Cardio-Vascular Conditioning in Pre-School Children

Patricia Anne Cole
Western Michigan University

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CARDIO-VASCULAR CONDITIONING IN PRE-SCHOOL CHILDREN

by

Patricia Anne Cole

A Thesis
Submitted to the
Faculty of The Graduate College
in partial fulfillment of the
requirements for the
Degree of Master of Arts
Department of Psychology

Western Michigan University
Kalamazoo, Michigan
August 1982
The effects of a changing criteria token economy system and a self-recording procedure on the duration and accuracy of pre-school children's distance running behavior are examined. In the first study, the use of tokens contingent on gradually longer duration of running times increased the length of time children would run, to twelve minutes, a clinically significant duration. In the second study, the use of package intervention that included a self-recording device and contingent tokens increased the accuracy with which preschoolers followed directions to run a specified number of laps. Tokens alone also increased the accuracy of lap running, but not to the levels seen with the addition of the self-recording procedure. The implications of these findings in the areas of physical fitness and educational technology are discussed.
ACKNOWLEDGEMENTS

I would like to thank my family, especially my mother, for their constant support and encouragement, without which I could not have completed this work.

Patricia Anne Cole
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CARDIO-VASCULAR CONDITIONING IN PRE-SCHOOL CHILDREN

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CHAPTER I

INTRODUCTION

Behavioral medicine, the study of the behavioral factors that affect physical health, and the design and evaluation of intervention techniques to enhance such health, is an increasingly important area in the field of behavior analysis. Research is currently being done in the areas of smoking (for example, Powell and Azrin, 1968), eating (Agona, Cassady and Drabman, 1975), early detection of breast cancer (Pennypacker), etc. Exercise behavior, both in relation to competitive sports and to physical fitness, is also receiving increasing attention. This study investigated the generation of sustained physical exercise—jogging for 12 minutes—with preschool children and the use of a self-recording device to help maintain that behavior without immediate teacher prompts.

Exercise and Physical Fitness

Studies have shown that sustained exertion involving movement of the long muscles of the legs and/or arms for 30 minutes or more is directly related to physical fitness (Cooper, 1978). Such aerobic exercises raise the heart rate and the respiration rate, thus increasing the fitness of the cardio-vascular and pulmonary systems. The physiological effects of aerobic conditioning (see Table 1) are well documented (Van Huss, 1969); in general, there is an increase in the efficiency with which the cardio-vascular system and the
Table 1
Physiological Effects of Exercise

<table>
<thead>
<tr>
<th>Heart</th>
<th>Increase in size.</th>
<th>Increase in amount of blood pumped per beat at rest. Increase in amount of blood pumped per beat and total pumped per minute at work.</th>
<th>Decrease in resting pulse.</th>
<th>Increase in exercise pulse.</th>
<th>More rapid during exercise.</th>
<th>Returns to normal rate faster following exercise.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Size</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Volume</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Resting pulse</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Exercise pulse</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Pulse rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Pulse rate recovery</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Oxygen Utilization     | