BIOFEEDBACK VS. VIDEO GAMES: EFFECTS ON IMPULSIVITY, LOCUS OF CONTROL AND SELF-CONCEPT WITH INCARCERATED JUVENILES

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Research has found hyperactivity, poor impulse control, impaired sustained attention and low self-concept to be behavioral deficits common to juvenile delinquents. Limited opportunities for exercising self-control while incarcerated may encourage helplessness. If biofeedback training enhances self-regulation skills, then perhaps these behaviors can be taught in confinement. A sample of 12 felonious juvenile residents (aged 15-18) from a highly restricted environment were assigned randomly to a biofeedback or video game group and trained for 10 half-hour sessions. Results indicated virtually no significant differences between biofeedback and video game training. However, pre and post differences for both groups combined demonstrated significant gains in impulsivity, EMG, and self-concept. Both groups rated themselves equally on self-control ability, regardless of training. Further comparisons between other institutionalized residents (N = 14) and staff counselors (N = 10) as non-treatment controls were made. On each measure, both training groups improved consistently and became more like their less restricted counterparts.

Rehabilitation programs for juvenile delinquents often introduce therapies designed to improve a youth's personal and social functioning with an emphasis on nurturing individual responsibility for behavior. Recent research on the evaluation of various behavioral interventions has indicated that flexible methods and individually tailored applications tend to maximize the likelihood of achieving successful results (Rutter & Giller, 1984). The unique nature of individual differences in offense, personality, social, and institutional variability makes program evaluations or recommendations exceedingly difficult. Developing specific cause-and-effect interventions equally efficacious with all delinquents seems virtually impossible. Although differences exist among young offenders, there is growing evidence of common psychophysiological characteristics associated with probable contributions to delinquency. For instance, research has found hyperactivity, poor impulse control, stimulus seeking, and impaired sustained attention to be frequently identifiable behavior deficits found in juvenile delinquents (Douglas & Peters, 1979; Olweus, 1980; Weiss, 1983). Furthermore, inattentiveness and impulsivity typically are linked to antisocial conduct disorders (American Psychiatric Association, 1980; Cantwell, 1980; Stewart, Cummings, Singer, & De Blois, 1981).

Some social learning theorists (Cairns, 1979; Feldman, 1977) emphasize early learning processes as instrumental in establishing personalities predisposed to delinquent activities. If these psycho-socio-physiological characteristics are in fact critical determinants of antisocial behavior, then behavioral approaches may want to initiate specific self-control skill acquisition rather than merely seek to suppress deviant behavior (Patterson, 1980; Rutter & Giller, 1984). The structured nature of the social environment for incarcerated or institutionalized individuals unintentionally may promote and sustain

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a loss of personal control while cultivating the feeling that one has very little direct influence over one's life. Moreover, limited daily opportunities to exercise control actually may encourage feelings of helplessness (Seligman, 1975) and a perceived external locus of control (Carlson, 1982; Lefcourt, 1976; Rotter, 1966). Some research in social skill programs has found internally oriented delinquents to have evidenced a 26% recidivism rate, whereas externally oriented delinquents demonstrated a 58% recidivism rate (Ollendick & Elliot, 1978; Ollendick & Hersen, 1979). Delinquents as a group frequently exhibit a lack of personal integration, feelings of inadequacy, and poor self-concept when compared to nondelinquents (Lund & Salary, 1980). Further restriction of one's self-assertion, self-efficacy, and self-control inadvertently may foster lower self-confidence and poor self-esteem and prevent development of personal responsibility (McKinney, Miller, Beier, & Bohannon, 1978).

