Reinforcing and Programming for Generalization of Exercise with Obese and Non-Obese Boys

by

Rayleen V. De Luca

A thesis submitted to the Faculty of Graduate Studies in partial fulfillment of the requirements for the Degree of Doctor of Philosophy

Department of Psychology

University of Manitoba

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TO TROY & TREVOR

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I thank the De Luca Family for valuing my goals and understanding when academics took so much of my time -- Voglio ringraziare le famiglie De Luca per il loro sopporto e affetto in tutti questi anni. Vi amo a tutti.

I wish to thank my brother, Lenny Giacomin, for so much -- but especially for being there when I needed him. His humour, coupled with his unconditional love and support, were a source of strength to me for as long as I can remember.

I am grateful for the continual support of my mother, Elsie Giacomin, who always understood my goals. Whether she was proof-reading my manuscript, taking my calls, explaining my absences at social functions, or making pizza for the "Psychology Department Parties" -- she never complained. It is to my mother and the memory of my father I owe my aspirations -- and the knowledge that I have the ability to achieve them.

Finally, my special thanks goes to my husband, Vincent, and our sons, Troy and Trevor, without whose constant support and love, this thesis would not be possible at all. To Vincent, who convinced me to take that very first university course, I owe everything. His efforts and at times the sacrificing of his own personal goals were at the root of my motivation. To Troy and Trevor who are the "light of my life", I express my love and appreciation and to whom I dedicate my work.

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Abstract

The effects of a variable ratio (VR) schedule of reinforcement on exercising in obese and non-obese children were examined. Eight 11-year-old boys, four obese and four non-obese, participated as subjects. One obese and one non-obese boy served as a control for social attention and maturation effects. Three obese and three non-obese boys were individually tested five times weekly over approximately 12 weeks on a stationary bicycle. A changing-criterion design was used where 3 VR phases of 8 sessions each were followed by a 3 session mini-reversal phase and a 5 session return-to-third VR phase. Each successive criterion was increased over previous performance by approximately 15%. Implementation of the initial VR subphase produced marked increases in the rate of exercising for all children with continued acceleration until the withdrawal of reinforcement phase when rates decreased. Response rates recovered during the final VR phase where the highest rates were achieved for all subjects. Cumulative records demonstrated high stable responding with no discernible pausing for non-obese boys. In contrast, pausing and accelerating which were initially evident in the obese boys' records were eliminated with higher VR schedules. The anthropometric measures taken at the pre-experimental, post-experimental and follow-up time periods revealed that the

obese boys who participated in the program gained substantially less weight than children who did not participate. There appeared to be no systematic difference in self-reported food intake between obese and non-obese children. Actometer data, as well as parents' and teachers' written and verbal reports indicated that exercise on a stationary bicycle, intermittently reinforced, as well as training parents to utilize praise and attention for exercise, appeared to increase physical activity in the natural environment. A social validation questionnaire as well as informal observation revealed that participants, parents, and teachers rated the biking program most positively.

Reinforcing and Programming for Generalization of Exercise with Obese and Non-Obese Boys

Childhood obesity appears to be reaching epidemic proportions. Several researchers have documented that between 10% and 40% of all children are overweight (e.g., Abraham, Collins, & Nordsieck, 1971; Dwyer, Feldman, & Mayer, 1973; Garn, Clark, & Guire, 1975; Jones, 1972; Khan, 1981; Rauh, Schumsky, & Nitt, 1967). A recent survey of public schools indicated that over 20% of the students were overweight by the age of 11 (Manitoba Department of Education, 1978).

In spite of the once common parental concept that "a fat child is a healthy child", it has been repeatedly demonstrated that numerous physiological problems are related to excess weight during childhood. For example, obesity may contribute to a number of orthopedic disorders (Mann, 1974; Mayer, 1970; Mobbs, 1970). In addition, obesity in children appears to be related to decreased growth hormone release, increased insulin secretion, carbohydrate intolerance, and childhood hypertension (Brook, 1980; Chiumello, Guercio, Carnelutti, & Bidone, 1969; Drash, 1973; Ellison, Newburger, & Gross, 1982; Londe, Bourgoignie, Robson, & Goldring, 1971). As well as physical problems, social and psychological problems frequently plague the obese child (Israel &

Stolmaker, 1980). Very often, heavier children are discriminated against and devalued by their peers (Brownell & Stunkard, 1978).

Importance of Controlling Exercise Behavior

Research has indicated that obesity is often associated with physical inactivity (e.g., Bullen, Reed, Mayer, 1964; Cohen, Gelfand, Dodd, Jensen, & Turner, 1980; Johnson, Burke, & Mayer, 1956; Mayer, 1968; Rony, 1940; Stefanik, Heald, & Mayer, 1959). For example, Corbin and Pletcher (1968) investigated the relative contribution of diet and physical inactivity in the development of obesity. Diet records of 50 fifth grade children were collected over a 7 day period. During this week the children were filmed during regular physical education classes. The film was analyzed and an activity score was determined for each child. The children were assigned to one of four groups on the basis of degree of body fat. The four groups were then compared on diet and physical activity levels. The results indicated that obese children ate no more than non-obese children nor did they consume differing amounts of protein, fat or carbohydrate. However, the obese children were significantly less active in all activity situations than their non-obese peers. The relative inactivity of the obese children taken in conjunction with the relatively similar diets of all children, regardless of body fat, supports the conclusion that inactivity is especially important in the development and

maintenance of childhood obesity. In a review, Stimbert and Coffey (1972) corroborated this conclusion, indicating that lack of exercise may contribute significantly to obesity in children.

While the literature appears to support the contention that the obese are less active than the non-obese, some researchers claim that the obese actually expend an equal or even a greater number of calories during equivalent activities than do their lean counterparts (Waxman & Stunkard, 1980). For example, Waxman and Stunkard found that activity values based on time-sampled activity assessments were significantly lower for four obese boys as compared to four non-obese boys. However, when the activity values were converted into energy expenditure by oxygen consumption measurement, there was no significant difference in energy expenditure between the obese and non-obese children. These findings support the view that when the obese do participate in physical activity, they expend more calories than do their non-obese counterparts.

On the other hand, Dietz (1983) suggested that energy expenditure during activity has not been shown to differ significantly for obese individuals from that in normal controls. Moreover, Corbin and Pletcher (1968) investigating 50 fifth-grade students, demonstrated that not only were the obese children less active, but also that their energy expenditure figures were

significantly lower than those for non-obese children. Nevertheless the results of all of these studies (Corbin & Pletcher, 1968; Dietz, 1983; Waxman & Stunkard, 1980) demonstrate the importance of incorporating exercise into the obese children's lives. Although the evidence relative to energy expenditure itself appears conflicting (e.g., Bloom and Eidex, 1967), there can be no doubt that when the obese do exercise, they expend more calories than when they do not exercise.

Behavioral Treatments Emphasizing Exercise

Thus from a practical point of view in treating obesity, it seems essential to implement a program to generate and increase exercise. Of course any program which targets increased activity must determine the child's physical capacity for participation prior to its implementation (Dauer, 1962). While restricting calories may be detrimental to a child's health (Brook, Lloyd, & Wolff, 1974; Mayer, 1980; Merritt, 1978), there are several major benefits of increased exercise, including increased caloric expenditure, and improved cardiovascular condition (Bjorntorp, 1976; Bray & Bethune, 1974; Naughton & Hellerstein, 1973; Horton, 1974). Mayer (1980) claimed that the "best diet is exercise", and expounded on exercise as the "real reducer". However, the role of exercise in weight control has been sadly neglected in the research. As LeBow (1984) aptly pointed out: "Moving more is

neglected in childhood obesity treatment" (p. 149). Coates and Thoresen (1980) lamented similarly, noting that far more programs treating obesity with children and adults focused on reduction of caloric intake than on increases in caloric expenditure: "This disparity is striking in view of consistent research findings regarding differences in activity levels, but not differences in caloric intake between obese and non-obese persons." (p. 250) Mayer (1980) emphatically warned that while programs attempting to restrict caloric intake are generally unsuccessful, that if a child were able to maintain the restricted amount of food, normal growth may be inhibited. In view of the fact that an increase in height sometimes helps to rectify the obesity problem, to jeopardize this growth seems unwise.

A number of studies with children and adults have included exercise management advice along with dietary counselling (e.g., Aragona, Cassady, & Drabman, 1975; Botvin & Williams, 1979; Brownell & Kaye, 1982; Carman, 1976; Epstein, Koeske, Zedansek, & Wing, 1983; Gross, Wheeler, & Hess, 1976; Hammar, Campbell, & Wooley, 1972; Kahle et al., 1982). However, adherence to the exercise program is usually impossible to confirm and it is equally difficult to determine whether the dependent variable, i.e., weight, was affected by caloric reduction, caloric expenditure or a combination of both. Many researchers ask that

their obese subjects increase their physical activity. For example, Merritt and Batrus (1980) recommended walking or biking, while Foreyt and Goodrick (1981) proposed swimming and jogging. However, they offered little advice as to how obese persons should program an exercise regime into their lives. It is interesting to note that Epstein et al. (1983) pointed out that their program which stressed caloric restriction, but included nutrition and exercise counselling as well, demonstrated that weight losses in obese children were related to improvements in fitness. However, the authors concluded: "The relationship of weight loss and final weight achieved to fitness changes provides no data on the relative importance of diet or exercise to this effect" (p. 657).

In a more recent study, Epstein, Wing, Koeske, and Valoski (1984) compared diet, diet plus exercise and no treatment control groups involving obese children and parents from 53 families. The results indicated that after 6 months parents and children in both treatment groups had equal or better weight changes than members of the control group. However, after 1 year parents given diet and exercise advice showed significantly greater weight losses than parents given diet programs alone. On the other hand, no treatment differences were found for children after 1 year. The authors hypothesized that the children did not benefit from the exercise component, due perhaps to poor adherence to the exercise

regime. Indeed one of the factors contributing to the lack of research in this area may be that although the benefits of exercise appear obvious, it is often very difficult to motivate the obese individual to partake in physical activity (LeBow, 1981, 1984). For example, it is a particularly difficult task for teachers to entice overweight children to participate in physical education programs (Sherrill, 1976). Certainly research has indicated that obese subjects are more likely than non-obese subjects to drop out of exercise programs (Dishman & Gettman, 1980; Martin & Dubbert, 1982; Massie & Shephard, 1971). As Brownell (1983) suggested: "Despite its benefits, exercise is useful only to the extent that it is undertaken. Exercise is not popular among people in general and even less so among the obese" (p. 77). For the overweight child, the negative consequences of physical discomfort and social punishment for appearance when exercising are immediate, whereas the positive consequences of improved appearance and physical fitness are remote.

