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The Comparative Effectiveness of a Science Anxiety Group and a Stress Management Program in the Treatment of Science Anxious College Students

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THE COMPARATIVE EFFECTIVENESS OF A SCIENCE ANXIETY GROUP AND A STRESS MANAGEMENT PROGRAM IN THE TREATMENT OF SCIENCE ANXIOUS COLLEGE STUDENTS

by

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VITA

The author, Joseph Gerard Hermes, is the son of John Joseph Hermes and Loretta (Opatka) Hermes. He was born May 2, 1955, in Chicago, Illinois.

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CHAPTER I

INTRODUCTION

With the limited resources available for mental health services there is an increasing demand for accountability in terms of effectiveness and efficiency regarding those mental health services for which funding is or will be provided (Posavac & Carey, 1980). Deffenbacher and McKinley (1983) comment specifically that evaluation of stress management services provided to students should be undertaken to find the most effective programs possible for given stress problems. They suggest that program evaluation designs should include measures of both targeted (those for which the program is specifically designed) and non-targeted (e.g. those for which the student has not directly sought treatment) stress reduction as well as an assessment of students' reactions to the program(s). In this way the possible effectiveness of stress management on other areas of functioning and performance can be evaluated. If two interventions are equally effective for a given stress problem, the intervention with the greatest non-targeted effects should be chosen. Given equivalent or nearly equivalent anxiety reduction, the less time consuming and more economical intervention should be utilized (Richardson & Suinn, 1974). In addition, evaluators and clinicians could make use of such information in making decisions regarding the feasibility of providing services to potential program recipients.

In the development of stress management interventions one common, yet often inefficient, approach is that the multi-faceted nature of the stress problem is recognized and everything but the "kitchen sink" is applied in the hope of hitting the key elements (Deffenbacher & McKinley, 1983). Multi-component programs are needed when: a combined intervention has shown consistent superiority over singular interventions; assessment of student stress problems has revealed more than one significant contributor to the influence of stress; or research has consistently shown that a stress problem has multiple contributors (Deffenbacher & McKinley, 1983).

In 1977, the Loyola Counseling Center began offering a multi-component group intervention program for self-referred, science-anxious college students (Alvaro, 1979; Mallow, 1981; Mallow & Greenburg, 1982). In designing the clinic, Mallow (1981) noted that the treatment for science anxiety should employ all the techniques necessary to reduce anxiety regarding science. These techniques included the enhancement of science learning skills, discussion of past bad experiences in science, changing negative self-images, relaxation and desensitization techniques, and "anything else we could think of" (p. 77). In an initial evaluation, Alvaro (1979) found the program to be effective in reducing students' science anxiety and interpreted the findings from her study as indicating that the effects of the Science Anxiety Clinic were specific to science content. This would argue in favor of science anxiety and its treatment being necessarily distinct from general test and other anxieties.

However, pretreatment data from Alvaro's (1979) study of students requesting treatment for science anxiety indicated that these students were also high on scales of trait, state, math, and debilitating test anxiety. Following treatment in the Science Anxiety Clinic, these students showed, in addition to decreased science anxiety, significant decreases in trait, state, and mathematics anxiety. Such results suggest that students who seek treatment because of the anxiety they experience in science situations are generally anxious in a variety of situations and that "science anxiety" may not clearly be a distinct phenomenon. This raises the possibility that a more generalized treatment approach may be effective in reducing "science anxiety" and may in fact have more utility if such an approach leads to greater non-targeted (e.g. test, trait) anxiety reduction than the Science Anxiety Group. The specificity of the phenomenon, its treatment, and the efficient use of therapist and client time are open to question.

A program designed to help individuals enhance their ability to deal more effectively with stressful situations encountered in their daily lives has been routinely available to students needing stress management services at the Loyola Counseling Center. This stress management program helps the student learn control over physiological arousal mechanisms through the use of progressive muscular relaxation training (Jacobsen, 1938) augmented by training in soothing mental imagery. This intervention has typically utilized the Quieting Response Training Program (Stroebel, 1978; Ford, Stroebel, Strong, & Szarek, 1982), an audio-

cassette program. The tapes emphasize instrumental, self-control over arousal by systematic repeated practice of the program's exercises. Because of the possible generalized nature of the anxiety experienced by students seeking treatment for their science anxiety, this program would be a plausible alternative to the multi-component Science Anxiety Clinic. In addition, not all students who have requested service in the Science Anxiety Clinic have been able to participate because of the difficulty of scheduling them into available group times (Mallow, 1981). Because of the individual format of this stress management program, it could be used to meet this service need.

The purpose of this study was to investigate the comparative effectiveness of a multi-component group program designed specifically to reduce science anxiety and a single component generalized anxiety reduction program administered in an individual format for reducing targeted (science) and non-targeted (e.g. trait) anxieties and improving academic performance. In addition, subjects' evaluations of the treatment programs and the credibility of the treatment rationales will be assessed. Given the aspects of the Science Anxiety Clinic and Quieting Response Training Program as utilized at the Loyola Counseling Center, literature relevant to the utilization of therapeutic interventions designed to reduce anxiety and increase academic achievement will be reviewed.

CHAPTER II

LITERATURE REVIEW

Anxiety, Academic Achievement, and Complex Learning

Science as taught at the college level can appropriately be considered as an example of a difficult and complex learning process for it involves formal reasoning operations (Mallow, 1981) and, like mathematics, necessarily requires the three highest categories of learning: concept learning, rule learning, and problem solving; i.e. learning of higher order rules (Gagne & Briggs, 1974).

Heinrich and Spielberger (1982) have reviewed the research literature on anxiety and complex learning. The tenets of drive theory as supplemented by trait-state anxiety theory have served as the conceptual framework for a majority of investigations on anxiety and learning (Heinrich & Spielberger, 1982). According to Trait-State Anxiety Theory (Spielberger; 1966, 1972) persons high in A-Trait will experience greater elevations in A-State than low A-Trait persons when the conditions (learning situations) involve some psychological stress such as implied threats to self-esteem, ego-involving instructions, or failure feedback. Test or evaluative situations have been viewed as this type of psychological stressor (Sieber, 1980). Once an anxiety state is aroused, predictions of effects of differences in A-State on performance

for easy and difficult tasks can be derived from drive theory (Spence, 1958; Taylor, 1956).

Following the tenets of trait-state anxiety theory and drive theory, various predictions have accumulated support (Heinrich & Spielberger, 1982). In general, high A-Trait subjects perform better than low A-Trait subjects under low stress conditions whereas low A-Trait anxious subjects do better than high A-Trait subjects under high stress conditions. Poorer performance for high-anxiety subjects on difficult tasks has been a common finding in the research literature. Stress produces performance decrements in high A-Trait subjects at lower levels of task difficulty than for low A-Trait subjects. When a situation involves mild to moderate psychological stress, persons high in A-Trait anxiety tend to perceive such situations as more threatening and to experience greater elevations in state anxiety than low A-Trait individuals. Difficult learning tasks induce higher levels of A-state than easy materials, high A-Trait subjects respond with greater initial increments in A-State than low A-Trait subjects in evaluative situations (O'Neill, 1972), and persons high in A-State make more errors than low A-State persons on most learning tasks (Meyers & Martin, 1974; O'Neill, 1972). In this regard high anxiety is detrimental to acquistion, retention, and generalization when relatively difficult concept-learning tasks are given in stressful, test-like, evaluative situations. Regarding anxiety and academic achievement, only rarely do high anxious students achieve at a higher level than low anxious students. Grinnell and

Kyte (1979), in a multiple regression analysis of first semester graduate students grade point averages, GRE scores, and STAI Trait-State scores, found that Trait and State anxiety scale scores played a minor role in the prediction of students' first semester grade point averages. However, the lower a student's A-Trait score the greater his/her likelihood of earning a higher first semester GPA.

Providing students with conceptual aids for organizing information has proved effective in reducing the debilitating effects of anxiety and improving learning. Conceptual aids are designed to eliminate or reduce error tendencies that compete with correct responses. Drive theory predicts that anxiety will facilitate performance once "correct" responses become dominant relative to error tendencies (e.g. through repeated practice).

The consequences of such results for clinical application in order to improve performance of high Trait anxious persons are twofold: (1) reduce the stress of conditions in which high A-Trait individuals are placed or (2) reduce their tendency to respond with elevated A-State to stressful situations (i.e. reduce Trait anxiety).

The importance of the state-trait distinction is obvious for clinical work. If a person exhibits intense anxiety reactions in only a very specific situation then a situation-specific intervention program is warranted. If the person responds in the same manner to several situations, a more generalized intervention program is warranted. Intervention programs designed to reduce general levels of anxiety will be reviewed next.

Spoth and Meade (1981) investigated the effectiveness of cue-controlled relaxation in the multiple-outcome reduction of general anxiety. They assigned college students who had scored at least one-half of a standard deviation above the normative mean on one or more measures of general anxiety (e.g. STAI-Trait) to two variants of cue-controlled relaxation. The authors interpreted their results of significant pre to posttreatment reduction on most of the measures of anxiety for their subjects as supportive of the use of cue-controlled relaxation to reduce trait forms of anxiety which are otherwise resistant to change.

In a more extensive investigation of generalized anxiety and its treatment, Houston (1982) and his colleagues conducted studies which examined the cognitive coping behaviors of high trait anxious individuals. They also investigated the effectiveness of non-cognitive interventions that might be expected to reduce trait anxiety. Results from laboratory and classroom situations indicated that highly trait anxious individuals tend to lack organized ways of coping with stress and instead ruminate about themselves and the situation in which they find themselves. In one study (Hutchings, Denney, Basgall, & Houston, 1980), 63 high trait anxious college students were randomly assigned to one of five experimental conditions: anxiety management training (AMT), applied relaxation training, relaxation-only with passive rationale, placebo of "subliminal extinction", and a no-treatment control group. AMT consisted of training in relaxation, instructions regarding application, and structured rehearsal in which the subject visually self-generated

anxiety provoking scenes and then applied relaxation coping skills in the treatment setting to reduce associated anxiety. Applied relaxation consisted of relaxation training and instruction regarding its active application. It should be noted that neither AMT nor applied relaxation deal with cognitive coping behaviors directly. Rather, they focus on relaxation, ostensibly a somatic response, as coping behavior. The AMT and applied relaxation conditions were active, self-control procedures whereas the relaxation-only condition employed a passive rationale that relaxation would automatically supplant anxiety. All treatment group subjects had comparable pretreatment expectancies for improvement. Measures of four physiological responses were taken during the period of assessment and no significant differences between any of the experimental conditions for any of these measures were found. However, AMT was found to be significantly more effective than placebo and relaxation-only conditions in reducing high trait anxiety and reducing highly trait anxious individuals' maladaptive cognitive coping behaviors of preoccupation and lack of coping maneuvers. The results for applied relaxation tended to parallel those for AMT and differences between AMT and applied relaxation were non-significant. Subjects in a stressful laboratory situation who had been in either the applied relaxation or AMT conditions performed better on a cognitive task than subjects in the relaxation-only, placebo, or no treatment control conditions.

The literature supports the effectiveness of behaviorally oriented treatments in reducing levels of general anxiety. It has been found

that such interventions, while not specifically targeted to do so, are effective in reducing the cognitive components of general anxiety.

Trait-State Anxiety Theory and Test Anxiety

Because of the desirability of rooting the study of anxiety in a defineable situational context, those studying anxiety have attempted to specify particular sources of anxiety (Sarason, 1980). Test anxiety has become the most widely studied of these specific anxieties. Mandler and Sarason (1952) differentiated test anxiety theory from general anxiety theory by hypothesizing that two kinds of drive are elicited in testing situations: (a) a learned task drive directed toward task completion, and (b) a learned anxiety drive that can direct responses that interfere with task completion or responses directed to task completion. The anxiety evoked task-irrelevant responses are characterized by heightened somatic reactions, feelings of inadequacy, and anticipated loss of status or self-esteem. These autonomic and cognitive responses interfere with the responses needed for effective test taking and result in poor test performance.

Trait-State Anxiety Theory has recognized the centrality of affective (emotional) and cognitive processes in reactive anxiety states. Moreover, the theory has specified that the characteristics of stressful conditions (stimuli) evoke differential levels of A-State in persons who differ in A-Trait (Spielberger, Anton, & Bedell, 1976). Both Trait-State Anxiety Theory and Test Anxiety Theory propose that test situations evoke emotional reactions and task irrelevant responses. The

psychological stressors that evoke A-State reactions in persons who differ in A-Trait are thought to be quite similar to the evaluative conditions that influence the performance of persons who differ in test anxiety. The two theories differ regarding the relative importance of the worry and emotionality (Morris & Liebert, 1969) components of test anxiety.

Test anxiety theory focuses upon the worry (cognitive) component comprised of task-irrelevant cognitive activity such as self-deprecatory responses and thoughts of helplessness and inadequacy. While test anxiety theorists (Liebert & Morris, 1967; Morris & Liebert, 1969; Sarason, 1975) have recognized the importance of emotional reactions (A-States) they have contended that it is the worry rather than the emotionality that leads to performance decrements. Spielberger, et al. (1976), however, attributed the performance decrements of anxious persons to the high drive level activation of strong error tendencies that are associated with elevations in A-State (emotionality). These anxiety-activated error tendencies are elicited by intrinsic characteristics of the task, whereas the self-preoccupying cognitions (worry) in Test Anxiety Theory are presumed to be directly elicited by the anxiety alone. Spielberger (1972) has conceptualized test anxiety as a situation specific form of trait anxiety. With regard to the worry component, Spielberger speculated that the self-centered responses of high test anxious individuals are cued-off by the A-State reactions evoked in such evaluative situations. Trait test anxiety has been conceptualized as reflecting indi-

vidual differences in the tendency to perceive evaluative situations as threatening; high test anxious persons respond to evaluative situations with increases in state anxiety and task irrelevant, self-centered interfering worry, both of which contribute to performance decrements. In test situations, the high levels of A-State (emotionality) that are evoked in trait test anxious persons activate task related error tendencies which compete with correct responses, and task-irrelevant worry responses that distract the test-anxious individual from effective task performance.

Behavioral approaches to the treatment of test anxiety attempt to modify or eliminate the emotional reactions (A-States) that are induced in test anxious persons in evaluative situations. While successful reductions in test anxiety are found, the review of the literature by Spielberger, et al. (1976) has indicated that behavioral treatment approaches have consistently failed to bring about improvement in academic achievement and performance on cognitive-intellectual tasks. Evidently, according to Spielberger, et al. (1976), the successful reduction of anxiety in evaluative situations is not sufficient to bring about improvement in performance. While desensitization and relaxation treatments appear to be effective in reducing A-State reactions in test situations, improvements in performance on intellectual-cognitive tasks has been consistently found only in studies in which a combination of desensitization and some form of study counseling was employed (Spielberger, et al., 1976).

Test Anxiety and Its Treatment

There are many issues regarding the treatment of test anxiety given the complex nature of its theoretical basis. The literature reviewed will attempt to address those issues relevant to the treatment of test anxiety as such treatment has implications for students who have identified themselves as being science anxious.

Some have theorized that test anxiety is composed of two components; emotionality responses and cognitive responses (Liebert & Morris, 1967; Morris & Liebert, 1969). Finger and Galassi (1977) examined the differential effects of treating the emotionality and cognitive components of test anxiety by randomly assigning 50 test anxious college students to one of four groups: (a) an attentional treatment group which focused on cognitive responses, (b) a relaxation treatment group which focused on the emotionality component, (c) a combined relaxation-attentional group, and (d) a wait-list control group. On measures of emotionality and worry (cognitive component), all treatment groups differed significantly from controls but not from one another indicating that regardless of treatment focus, reductions in emotionality and cognitive components were obtained. These results supported a theory of test anxiety that the emotional and cognitive components of test anxiety can be identified independently but interact as a single process in test anxiety (Lazarus & Averill, 1972). Increased levels of arousal can mobilize cognitive appraisals and strategies (arousal → cognition → test anxiety). Cognitive appraisals of threat can result in increased levels of

arousal (emotionality) and subjectively experienced test anxiety (cognition → arousal → test anxiety). From this perspective, affecting either component in treatment would result in a corresponding effect upon the other component as well as an effect on a global/unitary measure of test anxiety (Finger & Galassi, 1977).

Kaplan, McCordick, and Twitchell (1979) also found that cognitive only and desensitization only treatments produced changes on both the worry and emotionality components of test anxiety. The authors concluded that the cognitive components of the cognitive modification treatment (Meichenbaum, 1972) utilized were more effective than the desensitization component of the combined cognitive/desensitization treatment. Confidence in their conclusion is limited by the lack of a significant differential treatment effect on a global measure of test anxiety. The study is further limited by the exclusion of self-referred test anxious clients who had received D's or F's the previous semester. In addition, pretreatment expectancy levels for the treatment groups were assumed to be comparable and were not assessed. All treatment subjects also received study skills training.

Whereas the study by Kaplan et al. (1979) excluded students who had recently done poorly academically, Decker and Russel (1981) specifically targeted students who had been placed on academic warning or probation in an investigation of the relative effectiveness of two multicomponent strategies for reducing test anxiety and improving academic performance. They compared a treatment strategy of study skills train-

ing and a treatment strategy composed of cue-controlled relaxation (Russel & Sippich, 1973) and cognitive restructuring (Ellis, 1962). Both treatment groups met for four weekly 90-minute sessions. Results indicated that there were no significant differences between the two treatments on measures of test anxiety, state and trait anxiety, and grade point average. Within group comparisons revealed a significant improvement in GPA but not on the Survey of Study Habits and Attitudes (Brown & Holtzman, 1956) for the the study skills group and the reverse pattern for the cue-controlled relaxation/cognitive restructuring group.

In a study designed specifically to investigate the utility of study skills training for test anxiety, Altmaier and Woodward (1981) assigned a total of 45 test anxious college students to one of four treatments: study skills training, vicarious desensitization, a combination of these two, or a no-treatment control group. Vicarious desensitization consisted of having subjects watch six 50-minute videotapes of a college student receiving systematic desensitization for test anxiety concerns. Results indicated that subjects receiving vicarious desensitization, alone or in combination with study skills, had significantly lower postreatment test anxiety scores than subjects receiving study skills alone or no treatment. Significantly lower trait anxiety scores (STAI-Trait) were exhibited for subjects in the vicarious desensitization-only treatment as compared to all other groups. In addition, study skills-only subjects did not differ significantly from no-treatment controls on test and trait anxiety. There were no significant

effects for any of the treatments on various performance measures, Survey of Study Habits and Attitudes (Brown & Holtzman, 1956), grades, or grade point average.

Further evidence that study skills training need not be an integral part of multi-component treatment strategies for reducing test anxiety was obtained in an investigation by Thyer, Papsdorf, Himle, McCann, Caldwell, and Wickert (1981) who administered a core program of cognitive behavior therapy, progressive muscular relaxation training, and thermal biofeedback assisted relaxation training to two groups of test anxious (and trait anxious) individuals. The program did not include a study skills training component. The results indicated that significant improvements in test, trait, autonomic perception of anxiety and test performance were obtained. At least in this treatment combination, study skills were not necessary to produce significant performance increments.

Kirschenbaum and Perri (1982) reviewed the outcomes of published studies from 1974 to 1978 regarding the efficacy of programs designed to improve academic competence in adults. They concluded that behavioral interventions appear to be particularly helpful in reducing anxiety, whereas self-control study skills approaches seemed to affect study attitudes most dramatically. However, they commented that there is virtually no evidence that behavioral interventions <u>do not</u> effectively alter study attitudes or self-reported changes in study behaviors. Very few studies have assessed efficacy on measures of both anxiety and study

attitudes. The authors supported the use of multi-component programs (self-control plus study skills) as being the most efficacious for improving academic performance. However, they noted that very few studies actually controlled or tested for credibility of interventions; i.e., whether the intervention is seen by the subject as being appropriately effective for the particular problem. Given that multi-component interventions are more credible than simpler, single component programs (Kazdin & Wilcoxon, 1976), such studies may not have tested the effects of multi-component programs beyond the potentially powerful influence of credibility, expectancy, and related non-specific factors (Kirschenbaum & Perri, 1982). Two studies in which subjects expectancies were assessed and found comparable did not find that multi-component programs (with some form of study skills and self-control training) were consistently more effective than controls in improving exam scores or grade point averages (Grenier & Karoly, 1976; Richards & Perri, 1978) or improving study habits (Richards & Perri, 1978).

These studies taken together highlight the equivocal efficacy with which study skills training effects improvement in the performance and anxiety of test anxious persons. Studies which have found relatively greater effectiveness of multi-component treatment programs (which have often included some form of study skills training) as compared to simpler programs have not typically controlled for the potential confounding of credibility and expectancy.

