alpha blocking and alpha variability will be negatively correlated._

II: _Alpha blocking and feedback success will be negatively correlated._

III: _Alpha variability and feedback success will be positively correlated._

IV: _16PF PPI measures and alpha blocking will be negatively correlated._

V: _16PF PPI measures and alpha variability will be positively correlated._

VI: _16PF PPI measures and feedback success will be positively correlated._

VII: Alpha blocking will be positively correlated with RA and negatively correlated with RC and RL.

VIII: Alpha variability will be negatively correlated with RA and positively correlated with RC and RL.

IX: Feedback Success will be negatively correlated with RA and positively correlated with RC and RL.

X: 16 PF PPI measures will be negatively correlated with RA and positively correlated with RC and RL.

The primary process-alpha theory would predict no relationship between changes in subjective feeling state and changes in alpha level during feedback. Arousal theory, however, would predict that greater feedback increases in alpha level would be associated with greater decreases in subjectively experienced state of arousal. Such a prediction was the basis for Hypothesis XI, the final hypothesis included in this study. It was hoped that disconfirmation of this prediction based on arousal theory would offer some indirect support for the alternative theory.

XI: Feedback success will be positively correlated with reported decreases in arousal on the Mood Adjective Check List variables of Vigor, Fatigue, Nonchalance, Anxiety, Aggression and Concentration.

CHAPTER II

METHOD

Subjects

There were initially seventy subjects, all of whom volunteered to participate without pay. A lower age cut-off of 18 was the only restriction on the sample.

Twenty of the volunteers were excluded from the final experimental group: two, because of equipment malfunction; eight, because of failure to follow instructions; and ten, because of drowsiness during the feedback session. Table 1 gives some details about the final group of 50 subjects (26 male, 24 female).

Subjects were rejected for drowsiness when their self-reports of drowsiness occurred in conjunction with signs of drowsiness in the EEG and EOG record. These signs were evaluated by a blind judge who inspected all records for periods where a decrease in average level of alpha was accompanied by eye closure or eye rolling instead of by normal, eyes-open EOG patterns.[1]

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[1]The writer wishes to express his deep gratitude to Erica Wallace for performing the chore of judging the records.

TABLE 1

AGE, OCCUPATION AND SOURCE OF SUBJECTS

	Males	Females
Age range		
18 - 25	13	9
26 - 33	10	7
34 - 41	2	4
42 - 49	1	2
50 - 56	0	2
Occupation		
College student	10	9
Graduate student	2	3
White collar	2	5
Professional	3	4
Artist, writer or musician	9	3
How S learned of experiment		
Newspaper ad	11	7
Talking with *E*	5	6
Talking with other *Ss*	10	11

Experimental Environment

During all recording procedures, *Ss* sat upright in a lounge chair with legs horizontally extended. The chair was in a corner of a windowless, dimly lit, sound deadened but not soundproof room of size 2.1 x 3.8m.

A large box on legs contained a rear-projection screen (38 x 46 cm) which faced *S* at eye level at a distance of 1.2m. An 18 cm circle in the center of the screen was translucent;

the rest of the screen was opaque. At all times this circle was illuminated from within by an even, low level, diffuse light. During the alpha blocking procedure, the projected slides were superimposed on this diffuse illumination. Similarly, during feedback procedures, the alpha feedback stimulus consisted of a superimposed 2 cm circle of light in the middle of the larger circle.

Both the alpha blocking slide projector and the feedback stimulus projector were located inside the box. The light sources in each of these projectors were set as low as possible without making any appreciable sacrifice of image distinctness.

The aim of all of this was to create an ambience that would feel natural, muted and relaxing. In addition the setup was meant to insure that Ss would keep their eyes open, front and center; it was difficult to get information from the screen unless one was looking right at it. Finally, with these conditions the feedback stimulus seemed to softly glow on and off despite being simply switched on and off. Thus, the feedback signal did not jar attention as much as it would have if it were brighter or if the modulating effect of the background illumination on the screen had not been present.

<u>Recording and Feedback Equipment and Method</u>

For the EEG a single, monopolar lead was derived from the midline of the occiput, referenced to a joined pair of electrodes, one on each earlobe. The occipital electrode was in position Oz in the 10-20 electrode system (Jasper, 1957), that is, at a point 10 per cent of the inion-nasion distance up from the inion. A ground electrode was attached to mid-forehead. An additional pair of electrodes monitoring vertical eye movements were placed immediately above the left eyebrow and immediately below the left eye in a vertical line with the pupil. These were all Beckman miniature silver-silver chloride electrodes attached with double-sided adhesive collars after thorough cleansing of the skin and after rubbing a small amount of the electrode jelly (standard Beckman brand) into the skin at contact point. For the EEG recording, inter-electrode resistance was less than 9K ohms for all <u>S</u>s, and was less than 4K for 49 <u>S</u>s.

Respiration was monitored with a small thermistor taped below the right nostril. Analysis of the respiration data will not be presented here; hence, further details of the matter will not be discussed.

The recording was oscillographic on a Beckman Type R eight channel Dynograph. Respiration was recorded on one channel. A second channel, connected to the intercom, marked whenever S spoke.

Vertical eye movements were DC recorded on a third channel at an amplification of 0.5 mv/cm. DC recording continuously monitors the actual orientation of the eyeball, not just changes in orientation. Taking advantage of the fact that the eyeball rolls up when the eye closes, this method of recording could thus detect when an S became drowsy or failed to follow instructions. Methods for handling alpha scores that were artifactually elevated by eye closure are described below.

The five remaining channels on the oscillograph all operated off the EEG lead in one way or another. One channel recorded this lead directly with a time constant of 0.3 and an amplification of 0.04 mv/cm. On another channel the lead was similarly recorded except that an active band pass filter was inserted between the preamp and amplifier of the Dynograph. Both of these channels were operated with the coupler filter switch in position 2, attenuating frequencies above 32 Hz, and with the amplifier filter switch in the "Hi out" position, attenuating frequencies above 20Hz.

The filter was homebuilt from a schematic given to E by

Brown.[1] It is a Twin-T design using two op-amps in a high pass section, and two in the low. The frequency response of the filter built here is shown in Fig. 1. It is 3 DB down at 7.5 and 14.8 Hz. The pass band is flat between 8.9 and 11 Hz, but does have a hump which peaks + 0.4 DB up at 12.8 Hz. The lower cutoff is very sharp; the upper cutoff acceptably sharp.

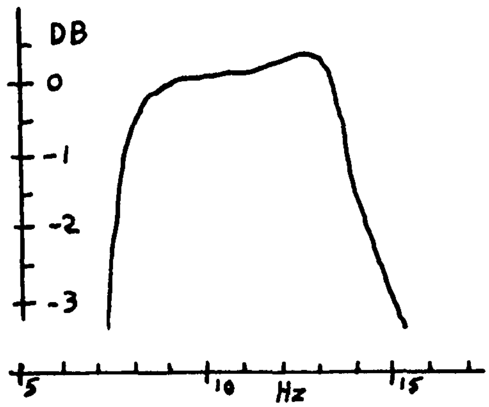

Fig. 1.-- Alpha filter gain characteristic.

The amplified output of the filter channel, in addition to being recorded, was rectified and led into a Schmitt trigger circuit and also into a Drohocki-type integrator (Drohocki, 1939.) (See Fig. 2 for a schematic representation of these and other connections described.) This type of integrator emits a series of pulses which, in a given period of time, are directly proportional in number to the area enclosed between the wave tracing of the filter output and the zero baseline of that trace. That is, a pulse is emitted every

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[1]The author wishes to express his gratitude to Barbara Brown, PhD., for generously sharing her filter design.

time some constant but arbitrary unit of area has been traced by the filtered EEG. The train of pulses was recorded on a third channel of the Dynograph.

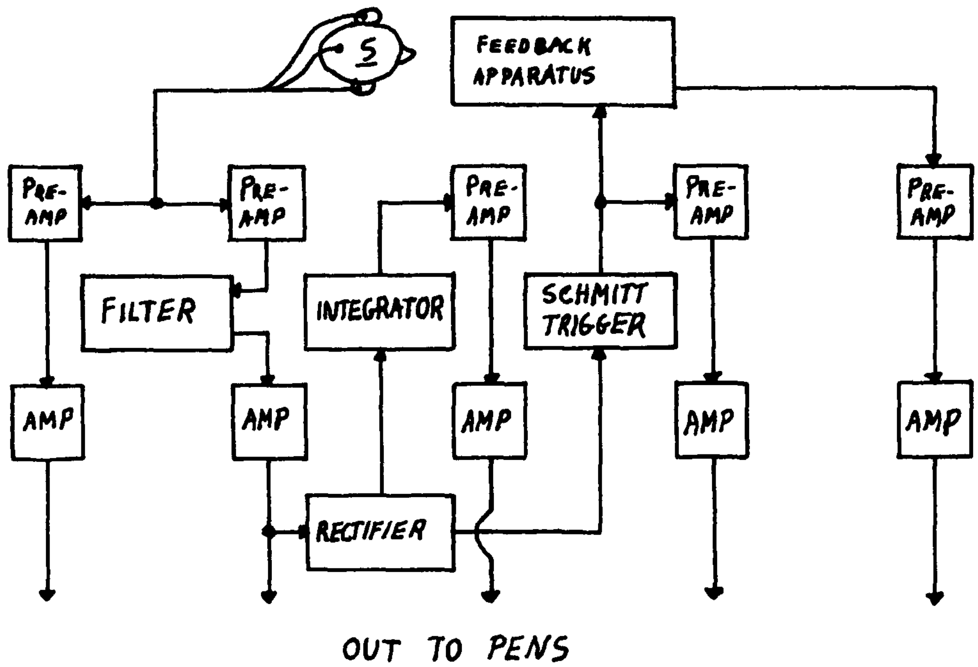


Fig. 2.--Flow diagram of EEG and feedback circuitry. Preamps and amplifiers are part of Dynograph.

The Schmitt trigger controlled a relay which switched on the feedback light in S's room. Both the operation of the trigger and of the light itself were recorded on separate channels of the oscillograph. This redundant information was provided to assist detection of equipment malfunction. No attempt was made to calibrate the range of levels that the trigger could be set to detect. Instead, the trigger was simply adjusted individually for each S to provide the maximum amount of reliable feedback possible from his alpha bursts. For a few Ss with high amounts of alpha activity, the trigger was set to detect only higher amplitude bursts.

Counts of emitted integrator pulses served as the basis for all measures of alpha activity in this study. In addition to saving work, this approach also avoids having to define an amplitude criterion for what constitutes alpha and what does not, which is very much a problem in any measure based upon the operation of a level detector. Moreover, since the integrator operates continuously, it detects changes in amount of alpha activity that would not be visible in the raw tracing, e.g. when a burst of alpha activity is buried in beta activity; and it also records changes transpiring above or below a threshold level which a trigger-based system set to that level would ignore.

Different parts of the system were repaired on two different occasions in the course of running the experiment. This resulted in the integrator operating with three different functions at different times. However, at regular intervals the system was calibrated by feeding in a 10.5 Hz sine wave from a signal generator and counting the number of integrator pulses emitted per unit of time at different amplitude levels. The functions for each of the three different calibrations were computed as well as transfer functions to convert data collected under two of these calibrations to the same standard as the third, which was the calibration that had been used for the greatest number of experimental sessions.

All integrator functions were found to be linear; and the calibration used as standard was:

$$Y = 0.625 + 1.925X$$

where Y is the number of integrator pulses emitted in a 15 second interval when a 10.5 Hz sine wave of X microvolts is fed into the system. With this calibration counts for 15 second epochs for different Ss varied from 1 to over 100, and between 5 and 40 in the great majority of cases. There is a small intercept value of 0.625, rather than zero, which results from the integration of low level, background noise in the system.

The integrator measure is in arbitrary units, but can be roughly equated to percent-time measures that are also commonly used in alpha research. In an alpha feedback experiment, Kondo, Travis and Knott (1972) have shown that integrator and percent-time scores are highly correlated. The comparability of the two kinds of scores seems to rest on the fact that average alpha amplitude is highly correlated with the percentage of time that alpha bursts are present (Pawlik and Cattell, 1965). Precise numerical conversion of one score into the other is difficult, however, since one must take into account that the integrator measures alpha buried in beta during times when readily discernible alpha bursts are not present. A rough analysis of the EEG records suggested that during bursts, average alpha amplitude was approximately three times higher than during stretches of apparent beta; and this relationship was used to estimate percent-time scores that would be comparable to the arbitrary integrator scores used in this study. Examples of such estimates will be found in the last chapter in the section headed "Sample Skewness".

Procedure

General plan. Subjects were asked to come to the lab for two sessions and had the option of returning for a third. During the first session the experiment was thoroughly explained excepting that Ss were not given any information at this time or any other time concerning what to expect from alpha feedback or how to proceed in working with it. Instead, E stressed that he was primarily interested in the different things that people do and experience with alpha feedback when they are not influenced by suggestions. Various paper and pencil data were collected on the first day, and a brief recording involving the Alpha Blocking (AB) procedure was done. This latter provided opportunity to screen out individuals with obvious EEG abnormalities (there were none), and allowed S a chance to become familiar with the business of filling out the Mood Adjective Check List (MACL) and of being wired up with electrodes to the electrical equipment. Although data collected in the AB procedure were used to test reliability of the AB measures (Table 11), the main purpose of the first day recording was for S to become adapted to the experimental situation.

The second session involved further collection of paper and pencil data, a repeat of the AB procedure, the alpha feedback procedures, and the Post-feedback Inquiry. Except where specifically stated otherwise, all data presented here came from this second session.

Since S's main reason for participating in the experiment was the opportunity to experience alpha feedback, and since only 20 minutes of free feedback was provided during the second session, S was told at the outset that he would have the option of having more feedback exposure in a third session. Data collected on this day are not included in this study. It had been originally planned to score whether or not S returned again as a variable measuring S's liking of alpha feedback. Twenty-four Ss returned for the third session, but many of those who decided not to were influenced by lack of time and the press of other activities and responsibilities. Hence, the variable was discarded.

It was also originally planned to have Ss take both forms of the 16 PF in the laboratory. Very fast Ss can finish both forms in an hour and a half; most Ss need much more time than this. Because of the length of the other experimental procedures, it was soon apparent that this additional time could not be demanded of Ss in the lab; and uniformity of administration was abandoned. Although some Ss did work on the 16 PF in the lab, most were given the forms to be filled out at home and returned later. Some Ss were given both forms at the same time, and returned both together. Others were given the second form after they had returned the first. All fifty experimental subjects filled out both forms.

Whether or not questions are answered as carefully and as seriously at leisure and at home as they are under laboratory conditions is not known. Scores on the two forms of the 16 PF were cross-checked for reliability and showed no cause for concern (Appendix D). Ss were promised (and later given) full results from the test; and this may have helped to insure validity of responding.

Table 2 outlines the whole experimental procedure, separate parts of which will be discussed in detail below.

TABLE 2

EXPERIMENT TIME PLAN

	Minutes
First session (90 minutes total)	
Orientation to experiment	15
Paper and pencil tasks: Questionnaires concerning personal information, ideas about experiment, knowledge of research area and a Spatial Ability test	15
First Mood Adjective Check List (MACL-1) .	5
Electrode application and connection . . .	15
Initial recording procedures	5
Alpha Blocking procedure (AB)	15
MACL-2	5
Electrode disconnection and removal	5
Second session (120 minutes total)	
Orientation	5
Personal information sheet and Imagery Test	5
Electrode application and connection . . .	15
Initial recording procedures	5
AB procedure	15
MACL-3	5
Feedback procedures including MACL-4 . . .	40
Electrode disconnection and removal	5
Post-feedback Inquiry	25

Initial recording procedure. This involved instructions to S to manipulate his eyes and breathing in various ways. The traces recorded during this were observed, and the controls adjusted for proper recording. A part of this procedure involved alternate shutting and closing of the eyes; the data collected here were used to compute the ratio of integrator count rates in the eyes-closed condition to that in the eyes-open condition for each S. This ratio was then later used to correct counts recorded in other parts of the experiment where Ss had closed their eyes briefly.

AB procedure. This followed the initial recording procedure on both experimental days, and began with reading of these instructions over the intercom:

> During the next part of the experiment your job is to just sit and gaze at the screen in front of you, keeping your eyes open except for normal blinking. For a long while the screen will be blank, but during this time just continue to gaze at it. Don't focus on it sharply, just adopt a relaxed waiting attitude, letting your mind wander as it will. At times you may get involved with a particular subject of thought, but try to minimize getting involved in any one thing by not fixing on things as they come to mind. Just relax, let your mind roll on, your thoughts slip by. When slides appear on the screen, look at them, but do so in the same relaxed manner. One of the slides will be blank, but during it continue to gaze at the screen, keeping your eyes open all of the time except for normal blinking. Do you have any questions?

Following the instructions the screen was blank for three minutes; then seven slides were projected for the time intervals indicated in Table 3. The screen was momentarily blank between slide changes. The slide changing mechanism was quite audible.

TABLE 3

SLIDE DESCRIPTIONS AND TIMES

No.	Sec.	Description- day 1	Description- day 2
1	80	palm tree	palm tree with sun
2	70	skyscraper	rocky seashore
3	90	beach umbrellas	airport
4	70	Manhattan air view	Riviera beach
5	80	Italian city square	rock formation, Utah
6	70	Mediterranean town	fishing boats
7	70	(3 letter word)	(3 letter word)

The first six slides on each day were tourist-type landscape views, some photographed by E, some bought in tourist shops. The same slide timing and slides were used for all Ss as indicated in Table 3. The aim was to have complex stimuli which would absorb S's attention, but would be neutral enough to avoid idiosyncratic emotional reactions or thoughts.

Ss were never informed that during the seventh slide, apparently blank, a subliminal word was projected (sex and tol, one on each day). Immediately following this slide, Ss were asked to give a series of free word associations for one minutes. Involved here was an unsuccessful attempt to extend the work of Heinemann and Emrich (1970). Data from this part of the procedure will not be presented.

Feedback Procedures

The feedback procedures, in sequence, were as follows:

1. Waiting period (6 minutes)
2. Feedback period (20 minutes)
3. MACL-4
4. Control periods (8 minutes)

No feedback was provided to S during the waiting period and during MACL-4; feedback was provided continuously during the feedback and feedback control periods.

The waiting period was provided to record a resting baseline, and also to give time to adjust the Schmitt trigger for optimum feedback. Instructions for this period were read over the intercom as follows:

> O.K. We're going on to the feedback part of the experiment now. The first thing I have to do is adjust the feedback circuitry to give you the best feedback. This will take a number of minutes, but it will help me if you maintain a constant, relaxed mental state while I'm doing it. All you have to od is what you've done before. Sit, relax, keep your eyes open, gaze at the screen and let your mind wander. When you get involved in particular thoughts, that's alright, but try to let your mind just roll on.

> Be sure to keep your eyes open except for normal blinking. I'll speak to you when we're ready to go on. Until the circuitry is adjusted properly, don't do anything which you think might change your alpha waves.

Usually, only a small portion of the six minute waiting period was needed to adjust the feedback properly, but a full six minutes passed before E spoke again to give the instructions for the feedback period. These were read over the intercom, as follows:

> We're ready to begin now. This light (manually operated at this point) will go on whenever you're producing alpha. It will tend to come and go in brief flashes, but try to keep it on as much of the time as you can so that you'll be able to learn more about your alpha. The light may go on sometimes if you're moving your body, or coughing or doing anything involving physical activity. You should move or do whatever you have to in order to be comfortable, but you should also know that feedback you get at such times is probably not alpha. So, be comfortable, observe yourself as you try to keep the light on. It will be difficult, but keep trying to produce alpha all the time. Remember to keep your eyes open. Do you have any questions?

When the 20 minute free feedback period was over, S was asked to fill out the fourth MACL. After he had indicated this was completed, instructions for the alpha control periods were read over the intercom as follows:

> In the next part of the experiment I want to see how well you can control alpha now. There will be a series of brief periods. In some I will ask you to try to keep the light on as much as you can; in the others I will ask you to keep the light off as

> much as you can. During each separate period continue trying to make the light come on or stay off as I've asked until I give you the instructions for the next period. Do you have any questions?
>
> Alright then, starting now, keep the light off. (2 minutes later) Now, keep the light on. (2 minutes later) Now off. (2 minutes later) Now on.

Two minutes after giving the last instruction to keep the light on, the alpha control procedure ended. Electrodes were disconnected and removed; and S was seated at a table by himself to fill out the Post-feedback Inquiry. Mutual discussion of the experiment was kept to a minimum until the Inquiry had been completed.

Score Transformations

The basic alpha scores employed in this study had two unfortunate characteristics in common with one another. First, score distributions tended to have marked positive skewness, and transformation by taking common logs was necessary. For distributions containing negative values, a constant was added to all scores that was just big enough to raise the lowest score above zero.

The second commonality among alpha scores was a tendency for each to have strong positive correlation with the others. That is, the higher a person's mean alpha level, the bigger his alpha variability and the bigger were alpha difference scores. Moreover, differences in alpha level among subjects were much greater than the differences in level any one subject exhibited over time. The general picture is of a floor effect. The higher the person's alpha level above the floor, the more freedom his alpha had to change in level over time. It was assumed that the central factor in this pattern was the subject's average alpha level, and that the pattern, along with mean alpha level itself, had little psychological significance. Hence, alpha difference and variability measures were submitted to a transformation designed to eliminate from the score distributions variance associated with mean alpha level. The aim was to get transformed scores containing a greater amount of variance that would be psychologically significant.

The need for such a transformation when change scores are involved has arisen in many fields (Harris, 1963). The most common approach to the problem, and the one chosen here, is the regression residual technique. This has been particularly recommended for scaling individual differences in change (Cronback and Furby, 1970), and its practical value has been demonstrated in non-EEG psychophysiological research (Lacey and Lacey, 1962). Hence, it seems the best suited for present purposes although no EEG reference to it is known.

A hypothetical example that is paradigmatic of the use of this technique in this study will be described to illustrate its characteristics. Consider a situation where alpha level has been measured at two different points in time, A and B, and where interest is in measuring the change in alpha from A to B. It is assumed that the group as a whole has shown an increase in alpha level from A to B, and that there is a high positive correlation between the A and B scores. These assumptions are typically valid in the present data.

The regression of B on A is computed and used to predict B' values from A. The B' values, projected directly from the regression line, represent alpha levels at time B that one would expect to observe on the basis of group tendencies in alpha change from A to B, given the A values. The residual scores, obtained by subtracting B' from B, represent how much a subject has exceeded or failed to obtain the alpha level at time B that would be predicted from his A alpha level.

When an *S*'s B' value is less than his obtained B value, this means that he has shown less increase in alpha from A to B than would be predicted for any member of the group with the same alpha level at A; and such an S receives a positive, high residual score to reflect his greater-than-expected increase. Similarly, an S whose B′ value is more than his obtained B score deserves and gets a negative, low residual score. In general, if a regression line is drawn through the A/B scatter plot, Ss whose points fall above the regression line receive positive residual scores; Ss below, negative scores.

Some general characteristics of residual score distributions are worth noting. Residuals computed in the above described way always have a mean of zero and symmetrical distribution. To the degree that the A/B distribution is bivariate normal, the residual distribution is normal. The residuals always have zero correlation with the predictor score in the regression equation - score A in the paradigm.

