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The Integration of Metabolic Measurement and the Behavioral Management of Nutrition and Exercise for Treating Obesity

Cheryl Rae Maphies
Western Michigan University

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THE INTEGRATION OF METABOLIC MEASUREMENT AND THE BEHAVIORAL MANAGEMENT OF NUTRITION AND EXERCISE FOR TREATING OBESITY

by

Cheryl Rae Maphies

A Dissertation
Submitted to the
Faculty of the Graduate College
in partial fulfillment of the
requirements for the
Degree of Doctor of Philosophy
Department of Psychology

Western Michigan University
Kalamazoo, Michigan
December 1989

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The integration of metabolic measurement and the behavioral management of exercise and nutrition for treating obesity

Maphies, Cheryl Rae, Ph.D.
Western Michigan University, 1989

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I want to express my deepest appreciation to my many friends who helped with this manuscript.

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Much appreciation goes to Roger Ulrich who once again gave me the support, freedom and encouragement to "do my own thing". Knowing Roger is a gift.

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Finally, thanks to my husband, Kerry, for his support, understanding, patience, and willingness to carry many burdens while I worked on this project.

Cheryl Rae Maphies

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CHAPTER I

INTRODUCTION

Problem Statement

Behavioral treatments for obesity have been documented to be effective by a large number of studies (see reviews by Brownell, 1982; Brownell & Jeffrey, 1987; Jeffrey, Wing & Stunkard, 1978; Stunkard, 1983.) These reviews and other authors, however, point out several of the limitations of behavioral research and/or treatments. These include: limited weight losses, inadequate dependent variables, and failure to make adjustments for physiological mechanisms of weight control.

Most behavioral research treatments have produced clinically insignificant rates of loss. For many years an average loss of eleven pounds in ten weeks was commonly reported (Brownell & Jeffrey, 1987; Jeffrey, et al., 1978.)

The overwhelming majority of treatment studies rely solely on weight loss for evaluation. There has been a marked failure to demonstrate treatment success by measuring target behaviors such as the use of behavioral
procedures or exercise. Treatment variables cannot be inferred to be effective from weight loss results. But few studies have substantiated any behavioral changes (Dahlkoetter, Callahan & Linton, 1979; and Stalonas, Johnson, & Christ, 1978).

Perhaps most important for maintenance of losses, there has been a failure to take into consideration the physiological mechanisms of weight loss/gain (Wooley, Wooley, & Dyrenforth, 1979). One of these mechanisms is the reduced metabolic rate that typically occurs with restricted caloric intake (Bray, 1969). This reduction is not immediately reversed upon the termination of the diet (Bray, 1969). Individuals with reduced metabolic rates are at risk to gain back weight upon the termination of the diet.

Brownell & Jeffrey (1987) made the observation only recently, that some of the research comparisons that had found behavioral methods to be superior to other methods may have been based on what they call "placebo treatments". These authors believe behavioral methods now need to be tested against more rigorous diets. The fact that obesity remains as one of the largest health problems in the country with one out of three American adults being overweight (Jeffrey & Foster, 1987) makes it imperative that treatments for obesity be improved.

Despite the drawbacks of behavioral treatments,
there are several reasons why it is believed that the improvement of behavioral treatments is an important place to start. First, behavioral treatments, at least in the area of maintenance, have been documented to be more successful in promoting maintenance of weight loss than other treatments (Stunkard, 1983). It is also the case that the emphasis on moderate and slow losses makes behavioral treatments most appropriate for the mildly and moderately obese individual whom comprise 95% of the obese population. It seems logical to pursue refinement of the treatment that has the highest probability of long-term success and is applicable to the majority of the population.

Even though maintenance of losses is of major importance, it continues to be inconsistent even for behavioral treatments (Brownell & Jeffrey, 1987). There are two issues that need to be addressed that are believed will provide clues about the limited losses and the limited maintenance of these losses. These issues are the failure to utilize appropriate target measures and the failure to consider the physiological effects of a weight-loss program.

The behaviors of food choice and exercise are believed to be important target measures. If one were to ask any individual (experienced dieter or not) what were two keys to losing weight, it would be surprising if they
did not mention eating less and exercising more or some other combination of less intake and more output. Behavioral treatments do not focus on a specific diet. At the heart of behavioral weight control philosophy, is the belief that obesity is caused by maladaptive eating patterns. It is presumed that unless eating patterns are changed the individual will regain any lost weight because they will continue their inappropriate eating. Eating less is an indirect focus of treatment while the alteration of patterns such as late night snacking are more important.

Unfortunately, the maladaptive patterns have not been clearly defined nor found to be consistent for all obese people. Early research (Goldman, Jaffa, & Schachter, 1968; Schachter & Gross, 1968) indicated that obese individuals are controlled by inappropriate cues for eating such as the presence of food or others who were eating. This early research has since been criticized as inconclusive (Rodin, 1981). Not all obese individuals are controlled by external food cues just as lean individuals are not unsusceptible to external food cues. In treatment research, those individuals who might have maladaptive eating patterns are not specified. Furthermore, research has not been conclusive because most researchers have failed to target and/or measure changes in eating behavior. The treatment protocols of research projects
are normally arbitrarily determined. All subjects are taught stimulus control techniques such as eating in one location without determining if the subject has difficulties eating in too many situations. Then to compound the error, no attempt is made to monitor the use of the technique and the sole measure of success is weight loss. Perhaps a better approach would be to focus on a specific diet and measure adherence.

The target behavior of exercise has been included more often in behavior research. Danikoetter, et. al. (1978) and Stalonas, et al. (1979) both included exercise goals and measured adherence to those goals. Most recent studies have included exercise, but the type and intensity of the exercise has not been consistent.

The issue of the physiological mechanisms of weight control is rarely mentioned in behavioral studies. Yet, for almost 75 years researchers have documented the reduction in basal metabolic rate that occurs as a result of a reduction in caloric intake (Apfelbaum, Bostsarron & Lacatis, 1971; Bray, 1969; Thompson, Jarvie, & Lahey, 1982). This reduction can be as large as 10-40% (Apfelbaum, et al., 1971). Simply stated, people on diets burn fewer calories. This phenomenon is probably the primary reason for plateauing of weight loss over time (Thompson, et al., 1982). Researchers have explored the possibility of reversing the reduction in metabolic rate.
after severe caloric restriction through exercise and have found some success (Donahoe, Lin, Kirschenbaum, & Keesey, 1984; Mole, Stern, Schultz, Bernauer, & Holcomb, 1989). One advantage to this approach could be that weight losses would be larger and more rapid. Several studies have; however, shown that a focus on slower loss vs. faster loss programs involving low-calorie diets results in the same overall amounts of loss (Wing, Epstein, Marcus, & Koeske, 1984; and Wing, Epstein, & Shapira, 1982).

In addition to the two primary issues of target measures and physiological mechanisms, there are other problems. Design problems such as too few target measures (e.g. the use of weight loss only vs. body fat percentage and weight loss and adherence to the program); short follow-up periods; and the lack of reliability checks on self-report measures also remain to be addressed completely.

PROBLEM SOLUTION

Preventing the reduction in metabolic rate was hypothesized to be a better approach to developing a successful weight-control program. It was believed that this could be done by focusing on diet and not allowing subjects to drastically reduce food choice caloric intake. Exercise was included because studies have shown exercise increases metabolic rate and may reverse any
reductions due to caloric restriction (Donahoe, et al., 1984; and Mole, et al., 1989).

For this study there was an emphasis on a well-balanced diet (e.g. based on American Dietetic Associations recommended allowances of carbohydrate, proteins and fats, 1987). Food choice was conceptualized as a target behavior or dependent measure. However, it was not the only target behavior. Behavioral programs are superior to diet alone in terms of maintenance of losses probably because there has been success in changing eating habits. This fact, again, points out the error in focusing solely on diet and weight loss. Diet alone is not sufficient for maintenance of losses because of the metabolic adaptation and the need to change individual behavioral patterns. It was hypothesized, however, that the behavior changes sought by behavioral treatments were not comprehensive enough and that food choice was an important target behavior that had been neglected. There is much anecdotal evidence that weight loss achieved through some "fad" diet is not generally weight that stays off. If behavioral treatments do not focus on training appropriate and long-term realistic choice of diet (e.g. proper combination of carbohydrates, proteins and fat) other behavioral changes may be unimportant.

The importance of the combination of a lack of a well-balanced diet and failure to recognize the possible
reduction in metabolic rate may be the major reason that losses are limited and maintenance is not guaranteed for everyone. The target behaviors of food choice and metabolic rate were included to monitor progress and identify those individuals that might be at risk for regaining weight.

The aim of this study was to achieve weight loss gradually without a disproportionate reduction in resting metabolic rate and to teach the subjects appropriate exercise, food choices and other eating behaviors that would enable them to maintain their losses. This study was also designed to include measures of target behaviors and other variables that would provide more information on progress than just weight loss. There were five focal measures: resting metabolic rate, food choice, duration of aerobic exercise and both weight loss and body fat percentage measures.

The primary hypothesis of this study was that by utilizing resting metabolic measures to assign a level of caloric intake that losses of one to two pounds per week with no accompanying reduction in resting metabolic rate would occur. The secondary hypothesis was that by utilizing standard behavioral techniques, specified changes in food choice and exercise behaviors could be developed that would maintain after treatment was terminated. A third hypothesis was that superior losses
would be found in a program that incorporated both diet and exercise throughout the program vs. a program that started with diet only and then included exercise.
CHAPTER II

METHODS

Subjects

Four female subjects, mean age 34, participated in this study. They were an average of 48% overweight according to the ideal weight scales of the Metropolitan insurance company. The average body fat percentage was 37%. The subjects reported histories of obesity for a mean of 15 years and an average of 1.75 weight loss cycles of 15 pounds or more in the last five years.