In addition to the utilization of study skills as a technique in multi-component treatments of test anxiety, others have studied the comparative effectiveness of specific single component interventions for the treatment of test anxiety. Bedell, Archer, and Rosmann (1979) found that individually administered relaxation (Jacobsen, 1938) and standard desensitization (Wolpe, 1958) were effective in reducing state anxiety levels during an actual exam. Trait anxiety scores did not change significantly from pre to posttreatment.

In a further assessment of relaxation procedures for the reduction of test anxiety, Trent and Maxwell (1980) assigned 21 test anxious students to a systematic desensitization, a pseudotreatment, or a no treatment control group. Both treatment groups evidenced significant improvement on measures of test and trait anxiety over the control group. Relaxation training, identified as the only treatment common to both treatment and pseudotreatment, was implicated as the critical variable in their study. In addition, the correlation between A-Trait and test anxiety was significantly higher than the one between A-State and test anxiety. Although the study has limited generalizability because of small sample size and brief treatments, these results support the use of relaxation techniques in the treatment of trait and test anxiety.

In addition to the question of whether relaxation is an effective treatment strategy for test anxiety, the type of treatment rationale and degree of active control the test anxious client receives during treatment has been investigated. Chang-Liang and Denney (1976) assigned test

anxious college students to one of four experimental conditions: applied relaxation, systematic desensitization, relaxation only, or no treatment control. Subjects in applied relaxation were trained in deep muscle relaxation procedures and told they were learning a general skill for coping with stressful situations. They were instructed to apply and practice relaxation whenever they encountered anxiety-provoking situations outside of the therapy setting. Assessment measures included a test anxiety scale and the STAI-Trait scale. Applied relaxation was effective in significantly reducing students' levels of test and trait anxiety. In addition, applied relaxation was significantly more effective in reducing test anxiety than either the relaxation only or control procedures. The authors also commented on the general advantage of providing clients with a "actively working toward the solution" rationale.

Denney and Rupert (1977) found that test anxious college students who had received desensitization with an active coping rationale achieved better grade point averages in the semesters following treatment than test anxious students who had received desensitization with a passive rationale. In addition, students who received self-control desensitization with an active rationale did significantly better than students who received self-control desensitization with a passive rationale on a measure of test anxiety.

Deffenbacher and Shelton (1978) compared standard group desensitization with anxiety management training (AMT) for the treatment of targeted (test) and non-targeted anxieties in self-referred test anxious

college students. Both treatments differed procedurally and AMT contained an active coping rationale whereas standard desensitization did not. Both treatments showed significant pre to posttreatment and follow-up reductions in test anxiety (Test Anxiety Scale). The AMT group reduced non-targeted anxiety (STAI-Trait) significantly at follow-up whereas desensitization produced no changes in non-targeted anxiety. Given the design of this study, the greater effectiveness of AMT as compared to standard desensitization could have been due to procedural differences, differences in treatment rationales, or both.

The presence or absence of an active, self-control rationale was removed as a possible confound in a later study by Deffenbacher, Michaels, Michaels, and Daley (1980) who compared the relative effectiveness of anxiety management training (Suinn & Richardson, 1971) and self-control desensitization (Goldfried, 1971) in the reduction of targeted (test) and non-targeted anxieties for test anxious college students. Counseling sessions consisted of six weekly 50-minute group sessions. Although the treatments differed procedurally, both attempted to develop generalized self-managed relaxation coping skills. Both procedures trained clients to recognize the physical cues of anxiety arousal and to self-initiate relaxation whenever tension was perceived. Given that the cuing of relaxation in these treatments is internal rather than external, the effects were expected to generalize across anxiety-arousing situations. Treatment groups were compared to wait-list controls and no-treatment expectancy control subjects. At posttreatment both

treatments reported significantly less test anxiety than either control group and the treatment groups did not differ from one another. At follow-up, both treatments had significantly reduced trait anxiety compared to controls. Additionally, students receiving treatment obtained significantly higher course grades than those not receiving treatment. These results, those of Deffenbacher and Shelton (1978), and those of others that have examined the effectiveness of active self-control procedures (Chang-Liang & Denney, 1976; Denney & Rupert, 1977) support the use of such procedures for reducing test and trait anxiety and improving academic performance.

The study by Deffenbacher, et al. (1980) compared the effectiveness of two treatments that were expected to generalize across anxiety-arousing situations because of utilizing internal cues for relaxation. A study by Barrios, Ginter, Scalise, and Miller (1980) more specifically investigated the utility of internal versus external cuing to initiate relaxation in test anxious clients. Barrios, et al. (1980) compared applied relaxation (Chang-Liang & Denney, 1976), cue-controlled relaxation (Russell & Sippich, 1973), and conditioned cue-controlled relaxation (relaxation paired with a nonsense syllable) in the treatment of test anxious college women. Relaxation training took place for all subjects in a combined group over the first three weeks and was followed by specific treatment procedures administered individually over the following three weeks. Assessment measures included a version of the S-R Inventory of Anxiousness (Endler, Hunt, & Rosenstein, 1962) modified for

test situations. Between group analyses showed no significant differences among the three relaxation based treatments but within-group analyses indicated that the applied relaxation procedure produced the greatest number of statistically significant improvements including those on the modified S-R Inventory of Anxiousness and a test anxiety scale.

In addition to the type of therapy, the focus of the therapy has been studied as one possible important component for the effectiveness of test anxiety treatments. Hussian and Lawrence (1978) studied the relative effectiveness of a test-specific and generalized form of stress inoculation training; a cognitive modification therapy program initiated by Meichenbaum (cited in Hussian and Lawrence, 1978). They hoped to determine whether coping statements of a specific nature were more successful in reducing anxiety of a specific nature than more generalized statements. Forty-eight highly test anxious students who had been invited for treatment were randomly assigned to either stress inoculation training, test specific stress inoculation training, a discussion placebo group, or a waiting list control group. Using the TAS and STAI-State as measures of test anxiety and the STAI-Trait as a measure of generalized anxiety, results indicated that there were no statistically significant differences between the generalized and test-specific approaches. Both variants of stress inoculation led to significant anxiety reduction as compared to waiting-list controls and there were no differences between the two stress inoculation approaches regarding perceived improvement in test performance. When the test-specific and gen-

eralized training program were compared to the discussion control group, the test-specific program had more consistent treatment effects. When compared to the no treatment control group, both treatment groups evidenced comparable treatment effects. The authors concluded that the test specific program was the treatment of choice for test anxiety. However, careful review of their pretreatment data reveals that the test-specific group was consistently more anxious on the TAS and STAI (the measures upon which the authors base their conclusions) than the other experimental groups. Although these pretreatment differences were not significant, the test-specific group's performance relative to the discussion control as compared to the generalized group relative to discussion control may be due, in part, to differential regression effects. In addition, the authors did not assess pretreatment levels of treatment subjects expectations for improvement or treatment credibility. Such differences, if they existed, may in part explain the very slight differences of one treatment group versus another in comparison to the discussion control. Taking these possible confounds and the lack of significant differences between the two treatment groups into consideration, it would seem that the test-specific and generalized inoculation training programs were indeed comparably effective in reducing test and trait anxiety.

Alvaro (1979) administered a multi-component program of systematic desensitization, cognitive modification, and study skills training to students who, in addition to being anxious about science, were test anx-

ious. Treatment subjects' test anxiety was not significantly reduced following treatment. These results are inconsistent with those of other studies which have utilized cognitive and behavioral treatment approaches to produce test anxiety reduction (Holroyd, 1976; Hussian & Lawrence, 1978; Meichenbaum, 1972; Sarason, 1980). To further assess whether the test anxiety of students who are anxious about science can be reduced by cognitive and/or behavioral treatments, factors from the Science Anxiety Questionnaire (Alvaro, 1979) regarding Science Study Test and Non-Science Study Test anxiety as well as a measure of Test Anxiety were included in the present study.

In summary, the literature supports the use of active coping techniques for the reduction of test and trait anxieties. Such techniques are effective in conjunction with study skills but these multi-component interventions are not necessarily more effective. In addition, treatment subjects' expectations for improvement and their evaluations of intervention credibility have not been systematically considered in comparative evaluations of multi-component anxiety treatment programs. Finally, test specific and general anxiety reduction programs have been effective in reducing test and trait anxieties. What is the evidence in regards to a more recently defined and investigated academic anxiety, math anxiety?

Math Anxiety

Mathematics anxiety has been viewed as a form of test anxiety but more than or at least different from test anxiety in that in addition to being a reaction to the evaluative nature of math tests, it may also be a reaction to the specific content of mathematics (Richardson & Woolfolk, 1980). Richardson and Woolfolk (1980) comment that "we don't hear very much about 'biology anxiety' or 'English-literature anxiety' because these areas of study don't have disturbing associations as compared to 'math anxiety' for many persons". Richardson and Woolfolk (1980) also cite papers by Suinn and Richardson in which students requesting assistance specifically for math anxiety scored significantly higher than a control group on a test anxiety measure and at a level comparable to that of students requesting test anxiety treatment. To what extent, if any, is "math anxiety" different from "test anxiety" and other anxieties?

Betz (1978) in an investigation of factors related to the prevalence and intensity of math anxiety in college students found that the expression of anxiety was most widespread in conjunction with math tests and that there was a moderately strong relationship between math anxiety and both trait (STAI-Trait) and test anxiety. Persons who report having math anxiety are also likely to report anxiety in a variety of situations.

The most widely used measure of math anxiety is the Math Anxiety Rating Scale (MARS) (Richardson & Suinn, 1972), a 98-item scale composed

of brief descriptions of ordinary life and academic situations involving the manipulation of numbers or solving mathematical problems that may arouse anxiety. Rounds and Hendel (1980) in an investigation which explored the relationship between the MARS and other anxiety scales concluded that math anxiety is less a response to mathematics than a response to evaluation of mathematics skills and that the participants in the study were almost as apprehensive about tests in general as math tests in particular. In general, moderate-to-high relationships exist between measures of math anxiety and measures of test anxiety--in some cases almost as high as the relationship between alternative measures of math anxiety (Rounds & Hendel, 1980). This can be interpreted as reflecting a general lack of actual, clinical significance between math and test anxieties.

Resnick, Viehe, and Segal (1982), investigating the prevalence and correlates of math anxiety among college freshmen by studying the MARS completed by over 1,000 college freshmen, identified three factors related to math anxiety. However, one factor accounted for the largest part of the variance and was labelled Evaluation Anxiety. They concluded that for the college population studied, it would appear the predominant factor in math anxiety involves evaluation of mathematical work. As such, intervention programs similar to those which have been effective for students presenting with test anxiety might prove effective in the treatment of students presenting with math anxiety. The literature regarding the treatment of math anxiety will be reviewed next.

Treatment of Math Anxiety

Very few controlled studies regarding the treatment of math anxiety can be found in the literature (Richardson & Woolfolk, 1980). Programs and services for math anxious college students are in existence at Wellesley College, Wesleyan University, and Iowa State University and have been cited by Alvaro (1979) and Richardson and Woolfolk (1980). The purpose of these clinics has been to reduce anxiety about mathematics and to improve math skills in order to encourage students to enter math courses and related careers. The Wesleyan University program involves individual counseling, group discussion, and remedial coursework. The Wellesley College program does not focus on the psychological aspects of math anxiety but rather provides students with opportunities to experience success and competence in a special class that focuses upon mathematical reasoning and its applications in a wide variety of contexts. The Math Anxiety Class at Iowa State University consists of a self-paced algebra class with individual and group tutoring and a weekly "clinic" in which systematic desensitization augmented by hypnosis and deep muscle relaxation is utilized. As cited by Alvaro (1979), an evaluation of the Iowa State multi-component program indicated that students who attended the program exhibited significant pre to posttreatment improvement on a measure of math performance and in levels of math anxiety and confidence regarding learning of mathematics.

Writing of their experience using a multimodal anxiety management training program for individuals with math anxiety, Richardson and Wool-

folk (1980) comment that by not focusing narrowly upon math situations, the program helps restructure responses which often play an important role even with "such relatively situation-specific problems of test and math anxiety" (p. 283). They comment further that it tends to increase client interest and enhance client perceptions of the program as plausible and potentially beneficial. Additionally, they state that math and test anxious students usually require some restructuring of their study habits if rewarding and successful work in mathematics is to be ensured. Unfortunately, no evaluation data are reported. Those studies which have attempted to systematically investigate the treatment of math anxiety will be reviewed next.

In studies by Suinn and Richardson (1971) and Richardson and Suinn (1973), mathematics anxiety in university students was treated by systematic desensitization, accelerated massed desensitization, and anxiety management training (AMT) and compared to no-treatment control groups. Anxiety management training (AMT) is a non-specific anxiety reduction program which uses a client's current autonomic arousal during self-generated thoughts and feelings of past anxiety provoking events as discriminative stimuli to relax physically and mentally. Accelerated massed desensitization (AMD), as used in their study, exposed clients to only the highest items in an anxiety hierarchy in a single 3-hour treatment preceded one week earlier by relaxation training and home practice. The programs emphasized self-control of anxiety. Results from the studies indicated that AMD, AMT, and systematic desensitization were compa-

rably effective in reducing math anxiety and all treatment group subjects improved as compared to no-treatment control groups regarding math anxiety.

The utility of adding a study skills component to relaxation in the treatment of math anxiety was examined in a study by Bander, Russel, and Zamostny (1982). Thirty-six students who scored one standard deviation below a sample mean of 400 students on a mathematics anxiety scale accepted invitations for treatment assignments to one of four experimental conditions: (a) mathematics study skills training, (b) cue-controlled relaxation (CCR) which is a general coping strategy consisting of training in progressive muscle relaxation while continuously pairing the relaxed state with a subvocalized cue word, (c) a combined study skills and CCR treatment, or (d) a wait list control group. The treatment programs met weekly for one hour over the course of five weeks. Assessment using a trait anxiety measure, mathematics anxiety scale, test anxiety scale, and math performance measure was carried out at pre and post-treatment and at a three week follow-up (a total of eight weeks). At follow-up, cue-controlled relaxation was found to be superior to the other treatments on levels of math anxiety and math performance. Additionally, the results indicated that from posttreatment to follow-up the CCR group continued to improve on measures of math and test anxiety and math performance. The CCR and the combined CCR/study skills groups showed improvement in trait anxiety but the lack of statistical significance was due in part to large within-group differences. The authors

conclude that, contrary to others recommendations a multi-component program of CCR/study skills, while superior to a study skills only group, was not superior to a single component program of relaxation only. In addition, they suggested that anxiety programs oriented toward the alleviation of generalized test anxiety may be superior to those focusing on mathematics per se.

In addition to the use of relaxation and study skills training for the treatment of math anxiety, various cognitive techniques have been implemented and examined. Deitch (1981) assigned 45 math anxious college women to one of three experimental conditions: (a) systematic desensitization, (b) cognitive restructuring, or (c) a no-treatment control group. The author reported significant reductions in anxiety as measured by a math anxiety rating scale and a state-trait measure of anxiety for both treatment groups compared to the no-treatment group.

Taylor (1981) administered a multi-component program of rational-emotion therapy, relaxation, and desensitization to 143 high school algebra students and assessed treatment effectiveness with a state-trait measure, algebra test, and a self-report measure of autonomic reactivity. As compared to control and placebo groups, the treatment group evidenced significant improvement but the treatment's relative effectiveness compared to less complex therapy programs could not be assessed.

The question of how much therapy is needed for effective math anxiety treatment was investigated, in part, by Hendel and Davis (1978).

Forty-seven college students (a majority were adult women returning to college after having completed some college or a four year college degree) participated in a math anxiety program consisting of three independent components: (a) a three-hour diagnostic clinic designed for the assessment of and education regarding math anxiety, (b) special math courses, and (c) a seven session support group. Students who participated in the diagnostic clinic only, a math course only, or a combined math course and support group all evidenced significantly lower math anxiety at the time of post assessment. Although this study contained several possible confoundings, its results and those of Bander, et al. (1982) suggest that more intervention is not necessarily better.

The available literature has suggested that the use of active behavioral self-control methods and multi-component treatment programs which incorporate some form of relaxation and/or study skills and cognitive restructuring are effective in reducing math and test anxiety. Whether multi-component programs are more effective than single component programs for reducing these academic anxieties remains open to question. In addition, the difficulty in effectively differentiating various anxieties experienced in an academic setting has been noted. Students who report being anxious in a particular academic situation often exhibit a propensity to respond with anxiety in a variety of situations. Therefore, the relative merit of specifically targeting interventions for a particular type of academic anxiety versus utilizing a more generalized treatment approach to improving students ability to

cope with anxiety remains open to question. Attempts to identify and treat specific academic anxieties continue. One of the most recent examples of a specific academic anxiety to become the focus of attention is science anxiety.

Science Anxiety and Its Treatment

Mallow (1981) has asked whether science anxiety is a seperate phenomenon from math anxiety or test anxiety and concluded that they do indeed differ. Mallow and Greenburg (1982) define science anxiety as "a diffuse or vague fear which arises in response to the prospect of learning science" and Mallow (1981) gives several examples and consequences of science anxiety for college students. How do students initially identify themselves as being science anxious?

At Loyola University where the first Science Anxiety Clinic was implemented (Alvaro, 1979; Mallow, 1981), students are notified of the availability of the treatment program for science anxiety through student newspaper ads, classroom announcements, and posters placed around campus. These posters and announcements (see Appendix A) essentially help the student identify oneself as being science anxious if they have avoided taking science because of prior bad experiences or because they think it's beyond them, are limiting career choices by not taking science, or are taking science but are anxious about it. Mallow and Greenburg (1982) have contended that, like other negative feelings, science anxiety results from intervening self-messages rather than from the science learning itself.

Detailed descriptions of the implementation and session by session activities for the procedures for the Science Anxiety Group are described by Mallow (1981) and by Alvaro (1979). Typically, students would participate in groups containing six to ten other self-referred science anxious students co-led by a professor or graduate student from a science department and a psychologist or graduate psychology student on staff at the Counseling Center. Groups would meet for seven weekly sessions, each lasting about one and a half hours. In these sessions clients would be helped to do three things: (1) learn skills needed to study science, (2) explore the roots of their science anxiety and devise ways to cope with it, and (3) learn relaxation techniques to be applied in science-related situations that produce anxiety. Each of the seven sessions is a structured mixture of these various components.

As Mallow and Greenburg (1982) have noted, the two components of science learning on which the group would concentrate are science classroom interactions and science study skills. The primary psychological components of the Science Anxiety Group are cognitive restructuring, based on Ellis's Rational Emotive Therapy (1957, 1962), and systematic desensitization (Wolpe, 1958). Study skills training is composed of learning how to read scientific materials, how to work word problems, and how to prepare for and take science exams. Cognitive restucturing, as utilized in the SAG, is composed of identifying and challenging irrational, negative self-statements related to science and replacing them with objective and/or positive self-statements. The pro-

cedures follow Ellis's A-B-C model in which "A" is the stimulus or event, "B" is one's thoughts or perceptions about "A", and "C" is the emotional and behavioral consequences of those perceptions. In this model, it is "B" and not "A" which causes anxiety and other negative feelings. Through homework and in-group assignments, clients in the SAG are helped to challenge their identified negative self-statements regarding science and are encouraged to look at all possible consequences about an event and to explore coping strategies rather than catastrophize and denigrate themselves.

The systematic desensitization component would begin with brief training in deep muscle relaxation (Jacobsen, 1938) and the use of pleasant mental imagery to reduce anxiety (Meichenbaum, 1977). Each student then would compose a personalized hierarchy of anxiety-inducing science related scenes and the group leaders would compose a group hierarchy which incorporates many of the group members personalized science scenes. These hierarchies invariably included science examination situations as the most anxiety provoking situations (Mallow, 1981; Mallow & Greenburg, 1982). Systematic desensitization for the group then would follow procedures by Wolpe (1958). Typically, three or four hierarchy items were presented in each session with clients attempting to maintain deep muscular relaxation. If any client became anxious in response to any scene the group was instructed to mentally return to pleasant imagery and the anxiety provoking scene was then re-presented until relaxation continued uninterrupted for all group members.

Alvaro (1979), in an investigation of the effectiveness of the treatment program offered in the Loyola Science Anxiety Clinic, assigned 29 self-identified science anxious students to either a no-treatment wait list control group or the science anxiety group. Self-report and physiologic measures as well as grade point average were used to assess subjects at pre and posttreatment. Self-report measures included the Spielberger State-Trait Anxiety Inventory (STAI), standardized measures of math and test anxiety, and a measure of science anxiety. Alvaro constructed the measure of science anxiety from an original pool of 50 items which described various science situations. The number of situations was reduced to 22 after classification into five categories; performance, preparation, doing, applied, and non-academic. An additional 22 items, parallel in format to the science situations, which described non-science situations were then added. This form was administered to 538 college students at Loyola University and the completed questionnaires submitted to factor analysis. Ten factors were identified and utilized as dependent measures in Alvaro's study.