The utility of the method depends mainly on the existence of linear correlation between A and B. When the differences in alpha level among subjects are far greater than those within subjects -- as is the present case -- either the A or the B score can be viewed as an estimate of mean alpha level; and their high correlation substantiates such a view. Since the residuals have zero correlation with A of mathematical necessity, they will also have little correlation with B if A and B are strongly related. Therefore, it makes sense to speak of the residual scores as representing measures of alpha change from which variance associated with mean alpha level has been removed. Strictly speaking, however, the variance that has been totally removed is that associated with A.

The residuals tend to have some correlation with straight difference measures of alpha change, e.g., B minus A. Ostensibly, difference and residual scores based on the same A and B scores attempt to measure the same thing. However, given a high correlation between A and B, the correlation between the difference and residual scores will tend to be lower, the higher the correlation between the difference measure and the estimates of mean alpha level. The interpretation of this would be that the more the difference measure of alpha change is contaminated by its relation to mean alpha level, the greater the effectiveness of the regression transformation in yielding scores that reflect the meaningful changes in alpha activity that occurred.

The reader may wonder why the difference between B and A itself is not regressed on alpha level. This would seem to provide a clearer basis for interpretation of the residuals. However, this method tends to be more adversely affected by errors of measurement in the A and B scores than is the method of regressing B on A (Garside, 1956). Moreover, Churchill (1962) has demonstrated that both methods are closely related mathematically, and yield results that are much the same.

The regression technique was also used here to transform alpha variability scores; and this was a departure from the A/B alpha change paradigm just described. In this situation, alpha changeability scores, i.e., standard deviations, were regressed directly on alpha level scores. The interpretation of the alpha variability residuals is, of course, essentially the same as that of the change residuals in the paradigm.

In short, scaling subjects by their residual scores has less dependence on mean alpha level than does scaling by straight difference measures or standard deviation. The differences between the residuals and the other scores will be greater, the stronger the correlations between the variables entered into each regression analysis.

The use of non-normal scores in regression analysis is questionable; but it is not illegitimate if no statistical inferences are made. Score transformations are usually resorted to because of harsh necessity; their value and validity can usually be only empirically demonstrated. This is the present situation where the regression technique was chosen because there seemed to be no better alternative.

Analyses were tried of residual scores computed from log transformed data, but yielded no consistent difference in results. Hence it was decided to use the simpler approach, described here in the paradigm, that sticks closer to the raw data.

The regression technique was used to create corresponding residual scores for each basic measure of alpha change or alpha variability in this study. As the basic measures are separately discussed in later sections, mention will be made of which variables were entered into regression analysis to yield the residual scores in each case.

In addition to the residual score corresponding to each basic alpha score, there was also the score derived by log transformation of the basic alpha score. Thus, for each alpha behavior measured, three different scores were derived: the basic score, the log transformed score, and the regression transformed score. In referring to these variables a simple label, e.g. "AB1", will represent both a particular alpha behavior and the basic score measuring that behavior. AB1, for example, refers both to the alpha blocking that occurred immediately following slide presentation and to the actual numerical drop in alpha activity at that time. The suffixes ".lg" and "r" added to the label refer to the related transformed scores. Thus, AB1.lg is the log transformed basic score; AB1r is the regression residual score that is based on the AB1 alpha behavior. A complete list of variables finally used to test hypotheses is cataloged at the end of this chapter. In general, for each alpha behavior measured, both the log transformed score and the residual score were used in the statistical analyses.

Scoring Alpha Activity

The first step in deriving the alpha scores was to divide the paper record into segments. The waiting periods, the feedback period and the control periods were divided into consecutive 15 second segments starting in each case at the point where the giving of instructions for the period had ended. In addition, six 10 second consecutive segments were marked off for slides 2 - 6 in the alpha blocking procedure immediately following the presentation of each slide.

No other portions of the recording were scored except for the eye opening-closing part of the initial recording procedure (described on p.77) which had no set time plan.

Thus, omitted from scoring were times when instructions were given, slides 1 and 7 of the alpha blocking procedure, short lengths of record after the single minutes scored for slides 2 - 6 which intervened before presentation of the next slide, and times when the MACL was filled out.

The number of integrator pulses recorded within each of the marked off segments was the basic measure of alpha activity. Pulses that came right on a dividing line between segments were included in the count of the preceding segment. Counts were whole numbered; no attempt was made to measure in fractions inter-pulse intervals divided by a segment mark. With rare exception, sufficient counts were emitted in any 15 second segment to make negligible the error introduced by loss or gain of fractional counts. In any event, since all of the measures employed in this study are derived from poolings of segment counts, small errors of this sort are assumed to have averaged one another out.

Because of the care taken to achieve low contact resistance when applying the electrodes, there were only rare and brief instances of artifact in the EEG. Where such artifact had passed the alpha filter and had thus artificially elevated the integrator count, score corrections were made. Artifact free sections of that S's record which were of comparable level of alpha activity by eye measure indicated the proper count values to be inserted in the contaminated places. Similarly, where Ss had closed their eyes briefly, thus elevating the count, scores were corrected by using the ratio described above in the section dealing with the initial recording procedure. Like the artifact correction, the eyes closed correction was used only if it was needed briefly and rarely for the S. Thus, two Ss were excluded from the final sample solely because of too frequent eye closure.

After checking the paper records scored in this way, the raw count scores were punched on computer cards. Programs were written to compute the various variables derived from these counts; and the scores of Ss on these variables were stored on computer tape to be used in subsequent analyses.

Alpha Blocking (AB). Day 1 and day 2 AB data were both scored in essentially the same way. (Data following the first and last slides were ignored. The subliminal slide was not comparable to the others, nor was the first slide in that it was the only one preceded by a blank screen.) Six average values, one for each of the 10 second segments marked off, were calculated after summing values for each segment across slides 2 through 6. The aim here was to arrive at a smoothed curve for each S, hereafter called the recovery function, which would depict the drop and subsequent recovery of alpha activity characteristic for that person when presented with a blocking stimulus under the conditions of this experiment. As discussed earlier, various researches had encouraged the expectation that different recovery functions could be found for each S, but that all would have the same general form.

It was originally planned to derive three different measures from each S's curve. AB1 would reflect how much alpha activity was initially suppressed immediately following the slide presentation. AB2 would reflect the degree to which alpha had recovered its normal level in a minute's time following the slide presentation. AB3 would reflect the length of time, within the minute period scored, that it took for the recovery function to reach asymptotic level. A number of low alpha Ss did not produce the expected curve, the curve for a few of these being highest on the very first data point, for example. Thus, since the third AB measure could not be computed universally for all Ss, it was discarded.

Measures of baseline Alpha Level (AL) were used to compute AB1 and AB2. For the day 1 AB procedure, AL was the average of 12 scores from the three minute waiting period and

20 scores from the slides data. (There were 30 ten second segments originally scored in the slides data, six for each of the five slides 2 - 6. The sum of these 30 segments was treated as equivalent to 20 fifteen second segments, thus preserving fifteen seconds as the time base for AL.) For the second day AB procedure, the basis for calculating AL consisted of the same scores used earlier plus the following data from the feedback procedure: 24 scores from the six minute waiting period, 80 from the free feedback period, and 32 from the alpha control test periods. (The reasons for measuring AL over all conditions, instead of just under resting conditions, were discussed in the first chapter.)

The numbers defining each S's recovery function were converted to fifteen second time base equivalent values. AB1 was calculated by subtracting the value for the first point on the recovery function from AL. AB2 was found by subtracting the mean of the fifth and sixth points from AL. (It seemed reasonable to attempt to gain greater reliability for AB2 by combining scores from two segments of the recovery function since the recovery function typically flattened in the last half-minute. On the other hand, AB1 might be improved by using an even shorter length for the initial segment of the recovery curve; but because of the problem of fractional counts discussed above, it did not seem possible to use shorter segments than ten seconds unless the counting rate of the integrator were to be stepped up.)

To compute the regression transformation scores AB1r and AB2r, mean alpha level was used to predict expected alpha levels during the slide presentations.

Feedback Success (FS)

Four different types of feedback success were measured: FS1, FS2, FS3 and FS4. (As stated earlier, these labels each have a kind of generic meaning, referring both to a category of alpha activity that was measured as well as to the basic score measuring that category.)

FS1 refers to how well Ss were able to control their alpha levels under the alternating "on", "off" instructions given during the Control Periods. Data from the first "off" and "on" periods were discarded. Subjects had not been forewarned that this test of alpha control would be part of the procedure, and were given a single throwaway trial under each instruction to give them a little chance at working under pressure before collecting the data that counted. Subtracting mean alpha score for the second "off" period from mean score for the last, "on" period yielded the basic score

FS1. For FS1r, the "on" score was regressed on the "off".

Basic score FS2 was designed to tap the maximum alpha level attained during the feedback period by measuring the difference between peak feedback and peak waiting period level. The peak to peak score was meant to cancel out the contribution of alpha variability here which it was assumed would tend to elevate peak scores in both conditions. Unfortunately, the data did not emerge as expected. In particular, a sizeable minority of the group tended to develop cyclical fluctuations in alpha level in the latter part of the feedback period, but not during the waiting period. Such rhythmical oscillations in level were discussed earlier as a general topic, but their possible confounding effect on FS2 was overlooked. The problem was that they artificially elevated the FS2 scores of a sufficient number of subjects to necessitate discarding the variable.

FS3 consisted of the difference between mean feedback alpha level and mean waiting period level. The residual score here was computed using the waiting level as the predictor.

FS4 was added to the experiment while data analysis was in progress because none of the originally proposed FS measures estimated how much alpha change S experienced during feedback. While the value of comparing feedback alpha levels to non-feedback reference levels had been evident, overlooked had been the fact that S's experience of feedback success would depend mainly on the changes in feedback he observed within the feedback period. Early analyses of the data had shown that the trend of alpha increase during feedback was near linear for most subjects. Hence, it seemed that an adequate measure of within feedback period alpha change would be provided by a simple two point estimate of each subject's alpha trend. To get the basic score FS4, mean alpha level for the first half of the feedback period was subtracted from mean level for the last half. Last half was regressed on first half for the residual score.

Subjective Experience Variables

Mood Adjective Check List. A copy of the MACL form used is included in Appendix A. Ss filled out this form four times. The first administration came early on the first day, just before the electrodes were applied. For this first administration, all usages of the word now were crossed out on the form and S was instructed to check words to describe the way he had felt "the past few weeks". Ss filled out this form while sitting at a desk.

For the subsequent three administrations, the form was used exactly as printed in Appendix A; and Ss filled it out on a clipboard, held in their laps, as they sat in the experimental room, electrodes connected to the recording apparatus. The second administration came at the end of the AB procedure on day 1, the third at the end of the day 2 AB procedure, and the fourth between the 20 minute feedback period and the control periods. Primary experimental interest was in changes in mood ratings between the two MACLs given on day 2, i.e. between the MACL administered before the feedback period and the one administered just after. The first two MACLs were given mainly to provide S with practice in filling out the form. The data from all four administrations, however, were submitted to separate factor analyses which are presented in Appendix B. Four of the MACL variables (Vigor, Surgency, Social Affection, and Elation) were found to define a strong factor in each of the four analyses; and it was decided to add this factor to the experiment as an additional variable which is called GFL for good feelings. Because of the limited data base for the factor analyses, scores on the four related variables were simply summed to establish scores on GFL. That is, instead of computing a set of factor weights for the variables, simple unity weights were used.

The instructions and words used in the MACL are borrowed primarily from the factor analytic researches of Nowlis (1965, 1970). This work has indicated that each of the words on the list tends to load on one and only one of twelve different MACL variables. Four of these variables have been separately factor analysed and studied by Thayer (1967, 1971)in researches into the relation between autonomic physiological arousal and self-reported feeling-state arousal. He names the variables differently, and his lists of identifying words are not quite the same as Nowlis'. However, the overlap is very great.

For the present research the number of words defining a variable was limited to five, picking the ones that seemed best. In three cases fewer words are used because none other have been found to reliably load the variable in question. In dealing with the four variables described by both Nowlis and Thayer, effort was made to include the best words from both, if their lists differed. Slight preference was given to Thayer's words since they had proven themselves in research more related to the present study than is the work of Nowlis. The words used for each variable in this study are listed in Table 4 along with their sources. These words were listed alphabetically on the form administered.

TABLE 4

MOOD ADJECTIVE CHECK LIST VARIABLES
AND IDENTIFYING WORDS

Vigor (VIG)	Nonchalance (NON)	Anxiety (ANX)
active b	at rest a, b	clutched up b
full of pep a, b	still a, b	fearful b
energetic b	leisurely b	jittery b
peppy a, b	quiet a, b	stirred up a, b
vigorous b	calm a, b	intense a, b
Social Affection (SAF)	**Aggression (AGG)**	**Fatigue (FTG)**
kindly	defiant	sleepy
friendly	rebellious	tired b
affectionate	angry	drowsy b
forgiving	grouchy	sluggish a, b
warmhearted	annoyed	dull a, b
Surgency (SUR)	**Concentration (CON)**	**Egotism (EGO)**
carefree	concentrating	egotistic
playful	engaged in thought	self-centered
witty	intent	aloof
lively	introspective	boastful
talkative	attentive	
Elation (ELT)	**Sadness (SAD)**	**Sketicism (SKP)**
elated	regretful	dubious
overjoyed	sad	skeptical
pleased	sorry	suspicious
refreshed		
lighthearted		

Notes: a - Not on Nowlis list.
b - On Thayer list.
All other words from Nowlis.

S's responses on the forms were put directly on keypunch cards letting vv = 4, v = 3, ? = 2 and no = 1. Programs were written to sum the scores of the words defining each variable, find S's mean score on the twelve basic variables and on GFL as well, and create difference scores for each of these by subtracting pre-feedback scores from post.

Plans had been made to apply regression transformations to these measures of feeling-state change in addition to the measures of alpha change. However, the correlations between the pre and post feedback MACLs on all scales were too low to support the method; and it was abandoned when it became apparent that the technique here did not materially transform the scaling of subjects.

It was also necessary to drop five of the basic MACL difference scores, namely, Anxiety, Aggression, Egotism, Skepticism and Sadness, because of response biases in the group to avoid reporting negative feeling states. The reasons for eliminating these measures are given in greater detail in Appendix B.

Post-feedback inquiry. A copy of this instrument, written specifically for this study, can be found in Appendix A. It was administered to S immediately after electrode removal on the second day, and had the purpose of tapping details of S's feedback experience. Although some interaction between E and S was necessary at the end of the EEG recording, this was kept minimal to avoid influencing S's thoughts about the session.

Part 1 of the Inquiry asks S to write out in detail a free description of his experience. This written report had two purposes: (1) to increase the validity of S's responses on the rating questions by forcing him to first review his experience; and (2) to provide supplementary data that might be useful in post-hoc analyses or that might offer leads and insights.

In part 2 of the Inquiry S was asked to estimate time lengths of the different parts of his feedback experience. Few Ss did this task carefully or easily; some in fact claimed inability to do it at all. Hence, no use of these data was attempted. Data from the question in part 3 were also not used.

S indicated his answers to questions in parts 3, 4, 5 and 6 of the Inquiry on two answer sheets provided. Copies of these sheets can be found in Appendix A. Questions in parts 4 and 5 demanded two ratings each, an "alpha" rating and a "not alpha" rating; and an "alpha" and a "not alpha" answer sheet was provided for S to make each kind of rating. Single ratings to questions in parts 3 and 6 were made on the "alpha" answer sheet. The double ratings were necessary in parts 4 and 5 to differentiate the degree to which the matter being rated was characteristic of S's "in alpha" experience as opposed to his "not in alpha" experience.

Part 4 of the Inquiry was concerned with measuring reported amounts of alpha-associated relaxation of attention. The questions here focus on different aspects of S's mental and physical experience in this connection. Item scores from questions 4a through 4f will be referred to as A1 through A6 respectively. A1, A2, A3, A4 and A6 were found by subtracting S's not alpha rating from his alpha rating. The scoring direction was reversed to yield A5.

Part 5 of the Inquiry measures reported amounts of alpha-associated mental content that might be loosely considered to be largely primary process in origin, e.g. personal memories, imagery, sexual fantasy and spontaneous, non-verbal thought. Item scores from questions 5a through

5g were labelled C1 through C7 respectively, and were calculated as were the A item scores, reversing items C2, C4 and C6.

Part 6 tapped how much S liked his feedback experience. The pool of items was quite tautological in content, asking S variously how satisfying, enjoyable, interesting or disappointing the session had been for him. Item scores from 6a through 6e were called L1 through L5 respectively, and were taken directly from S's actual numerical ratings, after reversing the scoring direction in questions 6b, 6c and 6e.

Scores on all A items were summed to create the variable Reported Attention (RA). Sums of C scores yielded values for the variable Reported Content (RC); and L items, Reported Liking (RL). All item scores and all scores on these three variables were entered into a psychometric analysis aimed at improving the measurement properties of the three main variables. Details of what was done are provided in Appendix C. In brief, it seemed advisable to drop item A6 from RA, C2 and C4 from RC, and L4 from RL in order to have three scales with maximum possible internal consistency. Thus, these four items were discarded altogether, and the three variables were finally based on the items remaining.

Sixteen Personality Factor Questionnaires

Answer sheets of Ss to both forms A and B of the 1967-1968 edition of the 16PF were hand scored twice. After this double checking, raw scores were keypunched and age corrected by computer, using the general adult correction values provided in Tabular Supplement No. 1 to the 16PF Handbook (Cattell, Eber and Tatsuoka, 1970). Age corrected scores were converted to stens using the general population norm tables for males and females separately. Stens are standardized scores on a ten point scale based on an area, rather than linear, transformation of raw scores. That is, they are designed to have normal distribution even though the raw score distributions on which they are based may not be normal. The use of age corrections and separate male and female norms removed variance associated with age and sex differences from the final set of scores.

In developing the 16 basic scales of the 16PF by factor analysis, Cattell used oblique rotations to final solution. Hence, correlations exist among the 16 factors, and the factors themselves can be submitted to a second factor analysis. At this second level of factor structure four dimensions have been well identified; and weights and constants are provided in the Handbook to compute second stratum factor scores from primary factor stens. Thus, for this study the 16 PF yielded scores on 20 different personality dimensions. These are listed and labelled in Table 5.

TABLE 5

16 PF VARIABLES

Label	Trait	Low Score Description	High Score Description
Primary Factors			
A a	Sizothymia vs Affectothymia	reserved	outgoing
B	Crystallized Intelligence	less intelligent	more intelligent
C a	Ego Strength	affected by feelings	emotionally stable
E	Dominance	submissive	dominant
F	Surgency	serious	happy-go-lucky
G a	Superego Strength	expedient	conscientious
H	Threctia vs Parmia	timid	venturesome
I	Harria vs. Premsia	tough-minded	sensitive
L a	Alaxia vs Protension	trusting	suspicious
M a	Praxernia vs Autia	practical	imaginative
N	Shrewdness	forthright	shrewd
O	Guilt Proneness	self-assured	apprehensive
Q_1	Radicalism	conservative	experimenting
Q_2	Self-sufficiency	group dependent	self-sufficient
Q_3	Self Sentiment	careless, lax	socially controlled
Q_4 a	Ergic Tension	relaxed	tense
Second-order Factors			
Q_I	Invia vs Exvia	introverted	extraverted
Q_{II} a	Anxiety	low anxiety	high anxiety
Q_{III} a	Pathemia vs Cortertia	responsive emotionality	tough poise
Q_{IV}	Subduedness vs Independence	subduedness	independence

Note: a - Factors hypothesized here to be related to Primary Process Integration.

Catalog of Variables

A complete listing of the main variables that were finally found suitable for use in the study follows.

Alpha variables. Here the suffix ".lg" indicates log transformation of the measure; the suffix "r", regression transformation.

Alpha Level

AL.lg	Mean alpha level over all conditions on the experimental day.

Alpha Blocking

AB1.lg and AB1r	Average difference in mean alpha level between baseline and first ten seconds following slide presentations.
AB2.lg and AB2r	Average difference in mean alpha level between baseline and last twenty seconds of minute following slide presentations.

Alpha Variability

AV1.lg	Standard deviation of the distribution of alpha scores for the waiting period preceding the feedback period.
AV2	Coefficient of Variation (CV) for the waiting period computed by dividing standard deviation by the mean.
AV3r	Computed by regressing the standard deviation on the mean for the waiting period.

Feedback Success

FS1.lg and FS1r	Difference in alpha level between "on" & "off" conditions in feedback control procedure.

FS3.1g and FS3r	Difference in mean alpha level between the waiting and feedback periods.
FS4.1g and FS4r	Difference in mean alpha level between the first and last quarters of the feedback period.

16 PF Factors

A, C, G, L, M, Q_I, Q_{II} and Q_{III}	Cattell's labels for the factors that were assumed to reflect Primary Process Integration.

Subjective Experience Measures

RA	Reported Attention, a measure tapping the degree to which alpha was found to be associated with relaxation of attention.
RC	Reported Content, a measure tapping the degree to which alpha was found to be associated with mental content that was primary process in nature.
RL	Reported Liking, a measure tapping how much the feedback experience was liked.

Mood Adjective Check List Variables

VIG Vigor CON Concentration NON Nonchalance FAT Fatigue	These were assumed to reflect feeling states related to level of arousal.
SAF Social Affection SUR Surgency ELT Elation GFL Good Feelings	These were included for exploratory purposes. GFL was created by summing VIG, SAF, SUR and ELT.

Statistical Analyses

Hypotheses were tested by computing Pearson product moment correlations among the main variables, using two-tailed tests against the null hypothesis of zero correlation. Because of the great number of coefficients computed, there was a danger of accepting some significant results that might emerge merely as a matter of chance. To safeguard against this, the total sample of fifty subjects (referred to hereafter as T) was divided into two sub-groups, A and B, that were matched for age, sex and mean alpha level. In addition it seemed advisable, for reasons soon to be detailed, to create two additional sub-groups, L and H, by simply dividing T at the median of mean alpha level scores. Thus, for any correlation between two variables, five correlation coefficients were computed, one each for A, B, T, L and H.

When a finding for T did not emerge consistently in both A and B, there was thus a basis for suspecting that the effect was not reliable. The L and H findings were of interest because of certain systematic variations in relationships between variables that depended on differences in mean alpha level.

In the regression transformation of scores, separate regression equations were computed for each of the five groupings. Thus, the actual score that a subject got on a given transformed variable was different in each of the groups in which he appeared.

CHAPTER III

RESULTS

Characteristics of Alpha Data

Some skewness of alpha score distributions was anticipated, but not of the magnitude obtained. Table 6 presents frequency distributions of four variables as examples of this: AL (average alpha level during the entire second session), AV1 (standard deviation of alpha for the waiting period), AB1 (measuring drop in alpha immediately following slide presentation), and FS4 (the rise in alpha from first half of feedback period to the second). The positive skewness here,

TABLE 6

FREQUENCY DISTRIBUTIONS OF ALPHA SCORES

AL		FS4		AB1		AV1	
Range	f	Range	f	Range	f	Range	f
5.8/17.0	28	-1.2/1.1	18	-1.4/3.0	34	0.8/4.6	30
17.0/28.2	13	1.1/3.4	14	3.0/7.4	9	4.6/8.4	10
28.2/39.4	4	3.4/5.7	8	7.4/11.8	5	8.4/12.2	8
39.4/50.6	4	5.7/8.0	6	11.8/16.2	1	12.2/16.0	1
50.6/62.4	1	8.0/10.3	4	16.2/20.7	1	16.0/19.9	1

typical of all basic alpha scores in the study, necessitated log transformations.

