ALPHA BIOFEEDBACK CONDITIONING AND RETARDED SUBJECTS

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Six institutionalized severely retarded adult male *subjects* were selected to participate in a biofeedback alpha conditioning experiment. An experimental group consisting of three randomly assigned *subjects* received binary tone feedback for alpha production with eyes closed in a relaxed sitting position. A control group of three randomly assigned *subjects* followed identical procedures and instructions, but did not receive feedback. Statistical analysis revealed a significant difference between groups in terms of alpha percentage increase over baseline, as well as a highly significant difference between groups comparing baseline and first session mean percent alpha production levels.

Learning is facilitated by feedback which provides the means for monitoring the consequences of our behavior. Feedback not only provides information as to whether or not a response was executed, but also whether or not the response executed was appropriate to the situation at hand. Within the past fifteen years, the rapid growth of biofeedback research and biomedical technology has equipped us with the means by which an individual may receive instantaneous and accurate knowledge of specific autonomic functions, thereby facilitating control over these functions through feedback (Miller, 1969; Schwartz, 1973; Green, Green and Walters, 1970; Brown, 1970; Travis, Kondo and Knott, 1974; Lynch, Paskewitz and Orne, 1974).

There has been considerable interest in recent years in electroencephalographic (EEG) conditioning of brain rhythms, the documentation of associated mental states, as well as possible clinical and psychotherapeutic applications. Of the four brain rhythms (beta, alpha, theta and delta), that have attracted the attention of many investigators, alpha is probably the most extensively studied rhythm. The strongest alpha records are usually taken from the occipital regions (Kamiya. 1968; Brown, 1970; Ellingson and Lathrop, 1973). Alpha appears most abundantly while relaxed with eyes closed, but has also been recorded and conditioned with eyes opened (Travis, et al., 1974; Brown, 1970; Pepper and Mulholland, 1970).

While many experimenters have found that alpha enhancement is related to such pleasant mental states as relaxed alertness, creativity, a free floating experience, and inward directed unstressful imagery (Kamiya, 1968), other experimenters have found such descriptions less consistent, often half of the subjects reporting such conditions, and half reporting unpleasant sensations in connection with "alpha experience" (Plotkin and Cohen, 1976). It is normally attenuated by visual tracking (Peper and Mulholland, 1970; Nowlis and Kamiya, 1970), concentration, anxiety, muscular tension, and orientation to external stimuli (Klinger, Gregoire and Barta, 1974; Brown, 1975; Kamiya, 1968).

No two individuals possess identical brainwave patterns (therefore the EEG is uniquely related to each individual). It appears then, that individual differences, exist in the ability to learn to produce and control specific brain rhythms. Some persons, for example, have little or no recordable alpha in their EEG,

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while others display alpha in copious amounts even with eyes initially open (Kamiya, 1968a; Brown, 1970). It is generally found that the ability to gain control over alpha levels occurs in relatively short periods of time, usually within a few sessions, and in one study (Travis, et al., 1974), *subjects* reached 80% of their asymptotic performance in 20 minutes.

While biofeedback procedures involving alpha have undergone extensive study, studies employing developmentally handicapped *subjects* are difficult to find in the existing literature. The present experiment was conducted as an exploratory study to investigate the experimental effects of biofeedback alpha training employing developmentally handicapped *subjects*. Specifically, two hypotheses were tested: (1) *Subjects* given contingent tonal feedback for alpha production will significantly increase alpha level over baseline more than the no-feedback control group. (2) Increases in percent alpha production will occur more rapidly in the experimental group than in the control group.

Method

Subjects

The selection of suitable *subjects* for this study was based on a number of criteria including age, EEG normality, severity of retardation, absence of severe behavioral disorders and possession of at least some degree of communication and comprehension skills. On that basis, six adult severely retarded male *subjects* within the 20 to 35 IQ range were selected from a group of 10 at a training center for the developmentally handicapped to take part in the study. Four *subjects* who exhibited zero percent alpha levels in their baseline EEG records were rejected. (Three *subjects* were randomly assigned to an experimental group and three to a control group.

TABLE 1

Ages and Level of Functioning of Subjects

Experimental Group			Control Group		
Subject	Age	Level	Subject	Age	Level
1	46	Severe	1	46	Severe
2	25	Severe	2	47	Severe
3	26	Severe	3	20	Severe
Mean Age — 32.3 yr.			Mean Age — 30.7 yr.		

Apparatus

Alpha recording was accomplished using a Beckman Type RS dynograph coupled with an Alphascan 600 alpha/theta brainwave analyzer having dual digital filters. Input frequency was set from 6 to 14 Hz to include extreme cases (Ellingson and Lathrop, 1973). Relevant feedback was a binary tone delivered through stereo headphones. The experimental room, located at the training center, contained few distracting stimuli. The *exeprimenter* was separated from the *subjects* by a partition. A closed circuit television camera was trained on the *subjects* and connected to a monitor on the *experimenter's* side of the partition where other monitoring, filtering and

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recording equipment was located. Electrodes, attached to an elastic headband, were situated over the right occipital, temporal and frontal regions of the skull.