Based on self-report measures, subjects in the science anxiety group exhibited significant pre to posttreatment improvement in trait, math, and science (five of ten factors) anxiety. The wait list control group exhibited nonsignificant increases in many of these areas of anxiety although a significant decrease in math anxiety was found.

The physiologic measure employed by Alvaro (1979) consisted of recording frontalis muscle tension levels as a subject listened to a

tape recording of descriptive science, non-science, and neutral scenes. Muscle tension levels in response to the neutral scenes were subtracted from the levels of tension recorded in response to science and non-science scenes and the resulting levels were used for statistical analyses. Prior to treatment in the Science Anxiety Clinic, self referred science-anxious students exhibited significantly higher frontalis EMG levels in response to science as compared to non-science scenes. Following treatment, students who had participated in the treatment program evidenced pre to posttreatment EMG reductions in response to science and non-science scences; the former was statistically significant. The wait list control group exhibited an increase in EMG levels in response to science and non-science scenes; the latter was statistically significant. These results lend support to the validity of recording a subject's EMG frontalis muscle tension levels in response to descriptive imaginal scenes as a measure of the subject's anxiety.

The performance measure used in Alvaro's study was the subjects' grade point averages for the semester in which treatment took place. Grade point averages for both science and overall coursework revealed that the treatment group had earned higher grades than the no-treatment control group. These differences were not statistically significant however.

The results of Alvaro's study regarding the treatment of science anxiety are similar to those studies regarding the treatment of other specific academic anxieties in that the specificity of the phenomenon

and its treatment through specific or generalized anxiety reduction remain open to question. In addition, it is not clear whether a simpler treatment program might not be as or possibly more effective than the multi-component science anxiety group in the treatment of students who identify themselves as being science anxious. To date, no research has examined alternative methods for the treatment of science anxiety.

A stress management program designed to enhance students' ability to deal effectively with stressful situations encountered in their daily lives has been routinely available at the Loyola Counseling Center. This intervention program consists of progressive muscular relaxation training (Jacobsen, 1938) augmented by training in soothing mental imagery and has typically utilized the Quieting Response Training Program (Stroebel, 1978; Ford, Stroebel, Strong, & Szarek, 1982), an audiocassette program. Because of the possible generalized nature of the anxiety experienced by self-referred science anxious students, this apparently simpler, generalized anxiety reduction Stress Management Program (SMP) as utilized at the Loyola Counseling Center might be a cost-effective alternative to the multi-component Science Anxiety Group.

In addition to the differential focus and complexity of these two programs, the format (individual format of the Stress Management Program versus the Science Anxiety Group) may be a factor influencing differential treatment effectiveness. The particular format of therapy programs designed to reduce anxiety and improve performance in academic settings has not often been specifically investigated as a factor which might

influence treatment effectiveness. One might expect a group format to result in better effectiveness given the opportunity for peer reinforcement and assisting peers with similar problems (Rose, 1977) and the powerful effects of group process (Yalom, 1975). Despite this supposed advantage for a group format, individually administered CCR (Russell & Sipich; 1973, 1974) and self-control desensitization (Denney & Rupert, 1977) have been effective for reducing test anxiety and enhancing test performance. Individual and group desensitization were compared and found to be equally effective in the treatment of test anxiety (Mann & Rosenthal, 1969). Also individual and group cognitive behavior therapy were not differentially effective in reducing state and trait anxiety (Shapiro, Sank, Shaffer, & Donovan, 1982).

Summary and Hypotheses

This study was undertaken to compare the relative effectiveness of a multi-component group therapy program and an automated single component individual therapy program for the treatment of college students identifying themselves as being science anxious and presenting themselves for treatment. The multi-component program is a combined desensitization, study skills, and cognitive modification group therapy program targeted to reduce science anxiety. The single component program is a progressive muscular relaxation program designed to facilitate anxiety reduction across a wide variety of situations. Both programs emphasize an active coping rationale.

The literature reviewed regarding the treatment of anxiety in academic settings does not clearly specify which type, focus, or format of intervention is most effective in reducing anxiety and improving performance in academic settings. This lack of clarity appears to be due, in part, to the difficulty of effectively differentiating specific academic anxieties. Students identified as being math and science anxious are also likely to be anxious in a wide variety of situations including those that involve some type of evaluation. Intervention programs which have been found effective in the reduction of anxiety in evaluative situations (i.e. test anxiety) have included single and multi-component programs, individual and group programs, programs with a somatic and/or cognitive focus, and programs with or without study skills training. Unfortunately, results from comparative studies regarding the effectiveness of various intervention strategies have been confounded by the possible differences in treatment credibility and expectancy among the treatments being compared. In general however, those treatments which have employed an active coping rationale have typically led to effective anxiety reduction. Given the growing trend for accountability regarding the design and implementation of human services and the specific need to provide an effective alternative to students seeking services in the Science Anxiety Clinic at Loyola Counseling Center, the current investigation was undertaken. The following hypotheses were made:

1. Comparing pre to posttreatment scores, the Science Anxiety Group (SAG) and the Stress Management Program group (SMP) will

show improvements in each of the following areas as compared to the No-Treatment Control group (WL):

a) trait anxiety (STAI-Trait)

b) science anxiety (SAQ Lab, Observer, Science Study Test, Mean SAQ)

c) test anxiety (SAQ Non-Science Study Test, TAS, SAQ Science Study Test)

d) physiological indices of anxiety (EMG Science, Endler)

e) ability to study and concentrate on coursework (Study Habits and Attitudes).

2. The SAG and SMP groups will not differ from one another regarding the degree of improvement obtained in each of the areas noted above.

3. At posttreatment, the SAG and SMP groups will have a higher grade point average for science coursework and for overall semester coursework than the WL group.

4. Regarding perceptions of change:

   a) The SAG and SMP groups, as compared to the WL group, will perceive themselves as having improved in their science and general anxiety and academic ability.

   b) The SAG and SMP groups will not differ from each other regarding their perceptions of improvement in science or general anxiety and academic ability.

c) For each experimental group, perceptions of change in science versus general anxiety and academic ability will not differ.

CHAPTER III

METHOD

Sample

Subjects were students attending Loyola University of Chicago in the Fall or Spring semesters of the 1982-1983 academic year who had contacted the Loyola Counseling Center regarding the Science Anxiety Clinic and volunteered to participate in the evaluation project. Subjects were recruited through flyers, student paper advertisements, and classroom announcements regarding the Science Anxiety Clinic. Advertisements were circulated to professors responsible for teaching first and second year level physics, biology, chemistry, mathematics, psychology, sociology, and nursing courses (Appendix A). All announcements and advertisements emphasized that the Science Anxiety Clinic was for students whose anxiety interfered with their ability to learn science and for students who avoided taking science courses because they believed they cannot understand science. Each student's appropriateness for treatment in the Science Anxiety Clinic was determined by the following: (1) absence of any signs of thought disorder or other severe psychiatric symptoms, (2) no current use of medication for anxiety, (3) absence of any physical disability or condition contraindicated for isometric exercises, and (4) main presenting complaint of anxiety regarding the study of or learning

of science. Over the two semesters in which the study was conducted, a total of 42 students requested treatment for their science anxiety at Loyola Counseling Center. An initial attempt was made to match subjects by sex, age, and year in school and then subjects were randomly assigned to one of two treatment conditions or a no-treatment comparison group. Because of the clinical nature of the study and the Counseling Center's emphasis that all "subjects" be treated first and foremost as "clients", as many subjects as possible were to be assigned to a treatment condition.

Thirty-eight students were assigned to the two treatment conditions; nineteen students in each. Two subjects did not begin treatment, nine dropped out of treatment, and one subject did not complete post-treatment measures. This resulted in 13 subjects from each of the two treatment conditions who completed the study.

Four students who had requested treatment were assigned to the no-treatment comparison group. Three treatment subjects who had attended one or no treatment sessions were included as part of the no-treatment comparison group. In addition, students in an introductory physics and psychology course were asked to rate themselves on a three question survey regarding their reactions to various science situations (Appendix B). Students who scored one or more standard deviations above the mean for all students completing this form and who agreed to participate in the evaluation project were recruited as part of the no treatment comparison group. Six of these students completed pre and post-

treatment measures. This resulted in a total of 13 subjects in the no-treatment comparison group.

A total of 39 subjects (26 females and 13 males) completed pre and post treatment measures. The mean age of the sample was 21.3 years.

Dependent Measures

Anxiety is typically assessed through one of three response modes: (a) self-report measures, (b) behavioral performance measures, and (c) autonomic activity levels (Borkovec, Weerts, & Bernstein, 1977). Baum, Greenberg, and Singer (1982) reviewed the literature regarding the use of psychological and neuroendocrinological measurements in the study of stress and recommended the use of a multi-level research strategy involving assessment of psychological, behavioral, and physiological parameters in response to stress. In the present study physiologic, self-report, and performance dependent variables were selected.

Physiological Measure of Anxiety

The physiologic measure consisted of electromyographic recordings (EMG) of frontalis muscle tension. The frontalis muscle has been one of the preferred recording sites of researchers who use surface electromyography (EMG) to quantify the electrical activity of a muscle mass as a measure of muscle tension (Simkins, 1982). Muscle tension was monitored by a series J & J M-55 and LGS 150 EMG monitors (ranges set at 5 or 10) connected to the subject's forehead via three silver/silver chloride electrodes (SE-20) filled with a non-allergic electrode gel (Signa-

Gel) and held in place by means of an adhesive collar. In conjunction with the EMG monitor, a series of tape recorded scenes were used as imaginal stimuli to evoke physiologic responses from individual subjects. The audiocassette consisted of a series of eight base rate (Neutral), three non-science (NS), and five science (S) scenes (Alvaro, 1979) which played for a duration of sixteen minutes. Scenes were separated by 20 seconds of silence in which the subject was to imagine themselves in the scene just described and in which recordings were made of frontalis muscle tension every 15 seconds. The scenes employed were selected on the following criteria: (1) appropriateness to an undergraduate science curriculum, (2) applicability to students from varying backgrounds, and (3) representativeness of experiences encountered in a standard science course (Alvaro, 1979). The science and non-science scenes were parallel in format except that the latter contained non-science content:

> Imagine you are in a chemistry classroom. Imagine where you might be sitting in the room. It is before the class has started, other students are talking. You are aware of the pressure of the chair on your back. The periodic chart is in front of you on the wall. You remember as you see it, that for your next class quiz, you must know by heart the order and the atomic numbers of each element.
>
> Imagine you are in a history classroom. Imagine where you might be sitting in the room. It is before the class has started, other students are talking. You are aware of the pressure of the chair upon your back. Your eyes focus on a chart depicting the history of western civilization. Part of the next class quiz will be to memorize significant dates in the period which begins with the Battle of Hastings.

The base rate images had been chosen for their apparent neutrality:

> Imagine that you are in a super-market shopping. You are strolling down the aisle pushing your shopping cart. You can feel the cool metal of the cart against your hand ...

Alvaro (1979) found a significant reduction from pre to posttreatment in levels of frontalis muscle tension reactive to science stimuli for students who received treatment in the Science Anxiety Clinic. There was no significant change in muscle tension levels reactive to science stimuli for a control group of students. At pretreatment, all of these self-referred science anxious subjects had exhibited significantly higher frontalis muscle tension levels in response to the science scenes as compared to the non-science and base rate (neutral) scenes.

Self-Report Measures

Spielberger State-Trait Anxiety Inventory (STAI). The STAI A-Trait Scale (form X-2) was administered to each subject at pre and at posttreatment (Spielberger, Gorusch, & Lushene, 1970). The A-Trait Scale consists of twenty descriptive statements and instructs the subject to rate how they generally feel on a scale of one to four (almost never, sometimes, often, almost always). The STAI-Trait scale was employed in the present study to determine the extent to which the treatments produced generalized anxiety reduction. Normative means and standard deviations for a sample of undergraduate males and females enrolled in an introductory psychology course at Florida State University (N = 484

253 males, 231 females) were M = 38.07, SD = 9.69 and M = 38.25, SD = 9.14, respectively (Speilberger, et al., 1970).

Science Anxiety Questionnaire (SAQ). The SAQ was modelled after the Mathematical Anxiety Rating Scale (Richardson & Suinn, 1972) and contains 44 science and non-science items in parallel form (Alvaro, 1979; Mallow, 1981). Subjects are instructed to rate how much they are frightened nowadays by each situation described. The rating scale consists of five points (not at all, a little, a fair amount, much, very much). Alvaro (1979) derived ten factors, using a Rao canonical maximum likelihood solution, from a standardization sample of 538 undergraduate students enrolled in physics, biology, or chemistry courses at Loyola University of Chicago. Means and standard deviations for this sample were not reported. In the present investigation, only those factors which contained at least two items with loadings above .55 and which revealed significant decreases in anxiety for treatment but not for control group subjects were employed. These criteria reduced the number of usable factors to three; Lab Anxiety, Science Study Test Anxiety, and Observer Anxiety.

Although validity and reliability coefficients are not available for the SAQ, the three factors above demonstrated a limited validity in that subjects, self-identified as being science anxious, who received treatment demonstrated significantly lower anxiety after treatment on these factors. A limited test-retest reliability was demonstrated by the lack of a significant change in scores on these three factors for a no treatment control group of self-identified science anxious students. A fourth factor, Non-Science Study Test Anxiety, contained two items

with factor loadings above .78. In Alvaro's study (1979) there were no significant changes from pre to posttesting for either the treatment or no-treatment control groups on this factor. Alvaro (1979) intrepreted this result as indicating the specific nature of the Science Anxiety Clinic. However, such a conclusion is at variance with her results which indicated that other anxieties were reduced. The Non-Science Study Test Anxiety factor was included in the present study in order to further assess possible reductions in non-targeted anxieties. Table 1 contains a list of the SAQ factors employed in this study and their respective item contents.

Study Habits and Attitudes Questionnaire. The Study Habits and Attitudes Questionnaire is composed of 25 True-False questions from the following sources: (a) The Inventory of Study Habits and Attitudes (Raygor, 1970), (b) Study Habits Inventory (Wrenn, 1941), and (c) Survey of Study Habits and Attitudes (Brown & Holtzman, 1965). A copy of the Study Habits and Attitudes Questionnaire is provided in Appendix C. The questions were selected by the principal investigator and regarded by three professors of psychology as having face validity to assess a subject's self-reported ability to attend to and concentrate on coursework and study materials. Nineteen items were keyed true and six items were keyed false to obtain an index indicating difficulty in these areas.

Test Anxiety Scale (TAS). The TAS is a 37-item True-False questionnaire measuring debilitative test anxiety (Sarason, 1978). Total

TABLE 1

Science Anxiety Questionnaire Factors

Lab Anxiety

1. Using a thermometer in order to record the boiling point of a heating solution.
2. Adding minute quantities of acid to a base solution in order to neutralize it.
3. Precisely inflating a balloon to be used as apparatus in a physics experiment.
4. Mixing boiling water and ice to get water at 70 degrees Fahrenheit.
5. Focusing a microscope.

Science Study Test Anxiety

1. Studying for a mid-term exam in Chemistry, Physics, or Biology.
2. Studying for a final exam in Chemistry, Physics, or Biology.

Observer Anxiety

1. Asking a question in a science class.
2. Having your music teacher listen to you as you play an instrument.
3. Having your professor watch you perform an experiment in lab.
4. Having a teaching assistant watch you perform an experiment in lab.
5. Having a teaching assistant watch you draw in Art class.
6. Asking a question in an English literature class.

Non-Science Study Test Anxiety

1. Studying for a final exam in English, History, or Philosophy.
2. Studying for a mid-term in a History course.

scores range from zero to thirty-five with higher scores indicating more debilitating test anxiety. A standardization sample of male and female undergraduates at the University of Washington yielded the following means and standard deviations: $\underline{M}$ = 16.72, SD = 7.12 and $\underline{M}$ = 19.74, SD = 6.73, respectively.

Endler S-R Inventory of Anxiousness. The Endler S-R Inventory of Anxiousness (Endler, Hunt, & Rosenstein, 1962) as modified for this study, asked subjects to describe three science-related situations which they found personally stressful or anxiety provoking. The subject rated response to each situation on 14 items regarding subjectively experienced physiological anxiety using a scale of one to five ("not at all" to "very much", etc.).

Expectancy Questionnaire. After assignment to conditions, subjects in the treatment conditions completed the Expectancy Questionnaire; a brief six item questionnaire designed for this study to assess each subject's expectations for improvement and appraisal of plausibility of the treatment approach for reducing science related and general anxiety levels (Appendix D). Subjects were instructed to answer each item using a rating scale from zero (lowest) to ten (highest). Because the procedures of the Science Anxiety Group, but not the Stress Management Program, had been offered in the past to students presenting at the Counseling Center with science anxiety, it was felt that differential expectations for subjects assigned to one or the other treatment condi-

tion might result. This questionnaire was implemented to assess this possible confound.

Posttreatment Evaluation Questionnaire. After treatment was completed, students were asked to complete the Post-Treatment Evaluation Questionnaire which was designed to have all students rate themselves for perceived change and all treatment students evaluate their respective treatment programs (see Appendix E). Part I of this form asked all students to rate their changes in levels of general or science related anxieties and academic abilities. Part II asked the treatment students to rate their agreement or disagreement with various statements regarding the match of a subject's expectations to their assigned treatment and the student's satisfaction with that treatment program. Part III asked the treatment students to rate how important they believed various treatment components were in contributing to any improvements in ability to cope with anxiety. Treatment specific sections (Parts II and III) were parallel in nature but contained wording specific to each treatment. Part IV asked all students to indicate the number of times they attended or participated in other study skills, counseling, or therapy programs while they were a participant in the present study.

Other Forms and Measures

(1) A form was provided to each student on which to indicate age, gender, year in school, and enrollment in current and previous science courses (Appendix F). (2) Students from science and psychology courses

recruited as subjects in the no-treatment comparison group completed a brief three question survey designed to assess level of anxiety experienced in various science situations (see Appendix B). (3) Consent forms which emphasized the voluntary nature of participation and the confidentiality of all information collected were employed in the present study (Appendix G).

Procedure

Advertisements regarding the Science Anxiety Clinic were circulated within the first two weeks of each semester to professors responsible for teaching first and second year level physics, biology, chemistry, mathematics, psychology, sociology, and nursing courses. Professors were requested to read the flyers to their classes. Flyers were also posted around campus and in classrooms. In addition, a brief advertisement was placed in the student newspaper. All announcements and advertisements emphasized that the Science Anxiety Clinic was for students whose anxiety interfered with their ability to learn science and for students who avoided taking science courses because they believed they cannot understand science. All students who contacted the Counseling Center regarding the Science Anxiety Clinic were given individual appointments during the sixth week of the semester for an initial interview with the principal investigator, an advanced graduate student in clinical psychology.

Initial Interview and Assessment

All students were asked why they sought services in the Science Anxiety Clinic. The principal investigator then explained the nature of assignment to treatment or wait list and the nature of the evaluation project as summarized in a written consent form (see Appendix G). Students were informed that if placed on the wait list they would receive priority for the next Science Anxiety Clinic and/or could avail themselves of other Counseling Center services if desired and deemed appropriate. The confidentiality of the evaluation project's records was explained. In keeping with Counseling Center policy, all records were not to be released to anyone outside the agency without written consent of the client and all data would be analyzed and reported in a manner that guaranteed each student's anonymity.

After a subject signed the consent form, an introduction to the biofeedback monitoring device was given. Clients were encouraged to ask questions regarding any procedures. The procedure for EMG assessment was explained before this procedure began so as to reduce anxiety associated with assessment. Subjects were then seated in a comfortable reclining chair and the electrodes were attached to their forehead. After being instructed to find a comfortable position in the chair and not to cross their arms and legs if possible, each subject was given a brief demonstration of the EMG recording device as they tensed and then relaxed their frontalis muscle. The tape recorded images were then presented with instructions to imagine oneself in each scene as vividly as

possible. EMG levels were recorded by the examiner who was seated to the side of the subject.

After the tape ended and the EMG equipment detached, the subject filled out a schedule of classes (and hours of employment) and was then handed a packet containing all the pre-test questionnaires. Subjects were asked to return the packet within the week and pick up their treatment or wait list assignment at that time. When subjects returned their completed packets, they were handed an index card which indicated their assignment and, if appropriate, the date and time of their first treatment session. All treatments began the following week.