If hyperactivity, poor self-concept, perceived external locus of control, and impulsivity are personality determinants likely to contribute to delinquent behavior, then perhaps behavioral programs designed to emphasize personal and direct influence over specific outcomes may encourage responsible behaviors. Behavioral research in the field of biofeedback has shown some promise as a physiological and psychological technique for assisting in the acquisition of self-regulatory skills. For instance, hyperkinetic children and hyperactive adolescent boys have made significant improvements after biofeedback-induced relaxation training (Anchor & Johnson, 1977; Hampstead, 1979; Omizo, 1980). The adolescent boys also became more internally locused in their orientation. Hughes and Davis (1980) found that physical and verbal aggression was diminished with biofeedback training by reinforcing relaxation as a competing response. Relaxation training with biofeedback has been shown effective for reducing inappropriate classroom behaviors as well, specifically with emotionally handicapped fifth- and sixth-grade males (Walton, 1979). Biofeedback may offer a procedure for training appropriate behavior by providing feedback and training in alternative coping strategies while simultaneously enhancing a belief in personal control (Eltizur, 1976; Stern & Berrenberg, 1977).

The present research originally was designed to examine the clinical efficacy of biofeedback training as a means of providing the necessary knowledge and direct experience to reduce impulsivity, increase personal influence, and improve one's self-concept. In particular, biofeedback training was selected to teach physiological self-control of emotional states by learning relaxation as a stress coping mechanism. In addition, biofeedback training also might serve as an immediate and consistent teacher of the value of sustained attention and internal locus of control on achieving successful self-regulation. Ultimately, successful accomplishment and knowledge of these conditions might generalize to other skills and encourage the self-esteem necessary for increased self-confidence and self-sufficiency. A population of incarcerated felonious delinquents under strict control was selected to test these assumptions. Because it is well known that biofeedback, as with most interventions, may contain highly potent placebo effects (Frank, 1983), video game training was selected to serve as an alternative treatment control group. Computer games and associated software sometimes have been classified candidly as "edutainment" (Piestrup, 1984); however, recently there have been some attempts to develop games with therapeutic benefits (Allen, 1984; Clarke & Schoech, 1984). Accordingly, this applied field research compared the effects of biofeedback training vs. video game training on impulsivity, locus of control and self-concept.

Method

Subjects

The main group of subjects consisted of 12 male residents aged 15-18 with a mean age of 16, who were committed to a maximum security unit (closed treatment unit, CTU)

in a state juvenile correction facility. The CTU maintains juveniles who have records of severe offenses and/or those who have become unmanageable in less restricted environments. These residents have committed such crimes as murder, sexual assault, robbery, and theft. The 12 residents were assigned randomly into two groups of 6. A third group of subjects consisted of 14 randomly selected male residents from the less restricted cottage program population from the same institution. Although some of these residents have spent time on CTU, the majority have not. This group was selected as an intact no-treatment control to serve as an institutional norm group. Their age range was 14-19 with mean age of 17. The fourth group of subjects included 10 counselors assigned to CTU who volunteered to participate in the personality assessment phase so as to examine themselves in relation to the residents whom they counsel. All subjects were white except for 2 Eskimos, 1 on CTU and 1 from the cottage.

Apparatus

All pre and post baseline testing and experimental sessions for the 12 CTU residents were conducted on CTU. Cottage residents were tested in their respective cottage environments and did not participate in either the video or biofeedback sessions. CTU maintains 13 individual 10′ × 12′ cell arrangements, which allowed subjects to practice video or biofeedback in the privacy of their room. Video game subjects practiced their skills with the Atari Video Computer System on a 19″ Quasar color TV monitor with a single joystick. Video subjects were free to select from the following games: Pac-Man by Atari, Pitfall by Activision, or Donkey Kong by Coleco. Biofeedback subjects practiced their skills with the following Cyborg equipment: P642 Thermal Trainer, P303 Electromyograph (EMG) Trainer, and a Q700 Data Accumulator/Intergrator.

Procedure

Residents on the CTU were assigned randomly to either a biofeedback group or video group and were instructed not to discuss their individual performance within or between groups because their results were personal and likely to be different for different reasons. Each of these groups spent one session prior to training taking a battery of assessment instruments as a pretest and 8 weeks later these same instruments as a post assessment. The complete testing battery was counterbalanced and included the following tests: Internal-External Locus of Control for Children, Impulsivity-Reflection Response Styles for Adolescents, and the Personal Attribute Inventory for Self-Concept. Both of these two groups watched a 30-minute film prior to the start of their training. The biofeedback group saw a film entitled "Biofeedback: The Yoga of the West," which described the use of biofeedback, while the video group watched a film entitled "Learning," which discussed principles of learning in man and animals. All CTU residents participated in eight assessment sessions: Three pre and post biofeedback sessions and two written assessments. In addition, subjects received 10 individual training sessions with specific counseling on their performance. Training was conducted every other day except Sunday at the same time of day for 30 minutes a session. All sessions were held during the afternoon from 1-4 P.M. Each pre and post biofeedback test session was conducted in the same manner.