There have been a number of behavioral studies with adult subjects which have demonstrated the utility of an exercise program in which the reinforcers are more immediate. For example, Wysocki, Hall, Iwata, and Riordan (1979) used behavioral contracting to encourage college students to exercise. Subjects deposited items of personal value with the experimenter which they

could earn back on fulfillment of contract contingencies. Keefe and Blumenthal (1980) demonstrated that a combination of stimulus control and self-reinforcement procedures were effective in the acquisition and maintenance of a walking exercise program for three middle-aged overweight males. Reinforcement techniques have also been used to increase attendance at exercise sessions (e.g., Dahlkoetter, Callahan, & Linton, 1979; Stalonas, Johnson, & Christ, 1978).

Many researchers profess that children will profit from increased activity. For example, Seltzer and Mayer (1970) emphasized that 350 obese elementary and junior high school students benefited from incorporating more physical activity into their lives, along with dietary education and psychological support. Later, Nelson (1977) suggested that school-based exercise programs be implemented as a first step towards prevention of obesity in children. However, seldom are such recommendations followed; nor are recommendations made as to how a practitioner can get children involved in exercise programs. As Brownell and Stunkard (1980) stated: "Prescribing a physical fitness program to obese patients requires more than exhortations to 'shape up'" (p. 308).

The benefits of utilizing behavioral principles of reinforcement to increase physical activity with obese children

have been demonstrated in recent studies conducted by De Luca and Holborn (1985, in press). De Luca and Holborn examined the effect of a fixed-interval (FI) schedule of reinforcement on exercising in obese and non-obese children. Four grade 5 boys, two obese and two non-obese, were individually tested in a school setting three times weekly on a stationary exercise bicycle. After a 20 session baseline, the 10 session FI 1 min schedule of reinforcement was implemented, followed by a 5 session return to baseline. During the contingent reinforcement phase, a bell and a red light were programmed to activate simultaneously after the first response following each 1 min interval, thereby constituting one token. Tokens could be accumulated and traded in for prizes later. The introduction of the FI schedule of reinforcement produced immediate, substantial increases in the duration of exercise for both obese and non-obese children. On the other hand, rate of exercise, as measured by speed of bicycle pedalling, which was not reinforced, rapidly declined for only the obese subjects; the rate of exercise for the non-obese subjects remained high and constant. We suggested that the obese children appeared more sensitive to the contingencies in operation, i.e., they increased the duration of bicycling when they were rewarded for same, but did not increase the rate of pedalling, as it was not rewarded. On the other hand, the non-obese children did not come under control of

the FI schedule, and it seemed that the exercise itself may have been a conditioned reinforcer, in that they continued their rate of pedalling despite the temporal schedule of reinforcement. It was hypothesized that the differences in performance under the same schedule of reinforcement may have been due to differing behavioral histories for obese and non-obese children (see Weiner, 1983).

While there were certain limitations to the study, for example, lack of physical fitness tests, generalization tests and social validation assessments, the study appeared to be an important contribution to the area as it provided experimental data consistent with the observed activity differences in the natural environment between obese and non-obese children, under precise laboratory conditions. While the study demonstrated that behavior modification could be a powerful tool to increase exercise duration, De Luca and Holborn (in press) acknowledged that the decline in response rate of the obese boys did not enhance their caloric expenditure, and concluded that because the promotion of physical fitness is undoubtedly dependent upon both the duration and rate of exercise, investigating alternate schedules of reinforcement seemed crucial.

Therefore, an alternate schedule of reinforcement was examined by De Luca and Holborn (1985), who investigated the

effects of FI and fixed ratio (FR) schedules of reinforcement. Six 11-year-old boys, three obese and three non-obese participated in the study. One obese and one non-obese boy served as a control for social attention and maturation effects. The task for each child was again pedalling a stationary bicycle programmed to ring a bell and flash a red light simultaneously. The boys were individually tested five times weekly over approximately 10 weeks. An ABCB single subject design was used where A = Baseline, B = FI 1 min, and C = FR. The FR schedule was individually matched to each subject's mean frequency of reinforcement during the first FI 1 min phase to ensure that the average density of reinforcement maintained during the initial interval schedule was the same during the ratio schedule.

The results were similar to the earlier study in that the introduction of FI 1 min produced substantial increases in exercise duration for all subjects. Again, the obese subjects' response rate rapidly declined; however, the non-obese boys' response rate increased. Implementation of the FR schedule produced dramatic increases in the two obese and one non-obese subjects' response rates, and high stable responding was maintained by the other non-obese subject. While increased responding was evident for all boys, the non-obese boys pedalled at a consistently higher rate than the obese boys. Response rates

decreased for all subjects during the Return to FI 1 min phase. The increased duration of exercising was maintained during all contingency phases.

The results of the pre and post physical fitness tests conducted by independent physical education assessors, who were blind to the conditions of the experiment, revealed that subjects who participated in the biking program improved their physical fitness. Post physical fitness tests indicated a reduction in percent body fat for two obese and one non-obese subjects. Both obese boys and one non-obese boy improved on flexibility and agility tests of generalization. Every subject grew taller during the study and although every subject gained weight, the two obese subjects gained the least amount of weight. Thus it would appear that the obese may have expended more calories than the non-obese even though they did not pedal the bicycle as rapidly. This outcome may be viewed as being consistent with Waxman and Stunkard's (1980) findings that although obese subjects were significantly less active than non-obese subjects, there was no significant difference in energy expenditure. A social validation questionnaire, as well as informal observation, revealed that participants, parents and teachers rated the biking program very positively.

De Luca and Holborn's (1985) study corroborated the findings of their earlier work in that it demonstrated that exercise duration can be increased utilizing behavioral principles of reinforcement with children. The high rates of exercising established during the ratio schedule undoubtedly contributed significantly to the improvement in physical fitness achieved by all children. However, several important questions remain to be examined. For example, would an alternate schedule of reinforcement, e.g., variable ratio, be more effective in increasing and maintaining physical activity? Could the programmed exercise on a stationary bicycle be used to produce generalized increased physical activity in the natural environment? Did the physical fitness improvements maintain for any length of time? Did the exercise program increase, decrease or maintain caloric intake for the obese and non-obese boys? The present research specifically explored these issues.

Variable Ratio Reinforcement

Long, Hammack, May, and Campbell (1958), testing approximately 200 children, demonstrated that children's behavior could be controlled by means of various schedules of reinforcement. Children operating a telegraph key or Lindsley manipulanda were reinforced intermittently with trinkets, pennies and projected pictures. Analysis of the effect of ratio schedules

indicated that the performance of children was similar to that reported of other organisms and that ratio schedules exercised considerable control over performance. Indeed De Luca and Holborn (1985) found that the highest rates of exercising were established during a fixed ratio schedule of reinforcement.

On a Variable Ratio (VR) schedule of reinforcement, the number of responses required for reinforcement varies around a mean value from one reinforcement to the next. The characteristic effect of a VR schedule for most species is a high steady rate of responding (Ferster & Skinner, 1957; Schoenfield, et al.,1972).

A VR schedule of reinforcement was utilized in the present research to investigate its controlling effects with obese and non-obese children exercising on a stationary bicycle. Although reinforcement histories have been shown to influence current behaviors (see Baron & Galizio, 1983), research has indicated that ratio schedules may overcome history effects (Baron & Galizio, 1983; Kaufman, Baron, & Kopp, 1966). As high rates of responding with infrequent pausing are typically produced with humans and animals on VR schedules (Lowe, 1979; Orlando & Bijou, 1960), it was expected that the VR schedule would come to eliminate any pausing from the obese subject's response rate. With increased response rates, caloric expenditure would undoubtedly be greater and excessive weight gain might be curtailed.

Food Intake

Research with animals has indicated that appetite can be suppressed with moderate increases in activity (Katch, Martin, & Martin, 1979; Scalafani & Springer, 1976). While there has been little work conducted with humans in this area, there is some support for the notion that appetite decreases after moderate exercise (e.g., Bjorntorp, 1976; Epstein, Masek, & Marshall, 1978; Holm, Bjorntorp, & Jagenburg, 1978; Mayer, Roy, & Mitra, 1956; Oscai, Williams, & Hertig, 1968). The present research examined whether increased physical activity affects food intake by having subjects record daily caloric intake prior to and during the exercise program.

Generalization of Activity

Baer, Wolf, and Risley (1968) convincingly argued that "generalization should be programmed rather than expected or lamented" (p. 97). Stokes and Baer (1977) stated that generalization refers to "the occurrence of relevant behavior under different, non-training conditions without the scheduling of the same events...when some extra manipulations are necessary but their cost or extent is clearly less than that of direct intervention" (p. 350). The importance of developing a technology of programming the generalization of treatment effects has been emphasized recently by behavior analysts (e.g., Forehand & Atkeson, 1977; McLaughlin, 1979; Wildman & Wildman, 1975).

There is a paucity of studies in the area of childhood obesity and physical activity which have programmed for generalization of treatment effects. LeBow (1984) stressed that "Few behavioral weight-control regimens, decidedly too few, ever attempt to program lasting change, let alone to accomplish the feat" (p. 103). Similarly, Martin and Dubbert (1982) articulated the importance of maintaining exercise behavior past the "early and middle acquisition stages" (p. 1013). Further, Coates and Thoresen (1980) in their review of childhood and adolescent obesity lamented: "Altering physical activity patterns remains neglected. A few programs have been marginally successful, but strategies are needed to help young persons remain active after the termination of formal programs" (p. 255).