Treatments

Stress Management Program. Subjects assigned to this condition in the Fall (N=13) and Spring (N=6) semesters were scheduled for individual sessions in which they received training in an active progressive muscular relaxation program which utilized the audiocassette portion of Quieting Response Training (Stroebel, 1978). Quieting Response Training is an active relaxation program which, through a series of tape recorded systematically sequenced exercises, guides the subject through four stages of functional skill development: (1) recognition of undesirable increases in physiological arousal, (2) reduction of both skeletal and smooth muscle activity to acceptable levels by practicing the "Quieting" exercises during the day, (3) application of this skill to stressful life situations whenever they occur through conscious use of a brief "Quieting" technique, and (4) routinization of such application so that

the skill becomes quasi-automatic (Stroebel, 1978). Through an integration of soothing mental imagery, progressive muscle relaxation, and the use of the subject's breathing rhythm as a discriminative cue, the subject is taught to become aware of and to control their response to stressful situations. The program emphasizes individual responsibility for acquiring and maintaining this ability. The program employs and emphasizes a learning curve concept where instrumental self-control over arousal emerges with systematic, repeated instruction and practice. Instructions for the training program are contained on eight audio-cassette tapes which vary in length from fifteen to fifty minutes.

Subjects assigned to the Stress Management Program received instruction in Quieting Response Training through seven individual sessions regularly scheduled on a weekly basis in which they were presented with the first seven audio-cassette tapes (one per week). During sessions, the subject was seated in a comfortable reclining chair in a quiet room. At the conclusion of each audio-cassette, the subject was instructed to practice the instructions and exercises of the tape for ten to fifteen minutes before ending the session. The subject was also instructed to practice the particular exercises of that week on a regular daily basis and to record their practices on a daily log.

The author met each client at the beginning of each session to briefly review the techniques for the present session and to turn on the proper audio-cassette tape. About halfway through each session the author returned for a few seconds to see if the subject was having any

difficulties. At the end of each session, the author returned to put away the audio-cassette tape and to address any concerns the subject had in a factual manner. Since the program was designed to be automated with clients assuming as much responsibility as possible for acquiring the responses taught to them, the author maintained a minimal involvement in the therapy program.

In the first session of the Stress Management Program each subject met with the author to disucuss what cues the subject used to tell that stress or anxiety is being experienced, and how relaxation was normally achieved. The author then briefly helped the subject clarify the emotional and physiological nature of responses to stressful situations. The author also explained his minimal role in the subject's acquisition of the "Quieting Response" and how the subject would have primary responsibility in this regard. The subject's commitment to and regular attendance in the Stress Management Program was emphasized. The schedule of sessions was reviewed and the subject was handed a description of the exercise element for the seven sessions from the manual of the Quieting Response Training program (Stroebel, 1978). The first audio-cassette was then turned on and the subject completed exercise element one. The subject completed exercise elements two through seven in regularly scheduled weekly sessions. At the conclusion of session seven, the subject scheduled a posttreatment assessment session for the following week and was handed a packet of self-report questionnaires to be completed and returned at that time.

Science Anxiety Group. In the Fall semester, two Science Anxiety Groups met (N=14) each co-led by a scientist and a psychology intern. In the Spring semester one Science Anxiety Group met (N=5), again co-led by a male/female team of one scientist and one psychology intern. Scientists were either a professor of physics or an advanced graduate student in Biology or Chemistry. Psychology interns were advanced graduate students in clinical or counseling psychology on internship at the Counseling Center. Each scientist/psychology intern team was supervised one hour per week by a clinical psychologist familiar with the procedures of the Science Anxiety Clinic. The purpose of the supervision was to clarify procedures from week to week and to process any difficulties or concerns encountered by the therapists in leading a group therapy program.

The techniques used in the Science Anxiety Groups are geared to help students develop science study skills and acquire psychological skills for coping with anxiety (Alvaro, 1979; Mallow, 1981). Groups met for seven weeks for one and a half hours per week. Science learning skills included having subjects solve a number of word problems and take quizzes on a series of science readings under the guide of the scientist co-leader. The two principal psychological techniques used were cognitive restructuring and systematic desensitization. In an effort to emphasize the self-control and active aspects of the program, commitment to treatment and regular attendance was emphasized. While in the group, members were provided with the opportunity to practice and apply the

techniques taught and to discuss each other's problems so that group interaction was encouraged. Individual make-up sessions for excused absences were designed with regard to collection and assignment of homework materials and a brief discussion of procedures from the missed session. Subjects were responsible for scheduling individual make-up sessions with one of their group leaders. At the end of the seventh session in each semester (which coincided with the seventh and final Stress Management Program session), each subject scheduled an individual posttreatment assessment session with the author and was handed a packet of self-report questionnaires to be completed and returned at that time.

Posttreatment Assessment Session

In both the Fall and Spring semester all Stress Management Program, Science Anxiety Group, and No-Treatment Comparison Group subjects were seen individually by the author for post-testing during the week following the final treatment session (the week before final exams). Subjects returned their completed packets of self-report measures at the beginning of this evaluation session. The subject was then connected to the EMG monitoring device and EMG frontalis muscle tension levels were recorded as the subject listened to the tape recorded imaginal scenes they had been presented with at pre-testing. The subject was disconnected from the EMG equipment and, as the subject completed the Post Evaluation Questionnaire, the author scored the subject's post-test questionnaires. The subject and author then briefly discussed the subject's experience in the program and any progress noted. No-treatment

comparison group subjects were reminded of their priority for the next Science Anxiety Clinic if they desired treatment.

CHAPTER IV

RESULTS

Demographic Data

A total of 39 subjects completed pre and posttreatment measures; 13 in each of the three experimental groups. The mean age of the subjects was 21.3 years and a one-way ANOVA revealed that the groups did not differ significantly with respect to age, $F(2,36) = 0.11$, $p>.05$. Pearson chi-squares revealed that there were no significant ($p>.05$) correlations between experimental group and year in school, $\chi^2(2, N = 39) = 1.73$, sex of subject, $\chi^2(2, N = 39) = 0.23$, previous science course enrollment, $\chi^2(2, N = 33) = 2.44$, current science course enrollment, $\chi^2(2, N = 39) = 4.22$, dropping of science course during the study, $\chi^2(2, N = 39) = 2.11$, or reception of other types of counseling during participation in the study, $\chi^2(2, N = 36) = 0.15$. Pearson chi-square revealed that experimental group and semester of participation were significantly related in that the majority of treatment subjects were from the Fall semester and the majority of comparison subjects were from the Spring semester; $\chi^2(2, N = 39) = 8.45$, $p<.05$. This meant that the three experimental groups could have differed at pretreatment. The analyses that were conducted to assess this possibility are presented in a separate section. Demographic data for the three experimental groups are pre-

sented in Table 2. There were no significant differences among the three groups for number of sessions of other counseling received during participation in the study; $F(2,23) = 0.54$, $p > .05$. Mean number of sessions for other types of counseling was 3.4. Demographically, the three experimental groups were equivalent.

Expectancy Questionnaire

This questionnaire was designed to assess each treatment subject's expectations for improvement and appraisal of the treatment rationale for reducing science-related and general anxiety (see Appendix D). For each subject, a mean for science (items one, four, and five) and general (items two, three, and six) anxiety were calculated and used in the following series of one-way ANOVAs. The Expectancy Questionnaire rating scale, means, and standard deviations for subjects in the SAG and SMP conditions are presented in Table 3.

The two treatment groups did not differ significantly in their expectancy for improvement of science-related anxiety, $F(1,24) = 0.18$, $p > .05$. The SMP subjects expected significantly greater improvement regarding general anxiety than the SAG subjects, $F(1,24) = 4.31$, $p < .05$. Within group comparisons revealed that the SAG subjects expected significantly greater improvement regarding science anxiety than for generalized anxiety, $F(1,12) = 10.29$, $p < .01$, whereas the reverse pattern was true for the SMP subjects, $F(1,12) = 14.34$, $p < .01$. The results indicated that treatment subjects expected greater improvement in the area of focus for their respective programs but that the two groups did not

TABLE 2

Demographic Data for Experimental Subjects

	SAG	SMP	WL	Total
Year in School				
Freshman/Sophomore	8	7	10	26
Junior/Senior/Other	5	6	3	13
Sex of Subject				
Female	9	9	8	26
Male	4	4	5	13
Previous Science Course Enrollment				
Yes	11	12	9	32
No	2	1	4	7
Current Science Course Enrollment				
Yes	13	13	11	37
No	0	0	2	2
Dropped Science Course During Study				
Yes	0	2	1	3
No	12	11	5	28
Other Help Received During Study				
Yes	7	6	5	18
No	6	7	5	18
Semester of Participation				
Fall	11	9	4	24
Spring	2	4	9	15

TABLE 3

Pre-treatment Expectancy Questionnaire

	Type of Anxiety			
	Science-Related		General	
	$\underline{M}$	SD	$\underline{M}$	SD
SAG	8.41	0.75	7.64	1.14
SMP	8.21	1.55	8.69	1.42

differ in their expected level of improvement regarding stress in science related situations.

Pretreatment Levels of Anxiety

Pre and posttreatment means, standard deviations, and summary ANOVA results for each of the self-report measures can be found in Table 4. Because the correlation between experimental group and semester was significant and the majority of Fall semester subjects were treatment subjects (20 of 24) whereas the majority of Spring semester subjects were comparison group (WL) subjects (9 of 15), it was important to determine that the three experimental groups did not differ significantly at pretreatment on any of the dependent measures.

One-way ANOVAs with experimental condition as the independent variable carried out for each dependent measure revealed that the Science Anxiety Group (SAG), Stress Management Group (SMP), and the Comparison Group (WL) did not differ significantly on any of the self-report measures at pretreatment (all $p>.10$). Using normative data from college populations for the two standardized measures in the present study (STAI A-Trait and TAS), it was determined that treatment subjects in the present study, in addition to requesting treatment for "science anxiety", were also trait anxious and test anxious individuals. As a group, the treatment subjects in the present study were more than one-half standard

TABLE 4

Means and Standard Deviations for Self Report Measures of Anxiety

Measure	SAG		SMP		WL		* Significant ANOVA Results
	M	SD	M	SD	M	SD	
STAI-Trait							$T^{c}, TG^{b}, SAG^{b}, SMP^{b}$
Pre	44.54	8.60	42.15	12.03	40.75	7.84	
Post	38.38	6.92	36.00	8.03	41.92	9.07	
SAQ Lab							T^{c}, SAG^{c}
Pre	8.92	3.55	9.38	4.54	9.23	3.03	
Post	6.77	2.01	7.00	2.27	8.00	2.77	
SAQ Science Study Test							$T^{c}, TG^{b}, SAG^{e}, SMP^{e}$
Pre	8.54	1.94	8.69	1.60	7.62	1.80	
Post	6.08	2.47	6.08	1.75	6.92	1.44	
SAQ Observer							T^{e}, SAG^{d}, SMP^{c}
Pre	15.31	3.52	14.92	5.01	15.00	2.94	
Post	11.46	3.04	11.00	2.52	14.15	2.97	
Mean SAQ							$T^{e}, TG^{b}, SAG^{e}, SMP^{d}$
Pre	2.87	0.61	2.90	0.66	2.72	0.50	
Post	2.10	0.63	2.09	0.39	2.47	0.45	
SAQ NonScience Study Test							T^{e}, SAG^{d}
Pre	5.62	2.02	4.77	2.92	5.85	1.95	
Post	4.38	2.02	3.69	1.60	5.08	1.44	

(continued)

TABLE 4 (continued)

Means and Standard Deviations for Self Report Measures of Anxiety

Measure	SAG		SMP		WL		*Significant ANOVA Results
	M	SD	M	SD	M	SD	
Study Habits							$T^{d}, TG^{c}, SAG^{b}, SMP^{c}$
Pre	14.00	6.12	12.23	6.19	12.15	5.80	
Post	8.77	7.57	8.08	5.07	13.31	6.56	
Test Anxiety							T^{d}, SAG^{a}, SMP^{b}
Pre	24.83	5.99	21.00	8.43	19.69	6.75	
Post	18.58	9.46	14.77	7.54	18.54	5.01	
Endler							$T^{e}, TG^{b}, SAG^{d}, SMP^{d}, WL^{b}$
Pre	38.92	6.26	42.28	8.21	36.14	7.35	
Post	30.95	7.11	32.56	6.11	33.25	7.34	

* Two-way ANOVAs (group X time of testing) with repeated measures on the second factor. T=main effect for time, TG=interaction for time of testing and group, SAG=simple effect for Science Anxiety Group, SMP=simple effect for Stress Management Group, WL=simple effect for Comparison group.

a: $p<.10$
b: $p<.05$
c: $p<.01$
d: $p<.005$
e: $p<.001$

deviation above the normative sample mean for the STAI A-Trait measure and the Test Anxiety Scale (TAS) placing them in the 70th and 75th percentile for each measure respectively.

As described in Chapter III, the physiologic measure consisted of pre and posttreatment EMG recordings of a subject's frontalis muscle tension while he/she listened to a series of tape recorded science, non-science, and neutral descriptive imaginal scenes (Alvaro, 1978; Mallow, 1981). For each subject, a mean EMG level for each of the three types of scenes was calculated at both pre and posttreatment, and these means were used for statistical analysis.

Using pretreatment data, a manipulation check to determine whether subjects' EMG levels varied as to type of scene was carried out with a two-way ANOVA (groups X type of scene). The main effect for type of scene was significant, $F(2,70) = 5.85$, $p<.01$, whereas the main effect for group, $F(2,35) = 1.24$, $p > .05$, and the interaction of group by type of scene $F(4,70) = 2.16$, $p > .05$, were not significant. Pair-wise repeated measures ANOVAs for type of scene revealed that subjects EMG levels were significantly higher in response to science as compared to non-science scenes, $F(1,37) = 10.56$, $p < .005$, and neutral scenes, $F(1,37) = 4.04$, $p < .05$, but that EMG levels in response to non-science as compared to neutral scenes did not differ significantly, $F(1,37) = 1.90$, $p > .05$. These results indicated that all subjects were indeed more anxious, as measured by frontalis muscle tension levels, when visualizing science as compared to non-science or neutral scenes and that

the experimental groups did not differ from each other at pretreatment in their levels of anxiety as measured by EMG recordings on any of the scenes.

The lack of significant differences among the three experimental groups on the pretreatment measures of anxiety supports the use of a repeated measures ANOVA statistical approach and diminishes the need for the use of analyses based on a statistical regression model. A further justification for the use of repeated measures ANOVAs versus the use of an analysis of covariance statistical approach comes from the results of correlations between the pre- and post scores on each dependent measure. As Keppel (1973, p. 525) notes, if the correlation between two scores is high, $\underline{r} = 0.8$ or above, the increase in sensitivity afforded by covariance can be substantial. However, in this study eleven of the fifteen dependent measures had pre-post correlations of 0.5 or less and the other four dependent measures had pre-post correlations between 0.5 and 0.6. Finally, as noted by Hull and Nie (1981, p. 49), the univariate approach (as in repeated measures ANOVA) is more powerful than a multivariate aproach, especially for small samples.

Because of the lack of pretreatment differences among the three experimental groups, the lack of high pre-post correlations for the dependent measures, and the small sample sizes, repeated measures ANOVAs were utilized in this study as planned. Simple effect analyses were conducted when justified by the presence of a significant interaction. In addition, because this study was conducted to investigate the rela-

tive effectiveness of one treatment versus another, simple effect analyses were conducted when not entirely justified by previous statistical analyses. It was anticipated that such analyses would be helpful in revealing potentially important trends regarding differential clinical effectiveness. It is acknowledged that such analyses were not always justified statistically, and the interpretation of results reflects this limitation.

Repeated Measures Results

Electromyographic Measures of Anxiety

A three-way ANOVA (groups X type of scene X time of testing) with repeated measures on the last two factors revealed a significant main effect for type of scene, $F(2,68) = 6.13$, $p < .005$. This main effect reflected that, overall, EMG levels in response to science scenes were significantly higher than EMG levels in response to non-science scenes, $F(1,36) = 11.67$, $p < .001$, but not significantly higher than EMG levels in response to neutral scenes, $F(1,36) = 1.29$, $p > .05$. In addition, EMG levels in response to neutral scenes were significantly higher than EMG levels in response to non-science scenes, $F(1,36) = 7.12$, $p < .01$. The first order interaction for type of scene by time of testing approached but did not reach statistical significance, $F(2,68) = 2.55$, $p < .10$. There were no other main effects or interactions that reached statistical significance (see Appendix H).

Because of the significant main effect for type of scene and the expected change in EMG levels on the various scenes for the treatment

groups, only EMG data for the SAG and SMP groups were used in a series of two-way ANOVAs (group X time of testing) with repeated measures on the last factor for each type of scene. Only for the science scenes did the main effect for time of testing approach statistical significance, $F(1,24) = 3.56$, $p < .07$, indicating that the decrease in treatment group subjects' EMG levels in response to visualizing science scenes was nearly significant. The changes in treatment subjects' EMG levels from pre to posttreatment on the non-science, $F(1,24) = 0.06$, $p > .05$, and neutral scenes, $F(1,24) = 0.20$, $p > .05$, were not significant nor were there any differential treatment effects. Pairwise repeated measures ANOVAs for type of scene on the post EMG data for the two treatment groups revealed that EMG levels in response to science as compared to non-science, $F(1,25) = 2.36$, $p > .05$, and neutral scenes, $F(1,25) = 0.00$, $p > .05$, and non-science as compared to neutral scenes $F(1,25) = 2.12$, $p > .05$, did not differ significantly. Finally, repeated measures ANOVAs for time of testing on each type of scene for the WL group data revealed that their decrease in EMG levels from pre to posttesting in response to science, $F(1,10) = 0.26$, $p > .05$, neutral, $F(1,10) = 0.05$, $p > .05$, and non-science scenes, $F(1,10) = 0.62$, $p > .05$, was not significant.

In summary, the results of the analyses on the EMG data indicate that the SAG and SMP group subjects did show a pre to posttreatment decrease in their EMG levels while visualizing science scenes. This decrease approached but did not reach statistical significance. Overall there was a trend for the experimental groups to show a decrease in

their EMG levels from pre to posttesting in response to all three types of scenes presented. In general, there were no significant differential decreases in EMG levels across the three types of scenes or among the three experimental groups.

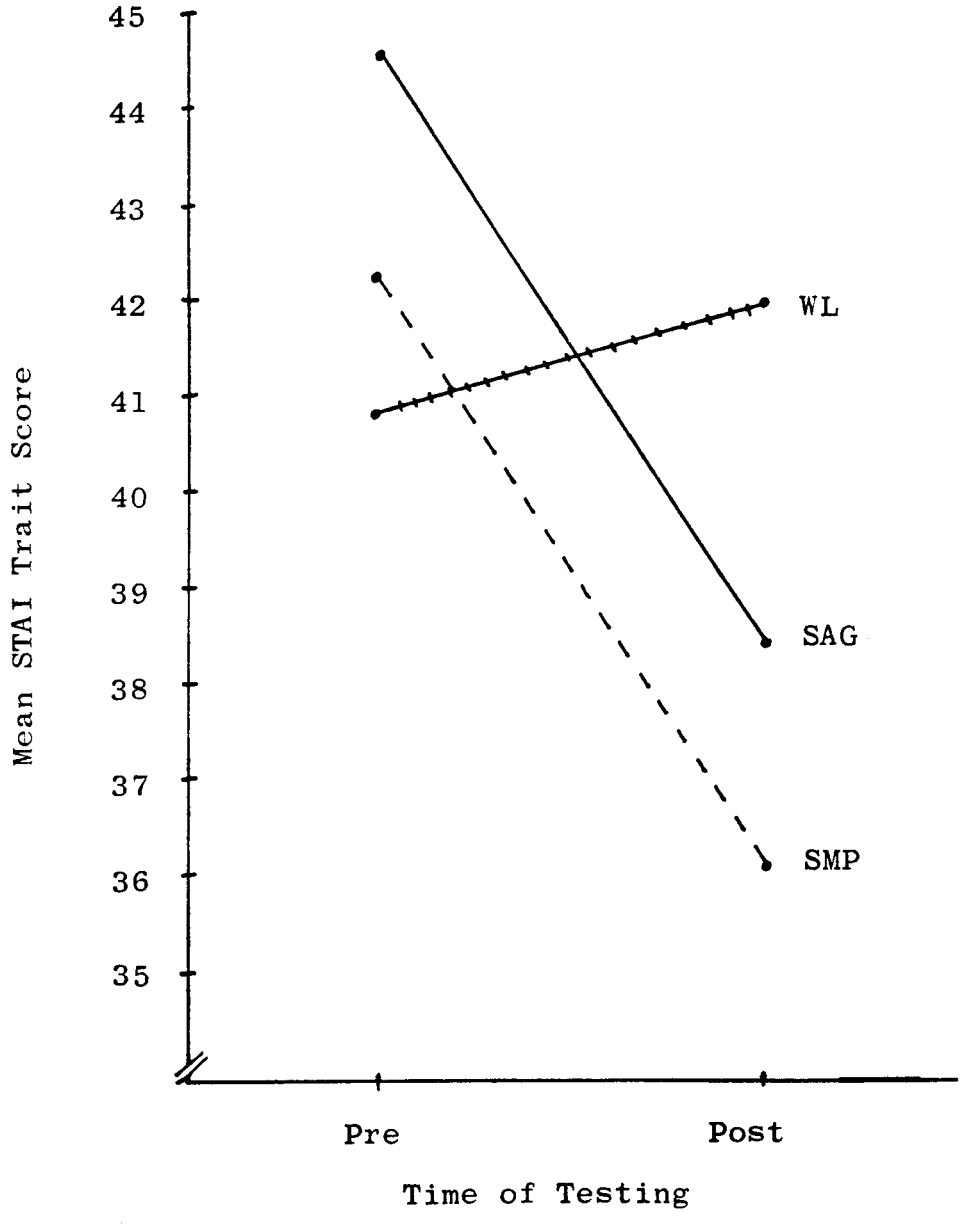
Spielberger State-Trait Anxiety Inventory (STAI-Trait)

A two way (groups X time of testing) repeated measures ANOVA for the STAI-Trait Scale revealed a significant main effect for the time of testing, $F(1,35) = 9.86$, $p < .01$, and a significant groups X time of testing interaction, $F(2,35) = 4.18$, $p < .05$. The main effect for groups was not significant, $F(1,35) = 0.35$, $p > .05$. The interaction of groups X time of testing can be seen in Figure 1. Simple effects analyses revealed a significant decrease in trait anxiety for the SAG, $F(1,12) = 7.58$, $p < .05$, and SMP, $F(1,12) = 6.82$, $p < .05$, groups. The comparison group increased in their levels of trait anxiety as measured by the STAI, but this increase was not statistically significant, $F(1,11) = 0.85$, $p > .05$. A two-way (groups X time of testing) ANOVA with repeated measures on the second factor for the SAG and SMP groups revealed a lack of a significant interaction, $F(1,24) = 0.00$, $p > .05$, indicating that there was no differential treatment effect.