During testing sessions, an independent experimenter unfamiliar with group identity collected digital skin temperature from the middle finger of the dominant hand and electromyographic activity from the frontalis muscle. All instruments and the experimenter were located behind the subject, and feedback was made unavailable to the subject. After a 10-minute baseline and hook-up period, Fahrenheit and microvolt readings were collected at 2-, 5-, 10-, 15- and 20-minute intervals.

During training sessions, both video and biofeedback subjects trained independently, yet simultaneously, because the experimenter would visit each subject routinely in his

cell and thereby observe and encourage individual performance. Both groups of subjects were requested to keep daily records of their progress by graphing their respective results. Video subjects recorded highest score and lowest time per game by session, while biofeedback subjects recorded highest temperature and lowest EMG reading by session. All other residents from the less restricted cottages and the counselors on CTU participated only in the written assessment phase of this study and, therefore, were not assessed on biofeedback parameters. Over 225 sessions were necessary to complete this study.

Finally, at the end of the study, CTU residents were asked to rate their own ability to regulate and control their life and behavior on the Closed Treatment Unit. This also included their independent written evaluation of their views on the study's purpose and what they had learned from their participation. A total debriefing and sharing of experiences followed.

Assessment Instruments

Impulsivity was measured by the adolescent Matching Familiar Figures Test developed by Kagan (1966). This test is designed to assess problem-solving style on a reflection-impulsivity dimension. The test provides two scores: Time latency and error rate. Higher time latency and lower error rate are indicative of greater reflection and less impulsiveness.

A locus of control scale for children was administered to assess internality and externality in children (Nowicki & Strickland, 1973). The test contains 40 questions that are answered yes or no; higher scores reflect greater externality. This test represents the children's version of the more familiar adult version developed by Rotter (1966).

Self-concept was assessed with the Personal Attribute Inventory (Parish & Eads, 1976) as a checklist with the target stimulus labeled "yourself." This inventory consists of 50 positive and 50 negative adjectives. Scoring is based on the number of negative adjectives selected with a limited maximum possible choice of 30. Previous research with other personality scales (Kappes & Parish, 1979) has indicated that personality characteristics such as apprehension, undisciplined self-conflict, and tension are particularly associated with self-concept on this inventory.

Counselor evaluations also were based on the Personal Attribute Inventory, but this time, the individual CTU resident served as the target stimulus with pre and post ratings by all 10 counselors. The scoring procedure was the same and based on the number of negative attributes selected by the counselors. The final evaluation instrument was a 7-point Likert scale developed to ascertain the CTU resident's perception of his perceived self-control ability. Items on the scale ranged from "I have no self-control" (1) to "I have extreme amount of self-control" (7). This instrument also requested residents to write individual paragraphs of their personal experience and interpretations of this study.

Results

Analysis of variance for physiological parameters by group found temperature differences not statistically significant, $F(1,11) = 1.29$, $p > .05$, although biofeedback subjects were naturally higher. EMG results were also not significant, but the biofeedback group was more favorable than the video, $F(1,11) = 4.37$, $p > .06$.