A recent study has demonstrated the benefits of generalization. Epstein, Wing, Koeske, Ossip, and Beck (1982) investigated the effects of lifestyle or programmed aerobic exercise, with or without dieting, on weight, fitness and exercise adherence with 37 obese children over a 17-month period. While the results indicated equivalent weight and relative weight change across all groups during the 8 weeks of treatment, the lifestyle subjects continued to lose more weight during maintenance and follow-up. The programmed exercise group's fitness tests showed greater improvement during the intensive treatment than the

lifestyle exercise group's. However, the programmed exercise group's fitness deteriorated during the maintenance period while the lifestyle group's fitness was maintained. In other words, when the treatment was over, children were more likely to stop the programmed exercise; however, the obese children who were in the lifestyle group were more likely to adhere to their increased activity, which included walking up stairs, walking instead of riding, etc. The authors suggested that "the lifestyle program provides the opportunity to make small and more varied behavior changes which are probably better incorporated into the person's routine than is a rigid schedule of programmed exercise" (p. 663). From a stimulus control perspective, it may be that the sight of the stairs, for example, sets the occasion for the obese child to walk up them; however, there really were not any stimuli in the natural environment which set the occasion for a rigid exercise program. It would appear that Epstein et al. (1982) programmed for generalization in their lifestyle program by taking advantage of the natural contingencies in the environment; however, a "train and hope" generalization technique (see Stokes & Baer, 1977) seems to have been utilized for the programmed exercise group. Certainly it appears quite evident that the authors were in support of the notion of programming generalization when they stated: "Since the effects of programmed exercise are better for

fitness...continued research efforts need to be directed toward developing behavioral treatments that foster adherence to programmed exercise" (p. 664). Epstein et al.'s (1982) research emphasized the importance of investigating methods to introduce physical activity into the obese child's lifestyle. As LeBow (1984) noted: "stimulus control of exercise behavior is rare" (p. 92). The present study addressed this issue by increasing and maintaining physical activity on a bicycle and programming for generalization in the home. Using a bicycle represents a technique of programming common stimuli whereby a prominent stimulus (the bicycle) from the natural environment is introduced to the laboratory and associated with reinforcement. The achieved stimulus control over pedalling behavior on the bicycle in the laboratory setting may thus be expected to generalize to a home bicycle. Natural reinforcers may then be obtained, as a bicycle can be used for lifestyle activities such as riding to school, the store, or a friend's home, instead of being driven in a car. Thus bicycling represents a particularly good choice of activity for examination of generalization of programmed laboratory activity to the natural environment.

In addition, research has shown that a partial reinforcement schedule can be used so that generalized behavior is maintained for long periods of time (see Kale, Kaye, Whelan, & Hopkins,

1968). Therefore, it was predicted that using a partial reinforcement schedule (VR) during training on the bicycle would enhance generalization.

In order to achieve lasting generalization, Martin and Pear (1978) stress "changing the contingencies in the natural environment so that they will maintain the behavior established in the training situation" (p. 166). Stokes and Baer (1977) and Baer (1982) also emphasize the importance of introducing "natural maintaining contingencies" to produce responding in the untrained setting. While research has demonstrated the effectiveness of utilizing schedules of reinforcement to shape and accelerate physical activity in the laboratory (e.g., De Luca and Holborn, 1985, in press), training parents to utilize social reinforcement to maintain exercise in the home seems clearly necessary. Indeed studies have demonstrated the benefits of including family members in treatment programs with obese children (see Brownell & Kaye, 1982). Parents are generally the major agents of reinforcement for children. Certainly parents have been taught to modify a number of behaviors, for example, pre-meal inappropriate behavior (see Bauman, Reiss, Roger, & Bailey, 1983). Training parents how and when to utilize praise and attention in the acquisition and maintenance of exercise behavior was also expected to enhance generalization.

In addition, it seems imperative to take advantage of pre-existing natural contingencies (Martin & Pear, 1978). Indeed research has indicated that behavior that can be put under control of peers will be maintained. Baer and Wolf (1970) refer to this phenomenon as "trapping". Trapping may occur when the child has developed bicycling behavior in the natural environment, that is, peers may reinforce the bicycling behavior by joining him on rides around the neighborhood. The present study investigated generalization by examining actometer readings (mechanical measure of gross motor activity), parents' and children's verbal reports of activity and the results of the follow-up physical fitness tests.

Method

Subjects and setting

Eight male 11-year-old children, whose parents consented to their participating in a study involving fitness tests, calorie counting and exercising on a stationary bicycle were chosen. Half of the subjects were obese and half were of normal weight (as defined by age, height, and weight norms, Demirjian, 1980; and skinfold thickness, Seltzer & Mayer, 1965). To qualify, obese children had to be at least 20% above average body weight for their age, sex and height (Demirjian, 1980), had to have no medical problems that contraindicated exercise, had to not be

taking medication that would affect body weight, and had to not be involved in a formal weight control program. The obese boys were at least at the 97th percentile for weight and ranged from 32% to 161.4% over the acceptable range for percent body fat. All obese subjects were classified as "overfat" (Department of Health and Welfare, 1984). Four non-obese boys were at, or slightly below, the 50th percentile for weight. Three non-obese boys were within the acceptable range for percentage body fat for boys and one was 5.5% over the acceptable range for percent body fat and was classified as "undesirable" (Department of Health and Welfare, 1984). The heights of six boys were within the normal range and two obese boys (one experimental and the control subject) were above the normal range. One obese subject and one non-obese subject received the pre, post and two follow-up physical fitness tests, but did not participate in the exercise program. Data from these two subjects served as a control for social attention and maturation effects. All testing was conducted in the nurse's room of an elementary school in Winnipeg, Manitoba.

Apparatus

A CCM stationary exercise bicycle, located in a small room, was programmed to ring a bell and illuminate a red light simultaneously after each variable number (VR) of responses during the contingency phases. Lehigh Valley and BRS electromechanical

modules were used for programming stimulus events and recording responses and reinforcements. The bell and light were programmed via electromechanical timers and relay circuitry. Each wheel revolution constituted a response and was recorded on magnetic counters. Folding 183 cm partitions were used to obscure the equipment panels from the subject's view. A 7 watt red light was mounted on the front middle panel of the bicycle in the subject's line of vision. The tension of the bicycle was set at moderately low resistance (2.27 kg) for all subjects throughout the study. A Ralph Gerbrands Company cumulative recorder provided a graph of the total number of wheel revolutions as function of time. Eight Timex Model 108 Motion Recorders (actometers) were used to mechanically measure gross motor activity. Each actometer was placed in a Velcro pod which was designed to both protect and cover the face of the actometer.

Experimental Design

This study utilized a single-case changing-criterion design (see Hartmann & Hall, 1976; Kazdin, 1982). The changing-criterion design is particularly suited to shaping behavior (Hartmann & Hall, 1976). Baseline was taken for three obese and three non-obese boys for eight sessions, until stability (see Kazdin, 1982) was achieved, after which the initial VR schedule was introduced. Eight sessions later, when responding was stable, the

second VR subphase was introduced. Following another eight sessions, when stability occurred, the third VR subphase ensued for eight sessions. To exhibit further control, a three session return-to-baseline phase was followed by a final VR subphase at the previous criterion, which lasted for five sessions.

Data analysis. Behavior modifiers typically employ the graphical techniques of single-subject research design. Theoretical and logical aspects of this research have been discussed by Johnston and Pennypacker (1980), Barlow and Hersen (1984), Dukes (1965) and Sidman (1960). There are several major advantages to using this approach in applied clinical research including "generality of findings" and "clinical vs. statistical change" (see Hersen & Barlow, 1976, pp. 37-55). Although research articles employing this strategy are increasing in the psychological journals (Barlow & Hersen, 1973), the utilization of this technique has been unfortunately "underrepresented" in obesity research (LeBow, 1981, p. 23). The present study utilizes single organism design and data analysis techniques outlined in Martin and Pear (1978, pp. 314-315) and Kazdin (1982).

Procedure

Throughout the study subjects were individually tested daily over approximately 12 weeks. The instructions given at the beginning of each session were identical for all subjects:

"Exercise as long as you like". No further encouragement was given. Recording began when the subject began pedalling the bicycle. The experimenter was seated behind the equipment panels out of the subject's view. Sessions terminated when the subject dismounted from the bicycle or when 30 min had elapsed, whichever occurred first.

Baseline. Prior to the first session each child was asked if he would like to exercise five times weekly on the stationary bicycle. During the first session, following the consent of each subject to participate in the exercise program, the instructions "Exercise as long as you like" were given. No stimulus changes occurred, nor was reinforcement administered during the baseline period. After eight sessions, the token economy was introduced.

Reinforcer survey. Reinforcement survey schedules (Cautela, 1977) were individually administered to each child during the first week of baseline. The responses were examined and 10 items from the preferred categories were selected as backup reinforcers. Subjects rated on a scale of 1 to 10 how much they "liked" each item. Higher costs were then assigned to the items with higher preference ratings.

VR (First subphase). The VR schedule of reinforcement was implemented during the 9th session, after a stable baseline had been achieved. The mean number of revolutions per minute during

the baseline was calculated for each subject. A separate ratio value was assigned to each subject during the initial VR phase on the basis of an approximate 15% increase over mean responding during baseline. For example, for the obese subject who pedalled a mean of 60 revolutions per minute during the baseline, his schedule was VR 70; whereas the schedule for the non-obese subject, who pedalled a mean of 70 revolutions per minute, was VR 80. This manipulation ensured that the shifts in density of reinforcement would be similar for subjects and that the first criterion would not be overly stringent. Prior to beginning the first session of this phase, subjects were allowed to examine the 10 backup reinforcers, tagged with the number of points necessary for purchase. They were advised that they may earn points by exercising on the bicycle to "buy" the items that they liked best. Subjects were told that each time the bell rang and the light went on, they would earn a point. At the end of each session, the subject received a tally of the number of points he had earned during the session and the cumulative total to date, which he could take home.

VR (Second subphase). The second VR schedule of reinforcement was implemented during the 17th session, when stability was achieved in the first VI subphase after 8 sessions. A separate ratio value was assigned to each subject on the basis

of a 15% increase over mean responding during the previous subphase. In other words, a different criterion for performance was specified for each subject, based on his performance in the previous subphase.

VR (Third subphase). The third VR schedule of reinforcement was implemented when stability was achieved for the second VR subphase, after eight sessions. Again, a separate ratio value was assigned to each subject during the third subphase on the basis of a 15% increase over mean responding during the previous subphase.

Return to Baseline. To provide further evidence of experimental control; the Return-to-Baseline phase was implemented after 8 sessions on the third VR subphase, when stability in responding occurred, and was continued for 3 sessions.

Return to VR Third Subphase. The subjects were returned to their individual third subphase schedules for the last 5 sessions, which coincided with the last 5 days of school prior to summer vacation for the children.

