The Effects of Covert Reinforcement on Solution of Arithmentic Problems in Grade Four Children

by

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University of Manitoba

A Thesis submitted to the Faculty of Graduate Studies

in partial fulfillment of the requirements

for the Degree of Master of Arts

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ABSTRACT

The present research attempted to test the three assumptions of covert conditioning as stated by Cautela and Baron (1977). The homogeneity and learning assumptions state that covert events obey the same laws of behaviour as overt events, the laws of conditioning. The interaction assumption states that covert events can influence overt events and that, reciprocally, overt events can influence covert events in a predictable manner.

Previous research on the effectiveness of covert reinforcement as a treatment procedure has contained serious methodological flaws (Kazdin & Smith, 1979). The present research attempted to provide better controlled experimental assessment of the interaction of covert and overt behaviors. One female and three male children were selected, on the basis of low skill level in arithmetic, from a grade four elementary school classroom. An A-A'-B-C-B combination multiple baseline reversal design was employed, where A = baseline. A' = rest placebo control, B = covert neutral stimulus placebo, and C = covert reinforcement. The primary dependent variable was the number of arithmetic problems completed within a 20 min. time period as the contingencies were applied directly to it. The number of correct solutions was a secondary dependent measure since it was not directly reinforced. Three out of four subjects completed 7.6 to 23.4% more problems during covert reinforcement than during any covert neutral stimulus phase. From mathematical extrapolation, subjects could have completed 8.6 to 24.5% problems during the covert reinforcement phase if 20 min. of work time (without imagining) had been provided. One subject did not display a positive

effect of covert reinforcement perhaps related to his unwillingness to attend sessions. Also, this subject may have been imagining positive scenes throughout several phases of the study, prohibiting demonstration of experimental control. Only for one subject did number correct directly follow the function for number attempted.

The results of the present research have provided tentative empirical support for covert reinforcement. However, more research is necessary to provide convincing empirical support for the three assumptions of covert conditioning.

LIST OF FIGURES

The Effects of Covert Reinforcement on Solution of Arithmetic Problems in Grade Four Children

The use of private events, particularly images, as therapeutic tools has received widespread application in contemporary behavior therapy and is generally referred to as covert conditioning (Kazdin & Smith, 1979). The relevance of the term covert conditioning is based on the tenet that private events such as thoughts and images are all subject to the same laws as public behaviors, the laws of conditioning. As a treatment paradigm covert conditioning contains procedures such as covert positive reinforcement, covert negative reinforcement, covert extinction, covert punishment, and covert modelling which are all considered direct parallels to their overt counterparts (Kazdin & Smith, 1979).

The actual imagining of a covert stimulus on cue may be explained through conditioned seeing (Skinner, 1953, pp. 266-270). For example, to imagine a blue sky, the individual must have experienced a "blue sky" previously. Furthermore, the cue words "blue sky" must have been associated with the corresponding visual representation. Then the verbalization "blue sky" may result in the imaginary "blue sky".

Covert Conditioning and Self-Reinforcement

Two major practical aims of covert conditioning research would seem to be: (1) to determine the efficacy of the procedures (the focus of the present research), and (2) to train the subject or client to utilize the effective procedures outside of the experimental setting. In other words, the client would be trained to emit appropriate self-control behaviors. (See Appendix A for further information on self-control behavior).

Assumptions of Covert Conditioning

Cautela and Baron (1977) have enunciated three assumptions which form the theoretical basis of covert conditioning. The first assumption, that of homogeneity (recognized also by Homme, 1965) states that covert events such as thoughts, feelings, and images obey the same laws of behavior as overt events. In other words, the laws of covert behavior are homogeneous with the laws of overt behavior. The second or learning assumption is a corollary of the homogeneity assumption. It specifies the laws of behavior as principles of operant conditioning. Kazdin and Smith (1979), in their review of covert conditioning, state that the theoretical basis for covert conditioning stems from the abundance of empirical support for operant procedures.

The third or interaction assumption argues that covert events can influence overt events, and that, reciprocally, overt events can influence covert events, in a predictable manner. The typical procedure has been to apply a covert treatment strategy to a covert behavior and, later, to measure the overt counterpart of the covert behavior to determine the success of treatment. The covert consequence does not have to be directly related to the imagined behavior but the intention is that the scene provide the appropriate (reinforcing or punishing) consequence for the imagined behavior (Kazdin & Smith, 1979). For example, a phobic subject may imagine approaching a feared stimulus and then covertly reinforcing herself or himself. The success of treatment might be assessed directly by examining a subject's approach to feared objects, or indirectly by asking a subject to fill out a fear survey after treatment has been terminated (e.g., Blanchard & Draper, 1973; Wisocki, 1973).

A similar but more direct method of assessing the interaction assumption has been to apply a covert treatment procedure directly to an overt behavior. For example, a subject may overtly approach a feared stimulus and then covertly reinforce herself or himself. This direct method has the advantage of measuring the approach behavior immediately, during treatment (e.g., Flannery, 1972), rather than at a time far removed from the experimental setting, i.e., after treatment has ceased (e.g., Hurley, 1976; Wisocki, 1973). It is easier to make causal inferences when the independent and dependent measures have a close temporal arrangement. To wit, if the interaction assumption is indirectly assessed, confounding variables have freer rein to intervene between covert reinforcement applied to the imagined behavior and measurement of the overt counterpart, than with covert reinforcement applied directly to the overt behavior. Three studies reviewed by Kazdin and Smith (1979) directly tested the interaction assumption (Flannery, 1972, Krop, Calhoon, & Verrier, 1971; Steffan, 1977). However, Kazdin and Smith (1979) have warned that previous covert conditioning studies lacked a sound methodological base.

Methodological Issues in Evaluating Covert Conditioning Research

Five major methodological issues are relevant when considering covert conditioning techniques. The first is the failure to control for non-specific treatment effects. The biggest problem has been the absence of imagery control conditions (e.g., a neutral image) to account for treatment placebo effects (e.g., Flannery, 1972; Krop et al., 1971). Another problem associated with non-specific treatment effects is the failure to control for subject expectancies. Different application of treatment and placebo features may create subject expectancies that contaminate the results (Kazdin & Smith, 1979).