Several one-way analyses of variances also were conducted to examine the differences between biofeedback vs. video training on the eight posttest measures. The results were consistently nonsignificant between these two groups except on measures of impulsivity: Time Latency, $F(1,10) = 4.66$, $p < .05$; Error Rate, $F(1,10) = 5.37$, $p < .05$; Temperature, $F(1,10) = 1.29$, $p > .10$; EMG, $F(1,10) = 4.37$, $p > .06$; I-E, $F(1,10)$

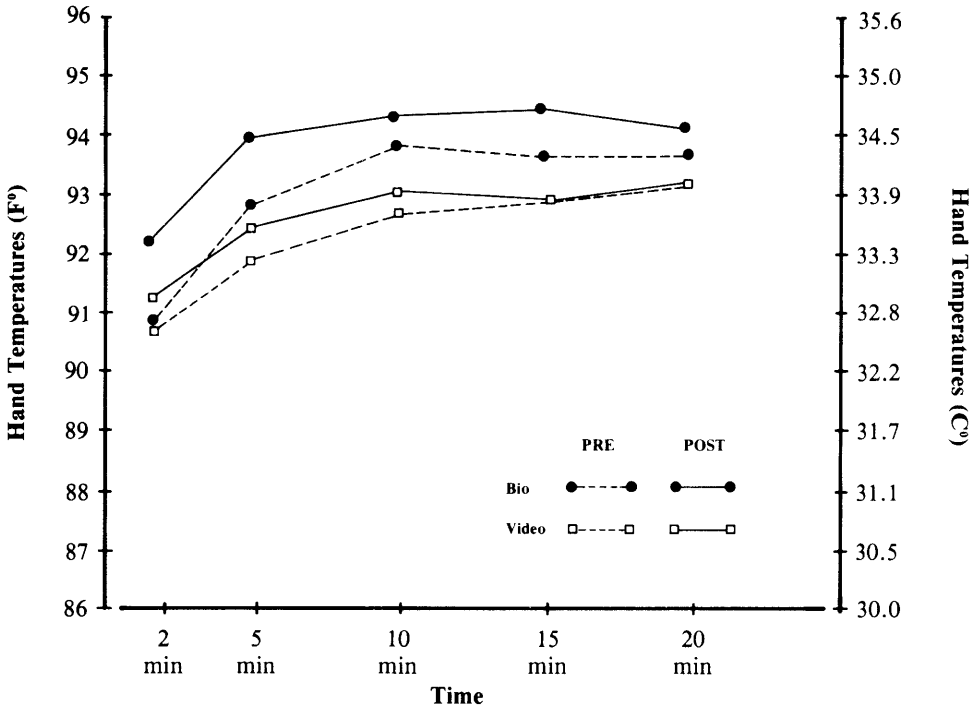

FIG. 1. Mean pre and post hand temperatures by group over time.

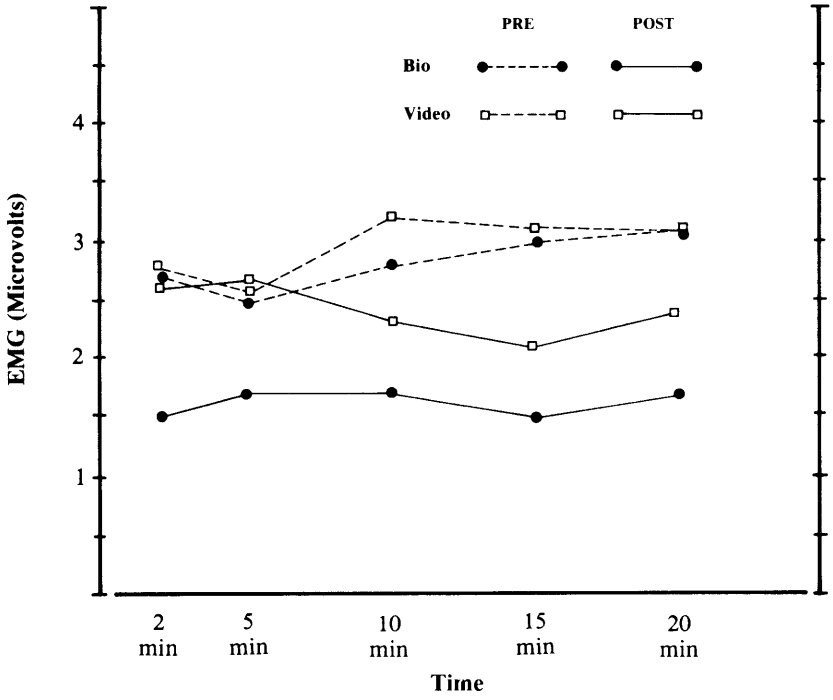

FIG. 2. Mean pre and post EMG by group over time.