These results indicated that the treatment groups reported significantly less trait anxiety at posttreatment than at pretreatment whereas the no treatment comparison group subjects reported more trait anxiety though this increase was not significant. Levels of trait anxiety at posttreatment for the SAG and SMP groups placed them at the mean for the STAI-Trait normative sample (within the 50th percentile).

FIGURE 1

Spielberger (STAI) Trait Scale



Science Anxiety Questionnaire (SAQ)

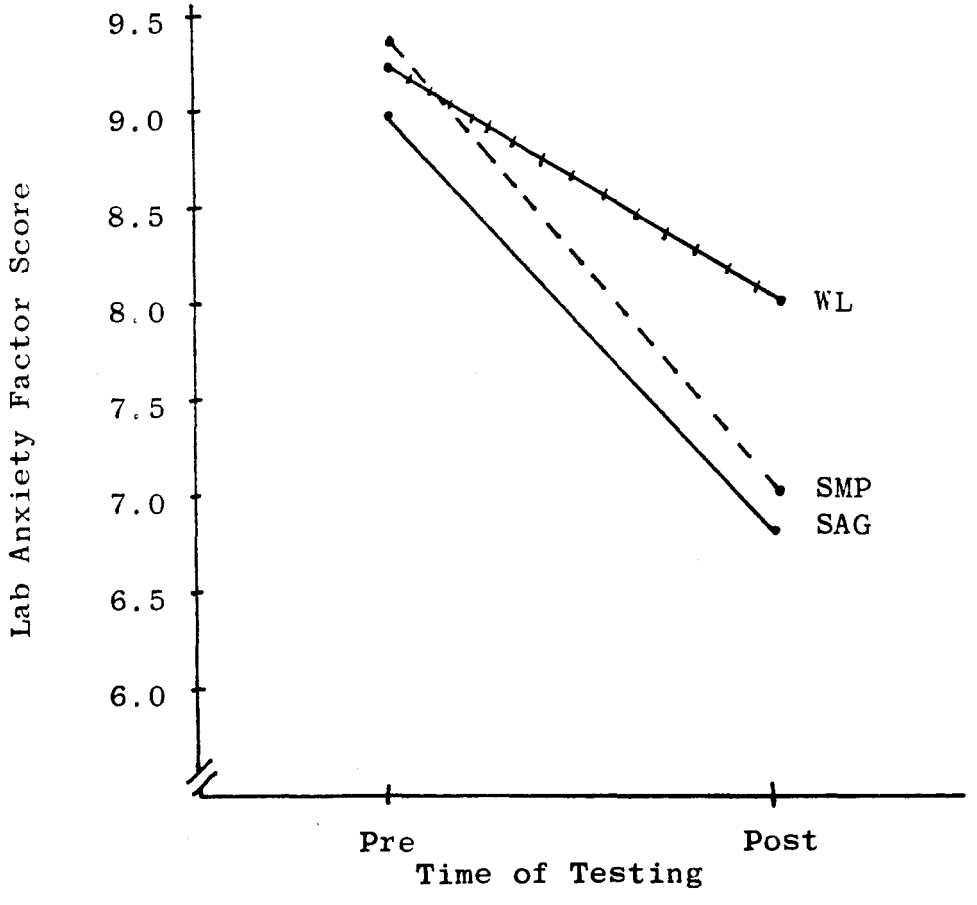
Two-way ANOVAs (groups X time of testing) with repeated measures on the second factor were carried out for each of the four SAQ factors (Lab, Science Study, Observer, and Non-Science Study anxiety) and on the mean of the first three factors (Mean SAQ). One-way ANOVAs were carried out to test for simple effects, and two-way ANOVAs with repeated measures for the SAG and SMP groups to test for differential treatment effectiveness.

SAQ Lab Anxiety Factor. Results are illustrated in Figure 2. There was no significant main effect for group, $F(2,36) = 0.26$, $p > .05$ nor significant interaction of group and time of testing, $F(2,36) = 0.48$, $p > .05$. The main effect for time of testing was significant, $F(1,36) = 14.16$, $p < .01$. The SAG subjects showed a significant decrease in self-reported Lab Anxiety from pre to posttesting, $F(1,12) = 16.56$, $p < .01$, whereas the SMP, $F(1,12) = 3.51$, $p > .05$, and the WL subjects, $F(1,12) = 3.36$, $p > .05$, did not. The two treatment groups did not, however, differ significantly with respect to a decrease in Lab Anxiety, $F(1,24) = 0.03$, $p > .05$. In general as seen in Figure 2, all experimental groups decreased in their levels of Lab Anxiety from pre to posttreatment.

SAQ Science Study Test Anxiety Factor. The main effect for groups was not significant, $F(2,36) = 0.02$, $p > .05$. The main effect for time of testing was significant, $F(1,36) = 35.3$, $p < .01$, as was the interaction

FIGURE 2

SAQ Lab Anxiety Factor



of groups by time of testing, $F(2,36) = 3.63$, $p<.05$. As seen in Figure 3, both the SAG group, $F(1,12) = 18.45$, $p < .001$, and SMP group, $F(1,12) = 20.10$, $p < .001$, showed significant decreases in their self-reported Science Study Test Anxiety whereas the WL group did not change significantly, $F(1,12) = 1.75$, $p > .05$. There was no significant differential treatment effect, $F(1,24) = 0.04$, $p > .05$.

SAQ Observer Anxiety Factor. Results for this factor are illustrated in Figure 4. The main effect for group was not significant, $F(2,36) = 1.11$, $p > .05$. The interaction of group by time of testing approached but did not reach statistical significance, $F(12,36) = 2,81$, $p < .07$. The main effect for time of testing was significant, $F(1,36) = 22.60$, $p < .001$. Whereas the SAG subjects, $F(1,12) = 13.91$, $p < .005$, and SMP subjects, $F(1,12) = 8.03$, $p < .01$, reported significantly less Observer Anxiety from pre to postesting, the WL subjects reported less Observer Anxiety but this was not a significant decrease, $F(1,12) = 2.34$, $p > .05$. There was no differential treatment effect when the SAG and SMP subjects were compared, $F(1,24) = 0.00$, $p > .05$. In general as can be seen in Figure 4, all experimental groups decreased in their levels of Observer Anxiety from pre to posttreatment.

Mean SAQ. The mean for each of the factors Lab, Science Study Test, and Observer Anxiety for each experimental group was generated and the mean of these means was used as MEAN SAQ in a repeated measures ANOVA as for the other SAQ factors. Results for MEAN SAQ are illus-

FIGURE 3

SAQ Science Study Test Anxiety Factor

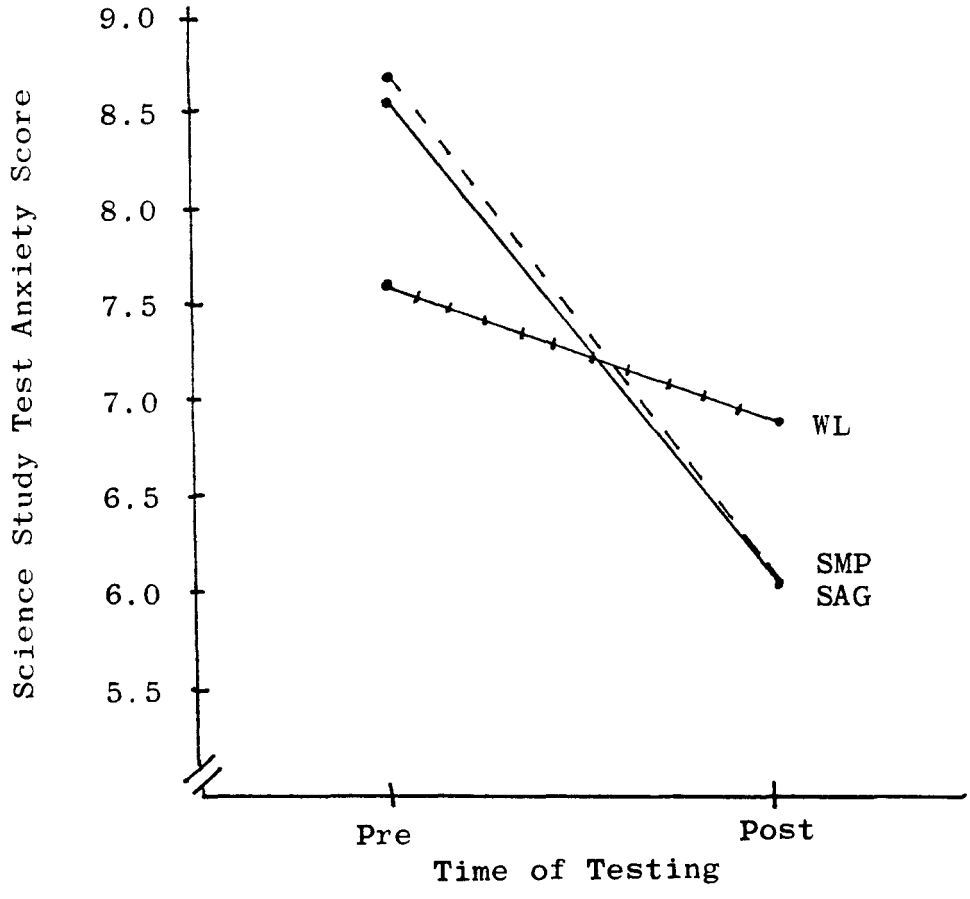
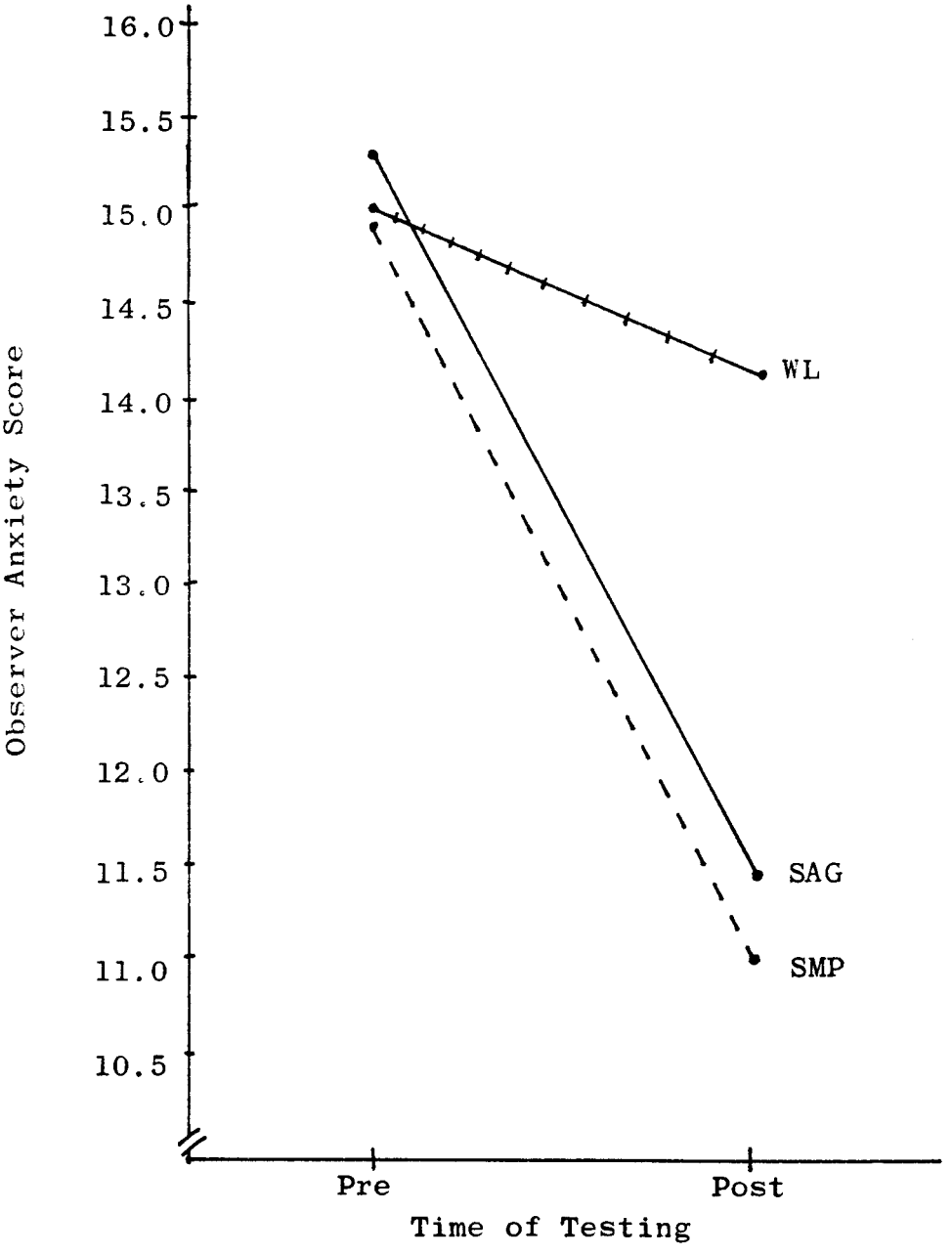


FIGURE 4

SAQ Observer Anxiety Factor



trated in Figure 5 The main effect for time of testing, $F(1,36) = 37.00$, $p<.001$, and the interaction of group by time of testing, $F(2,36) = 3.33$, $p<.05$, were both statisticaly significant. The main effect for group was not significant, $F(2,36) = 0.24$, $p>.05$. The SAG subjects $F(1,12) = 31.63$, $p<.001$, and the SMP subjects, $F(1,12) = 12.17$, $p<.005$, reported significantly less science anxiety as measured by MEAN SAQ from pre to posttesting. The WL subjects also reported less science anxiety but this change was not statistically significant, $F(1,12) = 3.50$, $p>.05$. The changes in reported science anxiety for the SAG and SMP groups did not differ significantly, $F(1,24) = 0.03$, $p>.05$.

SAQ Non-Science Study Test Anxiety Factor. Results for this factor are illustrated in Figure 6. The main effect for time of testing was statistically significant, $F(1,36) = 12.36$, $p<.001$. The main effect for groups, $F(2,36) = 1.49$, $p>.05$, and the interaction of groups by time of testing, $F(2,36) = 0.22$, $p>.05$, were not significant. This decrease was statistically significant for the SAG subjects, $F(1,12) = 12.91$, $p<.005$, but not for the SMP, $F(1,12) = 2.79$, $p>.05$, nor the WL subjects, $F(1,12) = 2.54$, $p>.05$. However, the reported changes in Non-Science Study Test Anxiety for the SAG and SMP subjects from pre to posttreatment did not differ significantly, $F(1,24) = 0.04$, $p>.05$. As seen in Figure 6, all groups reported less anxiety from pre to posttesting regarding their studying for non-science exams.

In summary, the results from the Science Anxiety Questionnaire (SAQ) revealed that both the SAG and SMP groups, as compared to the no-

FIGURE 5

Mean SAQ

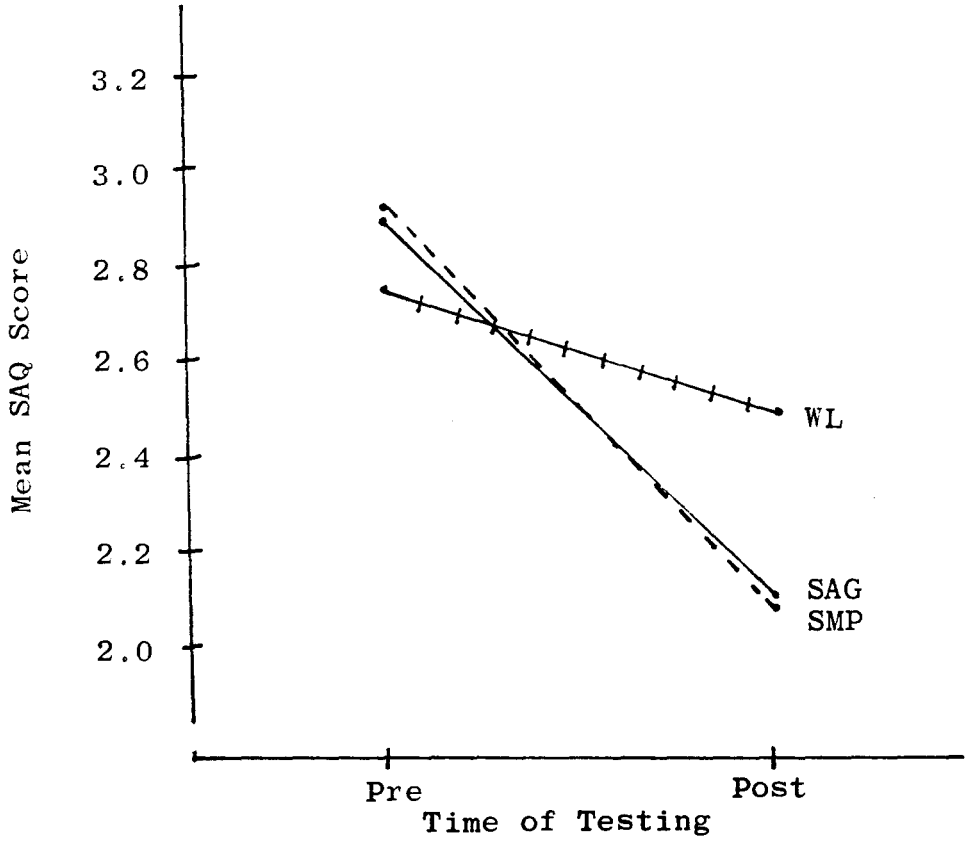
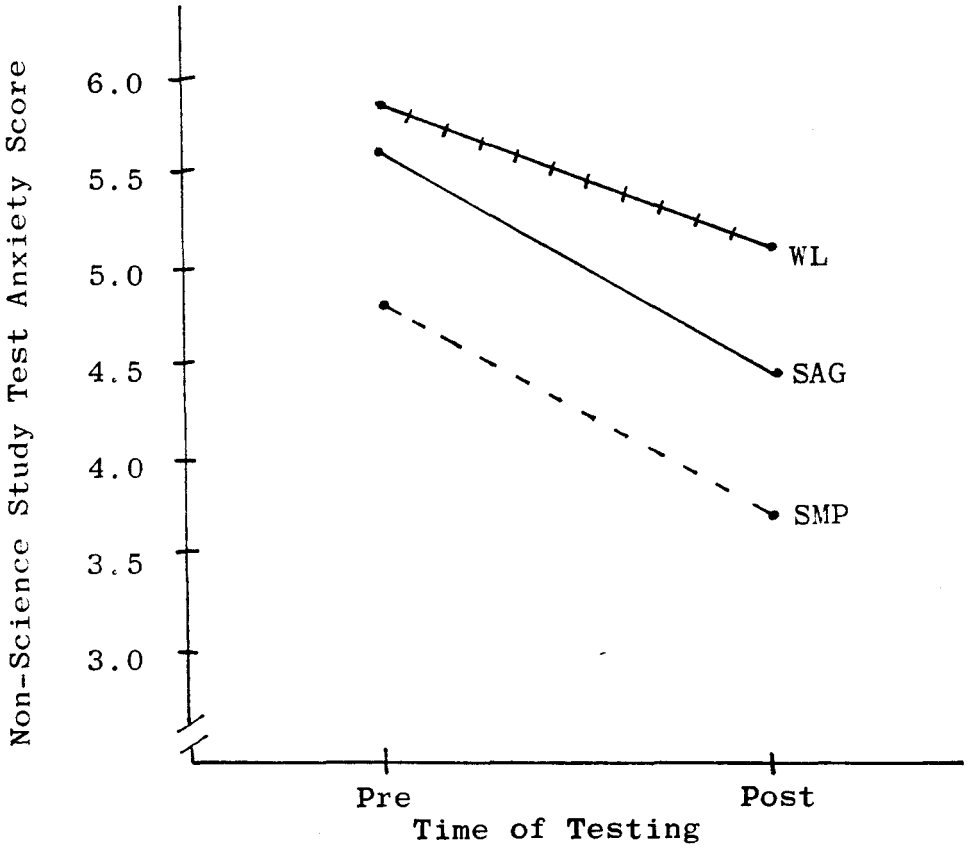