Pre, Post and Follow-up Physical Fitness Tests. Independent testers from the University of Manitoba Physical Education Department conducted four fitness tests for each subject: prior to the exercise study, at post treatment, at three months follow-up and at six months follow-up. Testers were blind as to

which students had participated in the bicycle exercise program. It was understood by the experimenter that the same testers would conduct the four fitness tests as research has indicated that utilizing the same testers eliminates errors that may exist among testers (Bray, 1976). However, due to "extenuating circumstances", the same testers were not available for the pre-treatment and post-treatment fitness tests. Test items included Height, Weight, Anaerobic Endurance, Flexibility, Agility Run, Aerobic Power and Percent Body Fat (as per protocol of "Manitoba Physical Fitness Performance Test Manual and Fitness Objectives"; Manitoba Department of Education, 1978).

Generalization of Activity. After the exercise program had been completed in the school, parents were instructed on how and when to use praise and attention for exercise behavior. Parents were asked to encourage their child to participate in lifestyle physical activities, i.e., walking instead of riding in a car, taking steps instead of elevators, doing errands by walking or riding a bicycle. Parents were assessed, through observation in the natural environment, on their skills in implementing the reinforcement techniques. Parents were encouraged to participate in physical activities with their children. Weekly visits were made by the experimenter to each experimental subject's home for

four weeks, following which parents were asked to record physical activities in which their son may have participated.

Generalization data included gross motor activity monitored daily using an actometer. Each child wore an actometer on his shoe. Actometers have been shown to provide reliable and valid information on individual differences in children's gross motor activity levels (Eaton, 1983). Actometer readings were monitored by each subject nightly before bedtime and were reported daily to the experimenter. Actometer readings were also taken by the experimenter at the beginning of each exercise session for the experimental subjects. Control subjects' actometers were monitored at the same time daily. The obese control's actometer reading was recorded by the experimenter at 1:00 p.m., and the non-obese control's actometer was monitored at 3:30 p.m. Actometers were not worn when exercising on the stationary bicycle in the school setting.

Physical fitness test results were also used to examine the effects of programming for generalization. It was predicted that the non-obese boys would be generally more "fit" at the beginning of the study and would maintain or improve their fitness. On the other hand, it was expected that while the obese might not be as physically fit at the beginning of the program,the bicycle pedalling would not only improve their fitness, but also would

increase their physical activity in alternate settings. This would be based on inferences from the anthropometric measures and verbal reports as well as from the physical fitness tests.

Social validation. Each subject was requested to fill out a questionnaire (see Appendix A) at the completion of the program, as well as the parents, home room teachers and physical education teacher (see Appendix B). The questionnaire ascertained whether there were any differences in the subject's physical activity and appearance from the beginning to the end of the program.

Food Intake Data. Parents were asked to record their son's daily food intake, with his help, each evening 2 weeks prior to and during the 12 week testing phases (see Appendix C). Caloric scoring was completed by a research assistant. To enhance compliance with data recording, children were advised that they could earn points for completing the daily food diary. Based on the research, it was predicted that there would be no differences between the food intake for obese and non-obese children (e.g., Cohen, Gelfand, Dodd, Jensen, & Turner, 1980; Corbin & Pletcher, 1968); however, it was expected that there may be a slight decrease in daily food intake for all children during the exercise phases (e.g., Epstein, et al. 1978; Holm, et al. 1978; Mayer, Roy & Mitra, 1956; Oscai, et al. 1968).

Results

The dependent measures were (a) the total time spent exercising per session, (b) the overall rate of responding per session (which was calculated by dividing the total number of revolutions per session by the total number of minutes spent exercising), and (c) the cumulative records.

Figure 1 shows the total time spent exercising by all subjects. Data points are absent for Perry for eight sessions as he was absent from school. It can be seen that during baseline there was a general decline over sessions in the amount of exercising for all subjects. Non-obese boys exercised a mean of 15.2 minutes per sessions while obese boys spent slightly less time pedalling ($\underline{M}$ = 12.9 minutes). The implementation of token reinforcement produced a substantial increase in the amount of time spent exercising by all subjects. Although one obese subject, Paul, did not exercise for the entire allotted period of time during the first session, performance of all subjects stabilized at the maximum of 30 min. All boys exercised the full 30 min during all contingency phases. Introduction of the Return-to-Baseline phase produced dramatic decreases in the time spent exercising for all non-obese and one obese boys. Peter, an obese subject, maintained the maximum performance of 30 minutes and there was only a slight decrease in the remaining obese

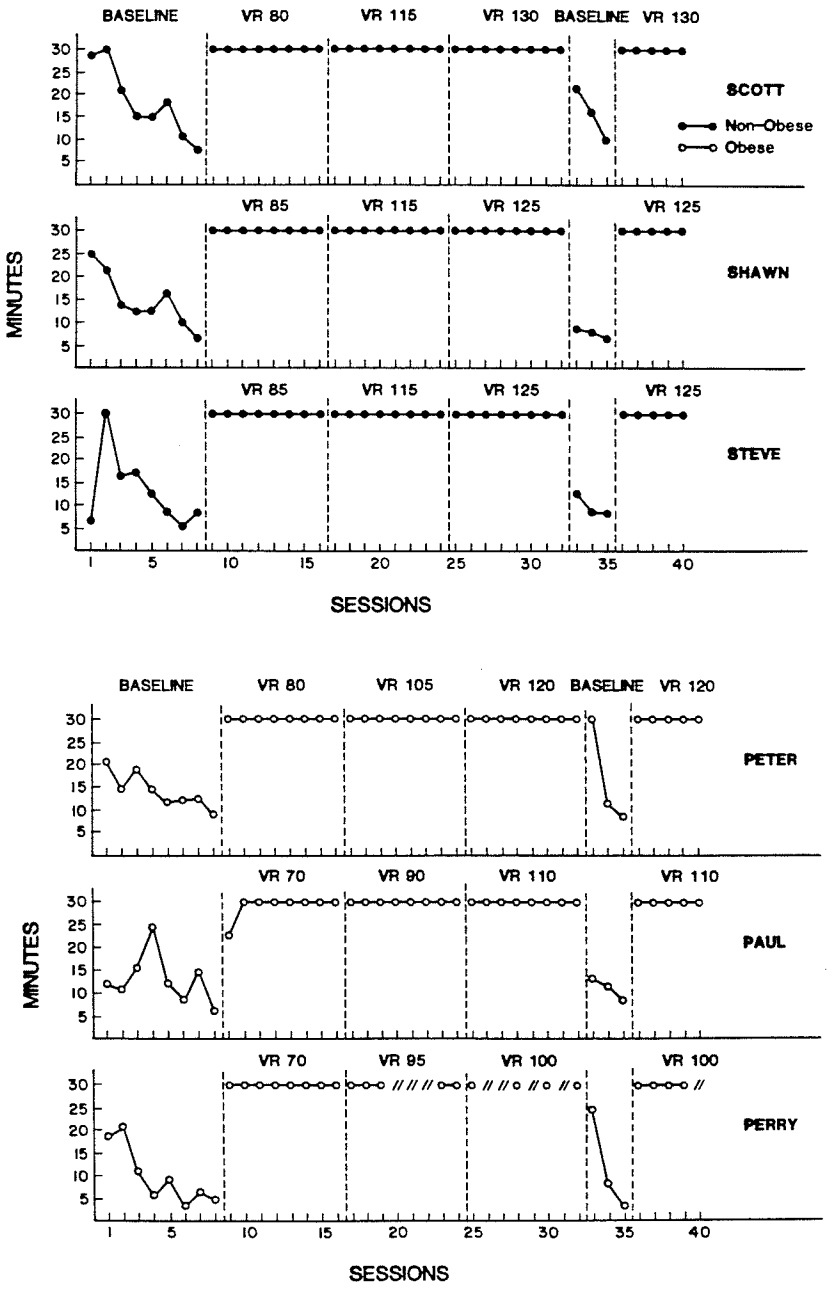

Figure 1. Total number of minutes spent exercising during Baseline, VR 1, VR 2, VR 3, Return to Baseline and Return to VR3 phases for obese and non-obese subjects.

subject's performance. However, the Return-to-Baseline phase produced decreases in the amount of pedalling over the three sessions for all subjects. Non-obese boys exercised a mean of 11.2 minutes per session during the Return-to-Baseline phase, while the obese children pedalled a mean of 13.3 minutes per session. The reintroduction of token reinforcement produced dramatic increases in performance and all subjects exercised the maximum of 30 min per session for the duration of the program.

Figure 2 illustrates the response rates for all subjects. During baseline there was some fluctuation in response rate with a gradual decline for two of the non-obese boys, Shawn and Steve. The response rate for the remaining non-obese boy, Scott, was relatively stable throughout the baseline phase. The non-obese boys responded at a mean of 71.9 revolutions per minute during baseline. For the obese boys, there was an initial increase in response rate, varying from an increase of 5 to 15 revolutions per minute. Performance was generally stable for two of the obese boys, Peter and Paul, during baseline. The performance of the remaining obese subject, Perry, continued to accelerate until the third session when there was a sharp decrement followed by stable responding. The obese boys responded at a mean of 59.2 revolutions per minute during baseline, which was 12.8 revolutions per minute slower than their slimmer counterparts. Upon