Using the same four variables as examples, Table 7 illustrates the high intercorrelations among the basic alpha scores. These could be largely accounted for in terms of variance associated with alpha level; and on that basis the use of regression transformations was indicated. Intercorrelations of other alpha scores will appear in later tables.

TABLE 7

EXAMPLE ALPHA SCORE INTERCORRELATIONS

Untransformed data				Log transformed data			
	FS4	AB1	AV1		FS4.lg	AB1.lg	AV1.lg
AL	.64	.93	.80	AL.lg	.42	.81	.83
FS4		.57	.58	FS4.lg		.36	.44
AB1			.77	AB1.lg			.74

Table 8 shows that the variables entered into each regression analysis were highly correlated, as they must

TABLE 8

REGRESSION RESIDUAL TRANSFORMATIONS

Score	Predictor variable, (x)	Predicted variable, (y)	r_{xy}
AB1r	AL	early blocking level	.94
AB2r	AL	late blocking level	.97
AV3r	waiting level	waiting std. deviation	.85
FS1r	"off" level	"on" level	.96
FS3r	waiting level	feedback level	.97
FS4r	1st half, feedback	2nd half, feedback	.98

be in order for the residuals to constitute significantly new scalings of the subjects. Both the high correlations in Table 8 and inspection of scatter plots indicated high linearity in all cases.

Composition of Sub-groups

As planned, the total sample of 50 was divided into sub-groups, A and B, matched for sex, age and alpha level. Two other sub-groups, L and H, were also formed by dividing the sample at the median alpha level score. Interest here was particularly in the H, or high alpha, sub-group. Because there were so many low alpha subjects in the total group, T, there are a number of subjects even in sub-group H with fairly low alpha levels. This sub-group, then, comes closer than any of the others to approximating the distribution of average alpha levels in the population at large. It also comes the closest to approximating distributions of alpha level in those researches in the literature where low alpha Ss have been excluded from experimental groups.

Table 9 gives the sex composition of the four sub-groups and shows as well that neither in L nor H was there a preponderance of subjects from either A or B and that the

TABLE 9

COMPOSITION OF SUB-GROUPS

		Sub-group L		Sub-group M	
		males	females	males	females
Sub-group A	males	6		7	
	females		6		6
Sub-group B	males	8		5	
	females		5		7

proportion of males to females was roughly the same in all groups.

Table 10 describes characteristics of all of the groups on alpha level and age, the two other variables that were

TABLE 10

ALPHA LEVEL AND AGE OF SUB-GROUPS

Alpha Level			Age		
Sub-group	Mean	S.D.	Sub-group	Mean	S.D.
A	19.52	13.62	A	29.32	9.94
B	18.41	11.01	B	28.08	8.28
T	18.96	12.27	T	28.70	9.07
L	10.61	2.75	L	30.84	10.27
H	27.32	12.43	H	26.56	7.28

used to match A and B. It will be noted that low alpha Ss tended to be older than the high alpha Ss. Correlations between Age and AL.lg for the five groupings A, B, T, L and H were, in the same order, -.39, -.28, -.34, -.38 and -.16. Only the correlation for T of -.34 is significant ($p<.05$, two-tailed). Exhaustive search of correlations of both age and sex with all other variables in this study yielded only this one weak relationship.

Alpha Blocking (AB)

Test-retest reliabilities of AB scores are given in Table 11 along with the correlations between alpha level and the Day 2 AB scores. It will be noted that both AB1.1g and AB1r exhibit some reliability while the AB2 scores do not. Also, AB2.1g does not correlate appreciably with alpha level in exception to the general rule that difference scores and mean alpha level have high positive correlation. Both of these findings for AB2 indicate there is something wrong with

TABLE 11

ALPHA BLOCKING CORRELATIONS

	Sub-group	Day 2 AB scores			
		AB1.1g	AB2.1g	AB1r	AB2r
Correlations with corresponding Day 1 AB scores.	A	.89	-.04	.76	-.04
	B	.68	.19	.48	.20
	T	.81	.05	.63	.10
	L	.75	.01	.39	-.01
	H	.68	.05	.61	.07
Correlations with AL.1g.	A	.76	.13	-.21	.04
	B	.88	-.23	.04	.09
	T	.81	-.12	-.11	.07
	L	.41	-.04	.04	.01
	H	.80	-.20	-.04	.07

the measure. The corresponding findings for AB1, on the other hand, suggest suitable measurement of a real dimension.

Inspection of the raw data indicated that the success of AB1 was due in part to the fact that the latency of the shift towards beta activity immediately after slide presentation tended to be roughly the same for a given subject across the different presentations. The failure of AB2 was due to the lack of uniformity in timing of the shifts between alpha and beta subsequently occurring. When alpha bursts tended to occur at different times on each slide for a subject, the recovery function averaged over the six slides tended to emerge with expected shape; but when alpha bursts had occurred at roughly the same time on different slides, the averaged alpha level at that point took a big jump, marked lows also tended to occur, and the plotted recovery function became erratic. In short, averaging across only six slides did not provide sufficient opportunity to cancel out variations due to the timing of alpha bursts; hence, the AB2 measure did not work and will not be referred to again.

Correlations of AB1r with AL were exactly zero - with AL.lg, close to zero. The log transformation introduces a negligible amount of variance here.

The reliability estimates for AB1r cannot be explained by variance associated with mean alpha level. The estimate for sub-group L is low because of the restricted score ranges.

Although precise estimates of the variance accounted for by these correlations cannot be made here, it nevertheless appears that some 60% of the variance of AB1.1g was associated with mean alpha level while some 40% of the variance of AB1r is reliable on test-retest. Since there must be a fair amount of error variance in these scores, it seems clear that the regression transformation has not only successfully removed variance associated with alpha level, but has also magnified in effect variance that more properly measures individual differences in alpha blocking.

Alpha Variability (AV)

Since it was thought that subjects' efforts to influence alpha during feedback would affect alpha variability, AV measures used for hypothesis testing were drawn from the waiting period. However, feedback AV measures were also computed to check how consistently individual differences in AV would be maintained across the two conditions (Table 12).

With the exception again of sub-group L, consistency was high, indicating that individual differences in alpha variability have some stability. Consistency was lowest for

TABLE 12

ALPHA VARIABILITY CORRELATIONS

	Sub-group	Waiting period AV scores		
		AV1.1g	AV2	AV3r
Correlations with feedback period AV scores	A	.85	.51	.60
	B	.90	.72	.83
	T	.87	.61	.78
	L	.42	.33	.26
	H	.79	.67	.80
Correlations with AL.1g.	A	.84	.07	.05
	B	.83	.33	-.04
	T	.83	.19	-.01
	L	.45	-.18	-13
	H	.58	-.19	-.05

AV2, the Coefficient of Variation measure. The CV measure also seems inferior to AV3r in that it contains some variance associated with alpha level although designed not to. Hence, the residual score seems preferable on two counts.

TABLE 13

CORRELATIONS AMONG ALPHA VARIABILITY MEASURES

Sub-group	AV1.1g with AV2	AV1.1g with AV3r	AV2 with AV3r
A	.58	.52	.90
B	.76	.34	.81
T	.67	.42	.86
L	.75	.77	.98
H	.64	.67	.93

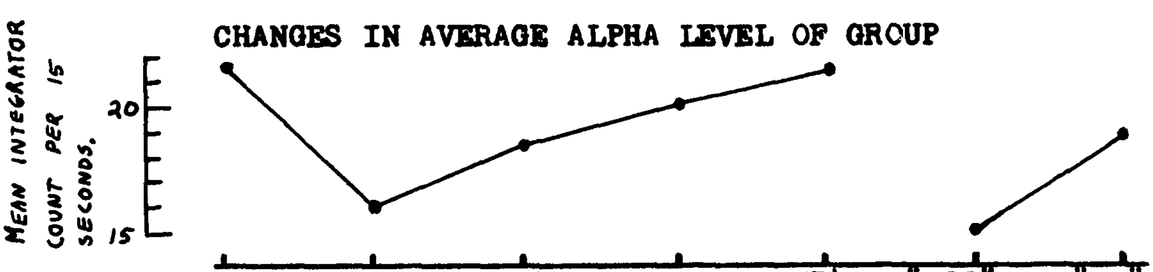
It is also clear in Table 13 that AV2 is more closely related to AV1.1g than AV3r, further indicating the superiority of the latter for present purposes. It is worth stressing that the regression technique has worked well here; this also seemed to be the case for AB1r as well. Thus, the findings for both of these measures supports the validity of computing residuals in this study even though the variables entered into the regression analyses are not normally distributed. Because AV2 was relatively inferior to AV3r, highly correlated with AV3r and yielded no significant findings differing from AV3r, no further AV2 results will be presented.

Alpha Feedback

Figure 3 graphs the changes in average alpha level for the whole group across the waiting, feedback and feedback control periods. The feedback period has been divided into quarters here. The group pattern of alpha trends was exhibited individually by a majority of subjects as can be seen from the frequencies tabled in the main diagonal of Table 14.

FIGURE 3

CHANGES IN AVERAGE ALPHA LEVEL OF GROUP



	Wait	FB1	FB2	FB3	FB4	"off"	"on"
Mean:	21.3	16.6	18.6	20.2	21.2	15.9	19.2
S. Dev:	13.7	11.5	12.7	13.7	14.0	9.5	13.5

TABLE 14

CONSISTENCY OF CHANGES IN ALPHA LEVEL ACROSS WAITING, FEEDBACK AND FEEDBACK CONTROL PERIODS

		FB1	FB2	FB3	FB4	"off"	"on"
Wait	f:	3	12	16	25	9	22
	z:	-6.08	-3.54	-2.40	0.0 a	-4.38	-0.71a
FB1	f:		40	47	47	30	45
	z:		4.10	6.08	6.08	1.27a	5.52
FB2	f:			42	40	18	36
	z:			4.67	4.10	-1.84a	2.97
FB3	f:				38	9	31
	z:				3.54	-4.38	1.55a
FB4	f:					3	19
	z:					-6.08	-1.55a
"off"	f:						44
	z:						5.23

Notes: a Non-significant z score.
f Number of subjects whose column score was greater than row score, e.g. "off" > FB2 for 18 Ss.
z Z scores estimate the significance of the difference between the null hypothesis frequency of 25 and the obtained frequency, after correction for continuity.

The standard deviations of the group's mean scores for the seven epochs in Figure 3 show trends that are nearly identical to the averages. In fact the correlation between the seven standard deviations and averages is .93. It has been repeatedly stressed before that alpha variability and alpha level are highly correlated across subjects. It now appears that the same pattern exists for group results across different conditions. This broadens the generality of the phenomenon.

Departures from the common pattern depicted in Figure 3 occurred chiefly in subjects with below average alpha levels who showed very little change of any kind. Trends of these basically "flat" subjects were erratic for the most part although in a few cases declines in alpha during feedback were present. But again, the declines were so small in size that the records of these and all other "flat" subjects could best be described as showing no marked change of any kind.

For most subjects alpha increased at a near linear rate from FB1 to FB3. The main reason that the FB1 group average level is somewhat low is that some subjects exhibited an alpha blocking and recovery effect at the start of the feedback period, i.e. their alpha levels were particularly low during the first minute of the period. After the first minute, with recovery completed the linear trend asserted itself.

A more common exception to the general pattern of steady increase during feedback was for alpha activity to level off or even show some small decline in the last quarter of the period. Although some subjects showed linear increase right to the end, the data for the group as a whole were in agreement with the reported finding that maximum feedback levels are generally reached within a period of approximately fifteen minutes (Travis, Kondo and Knott, 1972).

Maximum feedback level appears to be something quite close to average alpha level exhibited in the resting condition of the waiting period. Although FB4 scores for half the group were greater than their waiting scores (see Table 14), all of the obtained differences were small and the group mean for FB4 was less than the waiting group mean. Similarly, "on" control period levels for the group were not significantly different from waiting, FB3 or FB4 levels, and "off" levels were not significantly different from FB1 and FB2. In sum, these patterns support the conclusion of Lynch and Paskewitz (1971) that the changes in alpha observed during feedback are chiefly a matter of suppression effects. Exposure to feedback causes a reduction in alpha activity at the start, and subjects can learn techniques to volitionally suppress alpha. On the other hand, increases in alpha above levels normally observed in resting conditions are rare indeed. The present data, of course, limit this generalization to a single feedback session. No subject in this experiment was able to materially exceed his waiting alpha level at any other point.

Feedback Success (FS)

Table 15 presents the intercorrelations among the various FS scores and Al.1g. Most of the negative correlations in the table involve FS3.1g, tapping the difference in mean alpha level between the waiting and feedback periods. Because most subjects did not obtain mean feedback levels that were higher than mean waiting levels, the FS3 score distribution consisted largely of negative values. In line with the general principle that the absolute size of difference scores increase as alpha level increases, FS3.1g is negatively correlated with AL.1g, and tends to be negatively correlated as well with the other FS difference scores that are positively correlated with alpha level (those positive correlations reflecting, of course, the same general principle). In short the correlations among the difference scores FS1.1g, FS3.1g and FS4.1g are all largely accounted for by variance the measures share with AL.1g; and they cannot be interpreted to reflect behaviorally meaningful relationships among the different types of feedback success.

Correlations among the residual scores do not show any strong and consistent pattern across the sub-groups with the one exception of the negative relationship between FS3r and FS4r. The reasons for this negative relationship lie in the general tendencies for alpha levels at the end of the feedback period to be close to waiting period levels and for the amount of increase during feedback to depend in part on how much alpha had been suppressed from waiting level initially. The more alpha was suppressed at the start of the feedback period, the bigger the increase during the period (FS4) and the bigger the difference between mean waiting and mean feedback levels (FS3). Hence, a relationship exists between FS3r and FS4r because both tap aspects of this suppression-recovery pattern; and it is negative because each taps the matter from a different direction.

It seems paradoxical that two measures with the same aim would be negatively correlated, and an analogy may make the matter clearer. A person recovering from a serious illness has to improve more in order to recover, yet at the end of that time he may still be less healthy, i.e. show less "health success". Although this analogy may provide some insight into the paradox, it does not resolve it. The question remains: which is the more proper measure of feedback

TABLE 15

FEEDBACK SUCCESS INTERCORRELATIONS

	Sub-Grp.	FS1.1g	FS1r	FS3.1g	FS3r	FS4.1g	FS4r
AL.1g	A	63	8	-15	1	28	22
	B	76	35	-38	17	72	22
	T	69	22	-26	10	42	21
	L	40	29	-24	29	36	15
	H	66	37	12	28	4	12
FS1.1g	A		65	14	28	- 1	-18
	B		77	-53	- 7	65	37
	T		70	-29	5	21	4
	L		97	- 5	15	26	35
	H		76	-15	2	- 5	- 2
FS1r	A			51	56	-21	-17
	B			-57	-32	39	33
	T			-32	- 8	4	8
	L			8	23	27	41
	H			32	-15	- 4	11
FS3.1g	A				98	-21	-33
	B				76	-64	-79
	T				84	-34	-50
	L				85	- 3	11
	H				90	-23	-40
FS3r	A					-12	-25
	B					-30	-75
	T					-20	-44
	L					21	23
	H					-22	-37
FS4.1g	A						83
	B						74
	T						79
	L						91
	H						76

Note: Decimal points omitted.

success, FS3r or FS4r?

Since the correlations between the two measures are not particularly great in size, it seems that each taps "feedback success" in a different way more than in a way related to the other. This suggests that feedback success cannot be a unitary construct. The foregoing discussion also suggests, more generally, that the task of measuring change is not as straightforward as it may seem. Unexpected anomalies arise when one attempts to measure what seems like a simple construct. (The reader interested in such issues is referred to Bereiter, 1963, for a sophisticated discussion of the still unresolved conceptual and statistical problems which reside in the relationship between change measures and the scores on which they are based.)

Another problem to be noted in the relationship between FS3r and FS4r is the positive correlation in sub-group L which contrasts with the negative coefficients in the other groupings. Although neither the L nor H correlations are significant, the difference between them is ($p < .04$, two-tailed, tested by converting the coefficients to z deviates). This significant difference may result simply from sampling variations, or it may reflect the presence of a curvilinear relationship between these two variables in the total group that is associated with mean alpha level. That is, the L and H results each tap one half of the whole curvilinear pattern. Arguing against the curvilinear interpretation is the significant linear correlation for the whole group, T, and also the fact that comparable discrepancies are also evident between A and B results. For example, the difference between the A and B coefficients for the FS1r/FS3r relationship is bigger than that between the L and H results just discussed. This A/B difference seems to be purely a matter of sampling variation. Support for the curvilinear interpretation, however, was gained in analyses that dealt with two supplementary variables derived from the feedback period data.

Inspection of computer plotted changes in alpha level during the feedback period indicated that straight lines could be easily fitted by eye to each subject's feedback trends. Accordingly, it was decided to regress each S's feedback data on time, the slope of the regression lines thus obtained becoming an additional measure of feedback success. To remove the effects of differences in alpha level and variability on this measure of rate of alpha increase during feedback, each S's distribution of 60 raw feedback alpha scores (from the segmentation of the feedback period into 60 fifteen second epochs) was first standardized so that the distributions of all subjects had the same mean and standard deviation.

In the entire sample, this feedback slope measure (FBsl) ranged in value from -.006 to .036. Sixty percent of the FBsl scores fell between .011 and .029. Clearly, there was little variation among Ss in their rates of alpha increase when differences in mean alpha level were removed from the picture; and the rates appear quite slow.

The second measure to be derived post hoc from the feedback data was a time series statistic developed by von Neumann (von Neumann, 1941; von Neumann et al., 1941). This statistic (which is completely independent of the mean of the series) consists of the ratio of the mean square successive difference to the variance. That is, the differences between all contiguous pairs of data points in a time series are squared, summed, averaged, and then divided by the variance of the whole series. If a time series has smooth trends, the difference between successive data points will be small and the statistic will have a low value. On the other hand, if there are many erratic fluctuations in level, a high value will result. In short, the statistic taps the "smoothness" of a time series, and seemed of interest here since it could be theorized to reflect smooth homeostatic regulation of the alpha-beta alternation. (Burdick, 1972, has discussed the usefulness of von Neumann's statistic for psychophysiology. It has been employed in an EEG study, Murphree et al., 1967, and a GSR study, Leiderman and Shapiro, 1962.)

Called "k" by von Neumann, as computed here for each S's time series of 60 feedback alpha scores, it will be referred to as FBk. Scoring direction of the measure has been reversed in this study so that high scores mean high "smoothness" of feedback alpha trends.

Table 16 presents the intercorrelations among AL.1g, AV3r, FS3r, FS4r, FBs1 and FBk. It is strikingly clear that FS4, FBs1 and FBk share considerable variance in common. A strong relationship between FS4 and FBs1 is to be expected since each is an alpha level-free measure of the amount of rise in alpha during the feedback period. The relationships between these two measures and FBk indicates that the "smoothness" of feedback alpha is positively related to the size of feedback increases in alpha. If "smoothness" does reflect quality of homeostatic regulation, it would appear that subjects with better regulation than others have greater FS4 type of feedback success. This interpretation is in general agreement with theoretical ideas advanced in Chapter I, namely, that greater feedback success is to be expected in Ss whose alpha-beta alternation is functioning optimally.

TABLE 16

CORRELATIONS REFLECTING CURVILINEAR PATTERNS AMONG SELECTED ALPHA VARIABLES

	Grp.	AV3r	FS3r	FS4r	FBs1	FBk
AL.lg	A	5	1	22	29	29
	B	-4	17	22	23	32
	T	-1	10	21	26	30*
	L	-13	29	15	22	37
	H	-5	28	12	-47*	-59**
AV3r	A		-16	26	7	18
	B		4	-28	-5	15
	T		-16	2	-1	16
	L		-46*	30	31	19
	H		-9	-14	-30	3
FS3r	A			-25	-37	-22
	B			-75***	-50*	-24
	T			-44**	-37**	-20
	L			23	3	36
	H			-37	-47*	-27
FS4r	A				80***	64***
	B				79***	57**
	T				80***	62***
	L				82***	57**
	H				69***	47*
FBs1	A					75***
	B					63***
	T					70***
	L					54**
	H					78***

Note. Probabilities are two-tailed. Decimal points omitted.
* $p < .05$ ** $p < .01$ *** $p < .001$

As indices that are independent of alpha level, FBsl and FBk have an advantage over the residual scores in that variance associated with alpha level is removed separately from each S's data. In contrast, the residual scores remove such variance from the group data as a whole in a single operation. A basic assumption in choosing the residual method was that differences in alpha level are devoid of behavioral significance. Findings in Table 16 indicate that this assumption is invalid. When the effects of average level are removed from data in a way that destroys variance within subjects separately, rather than across subjects in a group, relationships associated with alpha level appear - curvilinear relationships.

The reader is referred to the differences between L and H results in Table 16 for the correlations of FBsl and FBk with AL.lg, AV3r and FS3r. The differences (tested by converting correlations to z deviates, two-tailed probabilities) are non-significant for the FBk/AV3r relationship; short of significance for FBsl/FS3r ($p < .07$); significant at the .05 level for FBsl/AL.lg, FBsl/AV3r and FBk/FS3r; and highly significant in the case of FBk/AL.lg ($p < .0005$). For FBk/AV3r there is no L/H difference because FBk is numerically derived from feedback period alpha variability scores and hence has a consistent relationship to AV3r. (Waiting and feedback period variability scores, it will be remembered, were highly correlated in Table 12.)

The high consistency among the A, B and T results for each of these relationships suggest that the significant L/H differences represent real curvilinear patterns that cannot be attributed to sampling variations. Moreover, theoretical interpretation of these patterns suggests that they are related to one another.

It appears that subjects who registered high alpha increases during the feedback period (FBs1) and who exhibited high smoothness of alpha-beta regulation (FBk) tended to be Ss with medium alpha levels (AL.lg), i.e. Ss who were of high alpha level within sub-group L, of low level within H. This may be because Ss with extremely low or high alpha levels were those whose alpha-beta alternation was not functioning at a normal, average level, i.e. the alternation had become biased in either an alpha or beta direction. Loss of smooth regulatory control appears to have been associated with such biasing.

The significant L/H difference for the FBs1/AV3r relationship parallel the FBs1/AL.lg correlational differences but are not statistically dependent on them since AL.lg and

AV3r have no correlation. For low alpha Ss the faster the increase in feedback alpha, the greater the alpha variability. For high alpha Ss the opposite pattern holds. Hence, it appears that, in addition to the "smoothness" of alpha fluctuations, the average extent of fluctuations may also be an important factor related to feedback alpha increases. The finding for sub-group L confirms the theoretical interpretation of alpha variability advanced earlier: the freer the swings between alpha and beta, the better the integration of the underlying regulatory process. The H result contradicts this, but if it is argued that the alpha-beta alternation of high alpha Ss tends to be biased in the alpha direction, low alpha variability in such Ss might reflect compensatory processes that function to keep alpha activity closer to normal bounds. It appears that the more such compensatory processes were characteristic of high alpha Ss, the smaller the feedback alpha increase. This is just what these considerations would lead one to predict.