Procedure

Each *subject* in both experimental and control groups was given a half hour baseline recording trial to obtain initial alpha percent levels and become accustomed to the experimental situation. Uniform instructions were given with additional explanations when certain subjects failed to understand what was required of them

Subjects in both groups were instructed to sit down in a comfortable chair, close their eyes, and to relax. Appropriate gestures accompanied verbal instructions when required. Instructions were also communicated regarding restrictions of muscle movement and eyeblinks which might introduce unwanted artifact components in the recordings. Closed-circuit video trained on *subjects* allowed observation of possible eyeblink at all times. *Subjects* were informed that the purpose of the study was to see if they could learn to sit still and relax for one-half hour with two minute rest periods every five minutes. No mention of a feedback tone was made to any *subject.*

A training day consisted of two sessions, and included one *subject* from each group. Individual sessions were comprised of three five minute recording and feedback trials, separated by two minute rest periods during which *subjects* could open their eyes and change their position. Rest periods also aided in preventing restlessness in *subjects*. All *subjects* received similar instructions and followed the same procedures, but only the experimental *subjects* received relevant binary tone feedback for alpha production. *Subjects* had no knowledge as to which group they were assigned. Data collection extended over five sessions for each *subject*. *Subjects* were debriefed at the conclusion of the study as to the purpose of the study to the extent possible.

Two EEG channels were recorded: frontal and occipital, with a grounding electrode over the right ear on the temporal region. For all experimental *subjects,* binary tone feedback was delivered through headphones for rhythmic activity in the 6 to 14 Hz range, measuring at least 20 microvolts.

Results

Changes in mean percent alpha occurred in the expected direction for both experimental and control *subjects*. One control *subject* who possessed a high baseline did however, double his percent alpha by the last session. Results are presented both idiographically and statistically due to the small sample size. Baseline and mean percent alpha levels per session are given in Tables 2 and 3. Figure 1 graphically compares *subjects* in both groups with reference to changes

TABLE 2
Mean Percent Time Alpha During Repeated Feedback Condition for the Experimental Group

Subject	Baseline	Session 1	2	3	4	5
1	4.67	13.67	30.43	23.57	24.14	33.83
2	4.11	12.83	8.0	9.56	17.67	12.0
3	2.83	10.33	7.0	8.56	14.0	17.67

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TABLE 3

Mean Percent Time Alpha During Repeated No-Feedback Condition for the Control Group

		Session				
Subject	Baseline	1	2	3	4	5
1	4.0	3.83	5.29	6.67	5.0	5.1
2	15.0	15.00	16.1	18.11	23.22	26.78
3	1.77	1.73	2.3	3.0	3.4	2.7

in mean percent alpha over sessions.

In the experimental group, it can be seen that all *subjects* displayed substantive positive gains in percent alpha over five sessions. *Subject* 1, for example, showed a percentage increase over baseline of 624.4%; *subject* 2 an increase of 191.9%; and *subject* 3 an increase of 524.4%.

In the control group, *subject* 1 showed an increase of 27.5% over baseline, *subject* 2 scored 78.5% and *subject* 3 demonstrated an increase of 52.5%. While the increase shown by *subject* 2 was somewhat larger than the other controls, it should be noted that this *subject* also possessed the highest initial mean percent alpha level over all *subjects*. That baseline activity is related to alpha generation over trials has also been noted by other experimenters (Lynch, Paskewitz and Orne, 1974).

A *t* test between groups showed the difference in percentage increase over baseline to be significant $t\ (4) = 2.99$, $p < .025$. A *t* test on the significance of the difference between groups comparing session 1 over baseline was highly significant, $t\ (4) = 17.98$, $p < .005$. Thus, both hypotheses were confirmed.

Discussion

While caution must be exercised in interpreting results due to small sample size, certain implications can be drawn from the observed changes in alpha levels in both groups In general, these severely retarded *subjects* demonstrated changes in percent alpha consistent with trends found in subjects of average intelligence in other biofeedback alpha experiments (Nowlis and Kamiya, 1970; Travis, et al., 1974; Klinger, et al., 1974).

It is interesting to note that the experimental *subjects* demonstrated immediate and relatively large gains in the first session with relevant tonal feedback. Experimental *subject* 1 almost tripled his baseline level in the first session, *subject* 2 more than tripled his baseline level, as did *subject* 3. During one trial, *subject* 1 generated 53% alpha over a 100 second time interval.