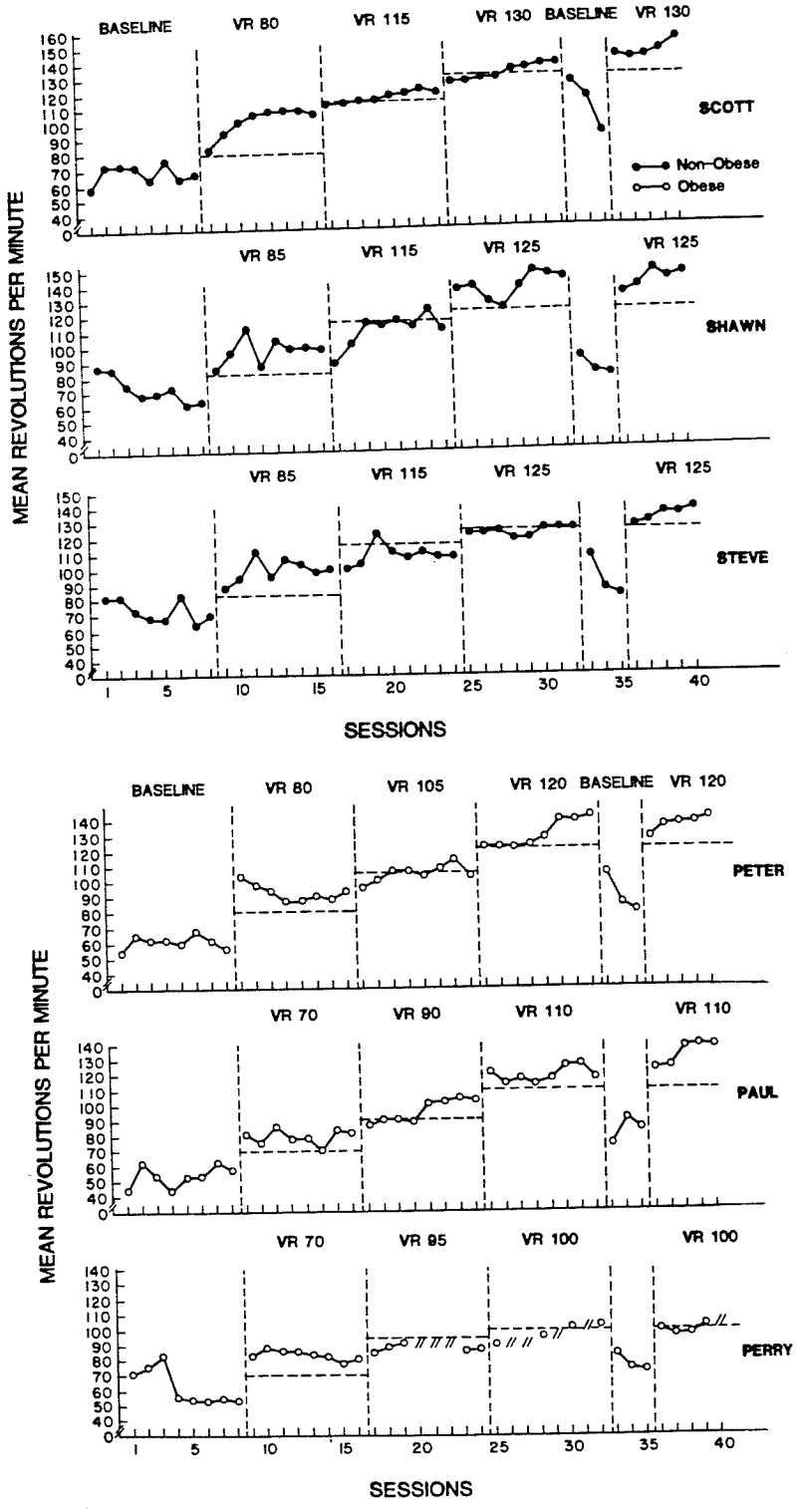

Figure 2. Mean revolutions pedalled per minute during Baseline, VR 1, VR 2, VR 3, Return to Baseline and Return to VR 3 phases for obese and non-obese subjects.

implementation of the initial VR schedules, response rates for all subjects increased dramatically. Performance was consistently above the criterion for all boys (i.e., criterion was set at approximately 15% over individual subject's baseline performance). The mean rate of responding during the first VR subphase was 98.89 revolutions per minute for the non-obese boys and 85.51 revolutions per minute for the obese boys. While there was an initial increase in performance for the non-obese boys, performance stabilized after the 13th session. For two of the obese boys, Paul and Perry, performance was relatively stable throughout the first VR subphase. However, while Peter's response rate had initially increased by 47 revolutions per minute (to 103 revolutions per minute), there was a gradual reduction in his performance which stabilized after the 12th session at approximately 90 revolutions per minute.

The change in criterion in the second VR subphase produced an increase in response rate for all subjects. The mean rate of responding during the second VR subphase for non-obese boys was 114.2, while the obese boys' rate was somewhat lower at 101.2 revolutions per minute. However, unlike the performance during the first VR subphase, each boy's response rate was initially slightly lower than the set criterion. Of course, falling below criterion still produced substantial reinforcement on the VR

schedule. Although Scott, a non-obese subject, responded at a relatively stable rate during the initial half of the phase, a gradual increase was evident during the latter half. Stability was not evident for Shawn and Steve until the 20th session. Two obese subjects, Peter and Paul, achieved the criterion response rate within three sessions and relative stability was achieved by the 21st session. While an initial upward trend was evident for the remaining obese subject, Perry, criterion was not reached following absent sessions.

There was an initial increase in performance for all boys upon implementation of the third VR subphase. One non-obese and two obese boys performed at or above the criterion throughout this subphase. The remaining subjects performed at approximately the criterion rate. The mean response rate for the non-obese subjects was 130.0 revolutions per minute while the obese boys pedalled a mean of 117.0 revolutions per minute. Relatively stable responding was evident throughout the third VR subphase for two non-obese boys, Scott and Steve, although there was considerable fluctuation in Shawn's performance. Shawn's performance was consistently above criterion and finally stabilized after the 30th session at approximately 145 revolutions per minute. Similarly, Peter and Paul, obese subjects, responded above criterion and their performance also stabilized after the 30th session. While

Perry initially performed slightly below criterion, over the phase he was able to increase his response rate to slightly above the criterion, despite continued absences from school.

Implementation of the Return-to-Baseline phase produced an initial decline in response rate for all boys. The mean response rate of 95.3 for non-obese boys was higher than the obese boys' mean rate of 83.6 revolutions per minute. A downward trend was evident for three non-obese and two obese children. For the remaining obese boy, Paul, an initial decrement was followed by an acceleration in response rate; however, a reduction in performance was evident during the last session. Reintroduction of the token economy produced substantial increases in all subjects' response rates. Both non-obese and obese subjects achieved their highest response rates during this subphase. The mean rate of responding during the final VR subphase was 138.7 revolutions per minute for non-obese boys, while the obese boys performed at the mean rate of 123.6 revolutions per minute. During the final subphase of the program, three non-obese and two obese boys consistently performed well above the criterion and upward trends were evident. The response rate for the remaining obese child, Perry, was relatively stable ($\underline{M}$ = 98.9) throughout the phase and he performed slightly above the criterion during the last session.

Figure 3 presents the individual cumulative records of responding for all subjects during the last session of each phase of the study. As Perry was absent for the final session, the 39th session was substituted for the 40th session.

As can be seen, during baseline the slope of the lines are slightly steeper for the non-obese subjects, indicating that they were pedalling at a higher rate. All non-obese boys responded at a constant pace. On the other hand, the obese boys pedalled at a more variable pace, which is demonstrated by the wavering in the records.

Upon implementation of the initial VR subphase, responding by the non-obese boys was constantly high and generally undifferentiated without pausing, which is indicated in the records which are stable, smooth and linear. The obese boys' records depict a slower rate of responding. While Paul and Peter responded at a fairly constant pace, Perry pedalled rather sporadically. The pausing, slowing down and accelerating are clearly evident.

During the second VR subphase, inspection of the cumulative records indicates a continuation of high stable responding with no discernible pausing for the non-obese boys. Again, the obese boys pedalled at a slower pace than the non-obese boys. Two of the

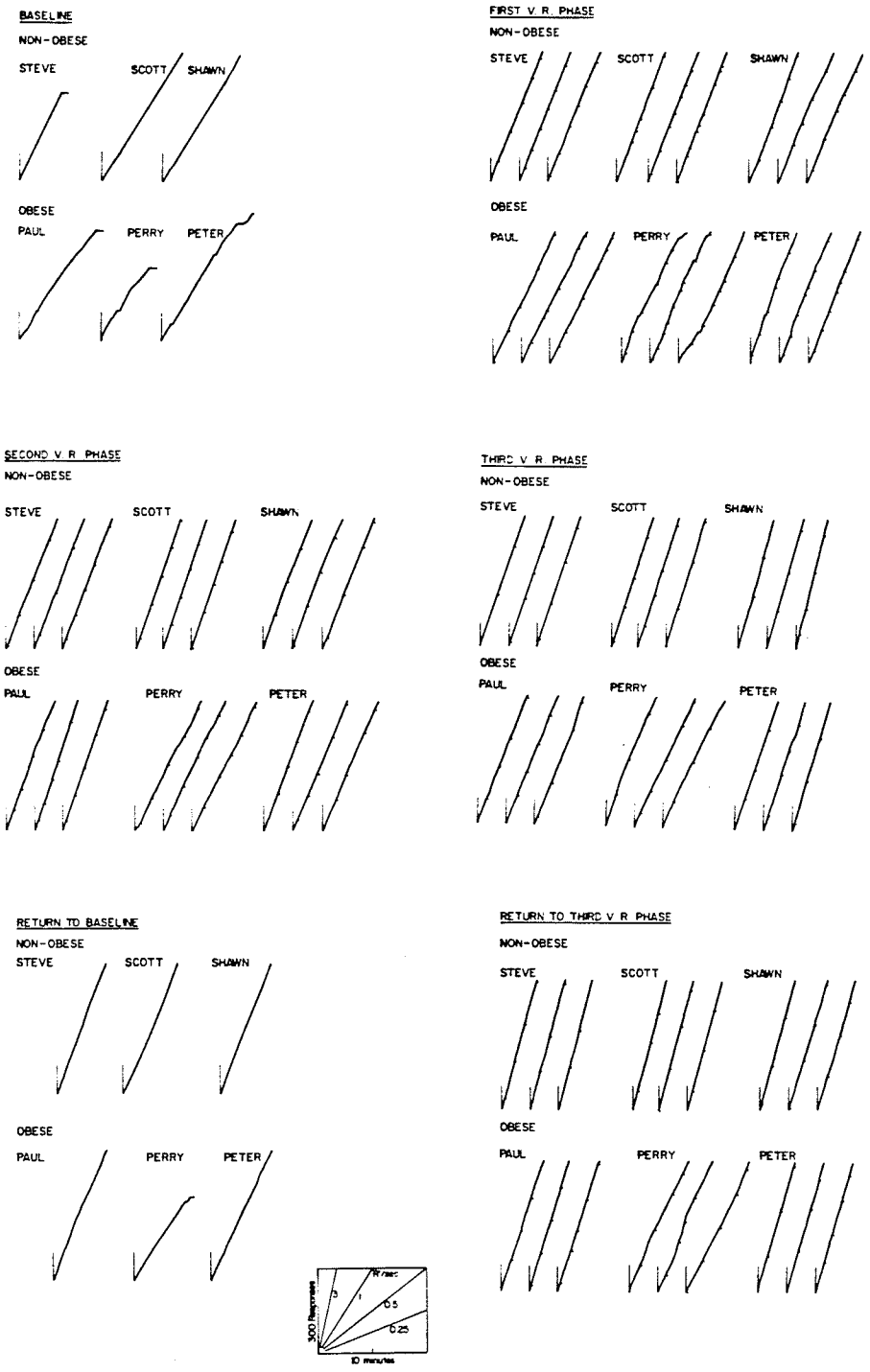

Figure 3. Individual cumulative records for Baseline, VR 1, VR 2, VR 3, Return to Baseline, Return to VR 3 phases for obese and non-obese subjects.

obese boys responded at a fairly constant pace. However, slight pausing and accelerating were apparent in Perry's record.