By a similar rationale, the L/H correlational differences involving FS3r (nearly significant for FBs1/FS3r, significant for FBk/FS3r) suggest that Ss with optimal integration of the alpha-beta alternation are those who showed high suppression of alpha activity at the start of the feedback period. (As discussed above, meaningful variance in FS3r chiefly depends on the suppression effect.) Ss with poorer integration seem to be those who tended not to exhibit the normally expected drop in alpha activity that typically occurs when experimental conditions change. Hence, the FS3r results further support the idea that the changeability of the alpha-beta alternation is directly related to the alternation's integration.

This general idea, however, is not as simple as it may sound since the "integration" referred to is clearly not a unitary dimension. Alpha level, alpha "smoothness" and alpha variability seem to represent different specific aspects of the matter, interacting here in complex and difficult-to-visualize ways in producing these many curvilinear correlational patterns. Interestingly, thorough examination of AB1r results failed to turn up anything that even remotely suggested involvement in these curvilinear interactions. This may be because alpha blocking is a relatively brief response to discrete external stimulation while the other alpha variables deal with the internal processes controlling the alpha-beta alternation as they are manifest over relatively long periods of time.

The existence of curvilinear interactions in the FBs1 and FBK results just discussed seems definite. Are such effects also present in other results, or do the sub-group differences for findings involving residual scores reflect sampling variations? It seems that both possibilities may be actual. If factors are present causing curvilinear effects in the non-residual data, these factors must receive some expression in the residual data as well. On the other hand, in both Table 15 and Table 16, A/B discrepancies in correlational pattern do indicate the presence of noise in the residual data. For example, although the A and B results for the FS3r/FS4r relationship agree in direction of correlation, the B value of -.75 is significantly different from the A value at the .05 level.

The residual transformation was employed to remove "floor" effects from the data, but the curvilinear patterns present suggest that "ceiling" effects were operating as well. That is, there were systematic decreases in the size of differencesand variability scores at both extremes of alpha distributions. Statistically, the floor effect is generally stronger in the total data because of the very low variations in alpha scores among subjects of very low alpha level. Hence, the residual transformation functioned primarily to eliminate floor effects, but its general effectiveness in controlling for variance associated with alpha level must have been weakened by the presence of ceiling effects running counter to the linear pattern it eliminated.

Ceiling effects might be expected to particularly come into play under conditions where subjects are induced to raise alpha levels, i.e. under feedback conditions. If the foregoing discussion is valid, one would expect that feedback residual scores would be particularly contaminated by the problem. This seems to be the case. The residual scores in Table 15 are not as free of alpha level variance as are AB1r and AV3r (Tables 11 and 12). Moreover, the feedback success residuals tend to have quite high correlation with their corresponding difference scores. Some correlation between a difference score and its corresponding residual is mathematically necessary and conceptually desirable, but these high values indicate that the feedback success residuals have little altered the scaling of subjects. The other residual scores seem to have fared much better in this respect. Between AV1.1g and AV3r correlations for the five groupings A, B, T, L and H were, respectively, .52, .34, .42, .77 and .67; for AB1.1g and AB1r, .23, .44, .31, .79 and .48.

Thus, it is concluded here that a major reason for inconsistencies in A/B results for feedback success residuals may be the use of residuals itself. In samples as small as 25, one or two anomalous subjects can have a disproportionately untoward effect on the regression line which determines the size of scores for all Ss. From this point of view A/B discrepancies would be a matter both of random sampling variations and of the magnification, as it were, of such sampling biases by the use of residual scores. By obverse rationale, L/H discrepancies would be less involved with sampling problems since the greater alpha homogeneity of these sub-groups would tend to preclude counterposed operation of floor and ceiling effects. In short, it is argued that sampling variations probably play a greater role in A/B discrepancies than L/H.

Given the apparent advantages of the FBsl measure over FS4r, the reader may later wonder why this measure - and FBk as well - was not used to test hypotheses in this study. Correlations of both variables were in fact explored and yielded little beyond what has just been presented. The writer could not think of satisfactory within subjects methods to control for alpha level in the other alpha variables. Hence, it seemed advisable to simply present hypothesized results according to the original experimental plan and to avoid the complication of interpreting relationships among measures that were variously free and not-free of across subjects variance associated with alpha level.

Hypothesis I

Alpha blocking and Alpha Variability will be negatively correlated.

TABLE 17

CORRELATIONS BETWEEN ALPHA BLOCKING AND ALPHA VARIABILITY

	Sub-Group	AV1.lg	AV3r
AB1.lg	A	70***	15
	B	79***	3
	T	74***	9
	L	25	13
	H	67***	9
AB1r	A	-11	12
	B	20	14
	T	2	10
	L	23	34
	H	22	12

Note: Decimal points omitted.
*** $p < .001$, two-tailed.

The only significant correlations in Table 17, which presents results pertaining to Hypothesis I, are accounted for by variance associated with differences in mean alpha level. Previously presented results show that both AV3r and

ABlr had close to zero relationship with AL.lg. Hence, if anything results here run counter to prediction; but the relationship between AV3r and ABlr is so weak that the safest conclusion is that Alpha Blocking and Alpha Variability individual differences are essentially uncorrelated.

Hypothesis II

Alpha Blocking and Feedback Success will be negatively correlated.

Hypothesis III

Alpha Variability and Feedback Success will be positively correlated.

Table 18 presents results pertaining to Hypotheses II and III. Excepting correlations that can be traced to alpha level associated variance, the only result of note in Table 18 is a barely significant tendency for AV3r and FSlr to have positive correlation. This offers weak support for Hypothesis III, but the failure of the relationship to appear

TABLE 18

CORRELATIONS OF FEEDBACK SUCCESS WITH ALPHA BLOCKING AND VARIABILITY

	Sub-Grp.	FS1.1g	FS1r	FS3.1g	FS3r	FS4.1g	FS4r
AB 1.1g	A	54**	9	-12	2	18	13
	B	75***	39	-45*	4	73	32
	T	63***	24	-30	1	36*	20
	L	14	13	2	21	14	11
	H	72***	44*	- 9	4	7	12
AB1r	A	7	18	21	20	- 4	-24
	B	26	20	-24	-19	20	16
	T	14	16	- 7	- 1	2	- 9
	L	6	9	12	11	13	17
	H	19	15	18	-14	11	- 3
AV 1.1g	A	49*	10	-35	-22	24	32
	B	75***	50*	-52**	-15	82***	39
	T	61***	32*	-42**	-20	44**	34*
	L	37	26	-63***	-39	47*	33
	H	52**	59**	-20	-17	3	16
AV3r	A	- 5	26	-18	-16	- 5	26
	B	10	28	13	4	- 4	-28
	T	6	35*	- 9	-16	0	2
	L	18	14	-38	-46*	29	30
	H	8	41*	- 3	- 9	-10	-14

Note. Decimal points omitted.
Probability levels are two-tailed.
* $p < .05$
** $p < .01$
*** $p < .001$

with comparable strength in sub-groups A and B suggests that the finding may be simply due to random variations in the data, or be confounded by curvilinear interactions. Even if the relationship is valid, it may not necessarily depend on the theory which generated the hypothesis. It may simply reflect that subjects with greater differences in "on" and "off" feedback control period levels obtain these because their alpha levels in general vary more under any conditions that tend to cause a change in alpha level for all Ss. By a similar line of reasoning, one might have expected a positive correlation between FS1r and AB1r since subjects generally achieved their "on"-"off" differences by mobilizing their alpha blocking responsiveness. It is possible that such an effect was operating here but was cancelled out by the presence of another effect, i.e. the one predicted by Hypothesis II.

Leaving such speculation aside, it is concluded that Alpha Blocking and Feedback Success had no clear correlation with each other, and that Alpha Variability showed a weak tendency to correlate positively with only one of the FS measures.

16PF Scores

The standardization norms for each 16PF scale are designed to yield normal distributions with a mean of 5.5 and a standard deviation of 2.0 when raw scores are converted to stens. Actual frequency distributions for the present sample are presented in Table 19, along with approximate values expected on the basis of the general population standardization. Stens greater than 10 were obtained by a few subjects on Q_{II}, Q_{III} and Q_{IV}. Although the basic 16 scales have score ranges of 1 to 10, in computing the second order factor scores from the primary factors, it is possible to get values outside of that range notwithstanding the fact that the standardization of these four was designed to yield the same range as the others.

On factors A, B, G, M, Q_1, Q_2, and Q_{IV} score distributions differed markedly from expected values indicating that the present sample is not representative of the general population. Less extreme deviations from expectation occur on many of the other factors; and only factors F, H, L, O, Q_{II} and Q_{III} approximate expected range, shape and central tendency.

Because the present sample is so atypical of the

TABLE 19

16PF FREQUENCY DISTRIBUTIONS

16PF Var.	Sten Score 1	2	3	4	5	6	7	8	9	10	11	Mean	S.D.
A	4	10	12	12	6	3	3	1				3.58	1.67
B				1	3	2	1	17	13	13		8.42	1.49
C	2	2	13	10	6	7	4	5	1			4.68	1.97
E		1	1	3	7	10	6	10	9	3		6.90	1.91
F	2	3	4	9	6	14	8	2	2			5.20	1.91
G	9	8	10	6	11	3	2	1				3.48	1.84
H	2	6	9	6	8	8	6	3	2			4.74	2.10
I			2	3	4	10	5	9	11	6		7.28	1.96
L		2	2	3	9	14	6	8	5	1		6.24	1.85
M				4	2	4	14	13	6	7		7.52	1.66
N	6	7	6	12	8	4	4	2	1			4.12	2.18
O	1	2	7	4	8	8	6	8	4	2		5.84	2.25
Q_1			1		2	6	9	11	7	14		8.06	1.68
Q_2				3	2	7	8	15	8	7		7.64	1.64
Q_3	4	4	7	8	14	8	2	3				4.42	1.82
Q_4		2	3	2	6	5	16	11	3	2		6.56	1.90
Q_I	3	2	10	12	13	3	5	2				4.46	1.67
Q_{II}	1	3	2	5	8	11	9	8	1	1	1	6.00	2.12
Q_{III}	1		4	7	13	11	4	7	1	1	1	5.73	1.96
Q_{IV}			1	1	3	5	5	12	7	11	5	8.23	1.97
Values expected from general population distribution													
	1	2	5	7	10	10	7	5	2	1		5.50	2.00

general population, scoring ranges on many of the factors are restricted; and this must restrict in turn the size of correlations with these factors. Hypotheses were made about factors A, C, G, L, M, Q_4, Q_{II}, and Q_{III} on the grounds that they reflected Primary Process Integration. Of these, only L, Q_{II} and Q_{III} have score distributions of good statistical quality. The properties of A, G and M are particularly bad.

Hypothesis IV

16PF PPI measures and alpha blocking will be negatively correlated.

Hypothesis V

16PF PPI measures and alpha variability will be positively correlated.

Table 20 presents results pertaining to Hypotheses IV and V. Correlations between the 16PF factors that were not assumed to reflect Primary Process Integration (PPI) and all other variables in this study were also computed, but yielded few noteworthy results. Hence, in Table 20 and in all succeeding tables where 16PF results are presented, only the PPI factors will be included.

TABLE 20

CORRELATIONS OF 16PF SCORES WITH ALPHA LEVEL, ALPHA BLOCKING AND ALPHA VARIABILITY

	Sub-Grp.	16PF factors (direction of relationship to PPI is indicated in parentheses)							
		A (+)	C (+)	G (-)	L (-)	M (+)	Q_4 (-)	Q_{II} (-)	Q_{III} (-)
AL.lg	A	-11	-13	-18	26	8	- 1	3	17
	B	30	20	7	-13	9	- 8	- 9	-14
	T	8	2	- 7	10	9	- 4	- 3	1
	L	-28	7	- 5	- 5	-17	0	0	30
	H	- 2	-25	-15	7	21	26	31	- 6
ABl.lg	A	-12	- 4	-33	21	29	-21	-16	37
	B	34	4	24	- 7	4	6	4	-12
	T	10	0	- 8	10	19	- 8	- 7	12
	L	-14	20	-10	-17	23	-31	-38	44*
	H	4	-45*	-10	23	8	40*	50*	- 5
ABlr	A	-23	-25	-29	17	14	7	19	32
	B	28	-26	50*	1	-19	16	23	-19
	T	- 2	-27	4	13	2	11	21	8
	L	-21	2	6	0	13	-21	-23	47*
	H	1	-37	6	17	-14	19	32	2
AVl.lg	A	-23	-21	1	40*	- 8	- 8	- 3	38
	B	48*	3	15	3	5	- 2	6	-34
	T	14	-10	8	23	- 2	- 5	2	- 2
	L	-25	-33	32	35	-37	-10	15	24
	H	14	-28	- 2	14	11	39	39	17
AV3r	A	-15	-11	8	32	-13	- 2	- 8	40*
	B	31	0	- 1	12	5	14	17	-14
	T	20	1	7	13	- 4	5	5	- 3
	L	-12	-41*	34	42*	-18	-12	13	6
	H	23	7	- 2	6	- 1	20	14	- 6

Note: Decimal points are omitted.
Probability levels are two-tailed.
* $P < .05$

In Table 20, significant correlations involving the total sample are none; and, while a few appear in the results for sub-groups A and B, they are not confirmed by both A and B. A few significant findings for sub-group L are all opposite to predicted direction, with the exception of the relationships of Q_{III} with ABl.lg and ABlr. Among the low alpha Ss, cortical alertness (Q_{III}) was positively related to amount of alpha blocking. This is probably a chance finding built upon the tendency for Q_{III} to be positively correlated with alpha level in this sub-group. Since the regression transformation was less effective in L, the pattern is maintained with ABlr.

There may be a curvilinear relationship in the correlations between Q_{II} (trait anxiety) and alpha blocking. The pattern in question also appears in the results for C and Q which are the two main primary factors on which the second stratum anxiety factor is based. The L/H difference for ABl.lg/Q_{II} is significant ($p < .002$); for ABlr/Q_{II} it falls short of significance ($p < .07$). It appears that among low alpha Ss high anxiety is associated with low alpha blocking, among high alpha Ss high anxiety is associated with high blocking. Statistically, the pattern here depends in part on a tendency towards positive correlation between Q_{II} and AL.lg in sub-group H, and thus the pattern is weaker in the ABlr results. Since the positive alpha level correlation in H runs counter to the sometimes reported finding that alpha level and trait anxiety are negatively related, it might be suspected that the significant results here are flukes. However, the convergence of other findings with this pattern (discussed below in connection with the results for Hypothesis X) tends to contradict this interpretation. The half of the curvilinear pattern here that appears in sub-group H is in agreement with Hypothesis IV. However, this is the only result in all of the findings pertaining to this hypothesis to offer such agreement.

There are a few scattered, barely significant results for the variability measures. However, most are contrary to prediction, and none show consistency in pattern across the sub-groupings. They are likely chance results. Hence, there is no evidence to support Hypothesis V.

Hypothesis VI

16PF PPI measures and feedback success will be positively correlated.

In Table 21 there are four statistically significant correlational patterns pertaining to this hypothesis. Three of these accord with prediction, namely, the correlations between factor A and FS1r for sub-group A and the total group; between Q_{III} and FS1r for sub-group B; and between M and FS3.1g for sub-group L. However, in each of these three cases, the weakness and, in some cases, opposite direction of results for the other groups raises suspicion that these results are flukes.

TABLE 21

CORRELATIONS OF 16PF SCORES WITH FEEDBACK SUCCESS

	Sub-Grp.	16PF factors (direction of relationship to PPI is indicated in parenthesis)							
		A (+)	C (+)	G (-)	L (-)	M (+)	Q_4 (-)	Q_{II} (-)	Q_{III} (-)
FS1.1g	A	20	- 9	-28	9	- 4	- 1	10	13
	B	28	- 9	12	8	- 1	24	23	-32
	T	24	- 9	-10	9	- 3	12	16	-11
	L	-10	-17	3	11	-28	23	20	25
	H	26	-18	-17	1	1	25	33	-26
FS1r	A	40*	6	-18	2	-14	- 1	2	27
	B	21	-11	- 4	12	6	28	31	-53**
	T	29*	- 3	-11	7	- 4	16	18	-21
	L	2	-11	- 1	6	-19	19	16	20
	H	28	- 3	-17	4	0	20	24	-31
FS3.1g	A	9	5	-25	4	10	12	12	4
	B	-10	4	7	- 2	- 2	3	- 5	37
	T	- 5	4	0	1	0	6	- 1	30*
	L	11	18	-17	-29	48*	16	- 3	-31
	H	2	9	3	13	- 6	- 3	-11	50*
FS3r	A	9	1	-33	7	15	13	13	6
	B	- 6	15	- 2	- 9	12	6	- 3	27
	T	- 8	3	-17	6	11	11	4	28*
	L	2	24	-21	-33	38	16	- 3	-17
	H	- 9	7	-17	19	- 3	2	- 5	55**
FS4.1g	A	-17	- 1	- 1	-18	0	-21	-12	- 9
	B	25	- 2	8	13	13	- 3	3	-17
	T	- 1	- 1	2	- 8	4	-12	- 6	-11
	L	7	-17	-12	16	7	8	18	21
	H	-16	- 2	9	-28	- 5	-12	- 5	-26
FS4r	A	-12	- 2	11	- 4	2	-21	-19	8
	B	- 1	-15	1	24	1	0	4	-14
	T	- 6	- 6	8	7	0	- 9	- 9	- 2
	L	11	-27	-14	22	14	15	23	15
	H	-24	-17	12	- 1	- 6	0	0	- 6

Note: Decimal points omitted.
Probability levels are two-tailed.
* $p < .05$
** $p < .01$

A possible curvilinear pattern appears in the Q_{III} (cortical alertness) correlations with FS3.lg (L/H difference has $p < .005$) and with FS3r (L/H difference has $p < .01$). Although the pattern is somewhat weaker for the residual score, the correlations of FS3.lg and Q_{III} with alpha level (Tables 15 and 20) cannot support the interpretation that either significant differential pattern here is mediated by variance shared with alpha level. Furthermore, the consistency of the A, B and T results for FS3.lg/Q_{III} suggest that the pattern is not due to sampling variations.

Although the half of the pattern that is separately significant here (H) goes against prediction, comparison of the whole pattern with the patterns in Table 16 that were interpreted to reflect quality of regulation of the alpha-beta alternation suggests that Cortertia (Q_{III}) may have a general inverse relationship to how optimally the alpha-beta alternation is integrated as had been theorized. More specifically, on the assumption that Cortertia is positively associated with "high alpha wave interruption in the EEG" (Cattell, Eber and Tatsuoka, 1970, p. 119), it could be argued that in sub-group L high cortical alertness was associated with low suppression of alpha activity at the start of the feedback period (FS3) because the more <u>S</u>s were beta-biased in terms of both Cortertia and average alpha level, the less they could exhibit the typical drop in alpha when experimental conditions changed. This would be a floor effect. In sub-group H the beta bias of high Cortertia scorers would appear to be positively related to the amount of initial feedback alpha suppression since the EEGs of high alpha Ss have plenty of room to swing in a beta direction.

These interpretations are admittedly speculative and statistics that would more directly support the argument are lacking. Q_{III} had very little relationship of any kind with alpha measures thought to be specifically related to alpha-beta regulation, i.e., AV3r, FBsl and FBk. It nevertheless seems suggestive that the one correlational pattern in Table 21 that has some strength appears to be curvilinear in nature and that interpretation of this pattern fits well with previous discussion of other curvilinearities. While the explanations made support the general idea that the alpha-beta alternation is homeostatically regulated, they offer no basis for thinking that primary process integration is associated with such regulation.

In sum, in Table 21 there was only the correlational pattern between Q_{III} and FS3 which seemed to be a possibly real effect. This pattern offered some suggestive support for part of the theory on which Hypothesis VI had been based.

Subjective Reports

Table 22 presents intercorrelations among AL.1g and the three measures derived from the Post-feedback Inquiry. The significant correlation of -.28 between RA (Reported Attention) and RC (Reported Content) for the whole group, suggested that individuals who found alpha to be associated with relaxation of attention tended not to be those who found alpha to be associated with primary process content.

This oppositional pattern was also evident in the written descriptions Ss gave of their feedback experience. Both the experimenter and a blind judge sorted these written protocols into three categories with agreement in 48 of the 50 cases.[1] Using the blind judge's sort, there were 14 Ss who reported they enhanced alpha only by fantasizing; 19, only by relaxing; and 17 who had little to report about feedback in any way. In short, subjects were quite clearly classifiable as being either fantasizers, relaxers or neither. Mean RC scores for these groups in the order given were 7.8, -2.16 and 1.8; the differences among these means were significant ($F = 31.23$, $p < .05$; all three t tests significant at .05 level). RA mean scores, in the same order, were 3.6, 9.2 and 4.8; but here only the difference between fantasizers and relaxers was significant ($t = 2.07$, $p < .05$).

These results strengthened the construct validity of the questionnaire report measures; subjects' free written descriptions of what they did during alpha feedback corresponded with their alpha vs. no-alpha ratings on RA and RC. Results

[1]To Jane Tucker who did the judging, the writer wishes to express his gratitude for her generosity and care.

for the "neither" group are, however, somewhat problematic. This group's written descriptions indicated that they had little clear idea what alpha was about; their RA and RC scores on the other hand indicated some awareness of both relaxation and fantasy associates of alpha. In a few cases Ss seem to have ended up in the neither group because they actually reported both types of experience and could not be put in the only relaxation or only fantasy group, but most of the "neithers" wrote very little. It is possible that some "neithers" did learn things about alpha which they simply didn't trouble to report in their free written descriptions. On the other hand, any S who had an unenlightening, and hence disappointing, feedback experience may not have made accurate forced choice questionnaire reponses. Each way of tapping subjective experience has its drawbacks; but despite these the agreement across methods is strong.

It is stronger for the fantasy type of report than for the relaxation reports. This seems to be because relaxation reports are related to awareness of the alpha blocking phenomenon, particularly to the awareness that relaxation reduces blocking. Because of the commonness of alpha blocking, there were a number of fantasizer-type subjects in the sorting who nevertheless came up with fairly high RA scores. Hence, there was not the same concentration of high RA scores among relaxer subjects as of high RC scores among fantasizers. The majority of subjects had some awareness of relaxation aspects of alpha although not all focussed on these. In contrast, it was a very specific minority of subjects who were fantasizers; the non-fantasizers tended to have absolutely no awareness of such experience.

Analyses of the relationships of the sorting to other variables in the study yielded the same pattern of results that RA and RC showed, and will not be presented to avoid redundancy. The main point of mentioning the sorting at all is that it confirms that there were two main and opposing types of feedback experience in this study.

It is worth mentioning that the method of sorting Ss was designed post hoc, in contrast to the questionnaire. In the initial analyses of the written protocols, 31 different score categories were established by reading the protocols as a group and looking for recurrent patterns such as sensations in the head or feelings of expense or effort. Exhaustive search of the correlates of these post hoc score categories indicated that only fantasy and relaxation type of reports were related to other variables, and this suggested that the two constructs which are the basis for RA and RC cover the only dimensions of feedback experience that are of major significance.