The second methodological issue is a lack of assessment of imagery procedures (Kazdin & Smith, 1979). For example, a covert reinforcer may not improve performance if the image produced is not accurate, i.e., the image is not clear or it shifts in content or reinforcing value from the original scene. Wisocki (1973) found a significant positive correlation between imagery vividness and covert reinforcement treatment effect. Therefore, imagery assessment should be conducted to help ensure clarity of images. Images should also be retrained at least periodically. The direct interaction studies of Flannery (1972); Krop et al., (1971); and Steffan (1977) did not include imagery assessments.

A third methodological issue is the utilization of college students as subjects. They may represent a very biased sample and generalization of treatment effects to other populations may prove problematic (Kazdin & Smith, 1979).

The fourth methodological issue relevant to many covert conditioning studies is the implementation of large-N between groups designs (Hersen & Barlow, 1977, p. 13). In large-N designs, data from individual subjects are averaged and the specific effects for individual subjects are obscured. Some subjects may improve, others may deteriorate, and others may display no change. Thus the average may be unrepresentative of individual performance (Sidman, 1960, p. 51). Because the average may be unrepresentative, generalization of improved behavior to any other particular subjects is difficult, because those subjects must have the same individual characteristics as the subjects who improved in the original study. When data are averaged, it is not known which subjects improved. Individual data should always be examined (Hersen & Barlow, 1977, p. 16).

Largely ignored in large-N designs is within-subject variability (Hersen & Barlow, 1977, p. 16). Progress is usually assessed only post-treatment and although there may be general improvement in performance, it may have been quite variable. The results can therefore be statistically weak but clinically significant. Alternatively, a single subject design enables continual monitoring of progress and better control in teasing out extraneous variables, thereby affording a more sensitive test of the independent variable (Sidman, 1960, p. 51).

Besides the basic limitations of the group comparison approach, i.e., averaging of results, generality of findings, and lack of assessment of intrasubject variability, it should be acknowledged that covert reinforcement originated from within the operant paradigm (Kazdin & Smith, 1979). Therefore covert conditioning seems best examined via single case experimental designs which constitute the basic methodology of operant conditioning.

The fifth methodological issue relevant to covert conditioning studies is the utilization of indirect assessments of the interaction assumption. The advantages of a direct test of the interaction assumption have previously been described (p. 3). Briefly, close temporal contiguity of independent and dependent variables enables more powerful support for causal inferences. Direct assessment of the interaction assumption limits the opportunity for potentially confounding variables to intervene between the covert manipulation and assessment of behavioral change. A more detailed analysis of methodological issues revealed in studies directly assessing the interaction assumption will now be undertaken.

The Direct Approach to the Interaction Assumption

One example of a direct test of the interaction assumption is a study conducted by Flannery (1974). Flannery used 45 female student nurses who feared rats in a between groups design and compared the presentation of covert reinforcement as applied to an overt behavior to covert reinforcement applied to a covert behavior, in increasing approach behavior to rats. Each subject was first trained to covertly reinforce herself upon hearing the word "reinforcement". Subjects in the overt behavior condition were taken to the laboratory and were instructed to concentrate on the actual environment. From this point on, the experimenter sequentially progressed through a 13 step hierarchy. For example, moving one step closer to the rat's cage was the first step of the hierarchy. The subject was then given a choice of moving one step closer to the cage, or remaining where she was and repeating the same hierarchy step. She reinforced herself for either behavior chosen. For subjects in the covert behavior condition, the same procedures were followed except that everything was conducted in imagination. In other words, subjects imagined that they were approaching the cage, choosing to progress to the next step or remaining at the same level, and then reinforced themselves for the imagined response they chose. Subjects in the control condition were given brief instruction in covert reinforcement at the beginning of each session. They then spent the rest of the session discussing fear of laboratory rats.

The results revealed greater fear reduction for the group presented with the actual fear stimulus than for the group presented with the imaginary stimulus. The control group displayed no change in fear of rats. The evidence from Flannery's study suggests that applying a covert reinforcer directly to an overt behavior (direct test of interaction assumption) is more effective than applying a covert reinforcer to an imagined behavior (indirect test of the interaction assumption).

As interesting as these results may appear, they do not adequately test the effects of covert reinforcement because there was no control of imagery group. In order to determine the relative effects of covert reinforcement, a covert neutral stimulus should have been presented to control for nonspecific treatment effects. Another weakness of Flannery's study is that it did not include an assessment of imagery control procedure. Had an assessment been conducted, it may have been established that the group that imagined the approach behavior shifted the approach scene as well as the reinforcing scene. That is, the approach scene may have been less anxiety provoking than the original scene and the reinforcing scene may have ultimately become neutral, thereby producing less fear reduction.

A further problem with Flannery's research is that it employed a large-N between groups design. Treatment results are not necessarily representative of any particular subject, but only of the group as a whole. No individual data were presented and progress was assessed only at posttreatment.

In another direct test of the interaction assumption Krop et al. (1971) provided covert reinforcement for overt responses associated with a positive self-concept, i.e., responses to true and false questions. The true and false questions were taken from the Tennessee Department of Mental Health self-concept scale. No examples of the items were given. The authors implemented a between-groups design with 36 hospitalized children. An overt reinforcement group was implemented as a comparison treatment. In the overt reinforcement condition subjects were given tokens contingent upon responses associated with a positive self-concept. The tokens were established conditioned reinforcers from an unrelated study. A no-treatment control group was presented with the true and false questions on two occasions (24 hr. apart) with no intervening treatments. Covert reinforcement was revealed as more effective than either overt reinforcement or the no-treatment control.

Three methodological problems are evident in Krop et al.'s design. The first is that a covert neutral stimulus should have been presented to control for covert placebo effects. In other words, it may have been that any covert procedure would have been effective. Another issue is that no assessment of imagery procedures was implemented. Even though covert reinforcement was effective, assessments of imagery should have ben utilized as a precautionary measure. Once again, a large-N groups design was employed. The results are not necessarily representative of any particular subject, but only of the group as a whole. No individual data were presented and progress was assessed only at post-treatment.