Inspection of the cumulative records for the third VR subphase indicates a continuation of high undifferentiated responding for the non-obese boys. Although the obese pedalled faster during this phase than during previous phases, very slight pausing and accelerating were apparent in Perry and Peter's records.

The Return-to-Baseline individual cumulative records indicate that the non-obese maintained fairly high and stable responding. Two of the obese boys responded at a consistent pace as well. Only slight pausing was evident in Perry's record.

The cumulative records show a continuation of high stable responding with no discernible pausing for the non-obese boys. Two obese boys also responded at a fairly high and consistent pace. Perry pedalled at a substantially lower rate, and slight pausing and accelerating are discernible in the record.

Pre, Post and Follow-Up Physical Fitness Tests

The anthropometric measures taken by independent testers for all subjects at the pre-treatment and post-treatment (12 weeks later) tests, and at the 3 month and 6 month follow-up tests are presented in Table 1. It can be seen that all obese subjects grew taller and heavier over the course of the study, with the obese

Table 1

Anthropometric Data

	Height (cm)					Weight (kg)					% Overweight	
	PRE	POST	3 MOS. FOLLOW -UP	6 MOS. FOLLOW -UP	DIFFERENCE BETWEEN FOLLOW-UP AND PRE-TEST	PRE	POST	3 MOS. FOLLOW -UP	6 MOS. FOLLOW -UP	DIFFERENCE BETWEEN FOLLOW-UP AND PRE-TEST	PRE	6 MOS. FOLLOW -UP
Obese Subjects												
PETER	155.5	156.5	159.6	160.9	+5.4	60.0	59.0	62.4	62.5	+2.5	20%	13.6%
PAUL	147.0	147.0	149.1	149.9	+2.9	50.5	50.0	54.0	54.0	+3.5	23.1%	22.7%
PERRY	146.5	146.6	149.0	150.7	+4.2	54.2	52.5	56.5	58.5	+2.5	42%	32.0%
CONTROL	148.5	149.5	153.2	154.2	+5.7	50.5	53.5	58.9	63.5	+13.5	20.2%	35.1%
Non-obese Subjects												
STEVE	139.5	140.8	141.1	142.1	+2.6	31.5	31.5	31.6	33.0	+1.5	0	0
SHAWN	135.0	135.8	137.0	138.0	+3.0	31.0	30.5	33.4	33.2	+1.2	0	0
SCOTT	136.0	136.8	138.0	138.1	+2.1	31.5	30.5	30.0	30.0	-1.5	0	0
CONTROL	145.0	145.1	145.2	145.2	+ .2	35.5	39.3	42.2	42.2	+6.7	0	0

control subject gaining over three times as much weight as any of the experimental subjects. Each of the obese boys who participated in the biking program reduced their percentage overweight (based on age, sex and height); however, the obese control subject increased his percentage overweight by 14.9%. While the control obese subject and Peter were both approximately 20% overweight at the beginning of the study, there was a 22% difference in their overweight at the end of the study--with the obese control subject being substantially more overweight than Peter. Turning to the non-obese boys, every subject grew taller and two of the boys who had participated in the biking program as well as the control subject gained weight, while Scott lost weight. Similar to the obese control subject, the non-obese control subject gained the most weight.

Results of the physical fitness tests can be found in Appendix D. Data may be viewed as suspect as the same testers were unable to conduct all four testing sessions. The use of same testers eliminates error that could exist among testers (Bray, 1976). A retest, taken after the biking program in the school (Post Test) because reported skinfold determinations appeared suspect, produced substantial differences in the data for 7 of the 8 subjects. For example, discrepancies in skinfold measurement between the retest data and the earlier data taken within a

two-week period ranged from 3% to 38%. Thus the data should be considered with caution.

The final physical fitness test results indicate that over the period of the study there was a reduction in body fat for one obese and one non-obese experimental subject, while one non-obese boy's percentage of body fat stayed the same and one obese child showed a slight increase. One obese and one non-obese subject as well as both control subjects showed increases in their percentage of body fat over the course of the study. Anaerobic endurance improved for four experimental subjects and two maintained their scores over the period of the study. A decrement in anaerobic endurance was evident for both control subjects. Improvements in aerobic power appeared to be evident for two obese subjects. Subjects' rank order for aerobic power indicated that while the obese control subject was ranked second among the obese subjects initially, his ranking dropped to the lowest at the 6 month follow-up. The non-obese control maintained the lowest ranking among the non-obese subjects throughout the study.

Figure 4 depicts gross motor activity monitored daily using an actometer during the 12 week period of the biking exercise program in the school. It can be seen that all non-obese boys were more active ($\underline{M}$ = 1026.0 units per day) than the obese boys ($\underline{M}$ = 625.8 units per day). Increases in activity during the

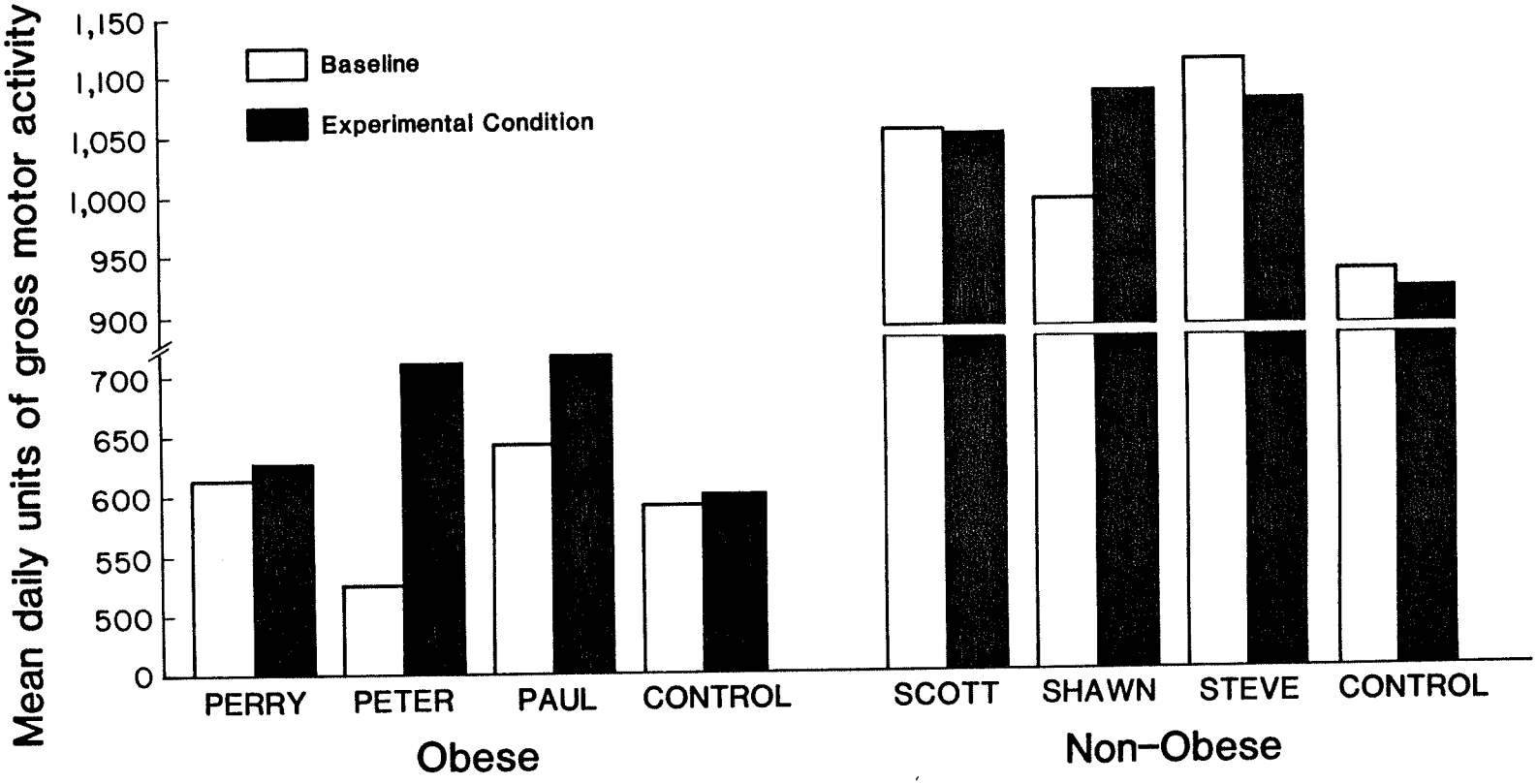

Figure 4. Mean daily units of gross motor activity during Baseline and Exercise Program for obese and non-obese boys.

exercise program over baseline performance were evident for all obese subjects. There were marked increases in gross motor activity for Peter and Paul, while only a small increase over baseline performance was exhibited by Perry. Absences from school and illness limited Perry's participation in the biking program and, therefore, less effect may have been anticipated in his data. After baseline, only a very slight increase in gross motor activity was evident for the control subject. An increase in activity over baseline performance was also evident for one non-obese boy, Shawn, while there were slight decreases in activity exhibited by Scott, Steve and the control subject. The non-obese control subject's gross motor activity, while greater than the obese subjects', was lower than the non-obese experimental subjects' activity level.