The opposition between RA and RC also exists in their correlations with FL.lg in Table 22. RA is positively correlated with alpha level in sub-group H, negatively in sub-group L; precisely the opposite pattern exists for the L and

TABLE 22

CORRELATIONS AMONG REPORT MEASURES
AND ALPHA LEVEL

	Sub-Grp.	RA	RC	RL
AL.lg	A	19	- 3	- 6
	B	37	- 1	27
	T	27	- 2	12
	L	-25	25	15
	H	38	-22	-31
RA	A		-39	9
	B		-16	21
	T		-28*	16
	L		-25	1
	H		-31	23
RC	A			28
	B			32
	T			29*
	L			63***
	H			-13

Note: Decimal points omitted.
Probability levels are two-tailed.
* $p < .05$
*** $p < .001$

H correlations of RC with AL.lg. Conversion of these coefficients to z deviates to test the significance of their difference yielded a two-tailed probability of less than .12 for the RC results and a two-tailed probability of less than .03 for RA. These findings suggested that each report variable had a curvilinear relationship to alpha level.

To further explore this suggestion, the sample was

TABLE 23

MEAN REPORT SCORES FOR TRI-PARTITE SUB-GROUPINGS
ON ALPHA LEVEL AND ALPHA BLOCKING

Report Variable	LO (n=17)	MID (n=16)	HI (n=17)	F Test	t Tests LO-MID	LO-HI	MID-HI
Sub-grouping on AL.1g							
RA	5.53	2.63	10.06	3.77*	.99	1.80	2.62*
RC	.35	4.63	.59	1.81	1.57	.10	1.64
Sub-grouping on ABl.1g							
RA	3.59	3.13	11.53	7.91***	.17	3.14**	3.42**
RC	.18	4.88	.53	2.18	1.76	.15	1.78
Sub-grouping on ABlr							
RA	2.71	5.13	10.53	4.54*	.90	3.03**	1.94
RC	1.24	4.81	-.47	2.34	1.27	.91	1.98

Note: Two-tailed probabilities.

* $p < .05$
** $p < .01$
*** $p < .005$

divided into three groups on the basis of alpha level: LO, MID and HI. Mean RA and RC scores for each group were found and the significance of their differences tested. Correlations between ABl measures and both RA and RC (see Table 23) had shown the same kind of oppositional pattern as that characterizing the relationships of these report variables to AL.1g. This suggested that curvilinear relationships were present in the case of the AB1 measures as well. Hence, tripartite groupings were done on both AB1.1g and AB1r in the same way as had been done on AL.1g, and mean report scores were analysed in the same way. Table 23 presents the results of these explorations.

It will be noted that RC has an inverted-U shaped relationship to all three alpha variables. RA has an approximate upright-U shaped relationship to AL.1g and AB1r, and an approximate linear relationship to AB1r. While F tests of the mean differences are not all significant in Table 22, analysis of variance of the trends using orthogonal coefficients to test for quadratic curvature in the RA data yielded good results. For the AL.1g sub-grouping, F equalled 5.21 ($p < .05$); for AB1.1g, F equalled 5.30 ($p < .05$). For AB1r, the quadratic component was not significant ($F = .63$); but the linear component was ($F = 8.67$, $p < .01$) . For the RC data, the quadratic component was marginally significant in the case of the AL.1g grouping ($F = 3.28$, $p < .10$), significant in the cases of AB1.1g ($F = 4.12$, $p < .05$), and nearly significant for AB1r ($F = 3.90$, $p < .06$).

The use of orthogonal coefficients may be questioned here since they are designed to be used when the groups are separated by equal scale intervals; but the problem here is not so much that the LO, MID and HI groups were chosen with no regard to this question, as it is that establishing equal intervals in the present sample of skewed alpha scores is not a straight-forward job. For reasons closely related to the need for regression transformations, one would be hard put to establish such a scale after the necessity of discarding the raw alpha scores has been realized. There is no reason to think that the present, simple method of dividing the sample has unduly strengthened or weakened results; and the correspondence in results across the different subgroupings argues that the curvilinearities described here are both statistically and behaviorally significant.

The overall pattern could be described as follows: *Ss* low in alpha level and alpha blocking responsiveness tended to score low on both RA and RC; *Ss* in the mid range of the alpha variables tended to score low on RA, but high on RC; *Ss* with high scores on the alpha variables scored high on RA and low on RC. For the RA results, means of the LO groups were generally close in value to those of the MID groups; for RC, LO means were generally close to HI means. The major effects here appear to have depended primarily on MID and HI *Ss* (note the *t* values), the LO *Ss* simply having low report scores consistently.

It is not possible to conclusively interpret these data, but the following exposition may seem plausible. To a large degree these relationships may reflect the nature of the feedback *Ss* received during the feedback period. *Ss* who had very low alpha levels received very little feedback, saw virtually no change in amount of feedback and had little opportunity to observe alpha blocking. Hence, they had little chance to observe any correlates of their alpha activity and ended up scoring low on both RA and RC. These Ss, of course, tended to be the "neithers" described earlier.

High RA scorers tended to be "relaxers". They had high alpha levels and high alpha blocking scores, the higher the both of these, the higher RA. The relationship here may be that the more prominent the alpha blocking, the more likely S was to get involved in using relaxation to minimize blocking to enhance alpha during feedback.

High RC scorers, the "fantasizers", tended to have moderate alpha levels and alpha blocking. In contrast to LO Ss, they had enough alpha to notice its apparent correlates; in contrast to HI Ss, their alpha blocking was not so marked that it dominated their experience. It is not clear, however, whether the high RC reports of MID subjects reflects a real relationship between alpha and fantasy activity that was salient only in these Ss, or whether these Ss superstitiously came to think this. Lacking the observation of marked blocking to cue their efforts to enhance alpha, they may have let their minds wander as they wondered what to do, eventually coming to feel that fantasizing itself accounted for the gradual increases in feedback that they observed.

Although the case for RA scores being primarily related to the nature of feedback received seems quite strong, the possibility cannot be ruled out that high RA scorers are the kind of individuals who would <u>not</u> be likely to notice that alpha and fantasizing were related if, say, they were in a situation that did not involve observing their own alpha feedback. Weighing against this speculation, however, is the fact that RA was more strongly related to ABl.lg than to ABlr. ABl.lg reflects S's actual feedback experience of alpha blocking much more closely than the regression measures. Some Ss with low ABl.lg scores got high ABlr scores, for example. Thus, it seems likely that the relationships between alpha blocking and RA were largely mediated by Ss' observations of feedback, as was argued earlier.

A similar rationale would argue that RC scores were <u>not</u> primarily determined by differences in feedback experience since the curvilinear relationship of RC to the regression measure, ABlr ($F = 3.90$, $p < .06$), is nearly as strong as it is to ABl.lg ($F = 4.12$, $p < .05$). Although the results for RC in Table 22 fall short of significance, it is clear that the marginally significant curvilinear relationships present cannot be accounted for by variance related to AL.lg, to which RC is most weakly related of all. Thus, although the relationship to ABlr is marginal, the possible effect here cannot be attributed to differences in alpha level or alpha blocking that Ss observed; for, if that were the case, the ABlr results would have been weaker.

In sum, it appears that Ss need a certain minimum amount of alpha if they are going to notice any experiential correlates of alpha. (This seems obvious enough now, but was overlooked in designing the experiment.) Ss who have enough alpha and are high in alpha blocking come to think that alpha is associated with alpha blocking, the more so the higher their alpha level and their alpha blocking; this relationship seems to depend directly on S's observations of alpha blocking during feedback. Ss with sufficient alpha to observe experiential correlates, but who do not have strong blocking responsiveness, tend to find that fantasizing is associated with alpha, the more so, the less their alpha blocking. This conclusion may be superstitious, but there is also reason to think that it may reflect the kind of relationship between alpha and primary process thinking that has been proposed. That is, Ss who are primarily reality oriented (i.e., oriented towards the secondary process and high in alpha blocking) would not be expected to notice fantasy correlates of alpha; but the less a person was oriented to external reality (i.e., the less his alpha blocking), the more he would be apt to notice such an association.

Hypothesis VII

Alpha blocking will be positively correlated with Reported Attention (RA) and negatively correlated with Reported Content (RC) and Reported Liking (RL).

Hypothesis VIII

Alpha variability will be negatively correlated with RA and positively correlated with RC and RL.

Table 24 presents the results pertaining to each of these hypotheses. Significant coefficients were obtained as predicted in the case of alpha blocking and RA; but rather than necessarily supporting the present theory, these results confirm the interpretation made in the preceeding section. Because the biggest correlation was obtained for sub-group H and the correlation for sub-group L was actually negative in the case of AB1.1g and zero in the case of AB1r, the overall pattern indicates, as was previously argued, that among high alpha subjects, greater amounts of alpha blocking are associated with greater amounts of alpha-associated relaxation during feedback. While the correlations of alpha blocking with RC are not significant, their direction agrees with the interpretation made earlier also.

As far as alpha variability is concerned, the only significant correlations involve AV1.1g. These disappear in the case of AV3r which indicates that the AV1.1g results

TABLE 24

CORRELATIONS OF REPORT MEASURES WITH ALPHA BLOCKING AND ALPHA VARIABILITY

Alpha Variables	Sub-Grp.	Report Measures RA	RC	RL
AB1.lg	A	19	- 5	1
	B	51**	6	35
	T	33*	1	19
	L	-16	17	14
	H	62***	-16	- 5
AB1r	A	32	-21	7
	B	58**	- 6	32
	T	42**	-13	18
	L	0	8	24
	H	56**	-14	38
AV1.lg	A	17	2	- 4
	B	40*	8	36
	T	28*	6	20
	L	-21	13	4
	H	49*	10	4
AV3r	A	14	15	24
	B	- 5	15	- 5
	T	5	16	11
	L	- 8	2	4
	H	9	24	8

Note: Decimal points are omitted.
Probability levels are two-tailed.
* $p < .05$
** $p < .01$
*** $p < .001$

depended on variance shared with the alpha level/alpha blocking vector. The results are also contrary to the direction predicted.

None of the RL correlations are significant nor are the remaining correlations for RA and RC that have not been mentioned. In summary, then, there are no results here that clearly support the present theory.

Hypothesis IX

Feedback Success will be negatively correlated with RA and positively correlated with RC and RL.

Table 25 presents the results pertaining to this hypothesis. The only statistically significant correlations are all for sub-group B, and with one exception involve only straight FS difference scores rather than those transformed by the regression technique. None of the significant correlations are very large nor are they confirmed by consistent correlational patterns in the other sub-groups. Hence, it is likely that the results are accidental. Inter-correlations of the variables involved in these significant results, with one another and with alpha level, are consistently stronger for sub-group B than sub-group A in Tables 15 and 22, and inspection of these patterns suggests that some correlations in the direction of the significant findings here might have been expected in any event. In addition, half of the significant correlations in Table 25 run contrary to prediction. In sum, there is no reason to think that any support for Hypothesis IX has been gained here.

TABLE 25

CORRELATIONS BETWEEN REPORT MEASURES AND FEEDBACK SUCCESS

	Sub-Grp.	Report Measures		
		RA	RC	RL
FS1.1g	A	11	3	0
	B	44*	1	32
	T	26	2	18
	L	3	15	20
	H	24	- 2	4
FS1r	A	12	18	17
	B	19	- 9	17
	T	15	3	17
	L	6	12	18
	H	16	3	17
FS3.1g	A	32	-29	26
	B	-40*	3	-41*
	T	-15	- 8	-26
	L	10	8	19
	H	-11	-14	-36
FS3r	A	38	-23	28
	B	-23	- 8	-37
	T	3	-17	-19
	L	- 2	18	29
	H	0	-27	-31
FS4.1g	A	23	3	5
	B	48*	- 3	45*
	T	31	0	21
	L	21	10	25
	H	27	- 3	9
FS4r	A	14	26	10
	B	32	- 1	43*
	T	22	11	27
	L	22	6	17
	H	29	9	15

Note: Decimal points omitted.
Probability levels are two-tailed.
* $p < .05$

<u>Hypothesis X</u>

<u>16PF Primary Process Integration will be negatively correlated with RA and positively correlated with RC and RL.</u>

The significant results in Table 26 that pertain to this hypothesis are all in agreement with prediction. (The reader

TABLE 26

CORRELATIONS BETWEEN REPORT AND 16PF MEASURES

	Sub-Grp.	16PF factors (direction of relationship to PPI is indicated in parentheses)							
		A (+)	C (+)	G (-)	L (-)	M (+)	Q_4 (-)	Q_{II} (-)	Q_{III} (-)
RA	A	-23	-46*	-32	40	17	23	34	31
	B	31	-21	24	1	- 9	19	26	- 5
	T	4	-34*	- 5	24	6	22	30*	13
	L	10	-20	-28	11	23	10	17	28
	H	- 7	-56**	12	31	-21	39	49*	3
RC	A	44*	21	-20	-17	11	-14	-26	- 5
	B	20	-24	9	- 3	-22	11	12	2
	T	30	- 2	- 5	-11	- 3	- 1	- 5	- 3
	L	7	-14	-31	- 2	- 5	3	2	- 1
	H	49*	12	19	-19	0	- 4	-12	- 5
RL	A	35	36	-27	- 3	- 3	-19	-27	-12
	B	-11	-15	14	- 3	- 6	3	1	0
	T	7	7	- 3	- 2	- 5	- 4	-10	- 4
	L	0	5	-29	- 9	- 3	7	- 4	13
	H	5	4	26	0	-15	-10	- 9	-23

Note: Decimal points omitted.
Probability levels are two-tailed.
* $p < .05$
** $p < .01$

should remember that PPI is scored in both positive and negative directions on different 16PF scales.) The significant results are, however, few in number.

Factor A and RC have some positive correlation chiefly among high alpha subjects. If this finding is not a chance effect, it can easily be explained as follows. Cattell describes low scorers on A as being detached, critical in outlook and having a flat and rather cold emotional life. High scorers on the other hand are described as warm-hearted, easygoing and freely expressive of their changeable feelings. One would expect the latter type of person to be more prone to fantasize in the feedback experiment. Thus, this personality factor may have tended to predispose subjects towards this kind of experience in addition to, and independently of, the factor of mean alpha level that has already been discussed. If the finding was determined in this way, it would offer no support for the alpha-primary process theory.

RA has some significant correlations with 16PF factors C and Q_{II} that seem particularly present in high alpha subjects. Since Q_{II} is based largely on factor C, there seems to be really only one correlational pattern here; and it will be discussed in terms of the broader construct, Q_{II} (trait anxiety). It appears that the more anxious the individual, the more likely he was to feel that alpha was associated with relaxation of attention (RA).

In previously discussed results, it has also been found within sub-group H that the more anxious the subject, the higher his alpha blocking (Table 20), and that the higher his alpha blocking, the greater his RA score (Table 24). In short, there seems to be a unitary factor present in H to which RA, AB1 and Q_{II} are all positively related. This finding is of particular interest for two reasons.

First, the AB1/Q_{II} relationship was treated as questionable in the earlier discussion; but the convergence of pattern here indicates that it was a valid reflection of a larger pattern in the data. Even though the AB1/Q_{II} relationship was of opposite direction in sub-group L, indicating a curvilinear pattern, the fact that there is only a suggestive weakening of the RA/Q_{II} correlation for L in Table 26 does not seriously weaken this conclusion. Since many low alpha _S_s did not have proper opportunity to observe experiential correlates of alpha, clear correlational patterns involving report scores should not be expected in sub-group L.

Secondly, the appearance of this small unitary factor here is the only instance where the research strategy of this experiment has had any success in the sense of yielding converging findings from different measurement domains. Interpretation of this convergence in primary process terms is not necessary, however. Tense, anxious subjects might be expected to be particularly involved with relaxation during feedback, and might be expected as well to show marked alpha blocking if it is assumed that anxiety is associated with hyper-alertness to the environment. On the other hand, if anxiety is assumed to be associated with defensiveness against the primary process, the factor could be interpreted to support the primary process theory of alpha.

In sum, there were two significant correlational patterns that agreed with Hypothesis X. One of these seems to have some solidity, but neither can be conslusively interpreted in terms of the primary process theory of alpha.

Feedback Mood Changes

Table 27 presents the means and standard deviations of the mood change scores for each of the sub-groups along with *t* tests of the differances between these difference scores and zero.

Comparison of the standard deviations and means will indicate that in all cases there was a wide range of reported mood changes in both directions so that most mean scores were not significantly different from zero. Excepting Surgency and Fatigue, the group as a whole did not consistently change in feeling state over the feedback period, and even with these two measures there were many subjects who behaved opposite to group trend. For reasons that are not clear the significant results for Surgency and Fatigue involve low alpha subjects more strongly than high alpha subjects. Perhaps the low alpha subjects who saw little actual change in alpha felt more surgently alive and/or more tired because of their unrewarded efforts at raising alpha level.

But this speculation brings up the apparent contradic-

TABLE 27

MEAN DIFFERENCES BETWEEN PRE AND POST FEEDBACK MACL SCORES

Sub-Grp.	Vigor			Social Affection		
	Mean	S.D.	t	Mean	S.D.	t
A	.10	.69	.73	.08	.65	.62
B	.04	.68	.29	.29	.79	1.83
T	.07	.68	.73	.18	.72	1.77
L	.17	.57	1.49	.10	.76	.67
H	-.02	.78	-.03	.27	.68	1.99
	Concentration			Nonchalance		
A	.16	.71	1.13	.10	.64	.78
B	-.19	.71	-1.34	.08	.84	.57
T	-.02	.73	- .94	.09	.74	.86
L	-.16	.83	- .96	.10	.89	.56
H	.13	.59	1.10	.09	.56	.80
	Surgency			Fatigue		
A	.32	.70	2.28*	-.02	.83	-.12
B	.19	.59	1.61	.57	.92	3.10**
T	.26	.65	2.83**	.28	.92	2.14*
L	.26	.60	2.16*	.46	.98	2.35*
H	.26	.70	1.86	.10	.83	.60
	Elation			Good Feelings		
A	-.14	.63	-1.11	.09	.53	.85
B	.06	.63	.48	.15	.46	1.63
T	-.04	.64	- .44	.12	.49	1.73
L	-.05	.60	-.33	.12	.43	1.39
H	-.02	.68	-.15	.12	.55	1.09

Note: Probability levels are two-tailed.

* $p < .05$

** $p < .01$

tion between the two sets of results which can be only partly accounted for by the fact that Surgency and Fatigue scores tended to be negatively correlated (Table 28). That is, subjects who became more surgent tended not to be ones who became less fatigued. However, since this relationship was weak in L, there apparently were a number of subjects in this sub-group who felt both more alive and more tired after feedback. A similar paradox is apparent in the negative correlations between Nonchalance and Vigor in Table 28. These results raise suspicion about the validity of these MACL scores.

More generally it is suspicious that so little consistency in mood change existed with each measure because alpha changes during feedback were remarkably consistent for most subjects. Obviously there can be no strong relationship between amount of alpha increase and feeling state change here.

Consistencies in the <u>reporting</u> of mood changes is indicated, however, by Table 28 which has been arranged to show three rough clusterings of variables. One cluster consists of Concentration and Nonchalance; another of Fatigue and Vigor; and the last of the Good Feelings factor and three of the scores on which it is based, Social Affection, Surgency and Elation. The first mentioned cluster has virtually no relation to the third while the FAT and VIG cluster has moderately strong relationships with each of the other two clusters. That such strikingly obvious correlational patterns emerge

TABLE 28

CORRELATIONS AMONG MACL CHANGE MEASURES

	Sub-Grp.	NON	FAT	VIG	SAF	SUR	ELT	GFL
CON	A	-30	-39	16	9	0	-21	1
	B	-41*	-24	41*	8	25	13	31
	T	-35*	-36**	28*	4	13	- 8	13
	L	-46*	-30	46*	5	19	- 2	23
	H	-12	-40*	21	- 4	9	-16	4
NON	A		45*	-44*	12	-32	6	-19
	B		- 7	-22	70***	23	26	39
	T		13	-31*	47***	- 3	17	11
	L		10	-40*	41*	- 8	18	9
	H		19	-27	59**	5	17	16
FAT	A			-62***	-21	-51**	-35	-54**
	B			-27	-16	- 5	-25	-27
	T			-42**	-13	-30*	-23	-37**
	L			-23	-19	-17	-26	-31
	H			-70***	1	-45*	-20	-45*
VIG	A				32	63***	32	73***
	B				- 4	31	5	47*
	T				12	48***	17	60**
	L				7	22	- 2	43*
	H				20	66***	31	71***
SAF	A					56**	59**	77***
	B					44*	52**	73***
	T					47***	56***	74***
	L					44*	57**	82***
	H					51**	57**	71***
SUR	A						59**	88***
	B						47*	79***
	T						51***	83***
	L						31	72***
	H						66***	91***
ELT	A							78***
	B							74***
	T							76***
	L							70***
	H							80***

Note: Decimal points omitted.
Probability levels are two-tailed.
* $p < .05$ ** $p < .01$ *** $p < .001$

here indicates that in large measure the size of mood change scores that a subject gave depended simply on how prone he was to change his mood ratings from one administration of the test to another. That is some subjects tended to make big changes on all of the scales; others tended to make little. The latter type of response is also discussed in Appendix B in connection with response biases in this sample against reporting negative feelings. It appears now that other more general types of response bias may also have been operating, and the validity of the MACL scores becomes even more questionable.

Hypothesis XI

Feedback success will be positively correlated with reported decreases in arousal on the MACL change measures of Vigor, Fatigue, Nonchalance and Concentration.

The results in Table 29 confirm the inference made earlier that changes in reported feeling state would not be related to feedback alpha changes. There are some scattered significant results, but the only correlational pattern to show any consistency across sub-groups is that involving Vigor and both FS3.1g and FS4.1g. Given the considerations raised in the preceeding section and given the fact that in Appendix B it is made clear that Vigor is one of the poorest measures included in analyses (16 of 50 subjects reported no mood change at all on Vigor), these results must be treated

TABLE 29

CORRELATIONS BETWEEN FEEDBACK SUCCESS AND MACL SCORES

	Sub-Grp.	MACL Variables							
		VIG	SAF	CON	NON	SUR	FAT	ELT	GFL
Fs1. 1g	A	- 1	- 1	24	-11	-17	-12	-26	-14
	B	-34	19	-12	14	-22	- 9	13	- 7
	T	-17	9	7	3	-19	- 9	- 7	-11
	L	-38	2	4	6	-24	- 8	-13	-25
	H	- 3	5	- 8	3	-23	4	- 9	- 9
FS1r	A	4	-23	8	-30	-12	-16	-11	-13
	B	-41*	28	-22	35	-31	7	6	-11
	T	-21	8	- 9	10	-21	- 2	- 1	-12
	L	-36	- 8	9	- 2	-28	- 6	-23	-34
	H	-12	11	-28	18	-22	6	6	- 6
FS3. 1g	A	10	-38	-23	-32	3	- 2	- 9	-10
	B	48*	- 1	0	-11	26	- 9	- 8	23
	T	35*	-12	1	-14	19	-14	-11	10
	L	- 2	- 4	- 9	- 2	-20	20	-23	-17
	H	40*	-11	19	-28	30	-41*	-11	17
FS3r	A	12	-36	-18	-32	0	- 3	-18	-12
	B	36	- 7	1	-22	21	-12	8	20
	T	29*	-16	1	-20	15	-13	- 9	6
	L	8	-17	- 2	- 3	-19	11	-26	-20
	H	36	-19	12	-37	33	-35	- 3	16
FS4. 1g	A	-25	-12	33	9	-18	3	-51**	-33
	B	-40*	- 3	12	-15	- 5	- 9	20	-10
	T	-29*	- 8	25	- 1	-13	- 3	-24	-25
	L	- 6	-43*	36	-36	-11	- 5	-26	-34
	H	-33	- 3	10	25	-17	15	-30	-27
FS4r	A	- 3	- 4	36	3	- 5	-12	-36	-15
	B	-39	11	0	12	0	7	22	- 2
	T	-18	0	23	7	- 2	- 8	-12	-11
	L	-15	-37	36	-34	-14	- 2	-28	-36
	H	-10	7	5	31	- 4	- 1	-15	- 7

Note: Decimal points omitted.
Probability levels are two-tailed.
* $p < .05$
** $p < .01$

with caution. Even if accepted, these results are difficult to interpret.