Design

The design of this study was a single-subject, multiple baseline that compared the combination of diet and exercise vs. the sequential combination of diet and exercise. Subjects were assigned to one of two treatment groups based on the starting availability of each subject. This study monitored changes in resting metabolic rate throughout baseline and treatment phases—in addition to changes in weight, body fat percentage, caloric intake, exercise, and food choices.
Treatment Procedures

**Baseline Phase**

Subjects were instructed to not make any changes in their food intake or exercise but simply to record what they ate and their daily activities. It was expected they would estimate the amount of food eaten but not make extensive efforts to measure the quantity to hopefully reduce the reactive effects of self-monitoring. Subjects kept track of their activities by blocking the day into two-hour blocks and identifying the major activity for the period.

**Diet-Only Phase**

Based on each individual resting metabolic rate (see Measurement Procedures section for details) a specific caloric limit was determined. For each subject, 500-1000 calories were subtracted from the daily metabolic rate ((resting rate per/minute X 1440) X 1.5) (McArdle, Katch and Katch, 1981). Also specified were the number of food exchanges required for each caloric limit to make a diet composed of 55-60% carbohydrates, 30-35% proteins and 10-15% fats. A food exchange was a measure of a standard serving based on an average number of calories for each food group. For example, one bread serving (e.g. one slice of bread) equalled 70 calories. The specific diet
chosen was obtained from the dietetic department of the University of Michigan and meets the recommendations of the American Dietetic Association for carbohydrates and proteins (American Dietetic Association, 1987). Subjects were also supplied with monitoring forms that indicated the appropriate number of exchanges. For more information, see weekly agendas.

Diet and Exercise Phase

In addition to the diet treatment, subjects were instructed to participate in some type of aerobic exercise three times weekly for a total of 90 minutes. For more information on exercise see weekly agendas.

Weekly Agenda

Pre-study Interview. During this interview information was conveyed regarding the purpose of the study which was to study the effect of utilizing metabolic measurements within a behavioral weight-control group. Subjects were told treatment would have a focus on teaching long-term, appropriate food choice and exercise behaviors. Information regarding subjects' time commitment, medical exam requirement, payment and consent form was reviewed. Subjects deposited $25, which was to be returned to them when they returned food/exercise records at the rate of $2 per week. An additional payment of $2
was to be given for each metabolic measurement session. The hypothesis concerning metabolic rate and pilot study results were also discussed.

**Week 1 and 2.** The collection of baseline data (food and exercise) was completed. Each subject was asked for clarification of amounts of recorded foods and activities in order to calculate average calories consumed and expended. Information regarding upcoming program was given. Subjects' diet history and goals were obtained.

**Week 3.** Diet phase began for Subject One. Information regarding physiology of weight loss and justification for utilizing high carbohydrate, moderate protein, low-fat diet was conveyed. The rationale included describing the various functions of carbohydrates and proteins and the benefits of an adequate diet (Table 1).

Each subject was then assigned a caloric limit based on their individual baseline metabolic rate.

The use of stimulus control was also introduced (e.g. instructions for choosing appropriate number of exchanges, food exchange lists, and standardized monitoring forms).

**Week 4.** Subjects Two and Three were added to treatment. Subject Two began the diet-only phase (see Week 3 agenda). Subject Three began the diet/exercise phase. In combination with Week 3 agenda techniques,
<table>
<thead>
<tr>
<th><strong>Aerobic exercise</strong></th>
<th><strong>High-carbohydrate, low fat diet</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Burns large amounts of calories.</td>
<td>1. The function of carbohydrates is to provide the majority of calories</td>
</tr>
<tr>
<td>2. Can result in increased metabolic rate that is of a longer duration than the exercise period</td>
<td>2. Protein is &quot;spared&quot; for tissue repair and fighting infection with sufficient carbohydrates</td>
</tr>
<tr>
<td>3. May reverse lowered metabolic rate due to caloric restriction</td>
<td>3. Carbohydrates are used in the metabolism of fat</td>
</tr>
<tr>
<td>4. Utilizes primarily fat deposits. Aerobic trained athletes metabolize fat easier</td>
<td>4. Complex carbohydrates are metabolized slowly and thus help with satiety</td>
</tr>
<tr>
<td>5. Conditions skeletal muscle so that oxygen utilization is more efficient</td>
<td>5. Carbohydrates are usually foods people &quot;crave&quot; on diets and may reduce binging</td>
</tr>
<tr>
<td>6. Improves cardiovascular functioning</td>
<td>6. Moderate amounts of protein are sufficient for tissue repair and helps to reduce level of dietary fat associated with high protein intake</td>
</tr>
<tr>
<td>7. Improves maintenance of weight loss.</td>
<td>7. Low-fat intake reduces nutritionally deplete calories and also total caloric intake</td>
</tr>
<tr>
<td>8. May decrease appetite.</td>
<td></td>
</tr>
<tr>
<td>9. Psychological benefits such as stress reduction</td>
<td></td>
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</table>

additional techniques for the behavior control of antecedents, techniques for altering eating responses and consequences were given (Table 2). Aerobic exercise was defined and the rationale for utilizing aerobic exercise was provided (Table 1).

Subjects were assigned an exercise frequency of three-times weekly for 30 minutes each time at target heart rate. The individual's target range for heart rate was determined to be 65-75% of aerobic capacity (e.g. 220 - AGE) (McArdle, et al., 1981). Instructions were given to record on food forms the frequency and duration of aerobic exercise at target heart rate.

Week 5. The diet/exercise phase was implemented for Subjects One and Four (See week 4 agenda). Experimenter controlled aerobic exercise treatment was introduced (3 times weekly, 45-minute, low-impact aerobic dance class. Subjects were required to attend one session per week for which they were given $1 back from their $25 deposit.

Week 6. The diet/exercise phase was implemented for Subject Two (See Week 4 and Week 5 agendas). Group treatment sessions were implemented at this point. The tool of cognitive restructuring was described. Various irrational beliefs common to dieters were identified (e.g.
<table>
<thead>
<tr>
<th>Narrow cues to eating</th>
<th>Strengthen positive cues for eating</th>
<th>Use positive reinforcement</th>
<th>Change eating behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eat in one spot</td>
<td>Use menus</td>
<td>Make rewards contingent on good behavior and not weight loss</td>
<td>Slow down pace of eating</td>
</tr>
<tr>
<td>Do not engage in</td>
<td>Have appropriate snacks available</td>
<td>Avoid food deprivation</td>
<td>Place fork down during chewing</td>
</tr>
<tr>
<td>activities while</td>
<td>Use smaller plates</td>
<td>Do not skip meals</td>
<td>Use special eating utensils for all meals, including snacks</td>
</tr>
<tr>
<td>eating</td>
<td>Make food appear larger</td>
<td>Eat a variety of foods</td>
<td></td>
</tr>
<tr>
<td>Do not purchase</td>
<td>Record prior to eating</td>
<td>Save allowable amounts for snacks</td>
<td></td>
</tr>
<tr>
<td>problem foods</td>
<td>Minimize contact with excessive food</td>
<td>Arrange for a variety of activities to reduce boredom</td>
<td></td>
</tr>
<tr>
<td>Shop from a list</td>
<td>Leave table when plate is empty</td>
<td>Make foods attractive</td>
<td></td>
</tr>
<tr>
<td>Shop on a full</td>
<td>Remove remaining food immediately</td>
<td>Eat favorite foods</td>
<td></td>
</tr>
<tr>
<td>stomach</td>
<td>Leave room during food commercials</td>
<td>occasionally</td>
<td></td>
</tr>
<tr>
<td>Plan weekly menu</td>
<td>Do not walk past bakery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clear plates to</td>
<td>Store foods in opaque containers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>garbage</td>
<td>Cock only enough for one helping</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Have others get own</td>
<td>Have others monitor your intake</td>
<td></td>
<td></td>
</tr>
<tr>
<td>snacks</td>
<td>Purchase problem, foods unprepared</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Focus on consequences of overeating</td>
<td>Use social reinforcement</td>
<td>Cognitive restructuring</td>
<td></td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>-------------------------</td>
<td>------------------------</td>
<td></td>
</tr>
<tr>
<td>Heart attacks and high blood pressure</td>
<td>Ask family for encouragement</td>
<td>Identify problem eating patterns and beliefs about food</td>
<td></td>
</tr>
<tr>
<td>Larger clothes</td>
<td>Join a group (Weight Watchers, aerobics, etc.)</td>
<td>Identify problem beliefs about exercise</td>
<td></td>
</tr>
<tr>
<td>Tape &quot;fat&quot; picture on refrigerator</td>
<td>Make a contract with a friend and write it down</td>
<td>Dispute these beliefs</td>
<td></td>
</tr>
<tr>
<td>Go try on new clothes and look at your body in the mirror</td>
<td>Make a graph weight chart</td>
<td>Forget about severely restrictive diets they reduce your metabolic rate</td>
<td></td>
</tr>
<tr>
<td>Reduce attractiveness of problem foods</td>
<td>Take appropriate snacks to parties and share</td>
<td>All foods are legal - you simply must eat reasonable quantities</td>
<td></td>
</tr>
</tbody>
</table>
"I've just eaten a bowl of ice cream and I've totally blown my diet so what's the use?" or "I don't have time to exercise."

Specific treatment techniques such as hypothesis testing and disputation of problem/irrational statements were demonstrated. At this point goal setting, use of positive reinforcement and weekly contracts for exercise and food/choice was implemented. Individual contracts were written. Each subject was provided feedback on body fat percentage measures by giving them their fat and lean weight and weekly changes to date. This feedback then continued weekly.