Steffan (1977) designed two studies that were each a direct test of the interaction assumption. Male hospitalized psychiatric patients (Experiment I) and male and female college students (Experiment II) were used in between-groups designs to determine the effectiveness of covert reinforcement. Subjects in the covert reinforcement group were trained to imagine a pleasant scene upon hearing the word "scene". The experimenter then said "scene" each time after the subject said a plural noun. Four control groups were used. Group one received no feedback but was simply requested to say 200 words, one at a time. The second group was told that the experimenter would say the word "scene" at certain times during the task. The experimenter said "scene" after each plural noun. The third group was taught to imagine a pleasant scene upon hearing the word "scene". The experimenter then said "scene" after a random number of responses. Group four was taught to imagine a neutral scene upon hearing the word "scene". The experimenter said "scene" after each plural noun. The hospitalized patients and the male college students both significantly increased plural noun responses in the covert reinforcement condition above the various control groups which did not differ from each other. However, there was not a significant treatment effect with the female covert reinforcement group.

Four methodological issues are of concern in the Steffan study. First, nonspecific effects due to "demand characteristics" may have been present (Hersen & Barlow, 1977, p.p. 134-136). Evidence exists that experimental subjects will conform to experimenter's hypotheses and expectations once they are known. This is especially well documented in studies of verbal conditioning (cf. Kanfer, 1968). For example the article relays very little information concerning the presentation of cues by the experimenter. It may be possible that subjects were attending to various social stimuli (which served as discriminative stimuli and reinforcers) from the experimenter in the covert reinforcement condition that were not occurring from the experimenter in the control conditions. Thes social stimuli may have systematically improved performance in the covert reinforcement group.

A second methodological problem is that a groups design was employed and only an F-statistic was presented. Summary descriptive data of ordering and variability of group data were unfortunately omitted. Also no individual data were presented.

A third methodological issue is that no imagery assessments were undertaken. Even though covert reinforcement was effective, assessments of imagery should have been taken as a precautionary measure.

Summary

In a review of the covert reinforcement literature, it was determined that only a few studies directly tested the interaction assumption (Flannery, 1972; Krop et al., 1971; Steffan, 1977). Thus further research directly testing the interaction assumption should provide valuable additional information.

Four methodological issues have been raised concerning the covert reinforcement studies that directly tested the interaction assumption. First, a lack of specific controls such as covert placebo conditions to control for expectancy effects has created results confounded by non-specific treatment effects (Flannery, 1972; Krop et al., 1971; Steffan, 1977). Second, a lack of assessment of imagery may have resulted in failure to detect shifts in images which may have underlain failure of covert reinforcement techniques (Flannery, 1972; Steffan, 1977). Third, the use of between-groups designs may produce nonsignificant results and severely limit the application of treatments to specific individuals even with significant results (Flannery, 1972; Krop et al., 1971; Steffan, 1977). Fourth, the utilization of college students has limited the generality of the findings (Steffan, 1977). Further research with improved methodology is imperative, if the principles of covert conditioning are to be firmly established.

Thus, the purpose of the present study was to provide a direct test of the interaction assumption with improved methodology. An individual organism design was implemented in applying a covert reinforcement strategy to a classroom problem in young children for increased generality beyond university student populations. A covert reinforcer was applied directly to an overt behavior, solution of arithmetic problems, to determine if covert reinforcement would increase the rate of problems completed within a 20 min. session.

Method

Subjects

Three male subjects and one female subject ranging in age from 9 to 11 yrs. old were selected from a grade four classroom in an elementary school in Winnipeg, Manitoba. Children with low arithmetic problem solution baselines were chosen in an attempt to optimize treatment effects.

Setting and Materials

The study was conducted in a small room in the school. Each subject had a booklet of arithmetic problems, selected by the teacher, and a pencil. The arithmetic problems consisted of 2x4, 3x3, and 3x4 additions. Addition problems were selected because the children were supposed to be well past that academic part of their schooling. Thus, little learning should have occurred to bias the results. The same 120 questions were always used but were presented randomly each day.

Each subject was given an imagery survey, developed for the present study, after the second phase of the experiment. The children rated the pleasantness of various scenes on a scale from "one" to "five", five being most pleasant. Of those scenes that received a "five", three were selected as covert positive stimuli. Three of the scenes that received a "one" were selected as covert neutral stimuli (see Appendix B for sample items).

Procedure

Design. Four subjects were utilized in a combination A-A'-B-C-B multiple baseline, reversal design where baseline (A) was followed by the rest placebo phase (A'). The rationale for the A' phase was to control for nonspecific placebo effects such as the introduction of novel stimuli (i.e., 15 sec. time allotment for imagery). The B or covert neutral stimulus phase was initiated to control for the possibility that imagining any scene, positive or neutral, would increase performance. The covert positive stimulus phase (C) was then introduced followed by a return to (B). The rationale for the combined multiple baseline reversal design was twofold: (1) to provide for powerful validation of the critical phases of the design (B-C-B) involving covert reinforcement and covert neutral stimulus phased with reversals as well as multiple baseline replications across four subjects; (2) to provide for assessment of the less critical sequence of the first three phases (A-A'-B) with less experimental effect by involving baseline, rest placebo and covert neutral stimulus conditions just in a multiple baseline across four subjects (i.e., without reversals).

Procedure common for all design phases. Each session lasted 20 min. with one subject performing per session. The experimenter was positioned beside the child and eye contact was avoided to help control for additional stimuli (visual cues) that may have confounded the results. Subjects were reinforced for attending sessions by receiving a check mark that could be later traded in to play basketball in the gym. Field hockey replaced basketball as a reinforcer towards the end of the experiment.

For each phase, each subject was presented with 120 arithmetic problems. The instructions were: "correctly complete as many problems as you can during the session". The experimenter used a stop watch to time session length and to time the 15 sec. rest and imagining intervals.

Baseline. As was previously indicated, 120 arithmetic questions were presented and the children were instructed to correctly complete as many as possible during the 20 min. session. No other instructions or contingencies were presented during baseline.

Placebo. As a control for fatigue and to maintain consistency across phases, a 15 sec. timeout as rest period was initiated after each five problem completion segment. During this time, the only controls were that the subjects were instructed to sit back and to cease working on their problems.