First of all they involve the puzzling negative correlation between FS3.lg and FS4.lg which has been discussed earlier. The correlations with FS4.lg here support Hypothesis XI while those with FS3.lg do not. What tied the two FS measures together was the alpha suppression effect. Thus, these results would suggest that the more alpha level dropped at the start of feedback, the less vigorous subjects felt at the end of the period. There is no obvious way to relate this effect to alpha arousal theory.

Another aspect of the correlational pattern is that it emerges only weakly among the corresponding FS regression measures. That is, the size of changes on Vigor were more closely related to the actual size of alpha changes that occurred than to what might be termed the effective size of changes which were relative to subjects' mean alpha levels. This suggests that the relationship, if it is valid, was mediated by subjects' awareness of the actual alpha changes they observed rather than by functionally significant changes in alpha level. The results are stronger among high alpha subjects. This is what would be expected if the relationships were so mediated since these were the only subjects to observe marked changes in alpha level.

In sum, there are no findings here that offer clear support for Hypothesis XI. The lack of relationship may be due only to the invalidity of the MACL scores which appear to have been affected by a number of response biases. Contaminating tendencies may have included avoidance of reporting negative feelings and a bias towards reporting positive feelings, individual differences in the general size of mood changes reported, and the influence of the actual amount of change in feedback that the subject observed. One mood change measure did yield significant results, but it was not possible to interpret these results as being directly a function of changes in alpha level.

Overview of Results.

This summary and organization of the results that have been presented includes all findings of any interest in the experiment. However, it does not include many of the cases where correlations were not significant, or too weak and inconsistent across sub-groups to be trustworthy. Although there were few significant results that accorded exactly with prediction, and although there were a large number of cases where no finding of any kind seemed clear, it may be worth noting here that there were no solid results that went opposite to prediction, except for cases where one half of a curvilinear relationship did so.

Alpha variables. The alpha blocking residual score, AB1r, had some test-retest reliability as did the alpha variability residual, AV3r, over two different experimental conditions.

Straight difference and variability scores had high correlations with alpha level, and hence with each other as well. When the residual transformation removed these dependencies, the transformed scores were found to be generally independent of one another. However, in some cases there was a significant but small amount of shared variance between certain measures. In one case, alpha variability (AV3r) had some positive correlation with success at "on-off" feedback alpha control, as predicted, but the relationship seemed to be simply a matter of FS1r tapping a special kind of alpha variability.

In a group of other cases, curvilinear relationships between a number of different pairs of alpha scores were found in interaction with differences in mean alpha level. This general finding contradicted a main assumption of the residual method as used here, namely that alpha level differences had no meaning. These curvilinearities were coherently interpreted in terms of the theory that the alpha-beta alternation is homeostatically regulated. The interpretation indicated that rate of alpha increase during the feedback period (FBs1) was positively related to quality of alpha-beta regulation. In this explanation "quality of alpha-beta regulation" was a hypothetical construct which seemed to be the complex product of a number of related but distinct alpha dimensions, i.e. alpha level, alpha variability and alpha "smoothness" (FBk).

The existence of those curvilinearities reduced the effectiveness of the residual transformation in the cases of the feedback scores. Although "floor" effects dominated correlational patterns of other alpha scores, the task of raising alpha level during feedback brought "ceiling" effects into play and thus the curvilinearities. The residuals worked better for alpha blocking and alpha variability where simple, linear, floor effects predominated. In particular, AV3r was shown to be a superior to AV2 (a "Coefficient of Variation" measure) in accomplishing the goal of removing variance associated with mean alpha level.

Experiential reports. Analyses of both questionnaire data and free written descriptions of feedback experience cross-validated the finding that Ss' experiences tended to be of two main, mutually exclusive types. Some Ss tended to use relaxation to enhance feedback alpha and to report that alpha was associated with the absence of mental content. Other Ss tended to find that fantasizing was associated with and enhanced alpha. There was also a third type of "non-experience". Some Ss had too little average alpha to observe anything noteworthy.

The two main types of experience were curvilinearly related to both alpha level and alpha blocking, but with clear statistical significance only in the case of the relaxation type of report (RA). These relationships may have been directly determined by the amount of alpha and alpha blocking _Ss_ observed during feedback rather than being an expression of individual differences in the nature of the alternation between primary process-alpha and secondary process-beta, as had been theoretically proposed. However, the latter interpretation could not be ruled out. Both types of effect may have been operating, the former being relatively more important in the case of RA, the latter in the case of the fantasy type of report (RC).

No conclusion could be drawn about results pertaining to the Mood Adjective Check List reports of changes in feeling state over the feedback period because of evidence that MACL reports were seriously contaminated by a number of strong response biases.

_16PF_. There were just two cases where results pertaining to the 16PF appeared to be solidly significant, and in both cases curvilinear relationships were involved. One pattern involved the 16PF measure of "cortical alertness" (Q_{III}) and the feedback success measure of amount of recovery of alpha level during feedback (FS3). It was interpreted to be in accord with the idea that the alpha-beta alternation is homeostatically regulated.

The other pattern involved the 16PF measure of trait anxiety (Q_{II}), alpha blocking (ABlr) and the relaxation type of feedback report (RA). The emergence of a unitary pattern among these variables was the only instance where the research strategy of this study was successful in yielding converging findings from different measurement domains. The total pattern of relationship could be interpreted to reflect the tenseness and high alpha blocking responsiveness of anxious Ss, but a primary process interpretation could not be ruled out since high anxiety may be associated with avoidance of primary process ideation.

Of questionable significance and meaning was a tendency for 16PF factors A to be positively correlated with RC, particularly in high alpha subjects.

CHAPTER IV

DISCUSSION

Methodological Problems

In the findings reviewed at the end of the last chapter, it is striking that most of the significant correlational patterns discovered are curvilinear in nature. While these results were in accord with the notion that the alpha-beta alternation reflects a homeostatic process, they were few in number and none could be unequivocally interpreted to support the rest of the theory on which this study was based. Opposed to this meager yield were many results that indicated no finding at all. Can the significant results be trusted when they lack converging support from other findings? Although there were no findings that flatly contradicted predictions, it is clear that the experimental yield has been unsatisfactory.

The question to be asked is whether this is due to inadequacies in the theoretical conceptualization of the study or due to inadequacies in the experimental method. The answer, it will be argued, is that both types of inadequacy are involved. Before attempting to evaluate the experimental theory, the ways in which methodological aspects of the study may have prevented clear results from emerging will be reviewed.

Sample skewness. Although this study had the methodological virtue of taking Ss as they volunteered, without excluding any for having very low average alpha levels, no attempt was made to control the distribution of alpha scores in the final group and it happened that the sample tended to have particularly low average alpha levels.

There are no modern normative EEG studies so it is difficult to substantiate this generalization. There are some older studies that attempted to establish population norms (Brazier and Finesinger, 1944; Davis and Davis, 1936; Rubin, 1938), but the methods they employed provide little basis for comparison to the present data. What can be said is that on day 2 the mean alpha score for sub-group L here roughly corresponds to 17μV alpha bursts occurring about 10% of the time, that the mean score for sub-group H corresponds to an alpha percent score of 30, assuming 26μV alpha bursts; and that only nine subjects in the sample had mean alpha scores that would correspond to alpha percentages greater than 25 microvolt alpha, 40% of the time, all eyes open.

In the writer's experience, as well -- he is sure -- in the experience of others, one does not tend to find such low alpha percentages in the average EEG subject. Whether feedback volunteers tend to have such low alpha levels is the question. In his own previous studies, the writer has noted this tendency; but it seemed particularly severe this time. Other published feedback studies have not gathered volunteers as was done here and do not present data that could be used for comparison.

Clearer evidence of the atypicalness of this sample was provided by their 16 PF scores which were summarized in Table 19. Using Cattell's descriptions of extreme scorers on those factors where skewness was marked, it would appear that this sample of alpha feedback volunteers tended to have the following characteristics. The group tended to consist of subjects who were unusually detached and reserved (factor A), highly intelligent verbally (B), undependable (G), imaginative and theoretical (M), liberal or radical in outlook (Q_1), and self-sufficient (Q_2). Factors M, Q_1, and Q_2 are main components of the second order factor Q_{IV}. Hence, there is also marked skewness in the score distribution of this factor as well. Individuals with high scores on this dimension are described as possessing "exacting criticalness, control, independence, . . . [and as being] better with machines and ideas than with people, perfectionistic, and not relaxing easily. . . [The trait is] . . a temperamental, compulsive component which favors expression of the superego in practical matters" (Cattell and Warburton, 1967, p. 198).

Taken together these characteristics suggest that the hypothetical, typical subject in this experiment had a compulsive character. Fenichel (1945, p. 530) has stressed the "lack of adequate feeling reactions" in compulsive characters because of their tendency to ward off impulses with verbal, abstract ideation. Shapiro has stressed the compulsive's "rigid technical cognition", his attraction to mechanical work, and his lack of "normal capacity for shifts between a sharply directed and a more relaxed, impressionistic cognition. . . . Elements on the periphery of attention are . . . distracting and disruptive . . . and they are avoided exactly by the intensity and the fixed narrowness of his preoccupation with his own idea or aim" (1965, p. 30).

Although it cannot be positively asserted that this sample of feedback volunteers contained many compulsive characters (the writer is too much of a compulsive himself to have recognized any readily), these psychoanalytic descriptions accord well with the 16PF factor descriptions listed above. (Tendencies toward low superego strength in the group indicated by skewness on factor G may not seem to accord, but Cattell reports obsessive-compulsive neurotics score below population mean on this factor . Cattell, Eber and Tatsuoka, 1970, p. 261) To diagnose the group would be absurd; the aim here rather is to suggest that this was not the sort of sample that would be expected to report their feeling states accurately (hence, the response biases on the MACL) nor the sort to have openness to primary process experience.

It might also be speculated that the general personality characteristics of this sample may be typical of feedback volunteers. Fenichel (1945, p. 300) has stated that the ego of compulsives "shows a cleavage, one part being logical, another magical". The compulsive, he says, often has magical belief in the power of an idea; the compulsive neurotic superstitiously believes in the efficacy of his rituals even though his logic tells him it is nonsense. It is suggested, therefore, that a person with compulsive characteristics might be particularly prone to want the supposed benefits of alpha feedback and to believe that he could easily and mechanically receive those benefits by having his head wired.

Weakly confirming the idea that the skewed 16PF scoring tendencies are typical of feedback volunteers were analyses showing that skewnesses were more marked among Ss who first heard of the experiment from a newspaper ad than among those hearing of it from E or other friends. These differences were all statistically insignificant, but the differences were in the direction stated for mean alpha level and for all 16PF factors where marked total group skewness had been evidence (except for factor B, Intelligence, where the three types of volunteers had nearly the same average score). Although insignificant, the existence of these differential tendencies counters the possible interpretation that sample skewness depended upon Ss whom E had personally recruited for the experiment.

Two types of problems may have been created by the skewness of this sample. In addition to being a group that seems particularly ill suited for an investigation of the correlates of primary process thinking, the skewness of both alpha and 16PF scores were undesirable statistically because of the difficulty of establishing correlates with scores of restricted range, and also -- in the case of alpha -- of computing good residuals by the regression method.

In summary, the sampling method of this study may have worked to provide insight into the nature of the typical feedback volunteer, but at the same time the sample had score characteristics that worked against establishing findings. The problems discussed here are not the sort that would invalidate significant findings, but rather the sort that could help to account for the plethora of non-significant findings.

Feedback experience. In designing this experiment it was erroneously assumed that all subjects would have comparable feedback experiences. Hence, the possibility was totally ignored that differences in alpha level and alpha blocking would influence feedback experience through differences in actual feedback received. As a result, the complex and curvilinear interactions of alpha level and alpha blocking with the variables Reported Attention and Reported Content could be interpreted to reflect this kind of feedback mediation rather than reflect associations among these variables that would depend upon a relationship between primary process thinking and alpha. Despite this an attempt will be made here to argue that both explanations have some validity.

Of all the hypotheses in this study, those involving the fantasy variable (RC) come closest to a direct test of the primary process theory. Though findings for this crucial variable lacked solid statistical significance, a number of lines of speculation -- no one of which is really conclusive -- together have some weight in supporting the validity of an alpha-primary process interpretation.

The first line of speculation stems from the written accounts of feedback experience of those Ss who reported that fantasizing directly enhanced alpha. Examples from five different subjects are as follows.

> I soon found that the light flashed when I was into a fantasy that took me away from here, when I was literally not seeing the screen. The flashing light interrupted the fantasy, bringing me back to present and the screen.
>
> I could produce the light by imagining myself in peaceful surroundings, such as by the sea.
>
> Imagining that I was violently beating someone up worked.
>
> Warm bed fantasies of caressing and being caressed before going to sleep worked well. A gently rolling warm bed.

> I thought it would be easy to keep the light off if I kept my eyes moving and my attention on the screen and avoid fantasy, but I slipped as I fantasized telling you of how the first alpha burst, when I was trying to turn alpha off, occurred because I moved. At that moment I got feedback.

As has been discussed earlier, the nature of the feedback situation can encourage superstitious learning, and a number of reports clearly evidenced this. One subject thought for a while that alpha came when he tipped his tongue to the roof of his mouth; another believed for a while that turning his hands palms upwards worked. But in these two examples, as in others like them, subjects did not report that such relationships held up for long. Here, the explicitness of these fantasizing reports, their common agreement, and their conviction encourage consideration, at least, of accepting them at face value. It must be remembered that while alpha activity only gradually and slightly increased on the average during feedback, for many subjects there were wide short term fluctuations in alpha level along the line of average trend. Hence, subjects had ample opportunity to observe experiential correlates that may have existed.

But even accepting these reports at face value, certain problems of interpretation remain. Two of the reports emphasize that fantasizing was associated with withdrawal of reality attention, as is, of course, usually the case. Perhaps the fundamental relationship here is between relaxation of reality-oriented attention and alpha rather than directly between primary process thinking and alpha. However, the fact that one subject, at least, purposefully tried to avoid fantasizing but failed and got alpha, suggests, as has been argued here, that the alternation between primary and secondary process thinking is not essentially under conscious control and that it is reflected in spontaneous swings between alpha and beta.

A second reason for speculating that alpha and subjective experience were directly related to one another, in addition to the relationship being mediated by the nature of feedback received, is that some subjects with very low alpha level and low alpha blocking responsiveness nevertheless became involved in relaxing attention to enhance alpha. Although a likely interpretation of this is that these subjects lacked sufficient alpha to detect any experiential correlate of alpha other than the grossly obvious effects of blocking, one might then ask why it was that some subjects with higher, i.e. moderate, alpha levels and alpha blocking tended to ignore blocking phenomena in their reports. If both high and low subjects got involved in blocking, why didn't the moderates? Fantasies with sexual overtones were particularly common among those who fantasized to enhance alpha, as has been elsewhere reported(Brown, 1974, p. 336). But two subjects in this study specifically mentioned in their reports that sexual fantasies blocked alpha. (Both of these subjects were low on ABlr; and one was very high in alpha level, the other very low.) If fantasizing blocked alpha for these subjects, why didn't it for others? In short, although low alpha blocking would tend to predispose subjects towards having fantasy experiences, as the feedback-mediation interpretation argued, that interpretation cannot explain why many subjects found that fantasizing was associated with alpha production. However, these considerations do not directly support the idea that alpha and primary process thinking are related; they merely weaken the alternative explanation.

The third point that might be considered here is that fantasy reports were related as strongly to the regression measure ABlr, which could not directly reflect Ss' experience of alpha blocking, as they were to ABl.lg, which would directly reflect such experience. This suggests that fantasy experience was determined by factors other than the feedback received. In contrast, the relative weakness of the ABlr/RA relationship as compared to ABl.lg/RA suggested the salience of feedback mediated effects in the correlational patterns for relaxation reports. That feedback influences would be stronger for RA than for RC might be expected since by nature the psychological processes involved with RC are less overt and would have more subtle and varied phenomenology than the processes involved in feedback-mediated RA correlational patterns, e.g. alpha blocking to reality stimuli. More simply put, it should be more difficult to reliably measure fantasy experience than relaxation experience. In line with this, internal consistency analysis of the two measures (Appendix C) indicated that some 64% of the variance of RA was reliable and only 48% of the variance of RC. Hence, weaker correlational results in general should be expected for RC. This was, in fact, the case.

To summarize to this point, there are three lines of speculation which weigh in favor of the favored theoretical interpretation of RC results and which may help to explain why these results were only of borderline significance. Since feedback-mediated influences on RA seem to have been stronger than on RC, the present general argument would be strengthened if there was also reason to think that such influences on RA were not overwhelmingly predominant. Additional lines of speculation provide such reason.

The first such line is concerned with the statistically significant relationships among trait anxiety (16PF Q_{II}), alpha blocking (ABlr) and relaxation reports (RA). This could be interpreted in terms of a tendency for highly anxious subjects to use relaxation to enhance their tension and to have high alpha blocking because of hyper-alertness to the environment. On the other hand, anxious Ss might also be expected to calm themselves under feedback conditions (solitude, darkness, brain being monitored, an introspective task) by repression of thoughts that arise. If it is assumed that repression is an essentially unconscious mechanism, and that alpha is related to primary process thinking, it would be expected that such Ss would find their minds blank when alpha bursts occurred. That such Ss would also feel such a blank state is desirable and seek to persist in it might seem puzzling to a person who often enjoys a spontaneous flow of cognitions of internal origin, but he could not know how pleasant the cessation of anxious rumination can be.

Inspection of the written reports of relaxers in the sample confirmed the idea that many of these were tense to a high degree. Some quotes from different Ss follow.

> I tried to relax my body, focus attention on the screen and "inner awareness", but I got jittery at times.

> Whenever I felt myself totally relaxed I became extremely conscious of my breathing which made me try to readjust myself and calm down . . . When the light came on the longest I experienced a feeling of being drawn into the screen which made me apprehensive.

> When the light went on, I had a sensation of a high pitched sound which I thought but did not really hear. (There was no sound. This is a classical symptom of intense anxiety.)

> I felt elated about the light going on, but also paranoid that the light was rigged.

> To turn alpha off I tried to concentrate and felt a bit tense. When concentration lapsed I got a flash, but was surprised and angry when I also got bursts for no reason.

Another aspect of relaxer type reports, which cannot be conveyed adequately by brief excerpt, was the intense concentration such Ss brought to bear on the feedback task, often wilfully focusing their attention on a part of the body or the screen (see first two quotes above for examples of such externally oriented focus) to achieve the calmness they sought. (It might be pointed out again that wilfullness and narrowing of attention are thought to be typical of compulsive characters. Shapiro, 1965) Many reported how tired they felt at the end of feedback, and how little success they felt they had.

> When I felt relaxed and free, the light went on, but I could never feel that way for long no matter what I did. I concluded that I cannot let go and will never be a guru.

A few felt their efforts were rewarded, but tended to describe this in a vague, high-blown manner.

> Finally my mind and body became one, they seemed to travel together.

To this experimenter at least, it seemed quite clear that more was involved in the use of relaxation to enhance alpha than merely a fixation on feedback presented blocking phenomena.

Another reason for thinking that observation of alpha blocking may not have been an overwhelmingly important influence on feedback experience is that the blocking response to a repeated stimulus typically diminishes with time -- it habituates. Habituation to the feedback light may not be marked because of the particular meaningfulness of this stimulus. However, if it did occur, this circumstance would weaken the feedback-mediation interpretation of experiential correlates.

The writer has eyeballed his records without finding a consistent pattern. Habituation effects seem to be present, but then blocking seems to reappear at times. Whether precise measurement would confirm these impressions and whether any such changes are related to experiential correlates of feedback remains to be established by research that would have to be quite tedious in nature.

Analyses pertaining to the major second-stratum 16PF factor Q_I, introversion vs. extraversion (not hypothesized to be a Primary Process Integration dimension), suggested it too was related to experiential tendencies in addition to trait anxiety. In this sample only 10 Ss had Q_I scores higher than population mean. Hence, it could be said that the group consisted largely of introverts and ambiverts. Correlations between this factor and RC were -.18 for subgroup L, and .62 for H ($p < .001$, two-tailed). The difference between these two correlations was significant ($P < .003$, two-tailed), suggesting yet another curvilinear pattern. (An opposite curvilinear pattern was suggested by the Q /RA correlations, but none of the pertinent analyses were significant. For Q /RA, the L correlation was .31; the H, -.12.)

The suggestive alpha level related, curvilinear pattern for RC is reminiscent of the similar patterns for Q_{II}, RC, and ABlr, although again the uncertain nature of low alpha Ss' feedback experience makes full interpretation of the significant curvilinearity difficult. However, the sub-group H half of it indicates that the higher RC, the higher Q_I; a

Q_I/AL.lg correlation,for H, of -.20 for H suggested that the higher Q_I, the lower mean alpha level; finally -- to complete the triad -- in H the AL.lg/RC correlation was -.22, i.e., the lower mean alpha level, the higher RC.

Hence, just as high alpha blocking, extremely high alpha levels, and high trait anxiety may have been interactively associated with the tendency to have relaxation experience, here there is weakly suggestive evidence that moderate alpha levels and ambiversion are interactively associated with fantasy experience. If ambiversion reflects a balanced adaptation to both the inner and outer worlds, then it might be given the same interpretation that is argued for moderate alpha levels, i.e. optimal integration of primary process-alpha and secondary process-beta, such integration in turn being associated with an openness to fantasy experience as hypothesized. In sum, there is suggestive evidence here that extremely high alpha levels, high alpha blocking and anxious introversion are associated with feedback experiences characterized by narrowly focussed attention and by attempts to achieve a relaxed, content-devoid mental state. The significant sub-group H correlation between RC and 16PF factor A now seems to be part of the Q_I pattern discussed here since A is a major component or second-stratum factor Q_I.

Two implications of the broad generalization just made are that the tendency for RA and RC reports to be mutually exclusive is a reflection of personality differences, and that differences in alpha level, in addition to differences in alpha blocking, were related to feedback experience in ways not dependent on feedback mediation. A counter-argument to the first point is that the oppositional tendency between RA and RC may be an artifact of the experimental design which left Ss free to have whatever kind of experience they wanted. Thus, if an S superstitiously believed that the mental associates of alpha he observed were causing the alpha increase he also observed (alpha typically goes up during feedback whatever S does), he may tend to persist in that activity even though he is potentially able to have quite a different kind of experience. However, such an effect could not account for the large differences in correlational pattern between RA and RC. Hence, to the degree the effect was present, it was likely yet another factor generating noise in the data.