= .02, $p > .10$; Self-Concept, $F(1,10) = 1.07$, $p > .10$; Counselor's Evaluations, $F(1,10) = .33$, $p > .10$; and Juvenile's Evaluation of Self-Control, $F(1,10) = .03$, $p > .10$. There were no significant differences between biofeedback or video training subjects for most of these measures except on impulsivity as measured by Time Latency and Error Rate. In each case, the biofeedback group performed significantly better by decreasing errors and increasing time latency as compared to the video group. Although the CTU counselor's evaluations by the group were not significant, nevertheless, they did demonstrate a lower number of negative adjectives from averages of 22 to 19. A remarkable finding on the posttest only self-rating was that both biofeedback and video subjects rated their perceived self-control ability equally, regardless of training. Their mean ratings were both 6 on the 7-point Likert scale.

Table 1

Mean Scores by Group for Impulsivity, Locus of Control and Self-concept

Measures	$N = 12$ CTU				$N = 14$ Cottage		$N = 10$ Counselors	
	Pre		Post					
	$\bar{X}$	*SD*	$\bar{X}$	*SD*	$\bar{X}$	*SD*	$\bar{X}$	*SD*
Impulsivity								
MFFT latency	28.7	7.9	32.2	12.6	40.3	24.5		
MFFT errors	12.7	7.8	9.6		6.3*	12.1	6.2	
Locus of Control								
Nowicki-Strickland	17.2	9.3	12.5	5.8	11.5	4.5	6.8	2.2
Self-concept PAI	10.4	3.8	6.2	5.6*	7.4	6.2	2.4	1.5

*$p < .01$.

Biofeedback and video subjects later were combined as a CTU group to examine overall pre-post test results using several dependent *t*-test analyses. CTU subjects demonstrated significant improvements over time in the desired direction; that is, they came to resemble more closely their less restricted counterparts, cottage juveniles and their counselors. These results were: Time Latency, $t(1,11) = -1.13$, $p > .10$; Error Rate, $t(1,11) = 2.78$, $p < .01$; Temperature, $t(1,11) = -1.28$, $p > .10$; EMG, $t(1,11) = 3.28$, $p < .01$; I-E, $t(1,11) = 1.71$, $p > .10$; Self-Concept, $t(1,11) = 3.56$, $p < .01$; and Counselor's Evaluations, $t(1,11) = 1.69$, $p > .10$. Although between-group differences were few, pre and post differences for CTU showed significant changes in Error Rate, EMG, and Self-Concept. These improvements as well as other measures were consistently toward the institutional norm and in some cases, specifically beyond the norm level. (See Figure 3.) For the most part, both biofeedback training and video game training results were quite similar, with notable effects in self-concept and perceived self-control.

Discussion

Interestingly, physiological measures of temperature and EMG were not significant between groups, particularly because the video group had not received any biofeedback training. Although room temperature was fairly constant, unfortunately, it was not controlled and is likely to have been an intervening variable. Perhaps it may have contributed to overall temperature increases, as seen in Figure 1. It is quite remarkable that both groups combined still demonstrated a significant decrease in resting frontalis tension,