Food intake. Table 2 presents the average caloric intake for all subjects for two weeks prior to the exercise program and during the 12 week program in the school. It can be seen that non-obese subjects' average caloric intake ($\underline{M}$ = 1311.9) was slightly greater than that of the obese subjects' ($\underline{M}$ = 1290.3). However, this was reversed during the exercise program and the obese subjects' caloric intake ($\underline{M}$ = 1442.9) was slightly greater than the non-obese subjects' intake ($\underline{M}$ = 1384.6). It can be seen that for 7 of the 8 children, there was an increase in food intake

Table 2

Average Daily Caloric Intake

	Pre Exercise Program		During Exercise Program		Difference
Obese Subjects	M	SD	M	SD	
PETER	1247.7	344.8	1407.9	526.1	+160.2
PAUL	1405.9	291.9	1611.5	411.4	+205.6
PERRY	1061.0	312.5	1155.4	576.2	+ 94.4
Control	1446.5	396.1	1596.8	435.2	+150.3
Non-obese Subjects					
STEVE	1020.7	180.1	1191.1	390.4	+170.4
SHAWN	1524.6	524.1	1461.0	414.6	- 63.6
SCOTT	1533.8	205.5	1623.5	333.3	+ 89.7
Control	1168.6	304.8	1262.8	351.3	+ 94.2

during the exercise program. A reduction in caloric intake was evident for one non-obese boy, Shawn, during the exercise program in the school.

Discussion

The results of the present experiment corroborated De Luca and Holborn's (1985, in press) findings that exercise duration can be increased utilizing behavioral principles of reinforcement with children. The introduction of a token economy produced increases in duration of exercising to the maximum 30 min. Control was clearly evident in the children's bicycle pedalling behavior, that is, when they were reinforced for biking, they continued for the maximum allotted time; however, when they were not reinforced for exercising, their bicycle pedalling behavior rapidly decreased in duration. When reinforcement was withdrawn and the bicycle's bell and light no longer signalled points, the boys reduced their time spent pedalling and complained about no longer being able to chalk up points.

The results of the present study also clearly indicate that the rate of exercise, as measured by the speed of bicycle pedalling, can be increased using a VR schedule of reinforcement. As predicted, the introduction of the initial VR subphase of the changing-criterion design produced marked increases in the rate of exercising for all subjects. This outcome is an extension of De Luca and Holborn's (1985)

findings that high rates of exercising were established during a ratio (FR) schedule of reinforcement. It is noteworthy that the highest rates achieved by both obese and non-obese boys in the present study were markedly greater than the most accelerated rates in the De Luca and Holborn (1985) study. This finding may have been due to the fact that De Luca and Holborn (1985) utilized an FR schedule of reinforcement, whereas the present study used a VR schedule of reinforcement. Indeed high rates of responding with infrequent pausing are typically produced with humans and animals on VR schedules (e.g. Lowe, 1979; Orlando & Bijou, 1960). In addition, further support is provided for the view that VR schedules can attenuate past history differences (Baron & Galizio, 1983; Kaufman, Baron, & Kopp, 1966). In particular, the obese subjects' histories of reduced rates of responding were eventually overcome by successively increasing levels of the VR schedule as evidenced in less pausing on the cumulative records.

Another contributing factor to the higher rates may have been the utilization of the changing-criterion design. While the changing-criterion design is relatively new, it has been demonstrated to be effective in shaping behavior (Hartmann & Hall, 1976). Brownell (1984) recommended that "one key to exercise instruction is to begin at the patient's level" (p. 412).

Using a changing-criterion design, the initial criterion is generally based on the subject's own baseline performance and increased via gradual increments. In the present study, the rate of exercising generally improved in increments matching the criterion specified. An exception to this occurred with one obese and one non-obese boy who did not meet the criterion during the third subphase. In many studies, not meeting the criterion would have negated reinforcement (Kazdin, 1982); however, in the present study, it resulted in slightly reduced amounts of reinforcement. The two children's behavior came under control of the criterion in the following phase and their exercise behavior accelerated in an attempt to "catch up" in points to their peers. However, subjects seemed to detect the increase in criterion. When the criterion increased from the second to the third phase, Paul complained: "This thing is taking forever to ring now. Am I going to get as many points as yesterday?" and Peter asked: "How come everybody did good at the beginning--are we getting worse?" and "You have to work harder every day, cause every day it's harder to get points". The experimenter responded that each boy had worked very hard, related the total number of points that had been accumulated to date and repeated the instructions "Exercise as long as you like."

It was interesting to note that all subjects pedalled the bicycle most rapidly during the final phase of the experiment. It

appeared that three non-obese and two obese boys were exercising very vigorously in an attempt to gain the most points possible. Each of the boys was intent on achieving a certain number in order to buy the prize he wanted--the more points achieved, the "better" the prize. On the other hand, Perry, who had missed a number of sessions due to absences from school, recognized that he could not buy the prize he really wanted and, therefore, the reinforcer may not have been powerful enough to increase his exercise behavior as much as the other subjects. Another contributing factor could have been that his absences from school may have occasionally been due to illness which ultimately could have affected his performance.

The cumulative record of the non-obese subjects' performance indicated a pattern which consisted of a high stable undifferentiated rate of responding between reinforcements. Similar VR patterning (Orlando & Bijou, 1960) in humans has been reported. As noted by De Luca and Holborn (1985, in press), although duration and response rate changed, the non-obese children's pattern of biking behavior did not change. Throughout the experiment, the non-obese boys entered the nurse's room, sat upright on the bicycle and began pedalling. Their pedalling was consistent and they seldom attempted to converse with the experimenter while exercising.

In contrast, wavering occasionally appeared in the obese children's records during the baseline phases. The obese children's behavior was similar to that reported by De Luca and Holborn (1985). The heavier boys frequently pedalled with one foot while resting the other on the partition. In addition, the obese children often complained. One obese boy who pedalled the full 30 min during the initial return to baseline sessions was shocked that he did not receive credit for the biking and responded "That was a rip-off". The news that the bicycle was "not working" travelled to the next obese subject who asked before the session began "Is it true that we don't get any points today". When he was given the usual instruction of "exercise as long as you like", he grumbled and stopped biking after approximately 12 min. It is interesting to note that unlike their thinner counterparts, the obese children frequently offered excuses for why they had stopped pedalling after a short period of time during the baseline phases. For example, during the baseline phases, there were frequent complaints from the obese boys, including: "I'm really tired today"; "sorry I can't do more; I'm exhausted"; "I'm winded today"; "my legs are sore"; "my knees are acting up today" and "my butt is aching". On the other hand, complaints were not forthcoming from the non-obese boys. When the slim subjects terminated the session during baseline, they stopped

pedalling, disembarked from the bicycle and made no comment relative to stopping prematurely. It may be that the obese subjects in the present study had a behavioral history of complaining to avoid participating in physical activity. Indeed this finding supports the work of a number of researchers in the area of physical fitness (e.g. Sherrill, 1976). However, when the token reinforcement was introduced, the obese children's "excuse making" behavior disappeared and they exercised as long as the non-obese boys. During the VR contingency phases, all subjects pedalled vigorously. However, Perry did not pedal as rapidly as Peter and Paul. Less schedule control over his behavior may have been obtained because of his absences from school.

The anthropometric measures taken by independent testers at the pre-treatment, post-treatment and follow-up tests revealed that subjects who participated in the biking program gained substantially less weight than children who did not participate in the program. The obese control subject gained much more weight than the experimental subjects over the 10 months. It was interesting to note that while one obese subject and the control subject both began the experiment at approximately the same percentage overweight, at the end of the study, the control subject was 22% more overweight than the experimental subject. It would appear that increased activity through the biking program in

the school augmented by programmed activity and lifestyle activity may have curtailed excessive weight gain in the obese boys. The non-obese children also seemed to benefit by the accelerated activity in their life. The non-obese control subject who was not involved in the biking program or the increase in life-style activities actually gained over four times as much weight as the experimental non-obese subjects.

The results of the pre, post and follow-up physical fitness tests were not particularly convincing in the present study when compared to De Luca and Holborn's (1985) research. One of the reasons for this may be the lack of reliability in the measures. A particular problem in the present study was the fact that different testers were used. Future studies should ensure that the same testers be used and research should be directed at improving the reliability and validity of these measures.

According to the actometer data as well as parents' and teachers' written and verbal reports, exercise on the stationary bicycle appeared to contribute to increased physical activity in the natural environment for all subjects. Every experimental subject participated in the school's track and field event. While the non-obese control subject also participated in the event, the obese control subject did not. Although the non-obese boys participated in running events, for example, 100m, 200m and 400m;

the obese boys participated in ball throwing, long jumping and high jumping. Two of the obese boys received ribbons of achievement for the first time in these events. The physical education teacher expressed that he was most pleased with their participation in this school event. While all of the non-obese boys received ribbons at the track and field meet, two of the experimental subjects (Shawn and Steve) went on to compete in the 200m and 400m runs in the city-wide track and field meet. Shawn won an award for his division. Shawn's mother reported that she felt her son's participation in the biking program improved his "stamina", enabling him to compete in a larger scale meet for the first time.

Each of the obese boys convinced their parents to purchase a new bicycle for him during the course of the study. The boys claimed that although each had ridden bicycles in the past, they really had not cared much for biking previously. With the new bikes, Paul and Peter were able to ride to the pool, where they swam at least three times weekly during the summer. Paul and Peter reported that they often rode their bicycles together in the evening. Paul was very proud that he was now able to go up hills at his beach"where the sand is deep" with his bicycle--"without having to get off and wheel it". The obese control subject, when asked if he rode his bicycle, stated that "I only like motorized

vehicles", and went on to describe his special motorized "dirt bike". His assertion supports the growing body of literature suggesting that the obese are less active than the non-obese in the natural environment (e.g., Meyers, Stunkard, Coll, & Cooke, 1980; Brownell, Stunkard, & Albaum,1980). Brownell et al. (1980) found that with a simple manipulation to the environment (a sign), they were able to increase physical activity (stair walking). Therefore, it may be worthwhile to investigate ways of modifying the school environment to increase physical activity in children.

With encouragement from their parents, Perry and Paul became involved in community club football, where they both played on the same team. Both boys said they enjoyed the activity. With both sets of parents intent on increasing their son's physical activities, they agreed to allow the boys to have a paper route. In addition, Paul's father joined him in a weight-lifting program.