FIGURE 6

SAQ Non-Science Study Test Anxiety Factor



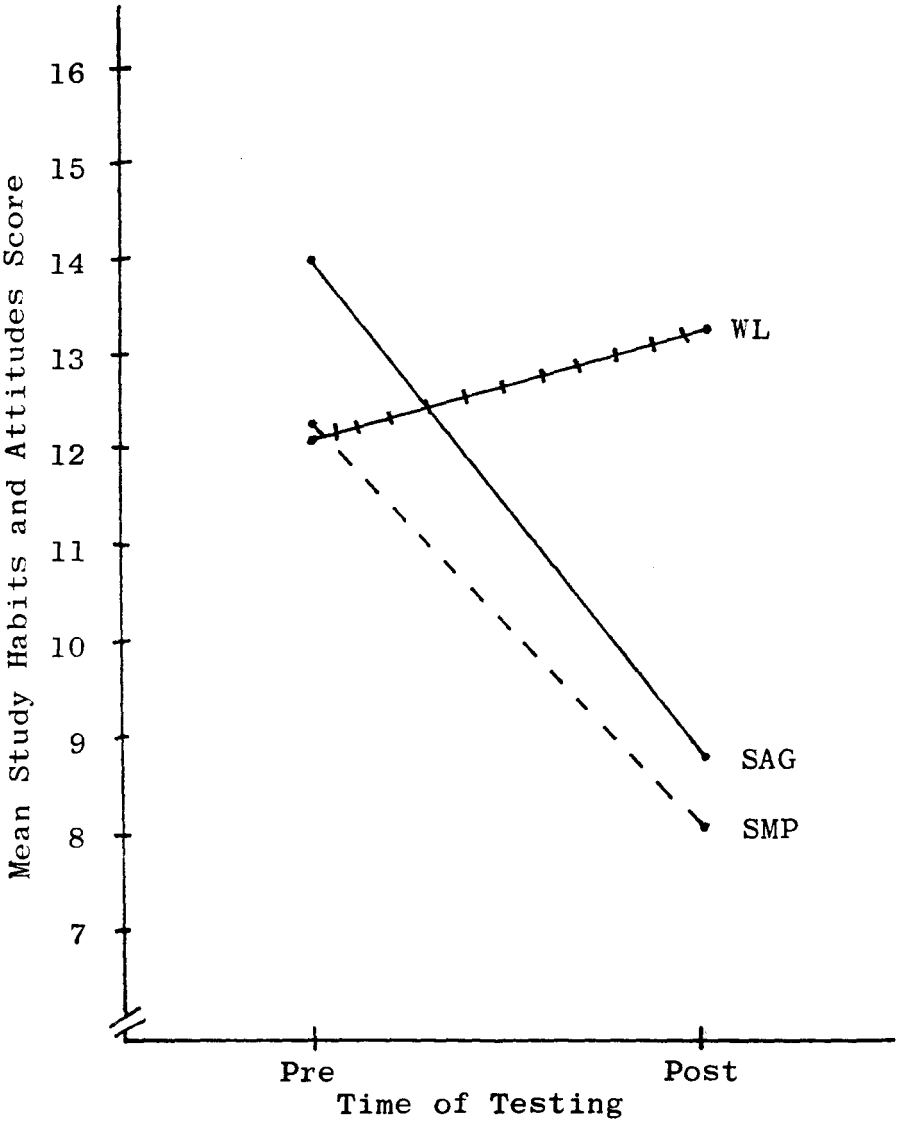
treatment group, reported significant anxiety reduction on a factor labelled Science Study Test Anxiety and nearly significant reduction on the factor labelled Observer Anxiety. The experimental groups did not differ significantly on factors labelled Lab Anxiety and Non-Science Study Test Anxiety. However, there was a trend for greater reduction in anxiety on all factors for the two treatment groups as compared to the no-treatment group, and both treatment groups exhibited significant anxiety reduction as compared to the no-treatment group on a measure of overall science anxiety (MEAN SAQ). The two treatment groups did not differ in their levels of anxiety reduction on any of the SAQ factors.

Study Habits and Attitudes Questionnaire

Results are illustrated in Figure 7. A two-way repeated measures ANOVA revealed a significant main effect for time of testing, $F(1,36) = 11.47$, $p<.005$, and a significant interaction for group by time of testing, $F(2,36) = 5.93$, $p<.01$. The main effect for groups was not significant, $F(2,36) = 0.66$, $p>.05$. As seen in Figure 7, both the SAG subjects, $F(1,12) = 7.11$, $p<.05$, and the SMP subjects, $F(1,12) = 10.29$, $p<.01$, reported less interference in their ability to attend to and concentrate on coursework and study materials from pre to posttreatment. This suggests a decrease in the "cognitive" component of their anxiety. The WL subjects's scores reflected an increase in interference from pre to posttesting, and this increase approached but did not reach statistical significance, $F(1,12) = 3.48$, $p<.10$. The SAG and SMP sujects did not differ significantly in their improved ability to study and concentrate on course materials, $F(1,24) = 0.21, p>.05$.

FIGURE 7

Study Habits and Attitudes Questionnaire



Test Anxiety Scale (TAS)

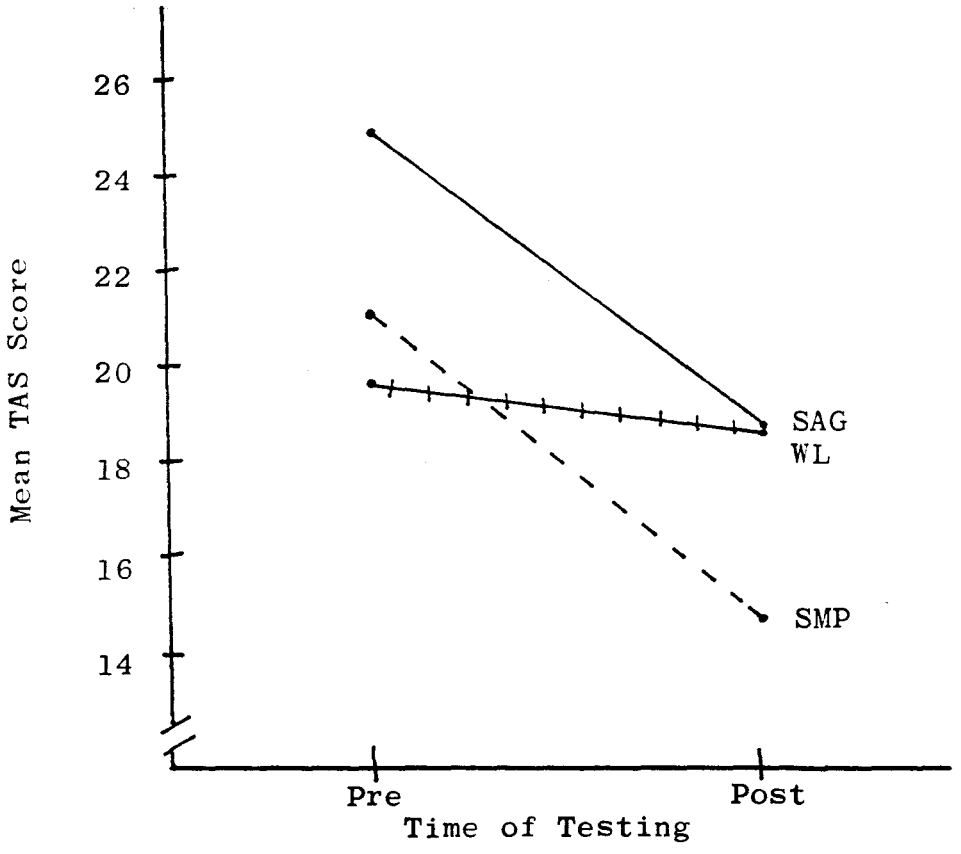
Results for the TAS are illustrated in Figure 8. A two-way repeated measures ANOVA revealed a significant main effect for time of testing, $F(1,35) = 10.51$, $p<.005$. Neither the main effect for groups, $F(2,35) = 1.34$, $p>.05$, nor the interaction of groups by time of testing, $F(1,35) = 1.48$, $p>.05$, were significant. As seen in Figure 8, all groups reported less test anxiety from pre to posttesting. This decrease was significant for the SMP subjects, $F(1,12) = 6.77$, $p<.05$, whereas this decrease approached but did not reach significance for the SAG subjects, $F(1,12) = 3.57$, $p<.10$. This decrease was not significant for the WL subjects, $F(1,12) = 0.76$, $p>.05$. The SAG and SMP groups did not differ significantly regarding their decreases in test anxiety from pre to posttreatment, $F(1,23) = 0.00$, $p>.05$.

Endler S-R Inventory of Anxiousness, Modified

The S-R Inventory, as modified for this study, asked subjects to describe three science-related situations which they found personally stressful or anxiety provoking. At pre and at posttesting, subjects rated themselves regarding subjectively experienced physiological anxiety in response to each of the scenes they had described at pretesting. For each subject, scores on each of the three personal situations were combined to form one mean score for the inventory at pre and at postesting, and these results are illustrated in Figure 9. These means were analyzed in a two way ANOVA (group X time of testing) with repeated measures on the last factor. The main effect for time of testing,

FIGURE 8

Test Anxiety Scale (TAS)



$F(1,35) = 41.05$, $p<.001$, and the interaction of group by time of testing, $F(2,35) = 3.58$, $p<.05$, were both statistically significant. The main effect for group was not significant, $F(2,35) = 0.75$, $p>.05$. As seen in Figure 9, the SAG, $F(1,12) = 16.62$, $p<.002$, the SMP, $F(1,12) = 18.39$, $p<.002$, and the WL subjects, $F(1,11) = 8.83$, $p<.05$, all reported significantly less subjectively experienced anxiety from pre to post-testing in response to their personalized science situations. The results of the simple effect analyses and the significant interaction of group by time of testing revealed that, though all groups reported less physiological anxiety, the two treatment groups evidenced greater anxiety reduction in this area than did the no-treatment comparison group. The improvements for the SAG and SMP subjects did not differ significantly, $F(1,24) = 0.34$, $p>.05$.

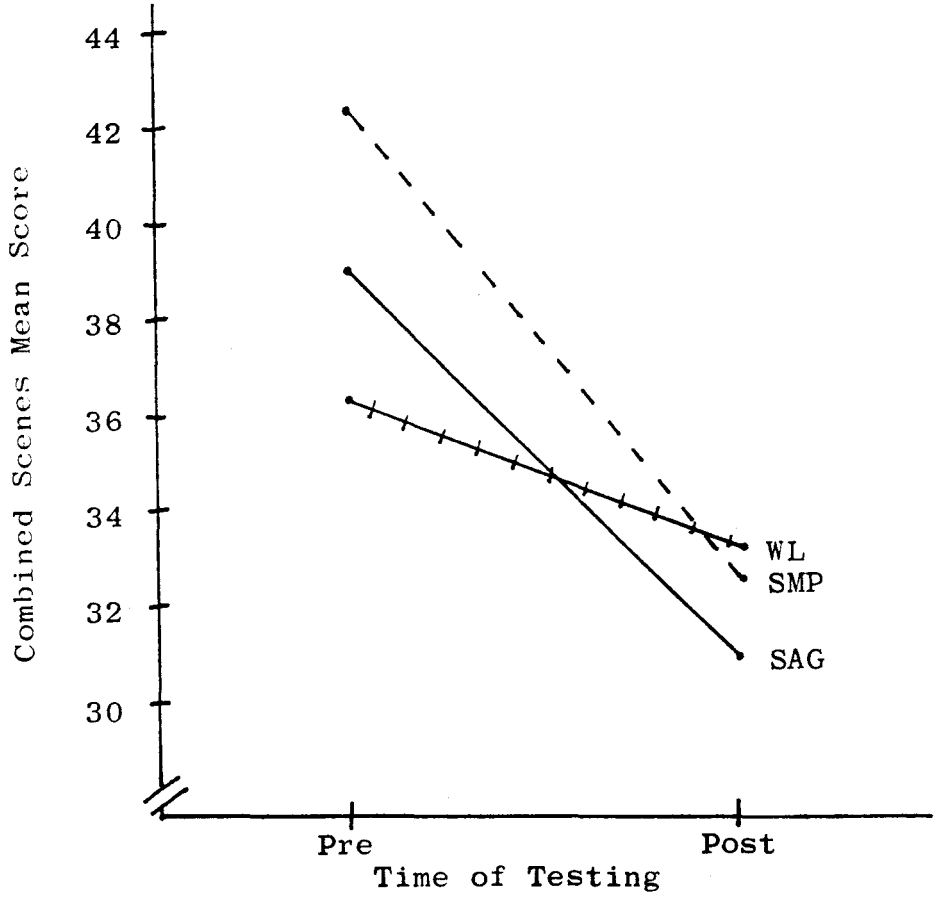
Post Treatment Evaluation Questionnaire

Part I: Perceptions of Change

All subjects were asked to rate themselves regarding their perception of changes in science-related and general anxieties and academic ability (see Appendix E). For each subject, items related to perceived change regarding science-related anxieties and academic ability (a,b,g,i,j) were combined and an average score generated. Items related to perceived change regarding generalized anxieties and academic ability (c,d,e,f,h) were treated likewise. Means and standard deviations for each experimental group for each type of perceived change are listed in Table 5. Two way ANOVAs (group X type of perceived change) revealed a

FIGURE 9

Endler S-R Inventory of Anxiousness (Modified)



statistically significant difference between groups on both the science-related, $F(2,31) = 11.06$, $p<.001$, and general areas of anxiety and academic ability, $F(2,31) = 8.11$, $p<.002$. A series of two-way ANOVAs were carried out to test planned pair-wise comparisons of the experimental groups on each of these areas of change. The SAG and SMP groups did not differ significantly from each other regarding the amount of perceived change in either the science-related, $F(1,22) = 1.03$, $p>.05$, or general areas, $F(1,22) = 0.93$, $p>.05$. However, the WL group perceived significantly less improvement than both the SAG and SMP groups for the science-related areas, $F(1,21) = 14.83$, $p<.001$ and $F(1,21) = 11.58$, $p<.005$, and for the more general areas of anxiety and academic ability, $F(1,19) = 15.81$, $p<.005$ and $F(1,19) = 14.33$, $p<.005$. A two-way ANOVA (group X type of perceived of change) with repeated measures on the last factor was carried out to test for within group differences between perceived change on science-related as compared to general anxieties and academic ability. The interaction of group by type of perceived change was not significant, $F(2,31) = 0.67$, $p>.05$, and indicated that within group differences for the two types of perceived change were not significant.

In summary, the results of Part I indicated that the two treatment groups perceived greater improvement in both science-related and general anxieties and academic ability than did the WL group, but that the treatment groups did not differ from each other in this regard. In addition, perceived changes in science related versus general anxieties and academic ability did not differ within any of the groups. Using the

rating scale of Part I, it should be noted that, overall, the SAG and SMP groups were "somewhat" improved regarding science related and more generalized anxieties and academic ability whereas that WL group improved "slightly" in each of these areas.

Part II: Satisfaction With Treatment

Means and standard deviations for each of the items in this section are presented in Table 6. Only the SAG and SMP subjects had been asked to complete this section as it only pertained to the treatments received. Both treatment groups agreed strongly that they would recommend their respective programs to a friend and the groups did not differ in this regard, $F(1,24) = 0.65$, $p>.05$. The treatment groups did not differ in their agreement with statements that their respective programs satisfied their expectations, $F(1,24) = 0.32$, $p>.05$, and were reasonable approaches to reducing science anxiety, $F(1,24) = 0.23$, $p>.05$. Both treatment groups disagreed with statements that their respective programs were too automated or that they would have wanted more opportunity to talk with others during treatment sessions. Both treatment groups did not agree with a statement that they would have wanted more opportunity to talk to either the group leaders or the technician. Overall, the treatment group subjects did not rate in directions indicative of a desire to alter the components of their respective programs. In general, the results of these ratings indicate that the SAG and SMP subjects were satisfied with the treatments they each received.

TABLE 5

Posttreatment Evaluation Questionnaire, Part I: Perceptions of Change

		SAG	SMP	WL
Perceived Improvement for Anxiety & Academic Ability				
	Science Related			
	Mean	[a]7.02	7.36	5.60
	SD	0.70	0.98	1.06
	General			
	Mean	6.75	7.13	5.64
	SD	0.84	1.06	0.69

[a]Rating Scale:

WORSE		BETTER
1	completely/extremely	9
2	much	8
3	somewhat	7
4	slightly	6
5	NO CHANGE	5

TABLE 6

Post-Treatment Evaluation Questionnaire, Part II: Satisfaction with Treatment

Item	SAG M	SAG SD	SMP M	SMP SD
k) talk more with group leaders/technician	5.23[a]	1.96	4.92	2.25
l) listening to tapes alone	3.77	1.96	7.38	1.66
m) recommend program to friend	8.38	0.65	8.15	0.80
n) comfortable in groups	6.92	1.50	6.69	2.13
o) program satisfied expectations	7.23	1.09	7.54	1.61
p) more opportunity to talk with others	2.31	1.38	4.00	2.31
q) program too automated	3.31	1.60	3.23	2.17
r) do things best on own	5.46	1.51	6.77	2.12
s) reasonable approach to reduce science anxiety	7.23	1.48	7.54	1.81

[a]Rating Scale:

DISAGREE		AGREE
1	completely	9
2	strongly	8
3	somewhat	7
4	slightly	6
5	neutral	5

Part III: Treatment Program Components

The third part of the Posttreatment Evaluation Questionnaire asked the SAG and SMP subjects to rate the various components of their respective programs for how important these were in contributing to their improvement (if any). Means and standard deviations for each item of Part III are presented in Table 7. It was expected that since the SMP program was more automated, subjects in this treatment would have found the technician who changed audiotapes and answered questions in a perfunctory manner to have been less important to perceived improvements than the group leaders would have been for the SAG subjects. As expected, the SMP group's rating for the importance of the technician was significantly lower than the SAG group's rating for the importance of the group leaders, $F(1,24) = 4.36$, $p<.05$. The SMP group rated the training in muscle relaxation as more important to their improvement than did the SAG group, but this difference was not significant, $F(1,24) = 2.00$, $p>.05$. Comparing ratings for the various components within each group revealed that the SAG group rated the group experience and the group leaders as having been very important to their improvement and learning word problem solving skills to have been only slightly important. The SMP group rated the opportunity to deal with anxiety on their own, deep breathing, and training in mental imagery as being very important in contributing to their improvement.

TABLE 7

Post-Treatment Evaluation Questionnaire, Part III: Treatment Program Components

Science Anxiety Group

Item	M	SD
a) word problem solving skills	2.31[a]	0.85
b) group experience	4.31	0.63
c) coping self-statements	3.77	0.73
d) "Negative Cycle" homework	3.38	0.51
e) muscle tensing and relaxing	3.15	1.28
f) group leaders	4.31	0.63
g) hiearchy of science scenes	3.08	0.76

Stress Management Group

Item	M	SD
a) deep breathing	4.15	0.99
b) dealing with anxiety alone	4.31	0.63
c) mental imagery training	4.08	0.86
d) "homework" practice	3.62	1.19
e) muscle tensing and relaxing	3.85	1.21
f) the technician	3.69	0.85
g) 8-10 minute practice periods	3.38	1.19

[a]Rating Scale: 1=not at all important
2=slightly important
3=somewhat important
4=very important
5=extremely important

Grade Point Average

The performance measure utilized in the present study was the science and overall grade point average for the semester in which the subject had participated in the study. Grade point averages (based on a four point scale) and standard deviations for each group are presented in Table 8. Grade point averages were analyzed with one-way ANOVAs for both science and overall semester coursework. The experimental groups did not differ significantly regarding either semester science grade point average, $F(2,26) = 0.57$, $p>.05$, nor overall semester grade point average, $F(2,32) = 0.43$, $p>.05$.