Training

Imagery training. After the second phase of the study, each child was individually trained in all six of the selected scenes, three covert neutral scenes and three covert positive scenes. Behavioral checklists containing statements describing each scene were constructed in consultation with the children. As an example of a neutral scene, one child was asked to visualize himself sitting on a park bench by himself in the rain. The checklist items were: 1) Sitting on a park bench. 2) It's drizzling. 3) It's cloudy. 4) I'm bored. 5) Nobody else is around (see Appendix C for the remaining checklists.) The children were then read the five statements and were told to imagine that the scenes were real. A scene was considered trained when the child reported that she or he could imagine the scene and could recall all five of the statements on three consecutive trials.

Covert neutral stimulus. Upon completion of each five problem segment, the child was cued, by the experimenter, to imagine the previously determined neutral scene. Only once, at the beginning of the first imagining session, the child was instructed to imagine the scene in terms of the five statements describing the scene. The cue that experimenter used was the word "imagine". The particular scene imagined (one of three) was counterbalanced across sessions such that different scenes were imagined in consecutive sessions.

Covert positive stimulus. The procedure was identical to that for the covert neutral stimulus, except that the scene imagined was one of the previously determined positive scenes. Again, each child was cued only once to imagine the scene in terms of the five checklist statements, and the particular scene imagined was rotated each session.

Dependent measures. The total number of arithmetic problems solved constituted the main dependent measure. In addition, solution accuracy was also measured as a secondary dependent variable, even though the reinforcement contingency did not pertain to accuracy.

Assessment of Imagery. Based on the suggestions of Kazdin and Smith (1979), the child narrated the scene aloud, either positive or neutral, dependent on the phase, at the end of each session. Kazdin and Smith's original suggestion was to narrate the scene aloud during or immediately following each scene the subject imagined so that within session changes might be examined. The procedure was changed for the present study because having the child narrate the scene aloud during the session would introduce an overt verbal component confounding the results.

Images were assessed and retrained to a criterion of one correct recall at the beginning of each session to help insure accurage imagery. The narrations were also tape-recorded so that interobserver reliability (I.O.R.) could be assessed. Subjects were reinforced with tokens exchangeable for gym times if they recalled at least four of the five statements about the scenes.

Imagery reliability assessments, conducted by an undergraduate student in the Faculty of Education at the University of Manitoba, were based on the taped scenes. The results revealed that all subjects were able to recall the five statements describing the particular scene they were imagining 90% of the time. Interobserver reliability measures were conducted once per phase on the taped scenes. The results revealed 100% agreement. Also, I.O.R.'s were conducted once per phase on the number of problems correct and on the number completed, both also achieving 100% agreement.

Results

As will be recalled, two dependent variables, number of arithmetic problems attempted and number of problems correct were assessed. For each subject analysis will focus mainly on number of problems attempted since the contingencies were applied directly to this dependent variable. The number of problems correct will receive secondary consideration at the end, in each case.

Figure 1 presents the total number of problems completed and the total number correct during the 20 min. sessions for subjects G.T., J.J., and T.B. These subjects will be examined together first because they all provided some empirical support for at least small covert reinforcement effects. Data on subject J.F. who did not, will be examined later.

During baseline G.T.'s number attempted response rate decreased initially and then remained stable at 33 completions per session for two sessions. Performance continued to decrease until the end of the rest placebo phase, stabilizing at 30 for the last two sessions. Introduction of the covert neutral stimulus phase produced an immediate increase of 10 problems per session that remained constant at a mean of 40 for these three sessions. The number of completed problems increased again during the covert positive stimulus phase to 47 problems per session, with a mean of 45 problems completed per session. During the return to covert neutral stimulus phase responding rapidly decreased as much as 13 prob-