**Week 7**. The experimenter aerobic group was reduced to twice weekly to promote individual exercise responsibility. Subjects were instructed to continue exercising three times per week. During group sessions there was a continued focus on cognitive restructuring of irrational beliefs concerning exercise that were interfering with the performance of exercise. For example, no one was using their spa memberships except for the experimenter conducted aerobic classes. Some of the problem statements identified included: "I can't stand it when guys watch me exercise at the spa. I know they are thinking how fat I am." or "I'm too embarrassed to go."

The experimenter talked about hypothesis testing of those particular statements and gave examples of disutations.
(e.g. "There are other possible reasons people watch exercise classes. The only proof they are watching your fat is if you ask them and they say 'yes'.") The experimenter also provided additional examples of disputations of "shoulds, musts, awfuls, etc." (Ellis, 1968). Individual contracts were written for the week.

**Week 8.** During a group session the concept of developing positive stimulus control and social reinforcement to promote exercise was introduced. One application of stimulus control and social reinforcement was described - arranging to be around other individuals who also participate in exercise. Each subject was asked to be group leader for a specified time with the responsibility of planning and implementing a group exercise session. Individual contracts were written to specify the time commitment for being group leader.

**Week 9.** The individual sessions were cancelled.

**Week 10.** The experimenter met the group in a restaurant for breakfast to discuss appropriate food choices on the menu and to practice ordering. The experimenter obtained reliability checks on food choices for this meal. Subjects One and Two contracted to develop three-days of menus and follow them exactly as they were having difficulty adhering to the exchange
recommendations. Subjects One and Two were not consuming enough and it was believed they were not using menu planning or purchasing the appropriate foods. Subjects Three and Four contracted to arrange for a special food treat. Both these subjects had a large percentage of days in which they strictly adhered to their food plan. The possibility of "setting themselves up for a binge was discussed." This was the last week of the experimenter aerobic class.

**Week 11.** This was an additional treatment week (to be explained in result section). The experimenter met with the subjects for a picnic. Reliability checks on food choices were obtained at this time (Table 3). The maintenance phase was introduced and described as a period in which they were expected to maintain the eating and exercise behaviors they had developed. The schedule of meetings for maintenance phase was discussed and tentative individual sessions were made.

**Maintenance**

Subjects One, Three and Four attended four maintenance sessions over a two-month period. Sessions consisted of reviewing food/exercise data, reviewing individual problems and developing appropriate contracts to address the problems. Subject One was asked to
continue self-monitoring and contracted for an increased frequency of exercise (e.g. for each minute of aerobic exercise she earned from the experimenter one minute of babysitting time). Cognitive restructuring for Subject Four was the focus as she was having difficulty maintaining a consistent exercise schedule. Subject Four expressed difficulty with motivation stating "I'm on a pity party." Clarifying the negative consequences of non-exercise and the suggestion to try aerobics tapes at home was given. Subject Three contracted to omit recording of food data on official record sheets and instead began using 3 X 5" cards. She also contracted to reduce exercise frequency to 5 days per week instead of daily.

Subject Two was only seen for three maintenance sessions as she was unable to attend regular meetings due to family obligations. Food/exercise data for her was lost from 8/11 to 9/19. Treatment included encouraging planning exercise by setting aside a specific time or joining some organized group. Subject Two joined an aerobic class that did not start until the end of September. Attempts to utilize cognitive restructuring by pointing out the consequences of non-exercise or to arrange positive reinforcement for exercise failed. She refused to make plans for exercise until the end of September.

One final treatment instruction must be noted as
it is important for evaluation of changes from the maintenance period to the five-month follow up. All subjects were instructed that they were to attempt to maintain their post-treatment losses and not to reduce any further. This was done for several reasons. It was hypothesized that these subjects needed to maintain reduced weights for a period of time to enhance their "belief" that they could be successful (they all had histories of regaining lost weight). Secondly, there was interest in the longer-term effects on metabolic rate of decreased but stable body weights. Additional measurement of the resting metabolic rates was scheduled for the five-month follow up (see discussion for more information).

Measurement Procedures

Target measures

Target measures included: caloric intake, food choice, use of contracting, weight loss, body fat percentages, resting metabolic rate, and frequency and duration of aerobic exercise at target heart rate.

Food Choice.

Subjects self-monitored their diets during baseline by recording foods eaten and amounts. During the
Diet phase they monitored the number of milk, fruit/vegetable, bread/starch, protein, and fat exchanges on special recording sheets. The diet/food exchange sheets were obtained by the author from a dietitian with the University of Michigan hospital dietetics department (Figure 1).

**Exercise.**

Subjects were instructed to perform some type of aerobic exercise at 65 to 75% of their maximum aerobic capacity (220 - age) for a minimum of three times weekly for a minimum of 30 minutes each time. The experimenter instructed aerobic class was designed to provide 30 minutes of aerobic work. Heart rates were monitored during class. Attendance records were maintained for this class as reliability checks. Subjects were instructed to record on the back of food recording sheets the date and duration of aerobic exercise at their training rates.

**Metabolic measurement.**

Resting metabolic rates were determined by indirect calorimetry based on measurements of oxygen utilization. Oxygen utilization was measured using a Beckman metabolic cart consisting of an OM-11 oxygen analyzer and a LB-2 carbon dioxide analyzer. A one-way valve was used to collect the expired air. Subjects'
Figure 1. Food Exchange Record Sheet.
oxygen uptake was measured three times per week for the first two weeks and then twice weekly for the six weeks of treatment. Measurements were taken for eight minutes after a two-minute, warm-up period. This period was to allow subjects to become comfortable with the mouthpiece. Subjects rested on a cot for 30 minutes before the actual measurement and were in a prone position during testing. The subjects were instructed to not eat or drink anything but water after 8:00 the previous evening. Measurements were taken between 8:30 and 10:00 a.m. The oxygen utilization information was then put into a formula that calculated calories per minute. The formula utilized was 

\[ \text{calories/minute} = 3.9 \text{ Liters Oxygen} + 1.11 \text{ Liters Carbon Dioxide} \]  

(Weir, 1949).

Weight loss.

Weights were taken twice-weekly (before eating) on standard balance-beam physician's scales.

Body fat percentage.

This measure was determined weekly from caliper measurements of skinfold thickness (Johnson & Nelson, 1987). The measurements were performed by a graduate student from the Health, Physical Education and Recreation department at Western Michigan University who was experienced in the use of the Lange instrumentation. It
was not feasible to obtain inter-rater reliability measures for this particular measure.

**Graphs.**

All data was individually graphed to monitor progress (Figures 2-11). The graphs were periodically reviewed with the subjects.

**Fitness measures.**

Cardiovascular fitness measure were taken twice for each subject. These were done before the exercise phase and at the five-month follow up. Subjects were required to walk/jog as far as possible in twelve minutes. The results were scored based on distance obtained (Cooper, 1971).

**Reliability measures.**

Inter-observer agreement scores were obtained for caloric intake during baseline for four days (Table 3). Agreement was defined as being within 50 calories per meal.
Table 3
Baseline Inter-rater Reliability Checks

<table>
<thead>
<tr>
<th>Subject 1</th>
<th>Subject 2</th>
<th>Subject 3</th>
<th>Subject 4</th>
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<tr>
<td>5/22 = 100%</td>
<td>5/22 = 100%</td>
<td>5/26 = 100%</td>
<td>5/31 = 75%</td>
</tr>
<tr>
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<td>6/8 = 75%</td>
</tr>
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<td>$\bar{x} = 81%$</td>
<td>$\bar{x} = 83%$</td>
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Observational checks were completed for food choice and exercise behavior using two approaches. Subjects asked a spouse/friend to record twice weekly what they observed the subject eating. Comparisons between these observations and the subject's recordings were made by identifying discrepancies in food items but not necessarily in the amounts. Two meetings were scheduled with the experimenter in which the experimenter observed eating behavior and recorded subjects' food choices (i.e. the restaurant exercise and a potluck picnic). Partial observational checks on exercise were obtained by recording attendance at experimenter-directed aerobic classes (Table 4).
<table>
<thead>
<tr>
<th></th>
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<th>S2</th>
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<td>50%</td>
<td>50%</td>
<td>100%</td>
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<tr>
<td>attendance</td>
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CHAPTER III

RESULTS

Figure 2 shows that all subjects lost weight when the treatment phases were implemented. As each subject in the multiple-baseline design began treatment, weights were reduced. Subject Four's weight fluctuated throughout baseline with a loss of 4.5 pounds in 16 days. She had regained 2.75 pounds prior to the treatment phase so treatment was implemented rather than continue baseline. Subjects in the combined diet/exercise treatment lost a mean of 21.9 pounds as compared to a mean loss of 10.5 for the sequential diet-only then exercise treatment.

Figure 3 demonstrates a reduction in caloric intake with the implementation of the treatment phase for each of the subjects. The mean difference for caloric intake between baseline and treatment for each subject ranged from 582 to 1303 calories.

The resting metabolic rate measures (Figure 4) indicate that despite the caloric reduction and weight loss the resting metabolic rates remained stable for three of four subjects. These three individuals continued to expend proportionately the same amount of calories in the
PLEASE NOTE:

The following figures have been refilmed in their entirety at the end of this dissertation (not available on microfiche). A xerographic reproduction has been provided for paper copies and is inserted into the inside of the back cover.

Black and white photographic prints (17" x 23") are available for an additional charge.

Figures 2-11

University Microfilms International
Figure 2. Weight for four subjects. B = Baseline, T1 = Diet only, T2 = Diet/exercise, M = Maintenance
Figure 4. Metabolic Rate/Kilogram Body Weight for Four Subjects.