In comparison, none of the control *subjects* demonstrated rapid increases in percent alpha during the first session, showing either no increase or a slight decrease over baseline levels. This was true even of the control subject with a high baseline score.

This study, while encouraging, remains exploratory and in need of replication with larger samples. Further experimenters must be careful to exercise greater controls due to the added complexities involved when using *subjects* with limited comprehension capabilities, or those who are brain damaged, hyperactive or taking regular psychoactive

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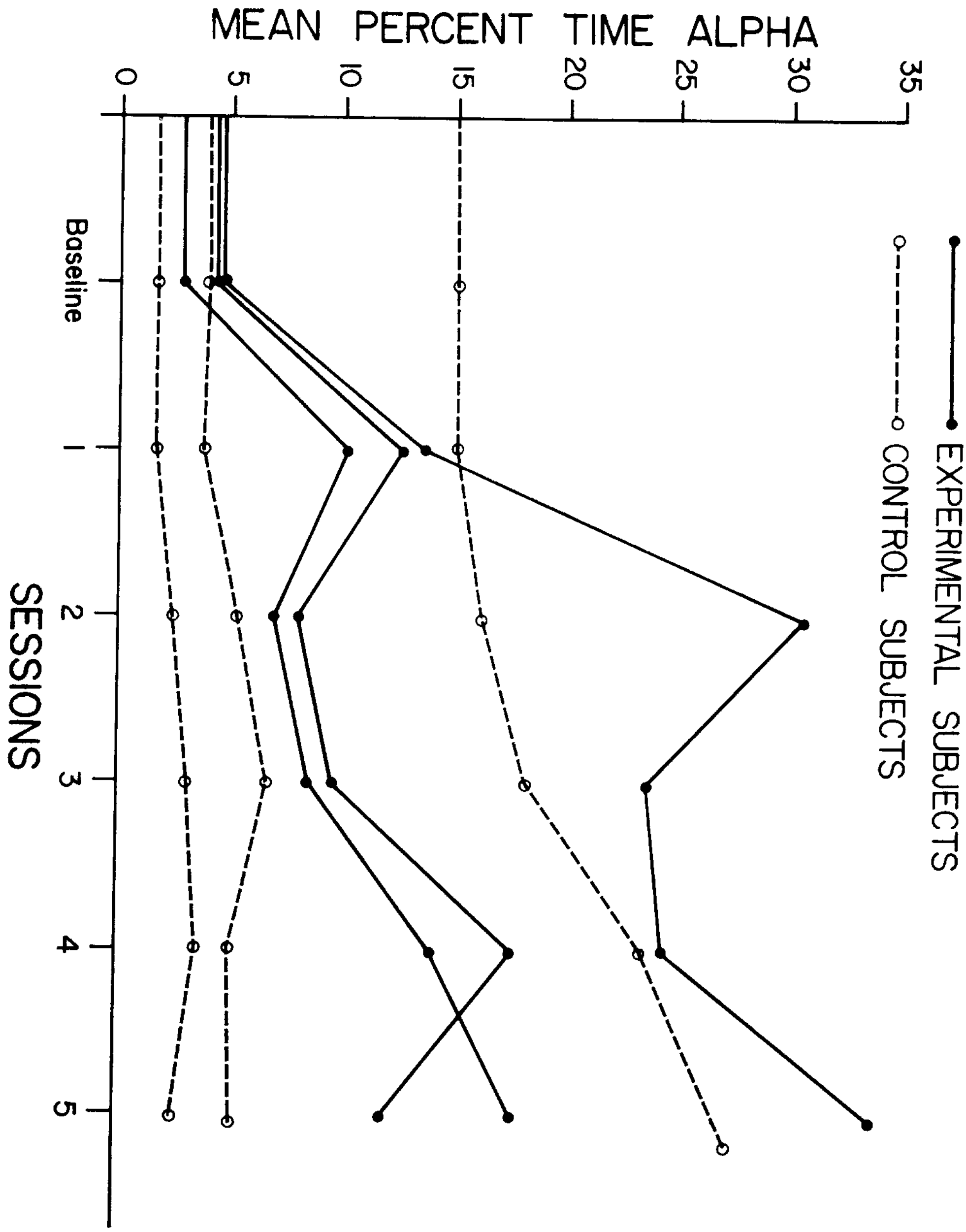
Figure 1. Comparison of experimental and control *Subjects* showing changes in percent alpha production over sessions.



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drugs, since all of these conditions may introduce factors which reduce internal validity. Caution should also be taken to guard against conducting sessions at times when institutionalized residents are accustomed to taking rest periods, since spurious results may be obtained at these times when alpha activity may be increased due to expected rest or sleep.

Since many biofeedback procedures may be accomplished with relatively minimal or simple verbal instruction, it would seem reasonable to assume that such procedures presently employed with normals may be adapted to play a useful role in the treatment and rehabilitation of the retarded.

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