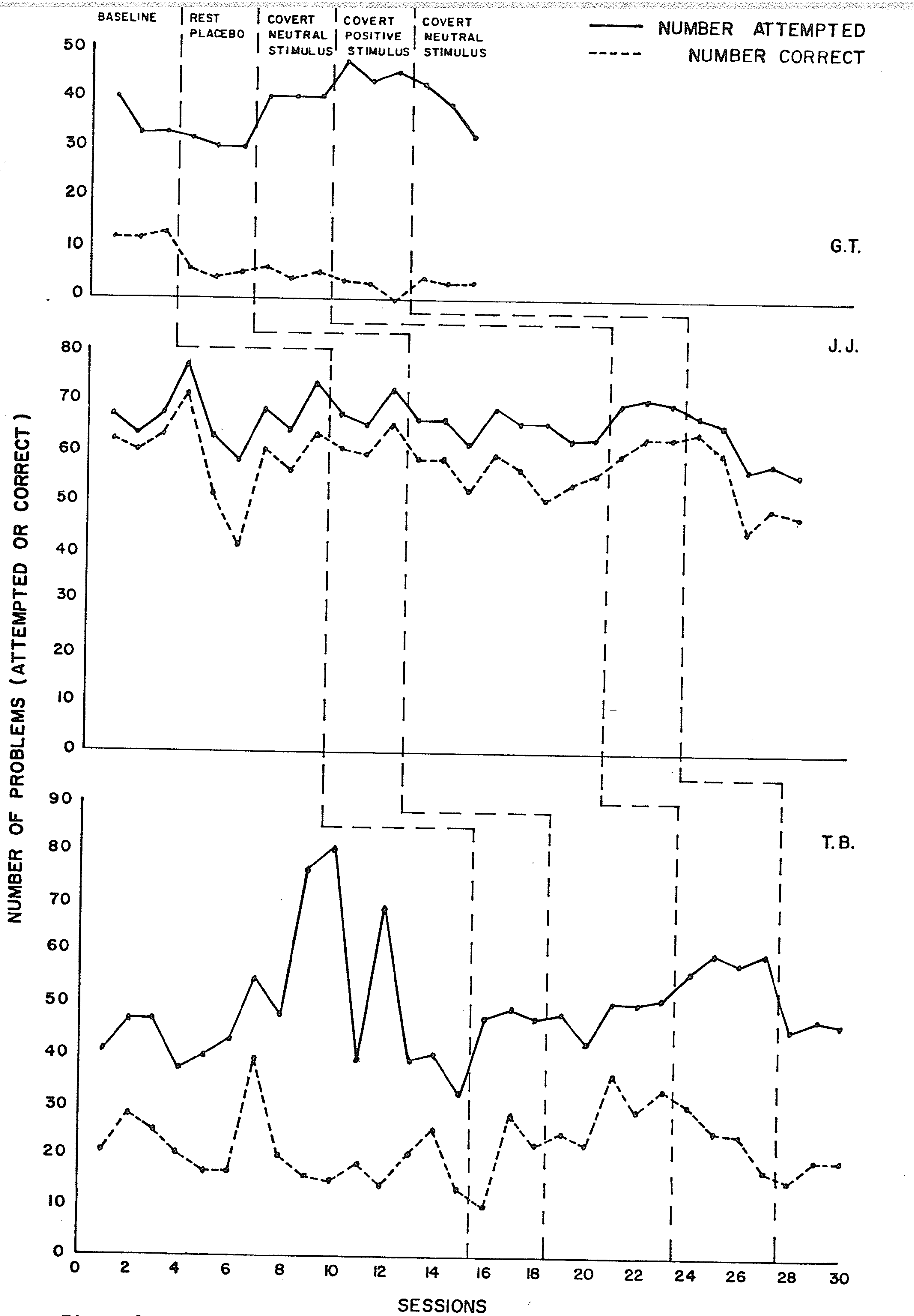

Figure 1. The multiple baseline and reversal design with results for covert reinforcement on number of arithmetic problems completed and correct for three subjects.

lems to a mean of 30 problems per session. There were no overlapping data points across adjacent phases.

G.T.'s sumbers of problems correct were proportionately low; i.e., there was a large gap between the number of problems correct and the number completed. Generally, the number of problems correct decreased slightly across phases, (although stable responding occurred during the rest and neutral phases) bearing no direct relation to the number of problems attempted.

Subject J.J.'s baseline response rate was variable throughout the phase. Introduction of the rest placebo phase did not drastically change his response rate (from a mean of 67 to 68 completions per session). Subject J.J's responding became more stable with a lower response rate (a mean of 64 problems per session) when the covert neutral phase was implemented. Next, J.J.'s response rate immediately increased to a mean of 69 problems per session and remained relatively stable during the covert positive phase. The return to covert neutral stimulus phase rapidly decreased responding with stability occurring around 60 problems per session. There were no overlapping data points between adjacent phases for the last three phases. In contrast to the number of problems correct data for G.T., J.J.'s number correct data showed parallel effects to the number attempted and the two were similar in quantity throughout the study.

Subject T.B.'s problems attempted response rate during the basline was highly variable with decreasing trend toward the end of the phase (mean response rate was 49 problems per session). An immediate increase in level of responding from 32 to 47 problem completions appeared during the rest placebo phase. The overall mean of 47.8 problems for this phase was lower, however. A further slight increase occurred during the covert neutral stimulus phase (mean of 48). The mean increase was dramatic (from 48 to 60 problems per session) during the covert positive phase. With a return to covert neutral scenes, response rate decreased immediately and dramatically to about 46 problems per session. Again, there were no overlapping data points between adjacent phases for the last three critical conditions involving covert neutral and covert reinforcement scenes. Like G.T., T.B. displayed a rather large gap between the number of problems attempted and the number correct. T.B.'s number of correct responses mimicked the number of attempted responses in direction except during baseline from sessions 9 to 13 where the discrepancy was the greatest. Also, and more importantly, the slopes were opposite in direction during the covert positive scene phase. Due to the critical importance of the covert reinforcement phase, the data may be taken to indicate a lack of congruence between number of problems correct and number attempted dependent measures. Again, it should be stressed that the contingencies were not applied to the number correct dependent variable.

To summarize, G.T. improved performance from a mean of 40 in the neutral phase to 45 in the positive phase, an increase of 12.5%. During reversal, his number of problems completed decreased to a mean of 38, reflecting a 15.6% decrement in performance. Subject J.J. also improved performance from a mean of 64 in the neutral phase to a mean of 69 in the positive phase, an increase of 7.6%. His behavior decreased to a mean of 60 or a 13.4% decrement in performance during the reversal phase. Subject T.B. showed the most effect; her mean increased from 48 during the neutral phase to 60 during the positive phase, an improvement of 23.4%. Her response rate decreased during reversal by 22.7% to a mean of 46 problems completed per session.

Subject J.F. did not provide convincing empirical support for covert reinforcement effects. His participation in the study was terminated because of his unwillingness to attend sessions and in light of lack of a treatment effect. Figure 2 represents J.F.'s total number of problems completed and the total number correct in the 20 min. sessions.

J.F.'s baseline behavior decreased from 64 problems per session to 48 problems per session with a mean of 56.2 An increase of about 11 problems per session occurred when the rest placebo phase was introduced. The mean increased to 60.6. This increase remained quite stable across the next two phases with no clear consistent change in behavior during the covert positive stimulus phase. In fact, performance decreased from a mean of 63 in the neutral phase to 61 in the positive phase, a decrease of 2.5%. Due to the lack of behavioral change, it was not necessary to reverse back to the covert neutral stimulus phase. J.F.'s number of correct responses showed variable effects in relation to the number of problems completed. The gap size between the number correct and number attempted was also variable but generally smaller than T.B.'s.

Discussion

The present study, implementing a relatively powerful combined multiple baseline reversal design, tested the three covert conditioning assumptions of Cautela and Baron (1977). Briefly, the homogeneity and learning assumptions state that covert events obey the same laws of behavior as overt events, the laws of conditioning. The interaction assumption states that covert events can influence overt events and that, reciprocally, overt events can influence covert events in a predictable manner. In the