B = Baseline; T1 = Diet-Only; T2 = Diet/Exercise; M = Maintenance.
resting state based on kilograms of body weight. There was no evidence that subjects' metabolic rates decreased disproportionately as has been found with more severe caloric restrictions (Bray, 1969). There was a decrease in metabolic rate for Subject Two of approximately 30% from the beginning of the diet-only phase to the start of the diet/exercise phase.

Figure 5 shows that all subjects reduced their body fat percentages. The fat and lean pounds were calculated based on the body fat percentages and scale weight. Weight losses were primarily fat losses. Subject One lost 10.98 pounds fat (100% fat loss); Subject Two lost 11.42 pounds fat (100% fat loss); Subject Three lost 16.7 pounds fat (79% fat loss); and Subject Four lost 13.75 pounds fat (61% fat loss).

Individual Treatment Results

**Subject One**

Figure 2 shows that Subject One lost 9.5 pounds at the end of the eight-week treatment period and an additional 6.25 pounds at the end of the two-month maintenance phase.

Figure 3 indicates that Subject One consumed a baseline mean of 2369 calories daily. During treatment caloric intake was reduced by 1074 calories per day to a mean of 1295 calories per day.
Figure 5. Body Fat Percentages for Four Subjects. B = Baseline; T1 = Diet-Only; T2 = Diet/Exercise; M = Maintenance.
Figure 3 shows that 36% of the treatment days were within + or - 50 calories of the recommended treatment level for caloric intake.

Figure 4 shows Subject One had a baseline mean for resting metabolic rate of .010 calories per kilogram of body weight per minute or 1685 calories per day. The mean resting metabolic rate remained the same for the combined treatment periods at .010 calories per minute or 1699 calories per day.

Figure 5 shows that Subject One reduced her body fat by 3% during treatment with a regain of .5% at the end of the maintenance phase.

Figure 6 shows that Subject One had a baseline of 0.0 minutes of aerobic exercise. During treatment Subject One exercised a mean of 7.2 minutes per day or 56% of the frequency goal of 90 minutes per week. Subject One scored within the very poor range on the cardiovascular fitness measure.

Subject Two

Figure 2 shows that Subject Two lost 11.5 pounds at the end of the seven-week treatment phase and one pound at the end of the two-month maintenance phase.

Figure 3 shows that Subject Two consumed a baseline caloric intake of 1782. Caloric intake during
Figure 6. Duration of Aerobic Exercise in Minutes for Four Subjects.

B = Baseline; T1 = Diet-Only; T2 = Diet/Exercise; M = Maintenance.
treatment was reduced by 582 calories to a mean of 1200 calories per day.

Figure 3 shows that Subject Two had 11% of treatment days ± 50 calories of the recommended caloric intake.

Figure 4 shows that Subject Two had a baseline mean resting metabolic rate of .010 calories per kilogram of body weight per minute or 1166 calories per day. The combined treatments mean resting metabolic rate increased to .011 calories per kilogram of body weight per minute or 1238 calories per day.

Figure 5 shows that Subject Two reduced her body fat percentage by 4% at the end of treatment and another .3% at the end of the maintenance phase.

Figure 6 shows that Subject Two had a baseline mean of 0.0 for aerobic exercise. During treatment Subject Two exercised an average of 18.5 minutes per day or 129% of the frequency goal of 90 minutes per week. Subject Two scored within the poor range on the cardiovascular fitness measure.

Subject Three

Figure 2 shows that Subject Three lost 21.25 pounds during the seven-week treatment phase. She lost an additional 2.25 pounds at the end of the two-month maintenance phase.
Figure 3 shows that Subject Three had a baseline caloric intake of 2515. During treatment she reduced the intake by 1040 for a treatment mean intake of 1475 calories per day.

Figure 3 shows that Subject Three had 52% of treatment days + or - 50 calories of the recommended caloric intake.

Figure 4 shows that Subject Three had a baseline resting metabolic rate of .009 calories per kilogram of body weight or 1238 calories per day. During treatment the metabolic rate increased to .012 calories per kilogram of body weight or 1440 calories per day.

Figure 5 shows that Subject Three reduced her body fat percentage by 4.7% during treatment and an additional 2.1% body fat at the end of maintenance.

Figure 6 shows that Subject Three had a baseline mean of 0.0 minutes per day for aerobic exercise. During treatment this subject exercised a mean of 20.6 minutes per day or 144% of the frequency goal of 90 minutes per week. Subject Three scored within the very poor range on the cardiovascular fitness measure.

Subject Four

Figure 2 shows that Subject Four lost 22.5 pounds during the six-week treatment phase. She lost an additional 9.25 pounds at the end of the two-month
maintenance phase.

Figure 3 shows that Subject Four had a mean baseline caloric intake of 2708 calories per day. During treatment the mean caloric intake was decreased by 1303 calories for a mean intake of 1405 calories per day.

Figure 3 shows that Subject Four had 45% of treatment days within ±50 calories of the recommended caloric intake.

Figure 4 shows that Subject Four had a baseline resting metabolic rate of 0.005 calories per kilogram of body weight per minute or 1512 calories per day. During treatment the resting metabolic rate was slightly reduced to a mean of 0.009 calories per kilogram of body weight per minute or 1302 calories per day.

Figure 5 shows that Subject Four reduced her body fat percentage by 2.6% during treatment and an additional 2% at the end of the maintenance phase.

Figure 6 shows that Subject Four had a baseline of 0.0 minutes of aerobic exercise. During treatment Subject Four exercised a mean of 13.4 minutes per day or 104% of the frequency goal of 90 minutes per week. Subject Four obtained a very poor rating on the cardiovascular fitness measure.
Additional target measures.

The target behavior measures of aerobic exercise duration and food choice also changed from baseline to treatment (Figures 3, 6-11). Subjects Two, Three and Four met and exceeded the recommended frequency goal for exercise. The average days of treatment that were within + or - 50 calories of recommended intakes was 36%.

Figures 7-11 show the food exchanges chosen during the treatment phases. The recommended number of each exchange is indicated by the solid line. The mean percentage of days at the recommended milk exchanges was 69%. The mean percentage of days at the recommended fruit and vegetable exchanges was 71%. The mean percentage of days at the recommended bread exchanges was 62%. The mean percentage of days at the recommended protein exchanges was 68%. The mean percentage of days at the recommended fat exchanges was 71%.

Five-Month Follow Up

Subject One

At the five-month follow up Subject One had regained 7 pounds of the 15.75 pounds lost during treatment. The body fat percentage was increased by .87%. She reported 0.0 minutes of aerobic exercise. Subject One
Figure 7. Number of Milk Exchanges for Four Subjects. Each Exchange Equals 80 Calories. Broken Horizontal Line Equals Recommended Level. B = Baseline; T1 = Diet-Only; T2 = Diet/Exercise; M = Maintenance.
Figure 9. Number of Bread Exchanges for Four Subjects. Each Exchange Equals 70 Calories. Broken Line Equals Recommended Level. B = Baseline; T1 = Diet-Only; T2 = Diet/Exercise; M = Maintenance.
Figure 11. Number of Fat Exchanges for Four Subjects. Each Exchange Equals 45 Calories. Broken Line Equals Recommended Level. B = Baseline; T1 = Diet-Only; T2 = Diet/Exercise; M = Maintenance.
increased her fitness score, but still scored within the very poor range. There was an increase of 130 calories over the treatment mean for an average caloric intake of 1425 calories. The follow-up mean metabolic rate measurement obtained was .012 calories per kilogram of body weight per minute or 1900 calories per day. This was an increase of .002 calories per kilogram of body weight per minute or 201 calories per day.

Subject Two

At the five-month follow up, Subject Two regained 3.25 pounds of the 12.5 pounds lost during treatment. Subject two lost an additional .23% body fat. She reported 30 minutes of aerobic exercise during the measurement period. Subject Two scored within the good range of cardiovascular fitness. There was an increase of 73 calories over the treatment mean for an average caloric intake of 1273 calories. The resting metabolic rate was measured at .017 calories per kilogram of body weight per minute or 1843 calories per day. This was an increase of .006 calories per kilogram of body weight per minute or 605 calories per day.

Subject Three

At the five-month follow up, Subject Three had regained 4.75 pounds of the 23.5 pounds lost during
treatment. There was an additional .5% reduction in body fat. She reported 44 minutes of aerobic exercise during the measurement period. Subject Three improved her fitness score but still remained within the very poor range. There was an increase of 204 calories over the treatment mean for an average caloric intake of 1679 calories. The mean resting metabolic rate was measured at .014 calories per kilogram of body weight or 1613 calories per day. This was an increase of .002 calories per kilogram of body weight or 173 calories per day.

Subject Four

At the end of the five-month follow up, Subject Four gained .25 pounds of the 31.75 pounds lost during treatment. There was an additional loss of 1% body fat. Subject Four reported no exercise. Subject Four scored higher on the fitness measure but still within the very poor range. There was an increase of 55 calories over the treatment mean per day for an average caloric intake of 1460 calories. The resting metabolic rate was measured at .013 calories per kilogram of body weight or 1613 calories per day. This was an increase of .004 calories per kilogram of body weight or 311 calories per day.

In summary, all subjects essentially maintained their post-treatment weights and body fat percentages. There was no evidence of a major drop in metabolic rate.
despite the reduction in body weight from post-treatment to the follow up. In fact, the resting metabolic rates were slightly increased. Exercise data indicated a significant drop in the frequency of aerobic exercise for two of the subjects.

One-year Follow Up

The one-year follow up data were obtained for weight, caloric intake, food exchanges and exercise and is included in Figures 2-11.