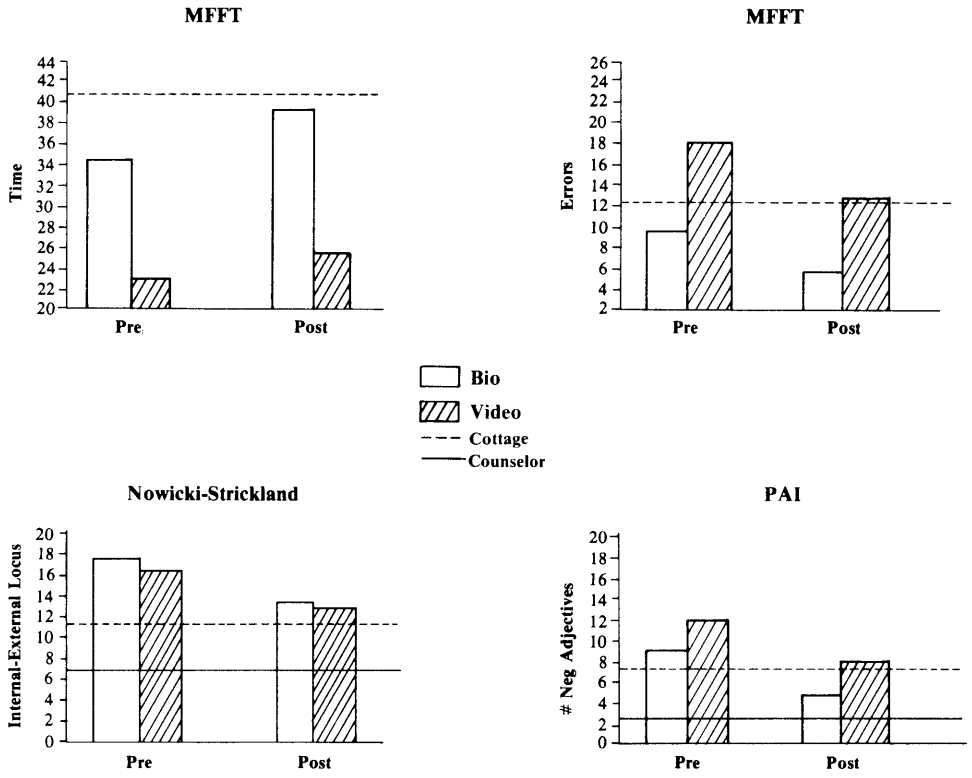

FIG. 3. Mean pre and post test measures for impulsivity, locus of control, and self-concept by group.

regardless of group. Figure 2 demonstrates decreases for both groups, with lower scores for the biofeedback group. This seems to suggest an increase in the relaxation response and/or increased comfort with the assessment procedure. When individual task performance data are examined by group, each CTU resident showed consistent performance gains, which supports high motivation and successful accomplishment in both conditions during the 10-session training periods.

Impulsivity, as measured by time latency and error rate, was significantly better for those trained in biofeedback than video. Yet, upon closer examination of Figure 3, the biofeedback group by chance was initially superior and more reflective. Later, when both groups were combined, as depicted in Table 1, they still significantly improved their error rate. It seems that each group became more reflective and less impulsive and that biofeedback subjects attained a slight advantage. In fact, several video subjects claimed that patience and relaxed concentration were instrumental in improving their skills. Similar remarks were made by biofeedback subjects about their physiological performance.

Locus of control was not significantly different across groups or overall. However, improvement again was found with both groups combined by increasing in an internal locus orientation. Biofeedback and video subjects became more internally directed and became more like cottage residents and their CTU counselors.

Self-concept was not significantly different between groups, yet significantly improved for both groups over time. Most notable, there was an important decrease in the number of negative self-attributed adjectives, regardless of training. Surprisingly,

these CTU residents as a whole improved their self-concept scores by surpassing their cottage resident counterparts. Increased improvement in skill acquisition and enhanced accomplishment may have been responsible. CTU residents seemed delighted each session to attempt to improve their last performance and to succeed. Consistent reinforcement, feedback, and immediate reward may have enhanced their self-esteem.

Although counselor evaluations of CTU residents were not significant, the ratings were still more positive than before. Interestingly, when each CTU resident was asked independently to rate his own ability at self-control, both groups rated themselves equally. CTU residents also were asked to write a paragraph on what they felt the experiment was about and what they had learned about themselves. In an ad hoc decision to have several colleagues blindly distinguish the responses into groups, discrimination was virtually impossible. Statements were frequently similar or identical in both groups with regard to concentration, relaxation, and the need to focus on personal physiological response to enhance success.

All in all, this study showed that some improvement was possible by different methods. Perhaps the real issue was one of *feedback,* regardless whether it was bio or video feedback. It is well known that immediate, continuous, and consistent feedback enhances learning and performance in most skills by allowing for individual adjustment and refinement of effort. Brief personal reinforcement gains for these youths in both conditions may have provided consistent feedback and reward, which often have been lacking in their lives.

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