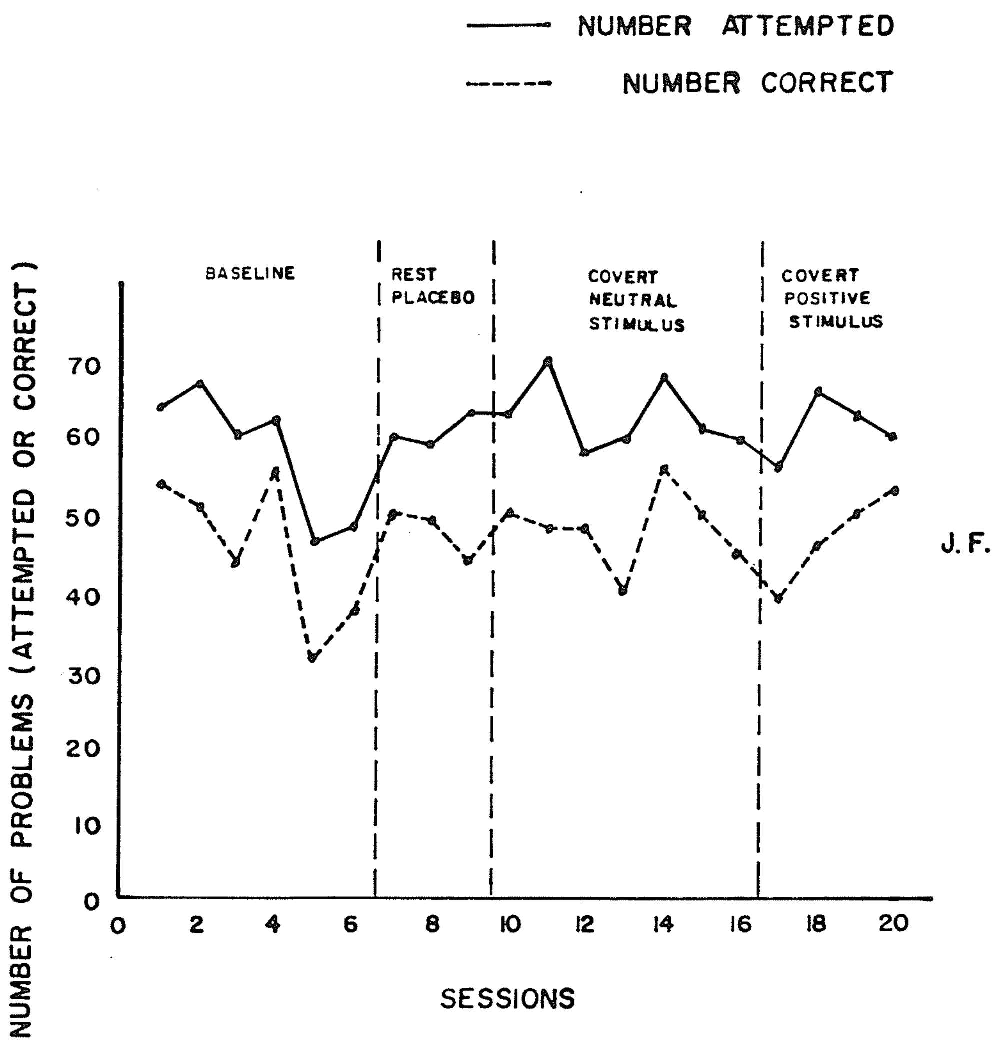

Figure 2. The multiple baseline and reversal design with results for covert reinforcement on number of arithmetic problems completed and correct for one subject.

present research a covert reinforcer (i.e., positive scene) was applied to an overt behavior (arithmetic problem completions). For three out of four subjects, results indicated that covert reinforcement influenced overt behaviors in a predictable manner; i.e., it increased problem completions. The trends are most clearly visible for subjects G.T. and T.B. with more limited support provided by subject J.J..

The fourth subject, J.F., displayed no improvement and variable behavior across all phases except the rest placebo phase. Improved performance during the rest placebo phase may have been due to the fact that arithmetic was so aversive that a respite was very reinforcing. To explain J.F.'s lack of improvement during the positive phase, one might at first surmise that the covert positive scene was not powerful enough. However, several times during the neutral phase, J.F. asked if he could imagine a positive scene instead. Despite being refused, it is possible that J.F. did indeed imagine covertly reinforcing scenes during the neutral phase. In the present research, for conveneience, all scenes were trained prior to the neutral phase. To avoid the problem of imagining positive scenes inappropriately, future research should consider training only those scenes that will be used in the immediate phase.

In the review of the literature, four very important methodological issues were raised concerning the covert reinforcement studies that directly tested the interaction assumption. To summarize; first, lack of covert placebo conditions to control for expectancy effects has created results confounded by nonspecific treatment effects. Second, lack of assessment of imagery may have resulted in failure to detect shifts in images which may have underlain failure of covert reinforcement techniques. Third.

the use of between-groups designs may have produced nonsignificant results and severely limited the application of treatments to specific individuals even with significant results. Fourth, the utilization of college students has restricted statements about the generality of the finding. The present study attempted to solve these four important methodological problems. First, both a rest placebo control and a covert neutral stimulus phase were used to control nonspecific treatment effects. Second, a novel approach to imagery assessment in the form of a behavioral checklist was implemented. The checklists were designed to minimize shifts in images that might have produced failure of covert reinforcement procedures. Fortunately, for three out of the four subjects covert reinforcment was effective. For the fourth subject, imagining a positive scene was no more effective than imagining a neutral scene, however, as previously discussed this may have been due to his imagining reinforcing scenes during neutral conditions; or perhaps to other uncontrolled factors.

The third issue is the use of between-groups designs. The current research included a single subject combination multiple baseline and reversal design. The data are highly representative of each subject's behavior because they are presented for each subject separately with no between-subject means summarizing the overall performance. The results are therefore generalizable to other subjects with the same individual characteristics. Because a single subject design was implemented progress was monitored continually providing a sensitive test of effects of the independent variable.

Fourth, the study used four children from a grade four classroom expanding the generality of findings from the typical college student subject. Thus, each of the four serious methodological issues raised earlier was successfully approached in the present research.

It should be pointed out that a large discrepancy between the number of problems correct and the number of problems attempted is evident for both G.T. and T.B. For G.T., the discrepancy is likely due to problems well beyond the scope of the present research. Suffice it to say that G.T. had a history of maladaptive behaviors that were inhibiting his academic performance at the time the study was conducted. Subject T.B.'s discrepancy may have been related to the somewhat careless approach she took in answering the questions. This carelessness characteristic, visually observable during the sessions, may be represented best during baseline where her behavior was most variable. Even though the number of attempts increased by close to 40 problems during sessions nine to 13, the number of correct attempts decreased by about five problems per session. To account for T.B.'s extremely variable baseline, the nature of the multiple baseline design and the fact that T.B. was also used to control for practice effects and the effects of extraneous variables must be considered. It was necessary for her to remain on baseline until G.T.'s results had been completed. Fifteen, 20 min. sessions leave much room for variability and it may have been that sessions spent doing arithmetic for such an extended length of time were more unpleasant on some days than on other days, especially on days where she participated in arithmetic exercises during regular class time.