Subject One

Subject One gained an additional 14 pounds over her pre-treatment weight (final weight +14 pounds). She reported a mean of 15 calories over the last recommended caloric level of 1365 calories. No exercise was reported.

Subject Two

Subject Two lost .25 pounds from the five-month follow up (final weight -5.5 pounds). She reported a mean of 23 calories over the last recommended caloric level. Subject Two reported no exercise.

Subject Three

Subject Three gained 7.5 pounds from the
five-month follow up (final weight -11.25 pounds). She reported a mean that was 43 calories below the last recommended level of 1575 calories per day. Subject Three reported no exercise.

Subject Four

Subject Four lost 3.5 pounds from the five-month follow up (final weight -28 pounds). She reported a mean of 320 calories over the last recommended caloric level. Subject Four reported no exercise.

In summary, the one-year follow up showed that only 50% of the subjects were able to lose additional weight between the five-month and one-year follow up. One subject regained 50% of her losses while another subject gained additional weight. The caloric records indicated that subjects were able to essentially maintain treatment recommended caloric levels. No exercise was reported during the one-year follow up.
CHAPTER IV

DISCUSSION

Several of the major problems with behavioral weight-control treatments include: the utilization of group designs and failure to identify individual response to treatments; the neglect of proper target measures; and the failure to incorporate information about the physiological components of obesity. A review of each subject's progress in this study made it clear that if only one dependent variable was utilized the conclusion about the effectiveness of the treatment would be different for each individual. For example, body fat changes were essentially equivalent while total weight losses differed. This study was designed to broaden the definition of success by including many target measures, including physiological measures, and by individualizing the treatment to problem areas.

Treatment was effective in helping each subject lose weight (Figure 2). Subjects in the combined diet/exercise treatment lost approximately twice the amount the subjects who received the diet-only and then diet/exercise treatment. This particular design, however, does not allow this result to be a clear demonstration
that combined diet/exercise is superior in terms of weight loss. To be a clear demonstration the subjects would need to be matched for percentage overweight, body fat, diet/exercise histories and diet/exercise procedures would need to be consistent across subjects during treatment. It was also the case that there was only a one week comparison between the two diet-only subjects and a diet/exercise individual. This time period would need to be lengthened.

The fact that the diet/exercise subjects lost more weight during treatment still remains. This cannot be explained by pre-treatment weight. The two subjects who lost the most weight did not have the most weight to lose. However, these subjects had higher body fat percentages. When it came to fat loss, Subject One (who was the heaviest) was as successful as the two subjects who lost more weight. This result is one example of how utilizing only one target measurement can result in inaccurate assessment of the effects of treatment.

The larger losses are also partly due to the much larger lean weight losses by the diet/exercise subjects. All subjects reduced body fat percentages with the diet/exercise subjects reducing only slightly more. Had the diet/exercise subjects not lost as much lean weight their fat losses could have been greater. So the diet-only subjects were essentially as successful as the
diet/exercise subjects for the measurement of body fat. This result could be difficult to explain as exercise is generally believed to be necessary to burn fat and one would expect the diet-only subjects to not lose as much fat weight. However, the inclusion of exercise did enhance the loss of fat. The support for the necessity of exercise was demonstrated as both Subjects One and Two lost lean weight during the diet/only phase and failed to lose any fat pounds until the exercise phase.

The larger weight losses for the diet/exercise subjects are probably also explained by the larger caloric requirements due to exercise.

Another interesting note is that the two subjects with the least amount of loss were the two subjects who had the most difficulty adhering to their food/exercise program. The exercise they did get, however, helped them to lose fat weight. Their total losses might have been greater if adherence to the food/exercise plan had been better. The two subjects who lost the most weight adhered fairly strictly to the recommended exercise and dietary instructions.

Another possible hypothesis to test concerning the lean tissue loss might be that the two exercise subjects actually consumed too few calories for the amount of exercise performed. Subject four lost fat pounds but also lean tissue as she tended to be under her caloric

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recommendation. She was encouraged to eat more and when her caloric intake increased the losses were composed of fat with a gain in lean weight.

It was believed that by utilizing resting metabolic measurement a specific caloric range could be found for each individual where weight loss would occur but the reducing effects upon metabolism of restricted caloric intake could be minimized. The graphs indicate that over time the metabolic rates remained stable despite weight loss for three of four subjects. During the diet-only phase Subject Two demonstrated a steady decrease in metabolic rate. This is probably best explained by the fact that she failed to consume the recommended caloric allowance. During treatment Subject Two was a mean of 173 calories below the recommended amount. For this subject the expected reduction in resting metabolic rate occurred with caloric restriction. When she began to exercise this reduction was reversed as has been found elsewhere (Donahoe, et al., 1984). The result of the diet/exercise phase was an alteration in body composition. Subject Two lost only four pounds during the diet/exercise phase but made large changes in body fat with a three percent reduction in body fat. It is possible that had there been no change in metabolic rate Subject Two might have lost more weight.

For three subjects there was loss without
disproportional reductions in metabolic rate. For Subject One there was an expectation of a reduction in rate as occurred with Subject Two. This did not occur. Because of this result this design does not permit exact specification of diet or the combination of diet and exercise as the independent variable responsible for maintaining a stable metabolic rate. One of the goals of treatment was to not obtain any reduction so a fairly high caloric intake was suggested and exercise was recommended for all subjects. Perhaps the reduction in metabolic rate can be offset simply by maintaining a higher level of calories. Subject One was given a higher caloric recommendation than Subject Two and did adhere more closely to that amount. Perhaps this was why there was no reduction. This seems unlikely as the Minnesota starvation experiments (McArdle, et al. 1982) utilized an average of 1500 calories over a 24-week period and obtained the marked reduction in metabolic rate. Subject One ate less than 1500 calories. It is probable that other factors such as greater lean mass, measurement error, or error in under-reporting caloric intake were responsible for the lack of a drop in metabolic rate for Subject One. Four additional comparisons of high-caloric diet-only vs. a low-caloric diet with/without exercise might have been useful to answer the question of whether it was the diet or diet/exercise responsible for the
stable metabolic rate. At very minimum the diet-only phase would need to be longer to identify if the metabolic rate can be maintained at a moderately restricted caloric level.

An interesting side point concerning metabolic rate was discovered during the metabolic measurement phase. On several different occasions (June 2, 3, 30 and July 5) the obtained values of oxygen uptake were extremely low (see Figure 4 for circled items). In fact, the values were not theoretically plausible as values were less than half of those obtained the week before (McArdle, et al., 1981). It was assumed during the first episode that machine failure accounted for the unlikely numbers. Exactly four weeks later the presumed malfunction occurred again. The machine was recalibrated but the same values were obtained. Upon graphing the data there appeared to be a pattern. The time frame of 28 days, the average length of a menstrual cycle, was noted. Further exploration clarified that the two individuals (Subjects Two and Three) with the largest deviations in oxygen values had menstrual cycles that coincided with the two "faulty data periods". The third subject (Subject Four) whose oxygen values were low could not provide definitive data. She had had a partial hysterectomy and did not have a complete menstrual cycle. This individual still had her ovaries, however, and consequently, the hormonal changes
that are believed to effect metabolic rate (Solomon, Kurzer, & Calloway, 1982). Subject One who had the smallest deviation in oxygen values had a cycle that was approximately two weeks different than the two "faulty data periods".

Upon looking in the literature it was discovered that other researchers had hypothesized changes in the metabolic rate due to the menstrual cycle but the research was not definitive (Solomon, et al., 1982). Solomon, et al. (1982) reported that the pattern is for the metabolic rate to drop at the beginning of the cycle and slowly increase to normal within approximately two weeks. It seems reasonable to assume that individual differences could be great and that it is likely not every female would exhibit the same pattern. The important point is that if a female experiences more than a 50% reduction in metabolic rate for several days coinciding with her menstrual cycle it may not be wise for that individual to begin a diet during that period. For those individuals already on diets, it may be helpful to increase exercise during that period in order to offset a reduced metabolic rate. Many women experience food cravings and increased calcric intake during their cycles. An increase in intake of calories and a reduction in calories burned, might result in weight gain and/or plateaus during this period. This gain could erroneously be chalked up to water gain.
Difficulty losing weight during this period may have been the cause of numerous diet failures. One could hypothesize that histories of unsuccessful dieting cycles correlate fairly highly with fluctuations in menstrual cycles. The additional treatment week was included to attempt to verify the possible drop due to the menstrual cycle. Unfortunately, the drop did not occur. The measurement was not done on day 28 and perhaps accounts for the failure to find a third drop. There is still the possibility that any metabolic rate cycle is irregular, as is frequently the case with the menstrual cycle.

This study was primarily a treatment study designed only to answer three questions with regard to metabolic rate. These were: 1) What happens to the resting metabolic rate with moderate caloric restriction vs. caloric restriction and exercise?; 2) Can weight loss be obtained without reduction in metabolic rate?; and 3) Can metabolic rate be measured consistently and practically?

The first question concerning the effects on metabolic rate with and without exercise was only partially answered. The literature supports that a reduction in metabolic rate would occur with severe caloric restriction within the one and two week period of the diet-only treatment (Apfelbaum, et al., 1971). Only Subject Two demonstrated a drop in metabolic rate which was not entirely the expected result. As noted earlier
this design did not allow for a clear statement regarding how the stability of the metabolic rate was obtained. It is not known whether the moderate caloric restriction or the combination of moderate restriction and exercise was responsible. Perhaps, the correct answer to question one is that there are marked individual differences with respect to their response to caloric restriction. In future studies, the diet-only phase needs to be lengthened and replications of this result sought.