Reduced girth measurements were most noticeable for Peter. He was very thrilled that he could now wear his step-father's pants (size 32) rather than the size 36 he had previously worn. The Vice-Principal of the school commented that "Peter looks like a new boy--He looks terrific". Peter's mother reported that when he went for a physical examination prior to going to camp, the doctor complimented Peter on his improved appearance and fitness. Playing soccer and swimming became frequent activities for Peter.

The non-obese boys were generally active prior to the program, with the exception of Scott. Moving from the Phillipines had been rather difficult for him and his mother claimed he had problems in relationships with his peers. Prior to the implementation of the program Scott had frequently returned from school claiming he had been "beaten up". When exploring ways to increase his physical activity, it was agreed that martial arts might be beneficial for Scott. He attended daily 1½ hour sessions of "Sikaran" throughout the summer and weekly sessions in the fall. Scott's mother claimed that not only had her son's "fitness" improved but that he seemed to have more confidence in himself and he no longer returned home "beaten up". Prior to the program, Scott had been in the "undesirable" range for percent body fat, but was within the normal range at the end of the study. This particular subject demonstrates the desirability of additional exercise programs within the school for all students, obese and non-obese alike.

Both Steve and Shawn continued to be physically active at school and in the community. Steve worked daily at "break-dancing" and entered a number of competitions. In addition, he swam at least three times a week and played soccer. Shawn played hockey year round on a daily basis. Moreover, he participated in any other sport he was able to fit into his busy

schedule. The non-obese control subject stated that he enjoyed biking and participating in team sports. However, the actometer data and reports from teachers suggested that he generally had participated in fewer activities than his peers who participated in the biking program.

Details of the above discussion provide social validation for the present research, as well as promising suggestions for generalization of exercise behaviors to the natural environment. The results of the social validation questionnaire indicated that all subjects enjoyed the biking program, rating it as "very much fun". On a number of occasions, boys in the program asked if their friends could participate. Many times when the 30 min were over, the children asked if they could bicycle for a longer time to "get more points". The children themselves, as well as their parents and teachers, noticed that they were more active in alternate settings. The principal, vice-principal, librarian and teachers frequently commented on the physical well-being of the obese boys. It may be that not only was the actual biking important, but also that the social reinforcement given by teachers and peers was a contributing factor towards increasing physical activity in alternate settings. In addition, training the parents how and when to utilize praise and attention appeared to enhance generalization. Undoubtedly "behavioral trapping" (Baer

& Wolf, 1970) occurred, where the contingencies of the natural environment helped to maintain physical activity. For example, once Perry began biking in the neighbourhood, his peers asked him to join in their games and sports.

All parents were very supportive of the program and felt their sons had benefited from it. The parents of one obese boy stated that they had been initially hesitant about the program, but were "very thrilled" with the outcome and their son's "changed attitude" about participating in physical activity. Peter's mother asked if her younger son could also be involved in the program. Parents of all obese boys noted that their sons were involved in a number of sports in which they had not previously participated. Parents of all of the boys reported that their sons had spoken positively about the program, with one parent of a non-obese boy stating "that's all he talked about for weeks". Parents commented on the positive changes in the physical appearance of their obese sons. It was encouraging that the obese children's parents recognized the social benefits of the program for their children. In addition, all parents were pleased with the increased life-style activity. Paul's mother claimed that for the first time her family was taking walks together rather than watching TV in the evening. She claimed: "I like the approach

because it gives you something--time together, rather than taking something away--like food".

Teachers stated that the program was very beneficial for all students. However, changes in physical activity were noticed particularly for the obese boys, whom they felt had particularly benefited from the program. The physical education teacher was especially enthusiastic about the program. He recognized the benefit of utilizing an exercise bicycle and commended each child on his progress throughout the program. In addition he noted that two of the obese boys seemed to be more enthusiastic about gym classes. Additional comments made by the teachers included: "I believe this is an excellent program because it developed a positive concept relative to physical activity in the student"; "At times it was a hassle, but I know the benefits to Paul far outweigh the inconvenience (at times) to me"; "I feel the program should continue as it is beneficial to the physical fitness and self esteem of the participants"; and "I liked the program and would like to see it continue".

Daily caloric intake data were rather interesting. Seven of the 8 subjects actually increased food intake after the exercise program began. While at first blush, these results appear to be in conflict with previous research (e.g. Epstein, et al.,1978; Holm, et al.,1978; Mayer, et al.,1956; Oscai, et al.,1968), it may

be that, because each child grew taller and heavier during this period, more calories were required. Indeed, while the control subjects were not involved in the exercise program, their caloric intake increased as well. In addition, while the obese boys reported eating less calories during the pre-exercise program, they reported eating a greater amount than the non-obese during the exercise program. It may be that the obese expended more calories during the exercise program than the non-obese children even though they responded at somewhat lower rates and were generally less active than their non-obese counterparts (Waxman & Stunkard, 1980). Of course, we must be cautious in interpreting these data. Lansky and Brownell (1982) found that estimates of food quantity made by subjects were fraught with error, suggesting that self reports of food consumption may be quite inaccurate. Although subjects did not calculate the calories, there is considerable room for error in this area as well.

The present research appeared to answer the four questions outlined in the introduction of this paper; namely (a) a VR schedule of reinforcement seems more effective than an FI or FR schedule of reinforcement in increasing and maintaining physical activity, (b) programmed exercise on a stationary bicycle seems to shape up biking behavior and generalized increases in physical activity in the natural environment, (c) improvements on some

fitness measures appear to have been maintained over a 10 month period, and (d) the exercise program did not seem to increase caloric intake, although maturation may have affected food intake.

While the present study addressed these issues, a number of interesting questions remain for future research. For example, would exercise behavior generalize without the support of parents? Would increased physical activity gains be maintained after two years or longer? Would weight gains continue to be curtailed for the obese boys who participated in this study? Would teachers be able to implement a similar program? Would females and younger children benefit from this program?

It would be interesting to study the effects of introducing exercise programs to pre-schoolers as well as elementary school aged children. Training teachers is another area which deserves study. Future research may consider training parents and evaluating whether changes in their behavior results in changes in physical activity in the children. As there are more overweight girls than boys (Manitoba Department of Education, 1978), it would be important to include obese and non-obese girls, as well as boys, in future research. While the results of the present study are promising, further research on curtailment of obesity at an early age is mandatory, if enduring lifestyle changes are to be provided to potentially obese youngsters.

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Appendix A

Student's Name

1. Did you find the biking program fun?

1	2	3	4	5	6	7
Not at all						Very much

Why? _____

2. Do you think the biking program helped you?

1	2	3	4	5	6	7
Not at all						Very much

How? _____

3. Are you more active now?

1	2	3	4	5	6	7
Not at all						Very much

How? _____

4. Did the biking program make you more physically fit?

1	2	3	4	5	6	7
Not at all						Very much

How? _____

5. Do you think your friends would like to participate in the biking program?

Yes _____

No _____

6. Would you participate again in the biking program?

Yes _____

No _____

7. Have you noticed your clothes fitting more lately?

Yes _____

No _____

Appendix B

_____

1. Do you feel _____ benefited from participating in the biking program?

1 2 3 4 5 6 7
Not at all Very much

2. Did you notice any change in his general physical activity?

1 2 3 4 5 6 7
Not at all Very much

3. Did you notice any change in his social relationships?

1 2 3 4 5 6 7
Not at all Very much

4. Did he seem to enjoy participating in the study?

1 2 3 4 5 6 7
Not at all Very much

5. Did you notice any change in his appearance?

1 2 3 4 5 6 7
Not at all Very much

6. Did he talk about the program?

Positively _____
Negatively _____
Not at all _____

7. How worthwhile was it physically for _____ to have participated in the biking program?

1 2 3 4 5 6 7
Not at all Very much

8. How worthwhile was it socially for _____ to have participated in the biking program?

1 2 3 4 5 6 7
Not at all Very much

Additional comments you might like to make relative to the biking program?

_____

_____

Appendix C

Name _____

Day _____ Date _____

FOOD DIARY

BREAKFAST:

_____

_____

_____

_____

LUNCH:

_____

_____

_____

_____

_____

DINNER:

_____

_____

_____

_____

_____

SNACKS:

_____

_____

_____

_____

Appendix D
Physical Fitness Test Data

Non-Obese Subjects

	STEVE				SHAWN				SCOTT				CONTROL			
	PRE	POST	F.1	F.2	PRE	POST	F.1	F.2	PRE	POST	F.1	F.2	PRE	POST	F.1	F.2
Percentage body fat	11.0	12.5	11.1	12.4	15.4	15.5	15.9	15.4	20.4	19.9	17.5	17.5	19.1	21.5	22.3	20.5
Anaerobic Endurance	15	34	56	28	18	33	18	22	6	9	9	11	18	12	21	12.9
Flexibility	32.8	31.5	30.0	26.7	30.1	27.2	25.9	22.5	22.4	17.0	22.5	23.0	23.0	25.9	23.4	24.0
Agility Run	11.1	12.5	12.9	11.6	10.5	11.8	12.1	11.9	12.6	14.5	13.8	15.9	10.2	13.7	12.8	12.2
Aerobic Power VO_2 MAX ($ml.kg^{-1}.min^{-1}$)	66.3	62.8	59.2	50.0	81.6	72.1	65.9	66.3	52.4	41.4	44.0	49.5	43.4	38.2	41.1	35.0

Obese Subjects

	PETER				PAUL				PERRY				CONTROL			
	PRE	POST	F.1	F.2	PRE	POST	F.1	F.2	PRE	POST	F.1	F.2	PRE	POST	F.1	F.2
Percentage Body Fat	29.2	29.5	29.7	28.5	30.2	31.0	31.6	30.9	33.2	35.0	35.4	37.4	23.5	25.8	27.0	26.6
Anaerobic Endurance	3	6	3	9	3	2	2	3	0	0	1	0	10	8	13	9
Flexibility	31.5	35.0	30.1	28.5	27.0	25.5	27.2	28.0	36.2	31.2	31.4	27.9	15.3	22.0	17.5	19.8
Agility Run	11.9	13.9	13.4	12.9	12.5	14.7	14.1	14.3	13.5	15.4	14.3	12.9	13.0	13.8	13.6	12.6
Aerobic Power VO_2 MAX ($ml.kg^{-1}.min^{-1}$)	32.8	36.5	40.0	39.0	45.5	30.0	41.0	34.6	26.4	36.5	32.0	33.5	36.0	28.0	30.0	32.9