Statistical Power of Current Analyses

Of the nine dependent measures used for repeated measures analyses in this study, five evidenced significant groups X time of testing interactions thereby justifying simple effects analyses. On three of these five dependent measures, the two treatment groups evidenced improvements at equivalent levels of statistical significance. On the other two of these five dependent measures, the SAG group evidenced greater statistically significant improvement on one measure and the reverse was true for the other measure. For three (SAQ factors) of the four dependent measures which did not evidence statistically significant group X time of testing interactions, simple effects revealed greater statistical significance for the SAG group as compared to the SMP group's improvement. The reverse was true for the remaining dependent measure (TAS). Given these "trends" (though quite weak), others might

TABLE 8

Posttreatment Grade Point Averages

	SAG	SMP	WL
Semester Sciences			
Mean	2.17	[a]2.47	[b]2.66
SD	1.28	0.85	0.77
Overall Semester			
Mean	2.83	2.99	3.08
SD	0.70	0.71	0.68

[a] N = 9

[b] N = 8

argue that there is some evidence that the SAG group demonstrated greater improvement than the SMP group on the Science Anxiety Questionnaire whereas the SMP group demonstrated greater improvement than the SAG group on the Test Anxiety Scale.

An important component of program evaluation that is often overlooked is the statistical power of the study and its analyses to find real differences between treatments or to not find real differences when such exist (Posavac & Carey, 1980). This is a particularly relevant question for the present study because of the general lack of differential effectiveness between the SAG and SMP treatments. Using the MEAN SAQ scores for the two treatment groups and two standardized measures employed in the present study (TAS and the STAI-Trait), the question was asked, "What was the power of the present study to detect real differences in effectiveness between the SAG and SMP treatments if indeed they existed?".

For the MEAN SAQ, clinically significant difference in amount of improvement in science anxiety was determined to be one scaled point. Since the average change for each treatment group was about one scaled point, this clinically significant difference would represent a change for either group of two scaled points (e.g.: bothered nowadays "a fair amount" versus bothered nowadays "not at all"). The power to detect such a treatment difference in the present study with alpha set at .05 was 0.9. What was the power of the current study to detect a treatment difference of one treatment group improving 100% more than the average

change for the two treatment groups in the present study on the TAS? The power of the present study to do so was approximately 0.65 with alpha set at .05. For the STAI-Trait measure, a clinically significant difference between the amount of change for the two treatment groups was defined as the average distance needed to return the treatment groups to the average mean of the STAI-Trait normative sample. Thus, if one treatment group returned to the mean of the normative sample and the other did not, this would be of clinical significance regarding the effectiveness of the two treatments. The power of the present study to detect such a difference was 0.7 at the .05 level of statistical significance. In general, the power of the present study to detect clinically significant differences in improvement between the two treatment groups was quite adequate and further supports the conclusion that there was little difference between the two treatments for effectively reducing science, test, or trait anxiety.

Summary of Results

Although a majority of no-treatment subjects were not recruited in a similar fashion as the treatment group subjects, pretreatment analyses revealed that the groups did not differ significantly on any of the pretreatment measures and were therefore comparable.

Regarding specific hypotheses, the following statements can be made: Hypotheses 1(a,b,e) that the SAG and SMP groups as compared to the WL group would evidence improvement in trait anxiety, science anxiety, and ability to study and concentrate on coursework, was supported.

Hypothesis 1(c) that the SAG and SMP groups as compared to the WL group would evidence improvement in test anxiety received mixed support. The treatment groups, as compared to the WL group, reported significant anxiety reduction in science testing situations (SAQ Science Study Test Anxiety factor). However, on the general measure of test anxiety (TAS) and on the SAQ factor labelled Non-Science Study Test Anxiety, the experimental groups did not differ significantly in their levels of anxiety reduction. Hypothesis 1(d), that the SAG and SMP groups as compared to the WL group would evidence improvement on indices of physiological anxiety received equivocal support. The self-report measure of physiological concommitants to anxiety (modified Endler S-R) indicated that all experimental groups improved in this regard whereas the direct measure of physiological reactivity (frontalis EMG) to science and other scenes indicated that none of the experimental groups demonstrated any improvement.

Hypotheses 2(a-e), that the SAG and SMP groups would not differ from one another regarding improvements in each area, were supported. Hypothesis 3, that the SAG and SMP groups would have a higher posttreatment grade point average than the WL group for semester science and overall semester coursework, was not supported. Hypothesis 4(a), that the SAG and SMP groups as compared to the WL group would perceive themselves as having improved in their science and general anxiety and academic ability, was supported. Hypothesis 4(b), that the SAG and SMP groups would not differ from each other regarding their perceptions of

improvement in science or general anxiety and academic ability, was suppported. Hypothesis 4(c), that perceptions within each group regarding changes in skills (academic and stress management) used to cope with science versus general situations would not differ, was supported.

CHAPTER V

DISCUSSION

The purpose of the present study was to compare the effectiveness of two therapy programs for the treatment of college students who identified themselves as science anxious and requested treatment at the Loyola Counseling Center. One of the treatment programs was a multi-component group therapy program composed of study skills training, systematic desensitization, and cognitive modification and targeted to reduce science anxiety. The other treatment was an automated progressive muscle relaxation program administered in an individual format and targeted to reduce anxiety experienced across a wide variety of situations. A group of college students who did not receive treatment and had comparable pretreatment levels of anxiety as those of the treatment groups served as controls.

Self-report and physiological measures of anxiety and a performance measure were obtained to determine the effectiveness of the treatments. Self-reports and the physiological measure (EMG frontalis muscle tension) were analyzed with repeated measures ANOVA's. The performance measure (grade point average) and data from a treatment evaluation questionnaire were analyzed with one-way ANOVA's. The following discussion will examine, respectively, results from self-report measures, physio-

logical measures, and the performance measure. In addition, the economics of providing each treatment will be briefly examined. A conceptual model that incorporates the results of the present study is then presented. Finally, conclusions are drawn, and the limitations of the present study and recommendations for future research are specified.

Self-Reports

Students who presented themselves for treatment in the Science Anxiety Clinic, in addition to being science anxious, were also trait and test anxious. Consistent with predictions, the results indicated that both the Science Anxiety Group and the Stress Management Program led to reduction of anxiety in many of these areas as compared to the no-treatment group. Treatment subjects' levels of trait anxiety were reduced; whereas they were in the 70th percentile at pretreatment, at posttreatment they were in the 50th percentile of the normative sample. On an overall measure of science anxiety, the treatment groups exhibited significant pre to posttreatment anxiety reduction as compared to the no-treatment group. More specifically, treatment subjects' observer anxiety and anxiety in science testing situations were reduced. Results from the Test Anxiety Scale revealed that the reduction in test anxiety for the treatment groups was not statistically different from the reduction in test anxiety for the no-treatment group. However, the clinical significance of the treatment groups' test anxiety reduction cannot be ignored. At pretreatment, levels of test anxiety for the treatment groups placed them in the normative sample's 75th percentile. At post-

treatment, the treatment groups' test anxiety level was lower than that of the normative sample's 50th percentile. In addition, treatment group subjects' study habits and attitudes were improved as compared to the no-treatment group subjects. Importantly, the two treatment groups did not differ from one another in the degree to which anxiety was reduced and study habits and attitudes improved. In general, the no-treatment comparison group subjects did not evidence any improvement in their levels of anxiety or study habits and attitudes.

Results from the Expectancy Questionnaire indicated that subjects in each treatment expected improvement in science anxiety and had given comparable credibility ratings to their respective programs for helping them do so. Both treatments had been presented to clients with active coping rationales. Following treatment, subjects in the SAG and SMP treatment groups reported comparable improvements in their ability to cope with science-related and general academic, anxiety-provoking situations. The treatment subjects' perceptions of improved abilities in these areas were also significantly greater than the comparison group subjects' perceptions of improvement.

The results from self report measures indicated that a multi-component treatment program of study skills, cognitive modification, and systematic desensitization in a group format and a progressive muscle relaxation program administered in an individual format were comparably effective for this population and more effective than if subjects had received no treatment at all. Treatment subjects reported and perceived

themselves to have made improvements in their ability to deal with science anxiety and general academic, anxiety-provoking situations.

Physiological Measures

Given the variability of technical and procedural characteristics in studies utilizing EMG as an assessment technique (Simkins, 1982), it is not surprising that despite subject selection from a very similar population and the use of the same descriptive imaginal scenes, Alvaro's (1979) and the present study's EMG results are at variance. Whereas Alvaro used a visual meter (typically a peak to peak measure of muscle activity) the present study used a digital display monitor (averaged muscle activity over a specified time period). The former type of monitoring may be more subject to experimenter bias.

In addition, whereas the majority of subjects in the present study and in Alvaro's (1979) study were female (67% and 63% respectively), the experimenter in the present study was male and the experimenter in Alvaro's study was female. Recent research regarding sex differences and EMG responsivity (Arnone, 1984) suggests that female subjects evidence less reduction of frontalis muscle EMG when a male experimenter is present as compared to a female experimenter. It may have been that in the present study the presence of the male experimenter acted to negate the effects of any objective physiological anxiety reduction as measured by frontalis EMG.

In the present study it had been assumed that since these students were "science anxious", asking them to visualize science scenes would

induce anxiety; much the same as in Anxiety Management and other desensitization techniques in which subjects are asked to visualize anxiety-provoking scenes. Although a manipulation check revealed that science anxious subjects had higher EMG levels in response to science as compared to non-science and neutral scenes, asking a subject to visualize such scenes may not necessarily have been "stressful". This issue is particularly relevant given the findings and suggestions of Burish, Hendrix, and Frost (1981) that a floor effect may often be operating when relaxation procedures are provided to subjects under non-threatening, benign conditions making it difficult to demonstrate reliable reduction in physiological arousal. Others who induced even greater levels of stress in subjects (e.g. an actual exam situation; Houston, 1982) did not find reductions in measures of physiological anxiety following treatment though self-reports indicated anxiety reductions occurred.

On a self-report measure of physiological anxiety in response to self-generated science scenes (modified Endler S-R Inventory of Anxiousness), subjects in all three experimental groups evidenced significant reductions in autonomic anxiety. Treatment subjects' results on this measure did indicate that they had greater decreases in self-reported autonomic anxiety than the comparison group subjects. The modified Endler S-R Inventory asked subjects to rate themselves on several indices of physiological arousal. The frontalis EMG measure is only one index of physiological arousal. Given the often low correspondence between one measure of physiological arousal and another (Hodges, 1976),

it is not surprising that the results of the Endler and frontalis EMG measures are at variance.

The discrepancy between the objective EMG and self-report measures of physiological anxiety can be understood given the findings that high test (Holroyd & Appel, 1980) and high trait (Hodges, 1976) anxious persons overestimate their physiological arousal as compared to low test and low trait anxious persons. At pretreatment, subjects in the present study were high trait and test anxious individuals. At posttreatment, treatment subjects were no longer highly trait and test anxious. Given no change in objective physiological arousal but a corresponding decrease in self-reported trait and test anxiety, treatment subjects' self-reports of physiological anxiety would be expected to decrease as was found in the present study.

The discrepancy between the EMG and Endler results may also be the consequence of objectively measuring anxiety in response to one set of stimuli and asking for self ratings of anxiety in response to a different set of stimuli. Future research might ask subjects to fill out the Endler in response to the scenes described on the EMG tape or monitor EMG frontalis muscle levels in response to the self-generated science scenes. Such a methodological improvement would more accurately assess the "stressfulness" of visualizing science scenes and possibly lead to less discrepancy between the objective measure and self-report of physiological anxiety. However, recent reviews of the literature have suggested that the evidence for a relationship between EMG frontalis muscle

tension levels and subjective reports of anxiety is equivocal (Qualls & Sheehan, 1981; Simkins, 1982). Some have found no clear relationship between frontalis muscle relaxation and subjective self-report measures of anxiety (e.g. Alexander, 1975; Counts, Hollandsworth, & Alcorn, 1978; Coursey, 1975; Mathews & Gelder, 1969; Rupert, Dobbins, & Mathew, 1981; Sime & DeGood, 1977) while others' results provide evidence for such a relationship (e.g. Canter, Kondo, & Knott, 1975; Hiebert & Fitzsimmons, 1981; Hughes & Harris, 1982; Reinking, 1977).

In summary, it is suggested that the results from EMG frontalis muscle tension did not support other results of anxiety reduction for the treatment groups due to: (a) the possible confound of sex of subject/experimenter, (b) potential for a "floor effect" to have existed because of the nature of the stimuli, and/or (c) the overall equivocal nature of the relationship between EMG as a measure of anxiety and subjective self-reports of anxiety.

Academic Achievement

The finding that treatment group subjects did not have higher GPA's than the comparison group for the semester of participation is disappointing. However, they are in accord with results from Alvaro's (1979) study and seem to reflect the low frequency with which interventions lead to significant improvement in GPA and course grades when compared to controls (Kirschenbaum & Perri, 1982). Because grade point average is influenced by a large number of factors (Goldman & Slaughter, 1976) its sensitivity as a measure of treatment effectiveness is

suspect. Perhaps a more effective measure of academic improvement in response to treatment would be to use a less broadly defined academic performance measure such as a science test or lab performance.

In addition, obtaining follow-up data regarding academic performance might have been helpful. Denney and Rupert (1977) found that treatments with an active coping rationale did not lead to significant improvements in GPA at the end of the semester during which subjects participated in treatment, but did so in later semesters following the study. For the present study, it may be that there is a lapse between the acquisition of an active coping skill and its affect upon academic performance as compared to improvements based on self-report. Thus, the complete effectiveness of treatment might not accrue for subjects until sometime in the future. The equivocal nature of the relationship between self-report measures and objective measures of achievement/ performance has also been reported in the literature. Hansford & Hattie (1982) conducted a meta-analysis on studies investigating the relationship between these types of measures and found the mean correlation between them to be only .21, that between self-measures and science achievement to be .24, and that between "self-concept of ability" and achievement/performance to be 0.42.

Of interest is the finding that the SAG program which incorporated study skills training did not lead to significantly higher academic performance as compared to the SMP treatment or no-treatment control groups which did not receive study skills training. In a review of studies

which have attempted to improve academic competence in adults, Kirschenbaum and Perri (1982) conclude that programs which incorporate study skills training should be more effective than intervention programs which do not. The results of the present study do not support their contention. However, because of the post-test only use of GPA in the current study it is possible that the non-significant posttreatment differences among the groups regarding GPA were due to differential pretreatment study skill abilities. It may be that students who are deficient in specific study skills would benefit from the study skills training offered in the SAG program and not do as well if assigned to the SMP treatment. Future research regarding improvement of academic performance in science situations should therefore attempt to more thoroughly assess study skill abilities prior to treatment assignment.

Economics

Costs were assessed with regard to the time needed by Counseling Center staff to provide each treatment as well as the time needed by treatment subjects to fully participate in their respective treatments. This included time needed by SAG group leaders, SMP technician, supervision of SAG therapists, session time for clients, and time required for treatment related "homework". The staff time needed to provide SAG treatment to thirteen clients in three groups over the course of two semesters was calculated to be 142 total staff hours or 47 staff hours per group (Appendix I). The staff time needed to provide SMP treatment to thirteen clients over the course of two semesters was calculated to

be 21.7 hours (Appendix J). Staff time per treated SAG client was 10.9 hours whereas staff time per treated SMP client was 1.7 hours. If all treatment clients had completed treatment, the staff time per SAG client would have been 7.5 hours whereas the staff time per SMP client would have remained 1.7 hours. Even if we assume completion of SAG treatment at a ratio of ten clients per group, the staff time per SAG client would still be almost three times the staff time per client ratio of SMP. What is the amount of time needed for clients to fully participate in the SAG or SMP programs? The total time needed by a client to fully participate in the SAG or SMP program was calculated to be 26.5 hours for the seven week SAG program and 20.6 hours for the seven week SMP program. This difference can be considered insignificant given the variability of actual time spent by clients in their respective programs.

The single component SMP program was more cost-efficient than the more complex, multi-component SAG program. This conclusion is based on the following: (a) SAG required much more staff time than the SMP to provide treatment to equivalent numbers of clients, (b) drop-out rates for the two treatments were equivalent, (c) both treatments led to comparable anxiety reduction, and (d) time needed by clients to fully participate in either SAG or SMP was comparable.

It may be that the SAG program, composed of cognitive modification, systematic desensitization, and study skills training was not more effective than the single component SMP relaxation program because of

the greater complexity of the SAG program. In a review of the literature regarding self-control intervention procedures for test anxiety, Denney (1980) suggested that the relative complexity of cognitive restructuring techniques may exceed clients' capacities to implement them effectively as compared to other self-control procedures which rely exclusively upon relaxation. Future research regarding the treatment of science anxiety might assess the relative difficulty clients have in implementing the treatment techniques of the SAG program versus those of the SMP program. Long-term follow-up would be warranted given that arousal generated by exercising difficult control would attenuate over time as persons become more familiar, experienced, and confident in their ability to implement the intervention procedures (Soloman, Holmes, & McCaul, 1980).

The simplicity/complexity of the treatment programs in the present study is confounded by the fact that the more complex SAG treatment was a group therapy whereas the simpler SMP treatment was administered in an individual format. Future research regarding treatment interventions for science anxiety might therefore investigate the relative impact of administering the simpler SMP program in both a group and individual format as well as administering the more complex SAG program in both group and individual formats. Such research may be particularly enlightening given the posttreatment evaluation ratings by subjects in both the SMP and SAG treatments which indicated that the individual and group aspects of their respective programs were very important to their achieving anxiety reduction.

Conceptual Model

Statements regarding reductions in anxiety and improvements in study habits due to the treatments in the present study are based on self-report measures. Clients who received treatment have told us that they now feel better and believe themselves to be better at coping with science-related and general academic, anxiety-provoking situations. As such, conclusions based on these results reflect what treatment clients, as compared to the no-treatment group subjects, perceived and believed about themselves over the course of treatment. Given that the no-treatment comparison group subjects were not all recruited in the same manner as the treatment group subjects and that statements regarding treatment effectiveness are based on self-reports, the possible operation of various placebo factors and demand characteristics must first be considered.

Although pretreatment levels of anxiety did not differ among the groups, nearly half of the subjects who were in the no-treatment comparison group had not actively sought treatment for their science anxiety. This lack of motivation may have limited the amount of change to be expected for the no-treatment group. Perhaps subjects who had sought treatment for their science anxiety but not received it would have improved over time simply because they were motivated to do so. However, Alvaro (1979) used control subjects drawn from a similar population as the treatment subjects in the present study and she did not find significant improvements over time for these "motivated" control subjects. This would argue against the possibility that the differences in

improvement for the treatment subjects in the present study were due solely to motivation to change rather than to the treatments themselves.

The no-treatment comparison group did not control for the possible demand characteristics of being presented with an active coping rationale for improvement. Both the SAG and SMP treatments were presented with active coping rationales, and, prior to treatment, subjects in both the SAG and SMP treatments stated that they would get better by participating in their respective treatments. After treatment, subjects in both treatments stated that they were better. It is plausible that these results were due to demand characteristics generated by an active coping rationale. However, the fact that treatment group subjects did not exhibit improvement on all self-report measures as compared to controls argues against the operation of demand characteristics. That treatment group subjects could have selectively exhibited improvements based on demand characteristics is unlikely. However, it may have been that some self-report measures were simply more susceptible to demand characteristics than others. Therefore, the operation of demand characteristics can not be entirely ruled out.

Clients had sought treatment because they perceived themselves to be unable to adequately cope with science situations. Assessment revealed that these clients were also anxious in a variety of academic situations. Their anxiety is the undesireable effect of the individual's belief that one's coping resources are inadequate. What the client lacks is an adequate coping skill (any class of cognitive or overt

behavior patterns) that would deal with a problematic situation (Goldfried, 1980). In the present study this would be the client's perceptions of anxiety in response to being unable to cope effectively with science-related and general academic situations. The treatment subjects of the present study are seen as active problem solvers who sought treatment to reduce their anxiety.

The Science Anxiety Group was targeted to reduce anxiety experienced in science-related situations whereas the Stress Management Program was targeted to reduce anxiety experienced in a wide variety of situations. Both treatment approaches were comparably effective in reducing clients' specific anxiety reactions in science situations and in reducing their propensity to respond with increases in anxiety to a variety of situations (i.e. trait anxiety). The treatments produced positive changes in treatment subjects' self-perceptions of their ability to cope with science-related and other situations. Despite the difference in focus, technique, and format of the two treatments, they each produced comparable changes in clients' self-perceptions.