Again, this design may not have answered question one. There was a reason the diet-only phase was not lengthened until a drop in metabolic rate occurred for Subject One. The justification for not lengthening the diet-only phase was the treatment goal of producing weight loss without reduction in metabolic rate. Thus, efforts were made to utilize independent variables that logically would seem to be appropriate or had been demonstrated to least effect or actually enhance the rate. A modest reduction in calories was chosen as studies had indicated severe restriction produced a drop in rate (Apfelbaum, et al., 1971). (Also keep in mind that Subject Two was strongly encouraged to eat more during the diet-only phase so that her metabolic rate would not change.) Exercise had been demonstrated to increase the metabolic rate for a period of time (Donahoe, et al., 1984; Epstein, Woodall, Goreczny, Wing, and Robertson, 1984; McArdle, et al.,
A high carbohydrate diet was chosen, in part because of the primary nutritional functions of carbohydrates for supplying energy and for "sparing protein".

Again the length of the diet-only period was preset arbitrarily rather than adjusting the time frame according to the results. When no reduction occurred for Subject One the decision was made to continue with treatment to: 1) Keep the subjects from quitting; 2) make use of the fortuitous stable rate; 3) and to maintain the integrity of the design for answering the other hypothesis regarding development of an exercise habit and the effects of exercise upon body composition.

The second question concerning exercise and weight loss without reduction in metabolic rate was answered in the affirmative. Three of the four subjects moderately reduced their calories, exercised and did not demonstrate any reduction in metabolic rate.

The answer to the third question concerning the practicality of metabolic measurement is more difficult. The equipment is expensive and not widely available. Also the time and effort required from the subjects was fairly extensive. Each subject participated over twenty-four hours in just the metabolic measurement task. To cut down on time, it is possible that weekly measures could be utilized. This would only be recommended after obtaining a
very stable baseline. A lengthy baseline period is specifically recommended for females. The problem with the very low values that coincided with the menstrual cycle provides at least one reason for using more than weekly measures. There is reason to believe these fluctuations would be different for every female.

The timing of the actual measurements is also important. Measurements must be done as close to awakening as possible and in conjunction with a normal sleep cycle. This makes measurement other than during the night or early morning impossible. Because of the nature of the measurement and the schedule of the experimenter this time period had to be between the hours of 8:30 and 10:00. Individuals who were not available during those hours or perhaps worked night shifts could not be utilized as subjects. This was to obtain a measurement that was as close to actual resting rate as possible. The subjects were required to rest for 30 minutes prior to the actual measurement to counter the effects of activity inbetween awakening and arriving at the measurement site. These subjects were up one to two hours prior to measurement. Night shift people would have been up anywhere from eight to sixteen hours prior to the measurement period and likely to have engaged in some heavy activity. An accurate resting rate could not have been measured given those circumstances and would definitely not have been
comparable to the subjects measured. If one were to transfer the feasibility of this procedure to a weight clinic the measurement of any individual's metabolic rate would have to coincide with that particular person's sleep cycle. However, it would need to be noted that if an individual's sleep cycle differed from the normal day/night cycle or the pattern was not consistent the obtained measures might not be entirely accurate. The measures could be obtained in a weight clinic but the schedule would need to be flexible.

Even though the equipment for measuring metabolic rate is expensive with limited availability, research studies need to incorporate this measurement. One appropriate use of metabolic testing would be for developing treatments for the moderate to severely obese. Current treatments for the moderate to severely obese can be very expensive (e.g. surgery) or do not have high success rates for maintenance (e.g. very-low-calorie diets). The purchase of metabolic equipment might be justified if the procedure provided specific information about the impact of very-low-calorie diets upon metabolic rate. This information could then be used to suggest possible avenues of treatment and to monitor progress.

Despite problems with the measurement of the metabolic rate that have been described it is believed that the measures obtained were valid. This is inferred
by comparing the measures obtained in this study to average measures published in tables (McArdle, et al., 1982).

There appeared to be a non-specific effect of the metabolic measurement. The emphasis on metabolic rate and the feedback provided during the measurement process seemed to help the subjects maintain their caloric intakes fairly close to the recommended levels. Subjects verbalizations indicated that they found the feedback and measurement process important for helping them maintain the recommended intakes. The recommended intakes were higher than the levels each individual believed would produce weight loss. Each subject questioned that they needed to be eating less. Also, for Subject Three the metabolic measurement functioned as feedback and may have become a conditioned reinforcer as it resulted in an increased exercise frequency. Subject Three became interested in observing the effect of an increased exercise frequency upon the metabolic rate. Although no significant difference was noted in the metabolic rate, she was able to express pride in her accomplishment and the exercise continued. Subject Four verbalized that the frequent monitoring and availability to feedback from the experimenter helped her maintain her "focus" on her program.

The design used was not conducive to clearly
identifying that the measurement process functioned as a cue and/or reinforcer for appropriate eating/exercise behavior. However, during the maintenance phase, when there was no measurement, adherence to food exchanges was not as close to the recommended amounts.

The graphs of caloric intake and food exchanges also demonstrate a change from baseline to treatment for all subjects. The initial behavioral procedures utilized to obtain this effect included: self-monitoring and two stimulus control procedures - instructions for a specific number of each exchange, and the use of special food exchange recording forms. Other antecedent control procedures (e.g., eating in one location, purchasing food from a list, no other activities while eating, etc.) were not introduced until the second week of treatment. Procedures such as contracting, goal setting, and positive reinforcement were introduced later.

But what other ingredients might explain the excellent adherence to treatment recommendations for food exchanges? Numerous studies have demonstrated that self-monitoring can effectively alter an individual's eating behavior (Corriga, Zegman, Crusco & Malone, 1987). Buxton, Williamson, Alisher, & Warner (1985) have also demonstrated that individuals will reduce caloric intake when instructed to do so but would not necessarily choose balanced meals. They found the simple instruction to
choose from a range of acceptable items from each food group resulted in a balanced diet. The subjects in this study were given a specific number for every exchange, not simply a range. It is also believed that the dieting experience of each of these subjects was one reason for their success. They knew much of the food exchange information.

Perhaps the biggest factor for successful adherence was that this particular diet was enjoyable. The prescribed diet was composed of 50-60% carbohydrates, approximately 30% protein and only approximately 10% fat. The diet included many of the enjoyable foods that are frequently not on diets (e.g. spaghetti, bread, potatoes, etc.). Given the reduced caloric intake prescribed for each individual, some foods would be limited but for the most part food items such as ice cream were legal. The instructions were that any food item was legal but had to be counted. All the subjects made numerous comments of appreciation that they could have their favorite foods and that they really liked the diet. They also indicated they believed they were learning food choices they could live with the rest of their lives. Subject Four commented several times that she "didn't feel deprived." As she described past diet experiences it became clear that her usual pattern was to severely limit her intake. As often happens with dieting, this individual would then binge.
(Polivy & Herman, 1985). In fact, Subject Four had just lost 100 pounds on a very-low-calorie diet and had regained the large majority of her lost weight in less than a year. It seemed she had set herself up for a cycle of restriction/binging by focusing on eliminating "fattening" foods.

Another factor in helping to promote adherence was that the caloric intakes were moderately high for a diet - 1325 - 1435 calories. No one complained of being hungry. On numerous occasions when subjects were encouraged to eat their allotted amount (to maintain a stable metabolic rate) the response was "I can't eat that much".

The final factor that helped these subjects maintain good adherence to the recommended food exchanges was the feedback they received from the various target measures - weight, body fat percentage and resting metabolic rate. Three of the four subjects lost weight at the expected rate of one to two pounds weekly on caloric intakes that they considered to be high. Subject Two did not lose as much because of the failure to consume enough calories and her reduced metabolic rate. By utilizing body fat measures subjects were able to see the content of their losses. When several of the subjects failed to eat enough they were able to see that the losses obtained were mostly water and lean mass and not fat. As the caloric intakes increased the feedback became fat loss and
adherence to caloric intake remained consistent. The metabolic data provided the feedback that the diet was sufficient and that their body was not compensating for too few calories. Towards the end of the treatment phase it was necessary to encourage Subjects Three and Four to be less strict in their adherence to their food exchanges in order to practice eating in a more normal manner.

The primary hypothesis concerning exercise was that an exercise habit could be developed by utilizing stimulus control of the subject's environment (e.g. researcher supervised exercise); teaching stimulus control procedures to subjects; and utilizing goal setting, contracting, and positive reinforcement. The initial six weeks of exercise was a required low-impact aerobic class conducted by the researcher. During this course one form of appropriate exercise was modeled and practiced. One goal was to obtain improvements in fitness to reduce possible injury that might sabotage any future fitness program. A second goal was let the subjects come in contact with the natural reinforcers of exercise (e.g. more energy and less fatigue, stress reduction, and improvements in physical condition (Thompson, et al., 1982). To help maintain exercise behavior until the natural reinforcers could take over the subjects were were paid for attendance. This approach was successful for two of the subjects who attended all classes. The scheduling
of the exercise class was fairly inflexible. Had it been possible to rearrange the schedule all of the subjects might have attended every class. The two subjects who were unable to attend every class had important, unavoidable schedule changes. Unfortunately, these individuals were not completely successful in developing exercise schedules on their own.

When it became obvious there was a problem with exercise adherence an analysis of one of the successful individuals was done (Subject Three). It was found she maintained an individual exercise schedule of walking in addition to the supervised exercise. The analysis indicated that she had social support for exercising (e.g. husband and friends walked with her). An attempt was made to arrange social support for all subjects by setting up group exercise without the instructor available. This procedure was successful for Subjects One and Three who maintained a reasonably consistent walking schedule together for approximately two months. Subject Four failed to rejoin Subjects One and Three as the pace of the exercise was too strenuous and was not enjoyable.