Concerning the second point, there seems to be some rather tenuous agreement between this study and one by Peper and Mulholland (1969) in that, in both, the Ss who had feedback experiences that were atypical of the kind of feedback report that has generally been publicized tended to have moderate alpha levels. In this study, such Ss were the fantasizers; in the other study 4 of 8 Ss reported tensing to enhance feedback alpha. The said 4 Ss all had alpha levels corresponding to the moderate alpha levels of this study; the other four Ss had alpha levels like the very high alpha Ss of this study. Despite the only partial agreement of the Peper and Mulholland data with present findings, and despite that study's small sample size, it was cited since it is the only other research in the literature, to present knowledge, that presents any kind of data that can be used for comparison on the issues discussed here.

Hopefully, there may be a trend in the feedback literature away from trying to reduce feedback reports to a common denominator. Travis, Kondo and Knott (1974) have reviewed four of their studies and found that half of 140 Ss reported the feedback experience to be relaxing; the other half said it wasn't relaxing, but no correlates of the difference were explored. (In the present study, only 2 of 50 Ss reported tensing to enhance alpha and relaxing to turn it off. Ss were not asked whether the experience as a whole was relaxing as was the question of Travis et al. Nevertheless, many of the relaxer Ss in this study would probably have reported that the experience was not relaxing because of their tense attention to the feedback task. Many of their reports said as much.) The present experiment will have to stand on its own in suggesting that the supposedly atypical experiences of fantasizers depended in part on the moderate alpha levels of these subjects because moderate alpha level is associated with optimal integration of the alternation between primary process-alpha and secondary process-beta.

To summarize, although the method of this study unfortunately precluded conclusive interpretation of findings, many arguments have been made that weigh in favor of the favored theoretical interpretation of results, or, at the very least, weigh in favor of continuing to entertain the theory. It is difficult to imagine a different experimental method that would provide controls for the problems encountered here and yet still allow opportunity for free development of subjective experience, particularly if primary process thinking is of concern. However poor the present method is with respect to precision, it has provided a rich harvest of data contaminated by human complexity. The noisiness of this complexity cannot invalidate the findings that did emerge; rather, it may encourage their acceptance. However, future research should pay methodological attention to factors that were uncontrolled here. Chief among these were individual differences in alpha level and alpha blocking which in this study seemed to have a feedback-mediated influence on differences in subjective experience, the relative contribution of which could not be assessed. Controls should also be instituted for a possible tendency for different types of feedback experience to be mutually exclusive simply because Ss tend not to change from one type of experience to another.

Alpha scores. Before discussing general methodological problems that tended to affect all alpha scores, some specific problems with the alpha blocking and feedback success measures will be noted.

Although the main alpha blocking measure (AB1r) showed enough test-retest reliability to support the conclusion that individual differences in this dimension were being measured, only some 40% of the variance of AB1r was reliable for the total group, some 37% in subgroup H (Table 11). Since day one estimates of alpha blocking are apt to be more variable than day two, as well as being based in the present study on a mean alpha level estimate of smaller data base than for day two, the day two AB1r variable may not have been quite as poor as these reliability estimates indicate. Nevertheless, it is clear that the measure left something to be desired, and it is likely that the present method of averaging the data for each S over only five stimulus presentations was not adequate. It was quite clear that the method was wholly inadequate for AB2, and the same problem that affected AB2 adversely may have worked on AB1 as well, namely that score variability resulted from variations in the timings of alpha burst occurrence relative to the ten second segmentation of the record.

Mulholland and Gascon (1972) have gotten regular alpha blocking and recovery curves by pooling the data of as few as seven Ss, each of whom had two stimulus trials, i.e. data were averaged over fourteen stimulus presentations. Here, averaging was done over only five presentations. Moreover, Mulholland and Gascon derive scores by measuring the actual length of alpha bursts as they occur, thus avoiding problems relating to any artificial segmentation of the record. Thus, while Mulholland's work was a main basis for the present approach to measuring individual differences in alpha blocking, there seem to be ways in which the present method was inferior to his. In particular, it would seem that if alpha blocking is to be measured by integrator method, many more trials must be given to each S than were given here.

Question might also be raised whether a mere four minutes of recording per S provided a sufficient data base for the on-off control measure of feedback success, FS1. In contrast, the other feedback measures may have been impaired by the averaging of too much data.

FS3 was based in part on a simple alpha average taken over the entire feedback period, FS4 on two averages, one for each half of the feedback period. FS4r was highly correlated with FBs1, the slope measure of rate of alpha increase during feedback which had surprisingly small range in this study. When scores are based on long term averages of alpha level, as all of these scores essentially are, one may end up with measures of narrow range because one has primarily tapped phenomena that tend to be characteristic of all subjects while meaningful individual differences in feedback performance that may have had shorter term effect get washed out in the averaging. On the other hand, if one attempts to deal with shorter term effects, other difficulties may be encountered.

Some of the subjects, high alpha _S_s in particular, tended to show a levelling off, or, in some cases, actual small decline in alpha towards the end of the feedback period. These subjects may have been ones who were able to reach an alpha peak early in the feedback period, and then showed a decline as an oscillatory regulatory mechanism came into play. Their ability to obtain an early alpha peak should have been rewarded by very high feedback success scores. Instead they were in effect penalized for their early feedback success since their later declines lowered their scores. Post hoc attempts were made to derive a feedback success score based on how soon peak feedback level was reached. However, this attempt foundered on the difficulty in distinguishing true peaks from other high points occurring due to random or cyclical fluctuations in level.

The general problem here is one of trying to extract meaningful measures of change from a time series which itself continually changes under the influence of diverse factors, only some of which may be of particular experimental interest. Different ways of slicing up and assigning numbers to the series will yield change scores that are determined by different admixtures of all factors involved. It is suggested that the present ways of slicing the feedback time series yielded measures which were particularly devoid of the influence of idiosyncratic responses to the feedback task and which, instead, were heavily influenced by factors common to all Ss. Twenty minutes gave most Ss enough time to exhibit the common pattern of feedback recovery of waiting period alpha level, and the narrow range of feedback success scores seems to reflect the "success" that was common to most Ss.

Hence, it should not be surprising that most of the findings involving FS3r and FS4r seemed to chiefly reflect the operation of homeostatic regulatory processes that control the alpha-beta alternation. At the same time, correlations between these variables and the more idiosyncratic measures of alpha blocking, alpha variability, subjective experience and personality traits were generally lacking. Interpretation of the findings pertaining to the feedback success measures indicated that quality of regulatory control was not tapped in any simple, direct way by any of the variables in the study. Rather, it appeared to be a matter of complex, curvilinear interactions among many of the different alpha dimensions measured here. Hence, none of the separate alpha measures that were related to quality of regulatory control could be expected to exhibit linear correlations with other non-alpha measures that were predicted to relate to that same dimension.

Score transformations. A more general methodological problem which concerned all of the alpha scores in this study is that of handling the correlations between mean alpha level and straight measures of alpha change or alpha variability. The use of residuals went a long way towards handling the problem, but far enough to make its shortcomings apparent in three ways.

First, being based on a linear regression, the residuals are weakened in effectiveness when curvilinearities are present. This problem seemed particularly present with the feedback success scores. Likely it was present to some degree with the other alpha scores as well, but there was no way of knowing the degree of this.

Second, residual scores are computed within a group of Ss and may be adversely affected by poor score distributions in the group. Although there were a number of reasons to think that this was generally not a serious problem in this study, it was a problem in sub-group L. Because of the marked alpha skewness of the sample, Ss in L had a very small range of mean alpha levels. This restricted score range reduced the size of correlations with alpha level and hence reduced the effectiveness of the regression technique. Reliability estimates for the residual scores AB1r and AV3r were particularly low in L; and, in comparison to H, L residuals yielded relatively few significant findings. Since a majority of the findings in this study seemed to involve curvilinear patterns appearing over sub-groups L and H, the necessary weakness of findings for L worked against conclusive interpretation of results. (It might be questioned here whether the particularly strong distortions of the residuals in L were actually the source of the apparent curvilinearities rather than being a reason why patterns were obscured. For this to have been true, the residual scores for L would have had to have been negatively correlated with their corresponding difference scores; they were not.)

Finally, being a method that removed variance associated with alpha level within the group as a whole instead of within each subject separately, the residual technique prevented investigation of relationships between individual differences in alpha level and other alpha dimensions measured. This was yet another reason why the use of residuals hampered study of the alpha level associated curvilinearities which were involved in the great majority of findings.

The three ways that the use of residuals worked to obscure findings in this study are not independent of one another since they are all related to the fact that this transformation is an across-subjects method. Clearly a within subjects method would be preferable. An example of such is the FBs1 measure used in post-hoc analyses where a regression measure of change was computed after within-subjects standardization of feedback data. The standardization was the crucial transformation here since other change measures other than regression slopes could have been derived from the data. (For example, the difference between the means of the standardized scores for each half of the feedback period provided a simple two-point estimate of linear increase in alpha that had a correlation of .95 or more with FBs1 in all of the five different groupings of the sample.)

Also not crucial to the transformation was the fact that the standardization gave the distributions of feedback scores for each S the same mean, i.e. zero, since the simple deviation scores have this property without there being any change in the size of any change score. Rather, it is dividing the deviation scores by the standard deviation which is crucial. The change scores derived from this transformation reflected the amount of change relative to the average size of all changes in level, i.e., the standard deviation, rather than the amount of change relative to mean alpha level. For practical purposes it may not make much difference whether a division method of transformation uses the mean or the standard deviation as the divisor since mean and standard deviation tend to be highly correlated in alpha data. Either type of division will remove variance associated with mean alpha level, as well as variance associated with alpha variability.

These considerations raise larger questions. Complex dependencies among various alpha dimensions were found in this study only when efforts were made to remove dependency on alpha level. Would it have been better to remove other dependencies instead? Would measures free of alpha variability variance yield better results? Perhaps the best measure would be one that did not try to eliminate dependency since it seems impossible to work on one aspect of the complex inter-relationships without affecting other aspects. That is, it might be best to work out ways of combining the different aspects of alpha activity that seem related to quality of regulatory control into a single measure that would reflect such a dimension. This, however, is a distant goal, and for the time being research must continue trying to take apart this complex phenomenon before anything satisfactory can be put together. For this purpose, division methods might be the best available within-subjects alternative to residuals. However, this alternative runs into the same problem that residuals do, namely, that relations between alpha measures are not linear.

The correlation between the straight measure of alpha variability (AV1) and mean alpha level showed a noticeable drop in size in sub-groups L and H (Table 12). The relatively low value for L may be due to restriction of score range, but the relatively low value for H suggests that there may be systematic variations in the size of the ratio between the mean and the standard deviation at different mean alpha levels. Inspection of the scatter plot here indicates that there was some tendency for the relative size of the standard deviation to drop off in Ss of very high alpha level, as homeostatic considerations would predict.

A question similar to one raised earlier for residual scores might be considered here: were the curvilinear patterns found for FBs1 an artifact of this kind of systematic variation in the size of the ratio between alpha standard deviation and mean. This ratio is, in fact, the Coefficient of Variation measure of alpha variability (AV2), and the L and H correlations between AV2 and AL.lg (Table 12) indicate that any systematic relationship that may have been present was not of sufficient size to cause such an artifact. Moreover, the possible artifact for sub-group H at least would work against the relationship found. That is, if variability tends to get relatively low at higher alpha levels, change scores based on a transformation that divided data by the variability estimate would tend to become higher for the Ss of higher alpha level. Just the opposite was found. FBs1 was negatively correlated with AL.lg in sub-group H. Here there is yet another example of results being obscured, rather than artifactually created, by methodological problems. The particular kind of score contamination just discussed would become more serious in sample containing a larger proportion of high alpha Ss than the present sample.

Non-linear relationships among alpha dimensions seem to reflect the presence of homeostatic processes and weaken the effectiveness of either division or residual transformations. The reader interested in the unsolved problems here is referred to -- but is warned he will not find many answers in -- a large conference that dealt with these conceptual and methodological issues (Wolf, 1962), as well as a book by Sollberger (1965) covering much of the same ground. Although some attention has been paid to homeostatic considerations in regard to autonomic measures, virtually no attention has been paid to these in regard to the EEG, with the main exception of some Russian work that touches only peripherally on the issues under discussion. (See, for example, Bundzen, 1966, or Nebylitsyn, 1972.) Mention might also be made here of an attempt to distinguish clinical groups in terms of differences in the slope of the regression line of alpha standard deviation on alpha mean (Burdick, Sugerman and Goldstein, 1967), and also of a technique for correcting autonomic scores which is essentially a division-by-variability method (Lykken, Rose, Luther and Maley, 1966).

Although skewed, the present sample did have the virtue of containing a sufficient range of low and high alpha Ss to create the opportunity of detecting the curvilinearities which raise so many methodological problems. Nevertheless, grasping these patterns by expressing the halves of each as linear relationships is hardly ideal. Luckily, median alpha level for the sample appears to have come somewhere near the point where the curvilinear patterns turned to go in an opposite direction. However, there is no saying how closely that point was approached here, and the degree to which it was missed would be yet another factor that worked against the emergence of clear findings in this study.

Measuring the alpha-beta alternation. A final general question to be raised is whether the vagaries of the alpha-beta alternation can be adequately studied by measuring only alpha. If beta in the normal waking EEG tends to have a constant inverse relation to alpha, then measurement of either would satisfactorily record changes in both. However, it does not seem to be the case that they have simple inverse relation (Gale, Dunkin and Coles, 1969). For this reason Mulholland (1972) has argued that it is necessary to measure both alpha and beta separately to adequately describe changes in the EEG. He has further proposed combining alpha and beta measures into a single index, perhaps by taking the ratio of the two. Although no study is presently known that has actually used an index of this sort to study relations between the EEG and behavior, the general idea seems a good one. For example, in a study such as the present one, beta activity could have been measured by filtering and integrating beta in parallel with alpha. Study of the relationships between the two sets of scores could well suggest a way of combining them.

One benefit of such an approach might be that the combined index would not have the troublesome statistical distributions that alpha scores have. Low alpha subjects generally have low amplitude beta activity as well. Similarly high alpha subjects tend to have high amplitude EEGs in general. Hence, there might be a tendency for the average relationship between the two sets of scores to hover around a central value irrespective of mean alpha level. In short, an index combining the two scores might tend to be normally distributed, and change scores based on such an index might be better suited than those in this study for exploring the complex curvilinear patterns which have been discovered here but not adequately measured.

This completes review of the many methodological difficulties present in this study. Before proceeding to a discussion of theoretical issues and a general evaluation of the research as a whole, the next section will discuss the light that present results cast on certain problems that have arisen in the feedback literature.

Feedback Alpha Changes

The present experiment confirms what many other workers have found about the nature of changes in alpha during feedback, namely, that such changes chiefly occur because of alpha suppression effects and that subjects are generally unable to exhibit alpha levels with feedback that are any higher than those exhibited in relaxed states before feedback (Lynch and Paskewitz, 1971), most reaching this limit within 20 minutes (Travis, Kondo and Knott, 1972). Beyond this, the pains taken in this research to carefully examine the relations of mean alpha level to alpha changes have yielded findings that can be used to resolve certain discrepancies in the feedback literature.

For example, in a study by Nowlis and Kamiya (1970) the rank order correlation between baseline alpha level and the difference between feedback-achieved on and off levels was .13 in an eyes-closed condition and .88 in an eyes-open condition. Nowlis and Kamiya offer the general interpretation that the higher an individual's baseline alpha, the greater the degree of alpha control that he can exhibit. In an eyes-closed study by Cleeland, Booker and Hosokawa (1970) a median cut of the sample was performed on the basis of the amount of "learning" to enhance alpha activity that had been exhibited. The high learners had significantly less alpha than the low learners, and the authors conclude that learned alpha control and alpha level are inversely related, in direct opposition to Nowlis and Kamiya.

In view of the results of this study, however, it would be argued that neither group of researchers has established correlates of individual differences in alpha control. Each has demonstrated the necessary kind of relationship between mean and difference alpha scores that tends to exist in all situations, and hence has nothing to do essentially with feedback learning of alpha control. The present data indicate that high positive correlations are the rule in eyes open conditions, as Nowlis and Kamiya found. While eyes closed conditions were not included in the present research study, findings did indicate that tendencies toward negative correlations (i.e., celing effects) come into play when alpha levels are high. Since eye closure raises alpha level greatly, it seems likely that such influences would account for Nowlis and Kamiya's very low, positive relationship in the eyes-closed data as well as the negative relationship found by Cleeland et al.

In both of these studies, the number of subjects was small, and analyses were not oriented towards estimating the size of eyes-closed correlations between mean and difference scores one might normally expect to obtain. The present research does provide such estimates for eyes-open conditions. Some eyes-closed research is needed to give some idea of the exact difference. It would appear, however, that eyes-closed correlations are not as marked as eyes-open. At any rate, it now seems clear that performance in an eyes closed feedback condition can not be directly compared to performance in an eyes open condition because of the different functional characteristics of alpha in each situation. One type of procedure has been used about as much as the other in feedback studies; but there has been little comment on these functional differences before. (However, see Brown, 1974.)

Similarly disregarded have been functional differences between feedback performance during "on-off" alpha control conditions and performance during free, continuous exposure to feedback. The lack of relationship in the present study between measures from each type of procedure as well as the different patterns of correlation each type of measure had with other variables indicate that quite different processes are involved in each type of performance.

Another matter about which there has been some confusion in the alpha feedback literature is the question of whether or not yoked control subjects show increases in alpha that are equal to those exhibited by regular feedback subjects. Since feedback increases are largely a matter of recovery of baseline levels, and since both yoked and regular subjects do show increases, it has commonly been held that there is no difference between the amounts of alpha increase each type of subject exhibits. The results of Paskewitz, Lynch, Orne and Costello (1969) seem to agree with this conclusion while those of Travis, Kondo and Knott (1972) do not. The latter authors found that yoked controls showed significantly less feedback alpha increase. However, in the first study cited the yoked control subjects had higher average alpha levels than the regular feedback subjects, and in the other study the pattern was just the opposite. If, as Paskewitz et al. argue, the influences causing alpha increases were the same for both experimental groups in their eyes open study, one would have expected the floor effect operating to have been reflected in greater increases in alpha inthe higher alpha yoked group. This suggests, then, that their interpretation is wrong. On the other hand, the Travis et al. study does not settle the issue since the differences between groups in this eyes open study were those that would be expected on the basis of differences in mean alpha level.

Beatty (1971) troubled to match experimental and control subjects on mean alpha level and found that yoked controls did not show as much increase as regular subjects. This conclusion, however, needs more precise sepcification. It may be that given sufficient time both yoked and regular subjects will recover baseline alpha levels. The difference between the two may be a matter of how rapidly the recovery point is reached. Variations in experimental procedure, e. g., length of periods when on-off control conditions are used, may also affect the speed of recovery. None of the researches cited have used the same procedure.

Conclusion

The major significant findings in this study involved complex curvilinear relationships to alpha level. These findings fell roughly into two groups.

One group of patterns involved chiefly the alpha variables of feedback success, alpha variability and alpha "smoothness". The general interpretation here was that these variables reflected quality of homeostatic regulation of the alpha-beta alternation. This explanation assumed that the sample contained Ss whose regulatory control was poor because of marked biasing of their alpha-beta systems in either an alpha or a beta direction. There was no direct evidence to either support or contradict this crucial assumption. Although this skewed sample plausibly did contain many beta-biased Ss, alpha-biased Ss would seem to have been few insofar as mean alpha level is an indicator of bias. However, it appeared that mean alpha level is only one of many complexly related variables that reflect the nature of an S's alpha-beta alternation, and no simple conclusion can be drawn from it alone.

The present sample appeared to contain a preponderance of Ss who would be more apt to wilfully concentrate on impersonal things in the external world than to relaxedly experience feelings and fantasies. It was suggested that these Ss might have compulsive personality characteristics.

Be that as it may, it seemed plausible that there was a high degree of defensiveness against primary process thinking in the sample. Hence, if the primary process theory of alpha has validity, the skewness of the sample in these respects might be related to a high incidence of strained regulation of the alpha-beta alternation.

A second group of curvilinear patterns involved chiefly the report variables, alpha blocking and certain 16PF factors. The major interpretation of this general set of findings, again not wholly conclusive, was that they were the result of an interaction between the factor of personality openness to primary process thinking and the influence of S's direct observation of alpha feedback on his feedback experience. With the exception of alpha level which was related to both sets of findings, the variables implicated in each set were not the same.

The variables in the first set were concerned, it seemed, with underlying processes regulating the EEG. Those in the second set seemed concerned with situational responses to environmental conditions, e.g., alpha blocking and feedback experience. In other words each set of findings seemed concerned with a different domain. Although 16PF factors were implicated in both sets, different factors were involved in each and 16PF relationships were generally stronger in the set concerned with situational responses.

Although both sets of findings offered some support for the general theoretical considerations on which this theory was based, there was a failure for the two sets to converge in a way that would further support theory. Variables in the first set may not have correlated with those in the second because no one of these measures was a good single index of quality of alpha-beta alternation. Conversely, while methodological artifacts might have artificially created certain predicted results for the report variables in the second set of findings, the existence of such effects would have generally obscured possible relationships between the two general sets of findings.

The feedback-mediated influences on feedback experience just alluded to constituted the only methodological problem in this study that would have worked to artifactually produce predicted relationships, rather than obscure them. Most of this chapter has been concerned with the many other problems that were obscurant in nature. In the writer's view these problems are so numerous as to preclude making any definite statement on the validity of the primary process-alpha theory in terms of present results. Nevertheless, the question must be asked whether theoretical inadequacies were also involved in the present confusion.

Perhaps the major theoretical error of the study was the assumption that a unitary dimension would underlie linear correlations among all of the variables of the study.

Certainly the findings that do offer suggestive support for theory here, offer no support for this assumption since they bear no single, simple, strong relationship to one another. Indeed, it now seems foolish to have expected otherwise. It is difficult enough to establish unitary factors within a restricted measurement domain. Here, measures -- many previously untried -- dealt with three general domains: the EEG, introspective experience, and questionnaire measured personality traits. If the EEG reflected some very specific aspect of physiological functioning, the general research strategy might not have been so audacious; but there is every reason to suppose that this grossly recorded phenomenon is the complex product of factors as numerous as the mind can imagine or the brain integrate.

In similar fashion, the psychological construct of primary process integration covers a host of factors that are far too complex to be pinned down by a few variables. Such a dimension has emerged in careful analyses and interpretations of multi-variate studies of sensory deprivation (Goldberger and Holt, 1965), but nothing approaching adequate investigation of such a dimension has been attempted here, mainly because there was only so much that could be done and because primary attention had to be given to problems of alpha change scores. One question that certainly needs more sophisticated, conceptual attention in future research along these lines would be whether both alpha and beta bias might be associated with personality defensiveness. Defensesiveness might be associated with alpha bias if it reflected a current struggle to contain fantasy life. Conversely, beta bias might reflect a long established, characterological constriction of primary process thinking.

Finally, although the author was well aware that contrasting floor and ceiling effects typically occur when measuring changes in homeostatically regulated oscillatory processes, he did not plan for such effects in the present research. As a result, the curvilinearities that appeared were poorly grasped.