One of the most important procedural problems in the present research was the difficulty involved in persuading subjects to attend sessions. The results can be drastic, as was evidenced by J.F., whose program was terminated, or the results can cause other problems such as variability; e.g., T.B. and J.J. One possible solution, was to provide more powerful overt reinforcers for attending sessions. Although J.F. indicated during interviews that he would like to play basketball with the other kids for attending sessions, it did not seem to be a powerful enough reinforcer. An interesting point was that, after J.F. was dropped from the program, he asked if he could join again when he knew floor hockey was being used instead of basketball. Unfortunately, he could not be accommodated at this late date.

One other variability problem relates to the unequal length of phases. Lack of a sufficient number of scenes to imagine may produce satiation, hence, variable behavior. One possible solution is to employ a wider variety of scenes than were used in the present study. Another solution would be to shorten the experiment through exclusive use of the B-C-B reversal design.

Another method to reduce variability would be to select different subjects. The present study used four children who were designated by the teacher as poor students in arithmetic. The rationale was to maximize the potential effects of covert reinforcement on increasing arithmetic performance. Future researchers should consider using subjects who are at a higher academic level in arithmetic where the work might be more reinforcing, so that even if they did it during regular class time, their performance during session time might not be affected.

To explain the variability in the number of correct responses, it is important to consider reasons that for three out of the four subjects the number of correct responses did not increase as a result of the contingencies applied to the number of problems completed. The first reason, as has already been indicated, may be related to the nature of the children chosen as subjects. Had subject with higher academic levels on arithmetic been chosen, both dependent variables may have changed together. Second, the contingencies were applied only to the number of problems attempted, not to the number correct. It would be interesting to replicate the present research by applying these reinforcement contingencies to the number of problems correct.

On a practical level, three out of the four subjects improved their mean performance by 7.6% to 23.4% when covert reinforcement was implemented. These increases are slightly less than what could have been obtained. Had the children been able to work continually for 20 min., they could have completed a projected mean of 8.6% to 24.5% problems during covert reinforcement. Because the amount of imagining time increases with the number of problems successfully completed, the more problems completed the less time there is available for work.

The results of the present research suggest support for the homogeneity and learning assumptions, that the laws of overt conditioning are homogeneous with the laws of covert conditioning. As a means of determining the degree of homogeneity between the laws of covert and overt conditioning, the magnitude of effect must be considered a crucial indicator. Two important questions are: What magnitude of effect is necessary, and, how will the nature of the target behavior effect that magnitude?

The present research obtained relatively small effects for covert reinforcement in comparison to what might have been expected had overt reinforcement been employed. One possible method of increasing the magnitude of effects would be to identify more powerful covert reinforcers. This might be achieved by first identifying powerful overt reinforcers, through manipulation of some unrelated behavior, and then training the subject to imagine those overt reinforcers so they may become covert reinforcers for the target behavior.

It seems reasonable to assume that an overt reinforcer would be more effective than a covert reinforcer, only because the individual is experiencing the physical value of that overt reinforcer. The magnitude of the effects of a covert reinforcer should be similar to the effects of a conditioned overt reinforcer. With a conditioned overt reinforcer, an individual does not experience the physical value of the back-up reinforcer immediately. Therefore, covert reinforcers seem best conceptualized as conditioned reinforcers, which are backed up by subsequent experiences in the natural environment. Future research should consider comparing established conditioned reinforcers, such as tokens, to covert reinforcers to determine the relative efficacy of each and to further test the homogeneity assumption. Furthermore, covert reinforcement should be compared with and without back-up reinforcement to determine if it is necessary to include back-up reinforcement in the experimental setting to maintain the power of a conditioned covert reinforcer.

It is important to note the nature of the operant when discussing magnitude of effect. Typically, a reinforcer is not applied to a behavior which may possess conditioned aversive components, which appears to have been the case in the present situation involving arithmetic calculations. A reinforcer is not expected to demonstrate its effectiveness in the face of a simultaneous aversive contingency. Therefore, in future research, it would be best to select an operant behavior that would be more neutral. For example, a more neutral behavior, simply tallying items for a shorter session length may enable covert reinforcement effects to show themselves more clearly.

In summary, the next step in assessing the effects of covert reinforement would be to systematically identify powerful covert reinforcers.

The magnitude of the effects should also be maximized by introducing a neutral target behavior rather than a potentially aversive one. If the effects of covert reinforcement are then compared to the effects of a conditioned overt reinforcer, it may indeed become visible that the laws of covert conditioning are homogeneous with the laws of overt conditioning (Cautela & Baron, 1977).

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APPENDIX A

A Comment on Self-Control

One widely used technique within the self-control domain is self-reinforcement. However, self-reinforcement as typically explained in the psychological literature is highly ambiguous (Skinner, 1953, pp. 237-238; Goldiamond, 1976). The term is used in a variety of situations, almost uncritically. For example, it has been argued that self-reinforcement can be responsible for a resultant behavioral change. However, it would seem more appropriate to claim that self administration of a reinforcer was responsible for the resultant behavioral change (Hanel & Martin, 1980 To claim that self-reinforcement was the controlling variable implies that application of the principle of positive reinforcement was all that was necessary to alter behavior.

An opposing argument enunciated by both Skinner (1953, p. 238) and Goldiamond (1976) indicates that other relevant information is critical. The key is in the self administration portion of the procedure. Primarily, the behavior one exhibits under the apparent influence of self-control is still behavior nonetheless. Because it is still behavior, it must be accounted for in terms of external variables and the individual's history. It is these variables that constitute the relevant information which ultimately provide the control (Skinner, 1953, p. 238).

For self-control procedures to be effective, an individual's reaction to specific environment factors must be predisposed to occur in the direction intended. For example, to prevent an individual from obtaining reinforcement prior to emitting the desired behavior (short-circuiting) that person must react to for example, disapproval, as if it were a punisher. To avoid punishment, the individual would first emit the behavior and then attempt to obtain the reinforcer.