Social reinforcement/support was helpful to Subject Two within a structured program of her choice. However, during the treatment period Subject Two's schedule continued to make exercise with the group difficult. She instead joined a softball team which was
her exercise. Although softball is generally not considered aerobic, Subject Two would act as pinch runner to increase the intensity of her workout. The duration of the activity well exceeded the thirty-minute requirement. Subject Two's lifestyle was hectic and during the treatment and maintenance phases there were family problems that made consistent exercise difficult. Finally, after several attempts to encourage her to walk on her own, she stated she was not even going to attempt exercise until September when she had joined an aerobic class. From September 15 to December 13, Subject Two reported exercising consistently 2 - 3 times per week. Although there was no observational check on her exercise, two of the target measures provide indirect evidence that exercise must have occurred. The body fat percentage at the five-month follow up indicated that despite no continued loss of pounds this individual lost additional body fat. Also, the physical fitness measure indicated significant improvement in physical fitness (i.e. from poor to good). These two results are unlikely without exercise.

Subject Three who did well in the experimenter-conducted exercise class was able to maintain exercise. Social support and structured exercise schedule were the two ingredients that were crucial to this result. Subjects One and Four did not have this structure.
It was believed that maintenance of losses would be improved if the metabolic rate remained stable throughout treatment, the appropriate food choices were maintained and exercise was maintained. At the five-month follow up all subjects maintained the losses they had achieved by the end of the treatment phase. The metabolic measurements obtained indicated that the resting rates remained essentially equivalent to the rates at the end of treatment. In fact, for Subject Two, who was exercising, the resting metabolic rate was much higher. However, only one measure was obtained at the follow up on this individual and the measure could have been inflated. There was a five-month break from the procedure and Subject Two could have been uncomfortable which would effect the measure. The data on the caloric intake and the food exchanges also indicated that the food choices were relatively similar to the treatment recommendations. The body fat percentages also were similar or lower indicating maintenance of fat losses. All subjects either maintained or improved fitness levels.

The report of minimal exercise (e.g. only Subjects Two and Three reported exercising during the follow-up period) was a factor of concern. Subjects One and Four reported no exercise. Subject One had lost additional weight during the maintenance phase, but had regained to post-treatment levels. The data on food exchanges
indicated her eating behavior was satisfactory. The probable reason for the weight gain was the lack of exercise. Subject Four continued to lose weight during the maintenance phase although she did not report much exercise. The loss during the five months from post-treatment was only ten pounds. If this subject had continued to maintain the caloric levels as indicated during follow-up, with the addition of exercise the losses probably would have been higher.

It needs to be noted that all subjects were given the instruction to maintain their food choice and exercise behaviors and to focus on maintaining their losses but not increasing them during the maintenance phase. Any additional reinforcement from weight losses may have helped to more successfully encourage the maintenance of exercise. This instruction was given to encourage a "shaping process" where each individual worked toward their goal weight in increments. It was also to provide a period in which the body could stabilize at the new reduced weight. The evidence from the literature is that when metabolic rate is reduced it does not immediately increase upon a refeeding diet (Apfelbaum, et al. 1971). Although no reductions in rate were found during the diet/exercise phase, a stabilization period was still believed to be important.

In retrospect, it may have been more positive for
the development of a "belief that these subjects could be successful" had they continued to lose weight and maintained their exercise. It was hoped to give the subjects' metabolic rates time to recover if necessary. The decision to not encourage additional losses may have been similar to terminating treatment prematurely. Brownell & Jeffrey (1987) point out the uselessness of emphasizing maintenance when clients have not reached goal weight. They suggest longer treatment phases. Unfortunately, the time frame available did not allow for a lengthy treatment period. These subjects had made behavioral changes but demonstrated difficulty maintaining these changes as the primary reinforcer (loss) was not available and the natural reinforcers for proper food choice and exercise were not well established. To more successfully encourage maintenance of food choice and exercise behaviors during the period in which weight is to be stable, perhaps the continuation of metabolic testing would provide some reinforcement in the absence of weight loss. The data on metabolic rate at the five-month follow up indicated subjects rates remained essentially equivalent at lower body weights. This finding is suggestive that individuals can reduce their weights and maintain stable metabolic rates.

Originally there was no plan to continue following these subjects past the five-month follow-up, due to time
constraints. When the time constraints changed for the experimenter, three of the subjects were offered the option of reentering treatment. Recent research had demonstrated that longer-term treatments and/or maintenance programs are more useful for increasing losses and success of maintenance (Bennet, 1986; Brownell & Jeffrey, 1987; and Perri, McAllister, Gange, Jordan & McAdoo, 1988). The intention of this additional treatment was to facilitate additional losses and to focus on the individual problems encountered throughout the original program.

All subjects had indicated they had difficulty scheduling exercise whenever they got busy. One of the most frequent statements they made was "I don't have time for exercise." Subjects One and Four believed exercise to be important for weight loss alone but not as a valuable activity for physical or emotional health. Neither subject during treatment had successfully developed a routine exercise schedule. An additional factor for Subjects One and Four was that neither subject ever found a type of exercise they found really enjoyable nor did they experience the improvements in physical fitness. Treatment between the five-month follow-up and one-year focused on: choosing an enjoyable exercise, developing a schedule for exercise, providing short-term reinforcement for this exercise and identifying and changing any
irrational beliefs concerning exercise that were responsible for the failure to maintain exercise behavior.

Subject One had dropped out of the experimenter conducted exercise program during treatment to attend a class. Although she began exercising with another subject, the schedule maintained was determined by two factors: the other subject's schedule and her son's babysitters schedule. Subject One never set aside any time for independent exercise.

Subject One was lost during this additional treatment period. Although several phone messages were left for this individual she did not recontact the experimenter. At the one-year follow up she had regained her treatment losses and gained additional weight. During this period, Subject One experienced many financial difficulties and depression. She reported that in addition to failing to maintain exercise behavior she also began to not choose foods wisely. The food data obtained during the one-year follow up period cannot be inferred to be a true reflection of her actual behavior from the five-month follow up to one year. This individual was unable to schedule any consistent exercise dating from the middle of the follow-up phase. The weight gain was easily predicted from the five-month follow-up data.

Subject Four stated she preferred to exercise on her own but insisted that she schedule her exercise around
her employment, family and household responsibilities. During the maintenance phase there were long periods in which Subject Four would not exercise until there was a request/encouragement from the experimenter. The behavior of planning exercise needed to be developed. During this second treatment phase Subject Four was able to identify her belief that she "didn't deserve special time for herself" and also that she would reward herself for working hard when she was feeling overworked by not exercising. I asked this subject to reread Your Erroneous Zones by W. Dyer and to design an exercise schedule. Utilizing extrinsic rewards for exercise failed because of the belief she had about not deserving anything special. However, when she identified her use of non-exercise as a reinforcement, she utilized this potent reinforcer by including breaks into her program. She picked certain days to exercise and on those days in which she was not scheduled to exercise she repeatedly reminded herself that she did not "have" to exercise that she was not scheduled to do so. She also discovered that having completed her exercise early in the morning became a source of pride and she was able to self-reinforce herself with the statement "I've already done my exercise for the day and I'm burning more calories all day." Upon the termination of this treatment period, Subject Four again began having difficulty maintaining her exercise. However, she had
identified that she needed external structure, cues and social support and was going to arrange to join a diet group to get such structure.

During this period Subject Three continued to maintain her diet plan but had much difficulty with the exercise plan. She began having physical problems with her foot that made it very painful to walk. She was encouraged to see a physician which she did. However, she went through a series of physician's until finally the problem was diagnosed. During this time she was encouraged to substitute other exercise that would be non-impact (e.g. swimming). Subject Three had chosen the exercise of choice to be walking and was reluctant to do other things. In addition, her schedule did not coincide with any schedule swim times at various pools. Eventually she was put on crutches and told to stay completely off her feet. Exercise was then eliminated. The weight gain for this subject at the one year follow-up was due to the decrease in exercise.

In summary, it is difficult to evaluate the success of the extra treatment. One subject was lost and another subject was physically injured and unable to participate in part of the treatment. One of the three subjects successfully lost additional weight and demonstrated an increase in exercise.

Unfortunately, Subject Four reported no exercise
during the one-year follow up period. According to this subject she had continued to exercise as per the last contract, but the follow-up week was especially busy for her. For Subject Two the one-year follow up fell after her aerobics class had recessed for the summer. It is possible that the results of the follow up were not representative and a longer period or several periods would have been better. However, a more likely explanation is that these individuals had not developed exercise schedules that were consistent. For example, Subject Two exercised only during Fall, Winter, and Spring when classes were conducted and Subject Four would exercise consistently for only short periods of time and then take several weeks off.

Future studies on exercise might clarify how regular exercise patterns need to be in order for a specific individual to maintain their losses and physical condition. The American College of Sports Medicine (1978) recommends thirty minutes, three times weekly. However, can a subject who exercises two to three times weekly for nine out of twelve months maintain losses and be considered a successful exerciser? Just as there are seasonal variations in food intake it needs to be recognized that exercise is a behavior that is frequently subject to changes in schedule. Certainly the ideal pattern is three times weekly but the definition of

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successful exercise adherence may need to be varied per individual.

Recommendations for Research

For years behavior weight control treatments have been considered to be successful because they focused on the alterations of maladaptive eating behaviors. Unfortunately, the research has not clarified these specific behaviors. To make matters worse the majority of research studies have failed to monitor and measure the actual changes in behavior and have focused on weight loss. It is further suggested that research has not actually focused strongly enough on the correct behavior changes. Instead of conceptualizing food choice and exercise as independent variables they need to be viewed as dependent variables and monitored and measured. Studies by Epstein and colleagues (1981 and 1987) are good beginning examples of such work. Additional target measures such as body fat percentage and resting metabolic measures will be important.