In summary, in a number of important ways both the theoretical conception and the methodological design of this research were far too simple for the object of study. In most cases, these failings were unavoidable concomitants of an attempt to explore uncharted land with limited resources. Hence, the contributions that this study makes to the literature lie largely in the methodological area. The territory is not quite as uncharted as it was.

The findings support the homeostatic aspects of the present theory, but only suggestively support its primary process aspect. For this writer there is reason to continue to entertain the primary process hypothesis. Even if largely mistaken and too simplistic, it is the kind of broad new theory that seems needed to orient continued investigation into the nature of alpha. The arousal theory of alpha continues to hold the field despite its long obvious inadequacies and despite the evidence against it which continues to accumulate.

In a recent feedback study (Kornfeld and Beatty, 1974) shocks were given when alpha was present; in another (Orne and Paskewitz, 1974), when alpha was not present. In neither experiment did this powerful feedback stimulus elicit feedback alpha patterns different from the typical ones described in this study. These findings confirm the idea that the alpha-beta alternation is under powerful regulatory control and that such control has little to do with state of arousal.

On the other hand, suggestive evidence that alpha is involved with informational processes comes from a report that the learning of repeatedly presented nonsense syllables is associated with increasing alpha levels (Freedman, Hafer and Daniel, 1966). Voicu reports a similar facilitative effect of alpha for verbal learning (1970), but his finding that it appears only among high alpha _S_s suggests the presence of a curvilinearity. These findings disconfirm arousal theory, have no direct connection to the present theory, but do suggest the value of looking at the EEG in informational rather than arousal terms.

Perhaps the only definite statement that can presently be made about alpha is that conclusive interpretation of any alpha finding with any alpha theory is still a goal far above the current level of theoretical sophistication. Consider again Heinemann and Emrich's study (1970) that found higher alpha levels following subliminal presentation of emotional words than after neutral words. (In this study each S was his own control, a method that bypasses many of the methodological problems discussed here.) Arousal theory can no more conclusively account for this finding than can the primary process theory of alpha. The present research is similarly theoretically inconclusive, and in this sense it is in general agreement with the EEG-alpha literature.

APPENDIX A

REPORT FORMS

This appendix contains samples of the forms subjects used to report their feeling states and alpha feedback experience, as follows:

Each of the following words describes feelings or moods. Please use the list to describe your feelings at the moment you read each word.

If the word definitely describes how you feel at the moment, circle the double check to the right of the word - (vv)

If the word only slightly applies, circle the single check - (v)

If the word is not clear to you or you can not decide whether or not it applies to your feelings at the moment, circle the question mark - (?)

If you definitely decide the word does not apply, circle the no - (no)

Work rapidly. Your first reaction is best. Work down the first column, then go to the next. Please mark all words. Please begin.

active	vv	v	?	no
affectionate	vv	v	?	no
aloof	vv	v	?	no
angry	vv	v	?	no
annoyed	vv	v	?	no
attentive	vv	v	?	no
at rest	vv	v	?	no
boastful	vv	v	?	no
calm	vv	v	?	no
carefree	vv	v	?	no
clutched up	vv	v	?	no
concentrating	vv	v	?	no
defiant	vv	v	?	no
drowsy	vv	v	?	no
dubious	vv	v	?	no
dull	vv	v	?	no
egotistic	vv	v	?	no
elated	vv	v	?	no
energetic	vv	v	?	no
engaged in thought	vv	v	?	no
fearful	vv	v	?	no
forgiving	vv	v	?	no
friendly	vv	v	?	no
full of pep	vv	v	?	no
grouchy	vv	v	?	no
intense	vv	v	?	no
intent	vv	v	?	no
introspective	vv	v	?	no
jittery	vv	v	?	no
kindly	vv	v	?	no
leisurely	vv	v	?	no
lighthearted	vv	v	?	no
lively	vv	v	?	no
overjoyed	vv	v	?	no
peppy	vv	v	?	no
playful	vv	v	?	no
pleased	vv	v	?	no
quiet	vv	v	?	no
rebellious	vv	v	?	no
refreshed	vv	v	?	no
regretful	vv	v	?	no
sad	vv	v	?	no
self centered	vv	v	?	no
skeptical	vv	v	?	no
sleepy	vv	v	?	no
sluggish	vv	v	?	no
sorry	vv	v	?	no
still	vv	v	?	no
stirred up	vv	v	?	no
suspicious	vv	v	?	no
talkative	vv	v	?	no
tired	vv	v	?	no
vigorous	vv	v	?	no
warmhearted	vv	v	?	no
witty	vv	v	?	no

Name: ______________________________

AN INQUIRY OF ALPHA FEEDBACK EXPERIENCE

It is very important in answering the following questions that you be as frank and as specific as possible. In any situation people differ widely in their experiences and reactions. The aim here is to learn as precisely as possible what <u>your</u> alpha feedback experience was like.

1. Please answer this question on the blank piece of paper. Giving as much detail as possible describe your experience in sequence from beginning to end.

First, state your reasons for volunteering for the experiment. What were your expectations about it?

Second, describe your attitude, thoughts, and feelings during the period just before you got feedback, the period during which the equipment was being adjusted.

Third, describe your experience during the feedback period itself. Give as much detail as you can about your emotions, your thoughts, your mental and bodily states, your method of approaching the feedback task and anything else that you can recall. Were there any times when your experience seemed to change markedly? Did you feel you were being successful? To what degree did you think you were successful in changing your alpha activity? These topics and questions are merely listed as suggestions about what you might discuss. Your basic goal is to describe anything that you can remember.

In this third section, it is important that your description follows the sequence of your experience exactly. Start at the beginning and just run through the period step by step, indicating where changes were noticed, and concluding by describing how you felt in the moments just after the feedback period ended while you were still alone.

Fourth, describe your experience during the period in which you were asked to turn alpha off and on alternately.

2. Go back over what you have written in the third section for the first question, and separate the narrative sequence there into blocks. Each block is to refer to a stretch of time during which there was no marked change in your experience. Mark off the blocks simply by drawing a line across the page, separating what you have written where it seems appropriate. Finally, write in the margin your estimate in minutes of the length of each block. The feedback period was 20 minutes long in total.

Answer the following questions by circling the number indicating your choice of answer. Some questions ask you to make two answers by circling one number in one column and one in the other. Answers in the alpha column should reflect your experience during times when you were producing alpha frequently. Answers in the not alpha colum should refer to times when your alpha was relatively infrequent.

3. How did you find the task of describing your experience in questions 1 and 2 here? Was it

very agreeable	1
agreeable	2
mildly agreeable	3
mildly disagreeable	4
disagreeable	5
very disagreeable	6

4a. Did your body tend to be tense or relaxed in

	alpha	not alpha
very tense	1	1
tense	2	2
mildly tense	3	3
mildly relaxed	4	4
relaxed	5	5
very relaxed	6	6

4b. <u>Mentally</u>, were you tense or relaxed in

	alpha	not alpha
very tense	1	1
tense	2	2
mildly tense	3	3
mildly relaxed	4	4
relaxed	5	5
very relaxed	6	6

4c. Did your mind tend to be blank or filled with content in

	alpha	not alpha
very filled	1	1
filled	2	2
mildly occupied	3	3
mildly unoccupied	4	4
blank	5	5
very blank	6	6

4d. Were you attending to things with sharp, focussed concentration or with a loose drifting awareness in

	alpha	not alpha
very sharp	1	1
sharp	2	2
mildly sharp	3	3
mildly loose	4	4
loose	5	5
very loose	6	6

4e. Were you thinking about things with a searching, critical attitude or with detached, non-evaluative acceptance in

	alpha	not alpha
very detached	1	1
detached	2	2
mildly detached	3	3
mildly critical	4	4
critical	5	5
very critical	6	6

4f. How would you describe the general emotional tone of your feeling state in

	alpha	not alpha
very unpleasant	1	1
unpleasant	2	2
mildly unpleasant	3	3
mildly pleasant	4	4
pleasant	5	5
very pleasant	6	6

5a. To what degree were your thoughts concerned with memories, the recalling of previous experiences, in

	alpha	not alpha
not at all	1	1
very little	2	2
a little	3	3
some	4	4
a lot	5	5
most of the time	6	6

5b. To what degree were your thoughts experienced in verbal terms, in the language of words, in

	alpha	not alpha
not at all	1	1
very little	2	2
a little	3	3
some	4	4
a lot	5	5
most of the time	6	6

5c. To what degree were your thoughts experienced imaginally, in terms of imagery, in

	alpha	not alpha
not at all	1	1
very little	2	2
a little	3	3
some	4	4
a lot	5	5
most of the time	6	6

5d. To what degree did things you thought about seem to come into awareness spontaneously as opposed to their occurring because of your willed concentration on specific subjects in

	alpha	not alpha
highly spontaneous	1	1
spontaneous	2	2
tending to spontaneous	3	3
tending to unspontaneous	4	4
unspontaneous, self-controlled	5	5
highly slf-controlled	6	6

5e. To what degree did your thoughts have a dream-like quality as opposed to having the quality of ordinary, everyday waking thought in

	alpha	not alpha
mostly ordinary	1	1
ordinary	2	2
more ordinary than not	3	3
more dream-like than not	4	4
dream-like	5	5
mostly dream-like	6	6

5f. In general, did your thoughts tend to deal with impersonal subjects or with matters of concern to your personal life in

	alpha	not alpha
mostly personal	1	1
personal	2	2
more personal than not	3	3
more impersonal than not	4	4
impersonal	5	5
mostly impersonal	6	6

5g. How often did your thoughts have a sexual quality in

	alpha	not alpha
never	1	1
rarely	2	2
occasionally	3	3
sometimes	4	4
often	5	5
very often	6	6

6a. Generally speaking, how did you find the feedback task of trying to keep the feedback light on as much as possible? Was it

highly frustrating	1
frustrating	2
a bit frustrating	3
a bit satisfying	4
satisfying	5
highly satisfying	6

6b. By the end of the feedback period, how interesting were you finding the feedback experience to be?

highly interesting	1
interesting	2
a bit interesting	3
a bit uninteresting	4
uninteresting	5
highly uninteresting, a drag	6

6c. In general, how enjoyable was the feedback period as a whole for you?

very pleasant	1
pleasant	2
slightly pleasant	3
slightly unpleasant	4
unpleasant	5
very unpleasant	6

6d. As the feedback period went along, how did you come to feel towards the feedback light in and of itself? When the light flashed did you tend to find it disturbing or comfortable.

very disturbing	1
disturbing	2
slightly disturbing	3
slightly comfortable	4
comfortable	5
very comfortable	6

6e. Although your experience may not have been what you expected, how do you feel now about it? Are you glad or disappointed with what you have experienced?

very glad	1
glad	2
slightly glad	3
slightly disappointed	4
disappointed	5
very disappointed	6

Do you want to come back to try feedback again? Yes___No___

Do you plan to come back? Yes___No___

AN INQUIRY OF ALPHA FEEDBACK EXPERIENCE

Questions 1 and 2 are answered on a separate piece of paper. Answer the remaining questions by circling the appropriate number.

3.	Agreeable	1	2	3	4	5	6	Disagreeable
4a.	Tense	1	2	3	4	5	6	Relaxed
4b.	Tense	1	2	3	4	5	6	Relaxed
4c.	Filled	1	2	3	4	5	6	Blank
4d.	Sharp	1	2	3	4	5	6	Loose
4e.	Detached	1	2	3	4	5	6	Critical
4f.	Unpleasant	1	2	3	4	5	6	Pleasant
5a.	Not at all	1	2	3	4	5	6	Most of the time
5b.	Not at all	1	2	3	4	5	6	Most of the time
5c.	Not at all	1	2	3	4	5	6	Most of the time
5d.	Spontaneous	1	2	3	4	5	6	Self-controlled
5e.	Ordinary	1	2	3	4	5	6	Dream-like
5f.	Personal	1	2	3	4	5	6	Impersonal
5g.	Never	1	2	3	4	5	6	Often
6a.	Frustrating	1	2	3	4	5	6	Satisfying
6b.	Interesting	1	2	3	4	5	6	Uninteresting
6c.	Pleasant	1	2	3	4	5	6	Unpleasant
6d.	Disturbing	1	2	3	4	5	6	Comfortable
6e.	Glad	1	2	3	4	5	6	Disappointing

Do you want to come back to try feedback again? Yes___No___

Do you plan to come back again? Yes___No___

Name:______________________________

APPENDIX B

FACTOR ANALYSES OF MACL DATA

Separate analyses were done on the data from each of the four administrations of the MACL. In each case, the computer was instructed to extract six factors by the principal components method and then do a Varimax orthogonal rotation using the P-Stat package of programs (Buhler, 1972). Table A presents results.

TABLE A

MOOD ADJECTIVE CHECK LIST FACTOR LOADINGS
(Decimal points are omitted.)
(Absolute values less than .30 are omitted.)

Mood Variable	Factors					
	1	2	3	4	5	6
	Day 1, pre MACL					
Vigor	72		45			
Social Affect.	65					46
Aggression		79				
Concentration			73			
Nonchalance					77	
Surgency	85					
Anxiety		71		30	-38	
Fatigue		47	-69			
Elation	76				32	
Egotism		35				
Sketicism				68		
Sadness		39		60		37

(Table A continued on next page.)

TABLE A (Continued)

Mood Variable	Factors 1	2	3	4	5	6
Day 1, post MACL						
Vigor		53	73			
Social Affect.		75				
Aggression	68			37		
Concentration					67	
Nonchalance	-74					
Surgency		73				
Anxiety	75				42	30
Fatigue			-66			
Elation	-37	76				
Egotism				54		
Sketicism	57			36		
Sadness	40		-31			58
Day 2, pre MACL						
Vigor	48				76	
Social Affect.	68					
Aggression			52			-30
Concentration				75		
Nonchalance	35					76
Surgency	71				40	
Anxiety		30		67		
Fatigue		68			-43	
Elation	89					
Egotism			73			
Skepticism		54	54			
Sadness		65				
Day 2, post MACL						
Vigor	76			-35		
Social Affect.	58	37				
Aggression		-42				
Concentration			73			
Nonchalance		86				
Surgency	89					
Anxiety			77			
Fatigue				78		
Elation	76	38				
Egotism					69	
Skepticism						61
Sadness					30	

Although the four MACLs were administered under different conditions (and in the case of the first one, under different instructions) it is plain that on each occasion Ss tended to give related responses on the separate variables of Vigor, Social Affection, Surgency and Elation. These four variables defined the first and largest factor extracted in three of the analyses, and they defined the second factor in the analysis of the second MACL. Inspection of Table A shows that there are a few other factor correspondences across the separate analyses; but none correspond consistently across all four analyses as does this.

Admittedly, the data base in any one of these analyses is not large enough for the separate results to be trustworthy. However, the strength of the factor that emerged, and the fact that it did emerge in four cases, despite the meager data base, support the factor's validity. The checklist words for the four variables defining this factor are: active, full of pep, energetic, peppy, vigorous for Vigor; affectionate, forgiving, kindly, warmhearted, friendly for Social Affection; carefree, playful, witty, lively, talkative for Surgency; and elated, overjoyed, pleased, refreshed, lighthearted for Elation. Inspection of these words together suggests that the unitary response tendency underlying this factor is a matter of some general feeling of well-being, or lack thereof. Hence this factor will be named Good Feelings. This interpretation accords well with a main result from an extensive study of self-reported moods. Wessman and Ricks identify "hedonic level" or "relative elation-depression" as a "central aspect of affective experience" (1966, p. 245). Indeed, such appears to be central to the factor identified here.

It must also be noted that on the variables Aggression, Anxiety, Egotism, Skepticism and Sadness, there was little range in scores. Not only did _S_s tend to give the same ratings on the words in question, few _S_s showed any change in rating over the different administrations of the MACL. In a sense, then, it was easier for the Good Feelings factor to emerge because the lack of range on five of the variables insured that they would not consistently load any factor. However, it is also interesting to note that the bad variables all deal with feeling states that are negative or socially disapproved. This suggests that not only were _S_s oriented towards reporting feelings of a positive nature, they were also oriented towards denial of feelings along negative dimensions. In fact, the stereotypy of response among _S_s on the bad variables was a matter of making ratings that were least unfavorable. For example -- and this was one of the worst cases -- 27 _S_s checked "No" to all of the Aggression words in _both_ administrations of the MACL on the feedback day. While it would be nice to think that this occurred because the experimental procedure was pleasant and pacifying, a much more reasonable speculation is that subjects avoided reporting their negative feelings. Certainly some scoring on a variable such as Aggression should be expected from a

TABLE B

CHARACTERISTICS OF MACL DIFFERENCE SCORES

MACL Variable	Frequency of subjects with no pre-post change	Standard Deviation
Concentration	3	0.71
Elation	5	0.64
Fatigue	10	0.92
Social Affection	10	0.72
Nonchalance	11	0.74
Surgency	12	0.64
Vigor	16	0.69
aAnxiety	18	0.54
aEgotism	19	0.43
aAggression	29	0.52
aSkepticism	29	0.66
aSadness	30	0.46

Note: a - Variables that were dropped.

group that tended to score high on 16PF factors such as E, L, Q_2 and Q_4 which measure, respectively, dominance, suspiciousness, self-sufficiency and tension caused by unconscious drives.

Table B presents the number of subjects who had no change in reported feelings over the two administrations of the MACL on the feedback day and the standard deviations of the day 2 pre-post differences for each of the 12 scales. Scales with low variability and high number of no-change subjects were Aggression, Anxiety, Egotism, Skepticism and Sadness; and these scales were dropped from subsequent analyses to avoid getting spurious results that would depend only on the MACL data of a minority of subjects.

APPENDIX C

PSYCHOMETRIC ANALYSIS OF POST-FEEDBACK INQUIRY

To refine measures based on the Post-feedback Inquiry, the data collected were analysed in three steps. In the first step, all inter-item and item-item sum correlations were computed along with coefficient alpha for each of the three variables based on item sums. Coefficient alpha is a measure of the reliability of a test based on the internal consistency of the items comprising it. Numerically, the value of the coefficient depends upon the average size of the item inter-correlations (Nunnally, 1967, p. 210). Items that seemed poorly related to the big variables were dropped out, and new variable scores were summed.

In the second step, item inter-correlations and coefficient alpha were again computed for each variable; and it was plain that purifying had improved the three measures. In the third step, further dropping out of items was explored, but no improvement resulted. Hence, the variables finally used in this experiment were those pointed to by the results of step two. Table C presents statistics from steps one and two.

Reported Attention (RA) finally consisted of items A1, A2, A3, A4 and A5. In retrospect, the omitted item, A6, seemed different in content from the others in that it dealt with _S_'s emotions in the feedback situation while the other

TABLE C

INTERNAL CONSISTENCY RELIABILITY ANALYSIS OF POST-FEEDBACK INQUIRY VARIABLES (Decimal points are omitted.)

Variable	Item-Variable Correlations							Coefficient Alpha
RA	A1	A2	A3	A4	A5	A6		
step 1	75	82	67	83	63	43		78
step 2	74	81	70	86	62			
RC	C1	C2	C3	C4	C5	C6	C7	
step 1	59	13	69	18	53	51	67	43
step 2	76		72		49	57	77	69
RL	L1	L2	L3	L4	L5			
step 1	75	56	64	55	60			58
step 2	72	62	74		72			63

items dealt with kinds of physical and mental relaxation. As Table C indicates, the internal consistency reliability of RA was satisfactory.

Although some improvement in RC was gained by dropping out items C2 and C4, the measure still left something to be desired. The content area being tapped here was broader and less well defined than in the cases of RA and RL. Inspection of item content yielded little to explain why certain items hung together and others didn't.

Leaving L4 out of RL improved the picture about as much as might be expected for a measure based, finally, on only four items. L4 referred the subject to a very specific part of his feedback experience, namely, his reactions to the feedback light itself. In the others, the subject is asked to rate his liking of feedback in general. Hence, it was not altogether surprising that I4 was only weakly related to the other items.

In summary, items A6, C2, C4 and I4 were eliminated because of their failure to relate well to the other items which were finally used as the basis for RA, RC and RL. RA emerged with acceptable item homogeneity, but the internal consistency estimates for RC and RL were somewhat low. The problem with RC appeared to lie in poor definition of the content area. RL was hurt by the fact that most subjects rated their feedback experience most favorably. The many uniformly high scores on RL items reduced scoring range and restricted the size of coefficient alpha in turn.

APPENDIX D

PARALLEL FORM RELIABILITY OF THE 16 PF

In this study most Ss filled out the 16PF questionnaires away from the lab and on their own. This was, of course, a departure from standard test administration procedure. Since there is no established knowledge concerning the effects of this method on test results, it seemed necessary, at the very least, to check the data for discrepancies in results between the two forms of the test given to Ss. Failure of the two forms to correlate with each other at expected levels would suggest that the unusual method of administration had indeed reduced reliability. Table D presents Pearson correlation coefficients relating to this question for the present sample of 50 Ss. In addition, for the purpose of comparison, coefficients from a sample of 6476 are presented from the 16 PF Handbook (Cattell, Eber and Tatsuoka, 1970, p. 33). Although the Handbook states that the coefficients refer to Form A with Form B of the 1967-68 edition, it is not clear what norm tables were used to arrive at the sten scores correlated. Nevertheless, these values can be compared to the present case where, taking males and females separately, General Adult norm tables for the 1967-68 edition were used to derive stens from age corrected raw scores.

TABLE D

EQUIVALENCE COEFFICIENTS FOR THE <u>16 PF</u> OF FORM A WITH FORM B

16 PF Factor	Coefficients Here	Coefficients Cattell	16 PF Factor	Coefficients Here	Coefficients Cattell
A	44	57	L	34	37
B	22	49	M	25	40
C	63	54	N	34	20
B	53	52	O	58	59
F	44	61	Q_1	38	34
G	44	47	Q_2	35	39
H	78	71	Q_3	54	43
I	51	59	Q_4	64	62

Note: Decimal points have been omitted.

Inspection of Table D reveals that in seven of sixteen cases higher equivalence of form, reliability coefficients were obtained than those Cattell reports. Of the nine remaining cases where Cattell's values are higher, the discrepancy is large only in the four cases of factors A, B, F and M. However, three of these factors (A, B and M) were ones on which the present sample was markedly skewed; and the low equivalence coefficients obtained here must be determined in large part by the restricted scoring ranges in the sample. On the other hand, scores on factor F (Surgency) came more close than those on any other factor to the distribution of stens the test is designed to yield. Hence, it is not at all clear what the low equivalence value for F might be attributed to. Since it is the only value in the entire group of sixteen to seem questionable, it does not seem likely that the failure to obtain expected reliability level here is a function of the method of test administration which would have an effect more on the test as a whole. The variability in Ss' scores on F from Form A to B might be related to the fact that the content of this factor is involved with feeling states. The Handbook also mentions that scoring on F is partially a function of time of day the test is taken (Cattell, Eber and Tatsuoka, 1970, p. 88); but this relationship which depends upon changes in metabolic rate is a small one. Thus, possible lines of speculation do exist that might account for the low reliability value for F; but these lines will not be pursued in any further detail here.

In summary, with the exception of factor F, equivalence coefficients for the 16PF were as good as could be expected in the present sample of Ss. Because a questionable discrepancy existed in only one case of sixteen, it was concluded that these equivalence coefficients as a group offer no support to the notion that the atypical method of test administration might have adversely affected the reliability and validity of Ss' responses.

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