More generally speaking, Goldiamond (1976) has reported that the difference between "self" and "other" reinforcement depends on whether the "self" or "other" controls the value judgment concerning the appropriate completion of the required task. For an example of "other" reinforcement, the rat in the cage depends upon the mechanical devices to deliver the reinforcement contingent on the rat's depression of the lever. As an example of "self" reinforcement, consider the individual who decides to sit down and relax with a beer upon completion of the task of cutting the grass. It is the individual who will determine if the task is completed and then will obtain the reinforcer, even if the decisional behaviors are subject to past histories of reinforcement by others.

Appendix B

Covert Reinforcement Survey (adapted from Cautela, 1977)

Now read the following list of items. Remember that in each case we want you to try really hard to imagine the thing which is described in each item.

1. Imagine that you are listening to your favorite musical selection.
   Degree of pleasantness 1 2 3 4 5

2. Imagine that you are playing with a friendly dog.
   Degree of pleasantness 1 2 3 4 5

3. Imagine the most beautiful scene that you have ever experienced.
   Degree of pleasantness 1 2 3 4 5

4. Imagine that you are swimming in cool, clear water on a very hot day.
   Degree of pleasantness 1 2 3 4 5

5. Imagine that the person whom you most admire says, "Wow, you really look terrific today."
   Degree of pleasantness 1 2 3 4 5

6. Imagine that the person whom you most admire says, "Gee, you're pretty bright."
   Degree of pleasantness 1 2 3 4 5

7. Imagine that you are eating your favorite flavor of ice cream.
   Degree of pleasantness 1 2 3 4 5

8. Imagine that you are eating your favorite type of pastry.
   Degree of pleasantness 1 2 3 4 5

9. Imagine eating your favorite kind of candy.
   Degree of pleasantness 1 2 3 4 5

10. Imagine that you are looking at a beautiful woman (handsome man).
    Degree of pleasantness 1 2 3 4 5

11. Imagine that you are lying on a beautiful, uncrowded beach; you can see the white sand and the blue, white-capped waves; you hear the surf and the seagulls; you smell the salt water and kelp; you feel the breeze and the warm sun.
    Degree of pleasantness 1 2 3 4 5

12. Imagine that you are sitting under a tree beside a beautiful, clear mountain lake.
    Degree of pleasantness 1 2 3 4 5

13. Imagine that you are the star in your favorite movie.

    Degree of pleasantness 1 2 3 4 5

14. Imagine that you have scored the winning goal for your team.

    Degree of pleasantness 1 2 3 4 5

15. Imagine that you are spending time with your best friends.

    Degree of pleasantness 1 2 3 4 5

APPENDIX C

Behavioral Checklists for Imagining Scenes

Neutral Scenes

A. Sitting on a park bench in the rain.*

1. Walking through the park.
2. It's drizzling.
3. I'm alone.
4. I'm sitting on a bench.
5. I'm bored.

B. Alone in the house.

1. There's nothing good on T.V.
2. My friend's are all out.
3. My family is out.
4. There's nothing to do.
5. There's nothing to eat.

C. Sitting alone in a field.**

1. I'm sitting in a field.
2. There's tall grass all around.
3. It's cloudy.
4. I'm all alone.
5. I'm bored.

D. Sitting by a lake by myself.

1. I'm sitting under a tree
2. I'm on the grass
3. I'm beside a lake
4. It's cloudy.
5. I'm all alone.

E. Watching the news alone.*

1. I'm at home alone.

2. I turn the T.V. on.

3. Every channel has the news of the Reagan shooting.

4. I watch it for a while.

5. I turn the T.V. off and sit in the dark.

F. Inside watching the rain.*

1. I'm looking out of my window.

2. It's raining.

3. There's puddles everywhere.

4. The trees are blowing in the wind.

5. There's branches lying in the puddles.

G. Alone in the Library.

1. I'm sitting at a desk in the library

2. There's a big dictionary in front of me.

3. There's no pictures in it.

4. I'm by myself.

5. I'm waiting for recess.

*same scene was used for two different subjects.
**same scene was used for three different subjects.

Positive Scenes

A. Going Roller skating.

1. I'm at the rink.

2. I'm putting my skates on.

3. * start skating.

4. I'm listening to fast music

5. I'm doing tricks.

B. Eating ice-cream.

1. I'm riding my bike to Dairy Works.
2. I'm going with Sharon and Cathy
3. It's really hot outside.
4. I'm ordering a pineapplie sundae.
5. I start eating and it's cold and refreshing.

C. Eating candy.

1. I went to the store.
2. I'm buying a blue and pink jawbreaker.
3. I'm starting to suck on it.
4. I'm getting to the last color.
5. I finally get to the gum.

D. Bike riding on trails.

1. It's a warm sunny day.
2. I'm with Randy and Tim.
3. We're on our bikes at Preco Hill.
4. We're flying over the hills.
5. We're jumping rampls.

E. Star Wars combat.**

1. I'm flying in my X-wing fighter.
2. I see Darth Vadar.
3. Darth Vadar shoots at me.
4. I dodge out of the way and he misses.
5. I come up from behind and blast him.

F. Playing basketball in the NBA.

1. I'm playing for the 76ers

2. There's T.V. cameras and a huge crown
3. It's a tie game with one second left.
4. I take a shot and score the winning basket.
5. We win the championship.

G. Horseback riding.

1. Brenda brings Little John.
2. I climb on top of him.
3. We're leaving the corral.
4. The horse starts to gallop.
5. I fall off.

H. Skiing

1. I'm at the top of Bobcat.
2. I look down and see the moguls.
3. I push off and do short radius turns.
4. I see a jump.
5. I fly off the jump and do a spread-eagle.

I. Playing hockey in the NHL.

1. I'm playing for the Islanders.
2. It's the Stanley Cup.
3. I'm playing centre beside Mike Bossy.
4. The game is on television.
5. I score the winning goal in overtime.

J. Playing soccer.

1. We're playing against Laura Secord.
2. The score is tied at 2.
3. I've scored both goals.
4. Time is running out.

5. I score the third goal to win the game.

** same scene was used for three different subjects.