Directly verifying actual behavior changes is important for research. This study utilized a combination of observational measures to determine if the treatment was impacting upon food choice and exercise behavior. The experimenter conducted exercise program was designed in part as a reliability check on self-report of exercise.
There were also two invivo eating situations arranged by the experimenter to get reliability checks on the accuracy of food records (e.g. a group meeting in a restaurant and a potluck picnic.) The experimenter recorded the foods eaten by the subjects without their knowledge and then compared the records to the subjects' records. The comparisons obtained were quite similar. The second method of obtaining observational data on subjects' eating was to request family/friends to record what they saw the subjects eating. Subjects’ friends/family members were mailed stamped, addressed envelopes with instructions for recording to remind them to keep the data at the appropriate times. Initially, the requirements for being a subject included having a roommate/family member who would also participate in the program in order to obtain more detailed observational checks on data. It was not possible to obtain subjects under this prerequisite, however. The comparisons obtained from family and friends were not accurate for portions, but, were quite useful for determining if all foodstuffs were recorded. The general tendency was that the subjects included foods that the observers missed. This data was combined with weight, body fat, and the physical fitness indicators in making the determination that treatment did impact on the behaviors and that the self-report data was reasonably accurate. Further refinement of the procedure of utilizing
family/friends for observation checks should include standardized forms, training these observers in the food exchange system and the estimation of amounts of food.

There are additional important recommendations for future research. Brownell & Jeffrey (1987) suggest that treatment be lengthened and subjects be followed until they reach goal weight. Brownell & Jeffrey (1987) also suggest stronger environmental control (i.e. providing food and/or exercise groups). This study demonstrated one way in which experimenter-controlled exercise could be successful. It is also recommended that refined observational checks by family/friends be studied and utilized. As the transition from experimenter- to self-controlled exercise is made the observational checks can provide data for evaluating the success of that transition and possible clues for solving any problems.

The target of resting metabolic measurement deserves special discussion. It is believed that research protocols need to include resting metabolic testing as one of the dependent measures. This study has suggested that by utilizing certain variables (i.e. moderate caloric restriction and aerobic exercise) that reductions in metabolic rate can be circumvented and weight loss achieved. It is still possible that the reduction cannot be circumvented in all cases. But perhaps unavoidable reductions in metabolic rate can be corrected with aerobic
exercise as has been demonstrated by Donahoe, et al. (1984). And finally, the metabolic measures may function as feedback that reinforces adherence to treatment recommendations for food choice and exercise. Despite the difficulties of time involved in obtaining these measures, it is believed that through the use of a metabolic cart this testing is feasible.

Treatment Recommendations

The recommendations for clinical treatment of obesity are fairly common sense and have appeared in numerous popular publications. The emphasis needs to be on learning appropriate eating/exercise behaviors and slow losses. The clinicians job is to utilize strong stimulus control and reinforcement procedures that will help the client focus on behavior change. Weight loss cannot be the major goal. To accomplish the defocus upon weight loss, clinicians need to understand the physiology of weight loss (specifically the effects of caloric restriction upon metabolic rate) and the contributions of nutrition and exercise to weight loss. It is the clinician's job to reeducate the client as to appropriate methods for weight loss. Clients need to be provided with an understanding of the physiology of weight loss and an explanation of why different diets/exercises work. One way in which weight loss can be defocused is to emphasize
the importance of fat loss and utilize frequent body fat percent measures. In conjunction with weight loss, the feedback on pounds of fat lost provides both cues and reinforcers for appropriate food choices and exercise.

It was assumed in past research that once behavior control techniques were taught that additional losses would automatically occur and treatment was short. Unfortunately, the actual use of behavior techniques has been assumed to occur. The consequence has been that additional losses have been found to be minimal. Brownell and Jeffrey (1987) point out that longer treatments have produced larger losses and it is important to lengthen treatment. In fact, following individuals until they reach goal weight is suggested. This may improve our ability to defocus weight loss. It seems reasonable to assume that once weight loss is complete, that long-term eating/exercise behaviors can become the primary focus. In addition, the appropriate eating/exercise behaviors included in the treatment plan will have been practiced for a much longer period; thereby, increasing the chance of maintenance of those behaviors.

This study was not originally a test of a longer treatment period. There was an attempt to defocus emphasis on loss by limiting the amount of loss during maintenance and focusing just on changes in food choice and exercise. This ploy was not entirely successful.
Weight loss is a major reinforcer of appropriate food choice and exercise behavior. Without that natural reinforcement it was necessary to find other means of reinforcing appropriate behavior. Identifying potent reinforcers for clients needs to be individualized and can prove to be difficult. Clinicians need to also be aware of any irrational beliefs concerning diet and exercise that can sabotage the use of other reinforcers. A longer treatment period increases the probability that individual problems will be solved and appropriate behaviors can be practiced and strengthened.

This study emphasized finding those behavioral techniques that were successful with each individual. For two of the individuals the stimulus control techniques of instruction in specific rules for food choices and special self-recording forms was sufficient for obtaining adherence to the dietary treatment recommendations. The other two subjects required some additional tools such as menu planning and social reinforcement for following those menus.

Finding the appropriate behavioral tools to strengthen exercise behavior proved more difficult. Clients need to be educated not only in nutrition but in proper exercise. Many individuals do not have correct information concerning the benefits of various exercises. The experimenter provided exercise class was successful

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for two subjects in that they cooperated and attended class. It was also successful in that the subjects were introduced to the type of exercise that is most beneficial for weight loss. All subjects then began participating in aerobic types of exercise as opposed to traditional calisthenics. Improvements in physical fitness are also important for developing adherence to exercise. It is recommended that attempts be made to provide exercise until fitness improvements are made. The subjects in this study made improvements in fitness but they were not great. An emphasis on changing body composition and the feedback provided by the body fat measures also was important for improving adherence to exercise.

The subjects who performed the most exercise were those who had chosen not only an enjoyable exercise but one in which they had social support for performing. However, it must be noted that not all individuals were positively effected by social support and chose to exercise alone. Providing a structured group for exercise may not always function as social support. The individual may not be encouraged by fellow clients but may find encouragement from friends.

Probably most important, is that the individual’s attitudes about exercise and their lifestyle/schedule must be understood. Subject Three was most successful in her development of an exercise program. She chose an exercise
that was enjoyable and allowed her special time with her family. She also believed that exercise was something for emotional and physical health not just weight loss. She enjoyed and believed exertion to be important. The less successful subjects believed exercise to be painful and to be gotten "out of the way". They were less successful in finding an enjoyable exercise. These subjects when their schedules were busy were not likely to schedule time for exercising.

In summary, this study demonstrated that greater amounts of weight loss can be achieved with improvements in design, the addition of target measures such as resting metabolic rate and body fat percentage, and the conceptualization of food choice and exercise as dependent variables. These larger losses were obtained without reductions in metabolic rate and the losses were primarily fat losses. It was further demonstrated that changes in food choice could be made utilizing primarily stimulus control procedures. Maintenance of exercise was found to be more difficult to develop. This was believed to be primarily a result of inappropriate attitudes regarding exercise and not large enough improvements in cardiovascular fitness. The predicted improvement in maintenance of losses was not successful for all subjects. Three of the subjects maintained their post-treatment losses. The other subject gained 14 pounds.
over her starting weight. This result was predicted based on the failure to maintain exercise behavior at the five-month follow up. Various individual problems and solutions were discussed. It is suggested that the metabolic rate measurement provided useful information and needs to be included in future research/treatment. Despite problems with this study it is the hope that future researchers and clinicians will incorporate the recommended features of this program.
BIBLIOGRAPHY


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Figure 2. Weight for four subjects. B = Baseline, T1 = Diet only, T2 = Diet/exercise, M = Maintenance
Figure 3. Daily Calories for Four Subjects. Broken Horizontal Line Represents the Recommended Level. B = Baseline; T1 = Diet-Only; T2 = Diet/Exercise; M = Maintenance.
Figure 4. Metabolic Rate/Kilogram Body Weight for Four Subjects.
B = Baseline; T1 = Diet-Only; T2 = Diet/Exercise; M = Maintenance.
Figure 5. Body Fat Percentages for Four Subjects. B = Diet-Only; T2 = Diet/Exercise; M = Maintenance.
Figure 6. Duration of Aerobic Exercise in Minutes for Four Subjects. B = Baseline; T1 = Diet-Only; T2 = Diet/Exercise; M = Maintenance.
Figure 7. Number of Milk Exchanges for Four Subjects. Each Exchange Equals 80 Calories. Broken Horizontal Line Equals Recommended Level. B = Baseline; T1 = Diet-Only; T2 = Diet/Exercise; M = Maintenance.
Figure 8. Number of Fruits and Vegetable Exchanges for Four Subjects. Each Exchange Equals 40 Calories. Broken Horizontal Line Equals Recommended Level. B = Baseline; T1 = Diet-Only; T2 = Diet/Exercise; M = Maintenance.
Figure 10. Number of Protein Exchanges for Four Subjects. Each Exchange Equals 70 Calories. Broken Line Equals Recommended Level. B = Baseline; T1 = Diet-Only; T2 = Diet/Exercise; M = Maintenance.
Figure 11. Number of Fat Exchanges for Four Subjects. Each Exchange Equals 45 Calories. Broken Line Equals Recommended Level. B = Baseline; T1 = Diet-Only; T2 = Diet/Exercise; M = Maintenance.