Both treatments were presented to students with active coping rationales which emphasized the client's active participation in the acquisition of a skill which would help them cope with their anxiety. In the present study, giving treatment subjects an active coping rationale and credible treatment procedure led to highly positive expectations for anxiety reduction in science-related and other situations. At the end of treatment, clients reported and perceived themselves as having

made improvements in their science-related and general anxieties as well as in their academic abilities. In other words, treatment subjects' self-perceptions of ability to cope with anxiety-provoking situations had been changed as a result of being in a treatment program with an active coping rationale. How might these cognitive changes have come about?

As Goldfried (1977) has argued, the effective ingredient in traditional behavioral treatments of anxiety is most likely the subject's acquisition of a coping skill which gives the sense of control over anxiety that was previously perceived as debilitating. Results from other studies (e.g. Denney & Rupert, 1977) suggest as well that the skills and techniques used to overcome anxiety may be less important than the belief that some form of active coping has been acquired. The results of the present study are also in agreement with Meichenbaum and Butler (1980) who argue that it is not the reduction of physiological arousal per se that makes the use of relaxation techniques effective for controlling excess anxiety, but rather that the (test) anxious individual's "internal dialogue" about the arousal has in some respects changed from one of being overwhelmed to one of coping and being in control. Similarly, Thompson (1981) comments that giving a client an active coping technique for coping with aversive stimuli enhances behavioral and/or cognitive control and thereby may change the meaning of the aversive stimuli from one that is unendurable to one that is within the limit of one's endurance. In a similar fashion, giving a client an active coping

strategy for reducing anxiety may change the meaning of the anxiety-provoking situation from one that is beyond one's capabilities to one that is within these capabilities.

What we have in the present study then is a model for cognitive change based on the individual actively coping with one's anxiety. The cognitive model of human behavior and cognition espoused by Guidano and Liotti (1983) is marked by the conceptualization of the individual being active in response to the environment. Anxiety is experienced when the individual perceives that one's actions are inadequate to deal with the demands of one's environment. The main aspect of mental functioning is the active processing of expectations, hypotheses, and theories. Treatment subjects in the present study sought treatment because they were active problem solvers who were aware of their anxiety. In being presented with an active coping rationale and credible treatment, they expected to improve in their ability to cope with anxiety. Following treatment, they reported increased ability to do so. In a coping skills conceptualization, when an individual expects that they can successfully cope with a given event, there will be an undermining of their perception of the situation as being stressful. Being presented with a procedure for active coping can begin this process. By actively engaging the coping skill, the client conducts an experiment in which the client's belief about themselves and the nature of the external threat is challenged (Guidano & Liotti, 1983). In utilizing this strategic process, it is possible to modify the stereotyped and repetitious features of a

client's attitude toward reality and begin to make changes in the client's superficial cognitive structures (Arnkoff, 1980; Guidano & Liotti, 1983). An intervention which produced only these changes would be of limited value because its effects would be short-lived if, in time, it did not lead to deeper structural changes (Arnkoff, 1980). Based on the model of knowledge organization presented by Guidano and Liotti (1983) in which deep structural change comes about through alterations in one's representational models of the self (e.g. self-esteem) and of reality (e.g. rules that coordinate problem solving), further assessment of clients' self-esteems and follow-up assessement of their continued utilization of the coping skills acquired during treatment would be helpful in determining the value of the treatments employed in the present study.

Conclusions

In helping students identify their anxiety in a specific academic setting and become aware of the availability of intervention strategies (e.g. announcements regarding the Science Anxiety Clinic), students are able to take an active step in coping with the anxiety they experience in this and in other academic situations. Providing students with a credible intervention to actively cope with their anxiety may be more important than the specific type, focus, or format of the intervention. By actively engaging their positive expectations for improvement and the newly learned coping skill, students' beliefs about their coping abilities and experiences of anxiety in previously threatening situations can be improved.

The active coping nature of the intervention should be emphasized, and the intervention should be provided as cost-effectively as possible. Students who present themselves for treatment for science anxiety should be assessed to determine to what extent they may also be trait anxious or have poor study habits. Students with generalized anxieties could be assigned to the Stress Management Program and students with less generalized anxiety and/or poor study skills could be assigned to the Science Anxiety Group. If clients are assigned to treatments based on such assessments, treatment would be provided in a cost-efficient manner and treatment effectiveness might also be enhanced.

Limitations and Recommendations

The sample size was small and necessitates further research to replicate the findings of the current study in order to enhance their generalizability.

Some of the dependent measures utilized in the present study were non-standardized. Although all the measures had face validity, construct validity has not been established and therefore limits generalizations based on results obtained from these measures. Future research might attempt to establish validity for these measures by including their use in studies with standardized measures of similar constructs.

In the present study, conclusions regarding improvements in physiological functioning were based on self-reports. The objective (EMG frontalis muscle) and self-report measures of physiological concommitants of anxiety were not in agreement and further limit the conclusions

drawn. For those researchers who will continue to use EMG as a measure of physiological anxiety it is recommended that other measures of physiological functioning be included. It is recommended that the objective and self-report measures assess physiological reactivity in response to the same stimuli rather than to two different sets of stimuli. In this manner, one possible source of confounding can be eliminated. In addition, the specific use of frontalis EMG as a valid measure of science anxiety could be enhanced if future research could reliably differentiate descriptive imaginal scenes by the anxiety evoked when visualizing them.

Conclusions regarding the improvement of treated versus non-treated students were based on self-report measures. As such the possible operation of demand characteristics can not be entirely ruled out as a plausible rival hypothesis. In addition, the improvements reported by the treatment group subjects could be attributed to the possible "placebo effect" of simply being presented with an active coping rationale. The treatments of the present study consisted of an active coping rationale and various technical therapeutic procedures. Future research should be undertaken which combines an active coping rationale with a theoretically inert procedure to determine to what extent, if any, this "placebo" can produce anxiety reduction in students presenting with science anxiety. Such research would have to include an evaluation of treatment credibility and comply with ethical considerations in offering a potentially inert, non-credible intervention to students seeking treatment.

The measure of academic functioning was limited to a posttreatment only measure of global academic performance. Future research should include more specific measures of academic performance such as a science test or lab experiment. In addition, attempts to specifically assess pretreatment levels of academic skills are warranted. In this manner, the relative contribution of deficits in academic and stress management skills in the experience of "science anxiety" can be further determined. Follow-up data regarding academic functioning and treatment subjects' continued use of learned coping skills should be collected in future studies. Such information would be helpful in determining to what extent, if any, treatment effects have accrued and changes in deep cognitive structures have been obtained.

Because the Science Anxiety Group was relatively more complex than the Stress Managment Program, students difficulty in implementing the SAG program's interventions may have been a factor which limited its effectiveness as compared to the SMP program. Future research should evaluate the possible difficulty students have in utilizing program interventions and investigate this as a possible factor contributing to overall effectiveness.

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APPENDIX A

LOYOLA UNIVERSITY OF CHICAGO

LOYOLA COUNSELING CENTER

*6525 Sheridan Rd., Chicago, Illinois 60626 * (312) 274-3000 Ex 431*

January 17, 1983

Dear Colleague:

Please read the following to your classes: Loyola's Science Anxiety Clinic is now taking applications for this semester. The Clinic is for students in science courses whose anxiety about learning science interferes with their learning. It is also for students who avoid taking science courses because they believe they cannot understand science. We believe that any college student can learn science and we have had a great deal of success in reducing students' science anxiety.

We will be conducting the Science Anxiety Clinic starting mid February. The Clinic meets one and a half (1½) hours per week for seven weeks.

Our clinic will focus on personal experiences, classroom pressures, and peer pressures. We will consider approaches to scientific thinking and practice ways to be more relaxed.

Interested students should sign up before February 4th at the Counseling Center, Damen Hall 123. If you have further questions, please call the Counseling Center (ext. 2740) or Dr. Mallow (ext: 3546).

Thank you,

Jeffry V. Mallow
Department of Physics

APPENDIX B

APPENDIX C

STUDY HABITS AND ATTITUDES QUESTIONNAIRE

Name: _____ Date: _____

DIRECTIONS: Please answer each question either True (T) or False (F).
Be sure to answer each and every question.

1. ___ It is usually hard for me to get started on my schoolwork.
2. ___ I tend to put things off much more than most students.
3. ___ In general, I think my study habits are good.
4. ___ I often get moody and can't study at all.
5. ___ My studies cause me a lot of worry.
6. ___ Often some thought or idea comes to me, and I can't stop thinking about it.
7. ___ I use my study time efficiently.
8. ___ If I have trouble in a course, I tend to give up in discouragement.
9. ___ I often consider dropping out of school.
10. ___ I have a tendency to become sleepy in classes.
11. ___ I can concentrate well when I study even if the material is quite dull.
12. ___ I am under a lot of tension when I study.
13. ___ I sometimes get so worried about a personal problem that I can't study.
14. ___ I am easily distracted from my schoolwork.
15. ___ I can usually sit and study for long periods without becoming tired or distracted.
16. ___ I often get so upset about little things that I can't study.
17. ___ I find it hard to keep my mind on what I'm studying--don't know what I have been reading about when I get through.
18. ___ I have a tendency to daydream when trying to study.
19. ___ It takes me sometime to get settled and "warmed up" to the task of studying.
20. ___ I feel that my grades are a fairly accurate reflection of my ability.
21. ___ With me, studying is a hit-or-miss proposition, depending on the mood I'm in.
22. ___ I am unable to concentrate well because of periods of restlessness, moodiness, or "having the blues".
23. ___ Even though an assignment is dull and boring, I stick to it until it is completed.
24. ___ I seem to accomplish very little in relation to the amount of time I spend studying.
25. ___ When I sit down to study, I find myself too tired, bored, or sleepy to study efficiently.

APPENDIX D

Date _____ Name _____

Please answer the following questions by placing a number from a scale of 0 to 10 (0=lowest.....10=highest) in the blank after each question.

Now that this program has been explained to you, how helpful do you think it will be in improving your ability to cope with:

1. science-related situations? ____
2. stressful situations in general? ____

To what extent do you think this program is a reasonable approach for improving your ability to cope with:

3. stressful situations in general? ____
4. science-related situations? ____

How helpful do you think this program will be in decreasing the degree to which you worry about:

5. your performance in science courses? ____
6. things in general? ____

APPENDIX E

SCIENCE ANXIETY CLINIC

Science Anxiety Group

NAME: _____ DATE: _____

1) Now that you have finished the program, use the scale below to rate items a-j:

WORSE					BETTER			
1	2	3	4	5	6	7	8	9
extremely	much	some-what	slightly	NO CHANGE	slightly	some-what	much	completely

(a)____ level of anxiety while performing laboratory experiments

(b)____ ability to study science materials

(c)____ degree of nervousness while studying for a non-science midterm or final exam

(d)____ level of general anxiety

(e)____ ability to do your best on exams

(f)____ ability to relax whenever you are anxious

(g)____ level of science anxiety

(h)____ degree of nervousness when a teacher is observing you work

(i)____ degree of nervousness while studying for a science midterm or final exam

(j)____ ability to reduce anxiety in science-related situations

2) Use the scale below to rate how much you disagree/agree with statements k-s:

DISAGREE					AGREE			
1	2	3	4	5	6	7	8	9
completely	strongly	some-what	slightly	NEUTRAL	slightly	some-what	strongly	completely

(k)____ I wish I had more opportunity to talk to the therapists (group leaders) about my science anxiety.

(l)____ I wish I had more opportunity to be alone while listening to the relaxation tape.

(m)____ I would recommend this program to a friend of mine who had science anxiety.

(n)____ I am the kind of person who is very comfortable in groups or crowds.

(o)____ This program satisfied my expectations.

(p)____ This program would've been better if I had a chance to talk about my science anxiety without other science anxious students being present.

(q)____ I think this program was too automated.

(r)____ I do things best on my own.

(s)____ This program was a reasonable approach to reducing my science anxiety.

(next page)

SCIENCE ANXIETY CLINIC

Science Anxiety Group

4) Looking back on the Science Anxiety Group, rate each factor below for how important you believe it was in contributing to your improvement.

1	2	3	4	5
not at all important	slightly important	somewhat important	very important	extremely important

(a)____ being taught skills for solving word problems

(b)____ group experience in dealing with my science anxiety

(c)____ training in coping self-statements

(d)____ written "Negative Cycle" homework

(e)____ learning muscle tension and relaxation techniques

(f)____ group leaders

(g)____ relaxing to hiearchy of anxiety provoking science scenes

5) Write down in the space provided the approximate number of times you attended any of the programs listed below while you were also a participant in the Science Anxiety Group.

(a) Learning Assistance Program at Loyola Counseling Center

(1)____ Science tutoring

(2)____ Math tutoring

(3)____ Other (describe:

(b)_____ Career Counseling at Loyola Counseling Center

(c)_____ Individual personal/social therapy at Loyola Counseling Center

(d)_____ English Department Writing Center

(e)_____ Physics volunteer tutoring

(f)_____ Math Club volunteer tutoring program

(g)_____ Tri Beta Science Test Review session(s)

(h)_____ EOP

(i)_____ Other (describe:

SCIENCE ANXIETY CLINIC

Stress Management Program

NAME: _____ DATE: _____

1) Now that you have finished the program, use the scale below to rate items a-j:

WORSE					BETTER			
1 extremely	2 much	3 some-what	4 slightly	5 NO CHANGE	6 slightly	7 some-what	8 much	9 completely

(a)____ level of anxiety while performing laboratory experiments

(b)____ ability to study science materials

(c)____ degree of nervousness while studying for a non-science midterm or final exam

(d)____ level of general anxiety

(e)____ ability to do your best on exams

(f)____ ability to relax whenever you are anxious

(g)____ level of science anxiety

(h)____ degree of nervousness when a teacher is observing you work

(i)____ degree of nervousness while studying for a science midterm or final exam

(j)____ ability to reduce anxiety in science-related situations

2) Use the scale below to rate how much you disagree/agree with statements k-s:

DISAGREE					AGREE			
1 completely	2 strongly	3 some-what	4 slightly	5 NEUTRAL	6 slightly	7 some-what	8 strongly	9 completely

(k)____ I wish I had more opportunity to talk with the technician (person who changed tapes, collected homework logs, etc.) about my science anxiety.

(l)____ Listening to tapes alone in a room suited me just fine.

(m)____ I would recommend this program to a friend of mine who had science anxiety.

(n)____ I am the kind of person who is very comfortable in groups or crowds.

(o)____ This program satisfied my expectations.

(p)____ This program would've been better if I had a chance to talk about my science anxiety with other science anxious students.

(q)____ I think this program was too automated.

(r)____ I do things best on my own.

(s)____ This program was a reasonable approach to reducing my science anxiety.

(next page)

SCIENCE ANXIETY CLINIC

Stress Management Program

4) Looking back on the Stress Management Program, rate each factor below for how important you believe it was in contributing to your improvement.

1	2	3	4	5
not at all important	slightly important	somewhat important	very important	extremely important

(a)_____ learning how to breathe in a deep, relaxed manner

(b)_____ opportunity to deal with anxiety on my own as emphasized in this program

(c)_____ training in mental imagery (e.g.: cool mind, warm body)

(d)_____ "homework" practice

(e)_____ learning muscle tension and relaxation techniques

(f)_____ the technician (person changing tapes, collecting homework logs, etc.)

(g)_____ 8-10 minute practice period at end of each session tape

5) Write down in the space provided the approximate number of times you attended any of the programs listed below while you were also a participant in the Stress Management Program.

(a) Learning Assistance Program at Loyola Counseling Center

(1)_____ Science tutoring

(2)_____ Math tutoring

(3)_____ Other (describe:

(b)_____ Career Counseling at Loyola Counseling Center

(c)_____ Individual personal/social therapy at Loyola Counseling Center

(d)_____ English Department Writing Center

(e)_____ Physics volunteer tutoring

(f)_____ Math Club volunteer tutoring program

(g)_____ Tri Beta Science Test Review session(s)

(h)_____ EOP

(i)_____ Other (describe:

APPENDIX F

Name: _____ Age: _____ Sex: _____ Date: _____

Class (Fresh., Soph., etc.): _____

Are you presently enrolled in a science course? ___Yes ___No

If yes, please give course name(s) and number(s) along with the grade(s) you expect to get:

Name	Number	Grade	

*Indicate actual grade received thus far for each course →

Have you taken previous science course(s)? ___Yes ___No

If yes, please list course name(s), number(s), and grade(s) earned:

	First Semester			Second Semester		
	Name	Number	Grade	Name	Number	Grade
Fresh.						
Soph.						
Junior						
Senior						
Summer School						

Note: If you are a freshman, use the "First Semester" box to list your High School science courses.

APPENDIX G

Consent Form

The Counseling Center has offered and is currently offering programs to aid students in managing their science anxiety. Depending upon the student's schedule, each student will be assigned either treatment in the Science Anxiety Group or the Stress Management Program. Those students whose schedules will not permit them to attend either program this semester will be placed on a waiting list for a Science Anxiety Program next semester. Participants in the program will attend a total of nine sessions at the Counseling Center and will be asked to practice appropriate home assignments and exercises.

In order to better understand the nature and treatment of science anxieties and to assess the effectiveness of each of these programs, a program evaluation project is being conducted. As such, we would like to collect some measures of your progress in the treatment program to which you are assigned. We will thus ask you to complete several paper and pencil tests before and after the treatment program. These tests are designed to provide information about your general and science-related anxiety levels, your means of coping with stress, and your academic functioning. Before and after treatment, we will also use an electronic monitoring device, a biofeedback unit, to monitor your muscle tension levels in response to various imaginal situations. This device, a biofeedback unit, is frequently used in conjunction with anxiety and stress treatment programs.

The progress measures taken will be treated confidentially in keeping with the policy of the Counseling Center. Your name will not be associated with any reporting of the results of the program evaluation project.

Please understand that your participation in the program evaluation project is completely voluntary. You are free to discontinue participation at any time. Your decision regarding program evaluation participation in no way effects your eligibility for the treatment program.

I have read the above description of the treatment program and the associated program evaluation project and agree to participate in the program as described.

_____ _____

Signature Date

_____ _____

Witness Date

CONSENT FORM

I am pleased that you have agreed to provide us with information that will be helpful in the Counseling Center's efforts to conduct an evaluation regarding the nature and treatment of science anxiety. Please understand that the information you provide will be treated confidentially and included in the reporting of the results of the evaluation in a manner that guarantees your anonymity. With regard to the evaluation project, we will ask you to complete some questionnaires now and again at the end of the semester. In addition, we will use an electronic monitoring device, a biofeedback unit, to monitor forehead muscle tension levels while you listen to various scenes and situations played on a tape recorder.

"I have read the information above and agree to participate in the evaluation project as has been described. I am also aware that my participation is completely voluntary and that I am free to discontinue my participation in the evaluation project at any time."

Signed _____

Date _____

APPENDIX H

Three-Way (Group X Type of Scene X Time of Testing) Repeated Measures ANOVA on EMG Levels

Source	DF	MS	F	p
Group	2	18.10	2.07	.142
$Error_G$	34	8.75		
Scene	2	1.43	6.13	.004
Scene X Group	4	0.27	1.17	.334
$Error_{SG}$	68	0.23		
Time	1	4.78	0.87	.358
Time X Group	2	0.93	0.17	.844
$Error_{TG}$	34	5.47		
Scene X Time	2	0.53	2.55	.086
Scene X Time X Group	4	0.36	1.74	.151
$Error_{STG}$	68	0.21		

APPENDIX I

Staff Time for Science Anxiety Group

Activity	Time
Group leaders running weekly groups (2 leaders/group X 3 groups X 1-1/2 hrs/week X 7 weeks)	66 hrs
Supervision for group leaders (1 hour/wk X 8 wks/leader X 6 leaders)	48 hrs
Supervision provided by Ph.D. psychologist (1 hour/wk X 8 wks/semester X 2 semesters)	16 hrs
Preparation time for group leaders (Minimum 15 minutes/wk X 8 wks/leader X 6 leaders)	12 hrs
TOTAL	142 hrs

APPENDIX J

Staff Time for Stress Management Program

Activity	Time
Client introduction to program by the technician (1/2 hour X 13 clients)	6.5 hrs
Set up, checking in, and take down by the technician (Maximum 10 minutes/client X 13 clients X 7 weeks)	15.2 hrs
TOTAL	21.7 hrs

APPROVAL SHEET

The dissertation submitted by Joseph G. Hermes has been read and approved by the following committee:

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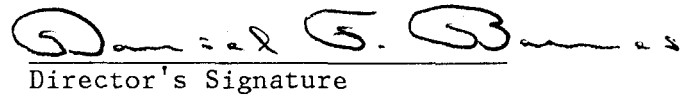
The final copies have been examined by the director of the dissertation and the signature which appears below verifies the fact that any necessary changes have been incorporated and that the dissertation is now given final approval by the Committee with reference to content and form.

The dissertation is therefore accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

3-15-85
Date


Director's Signature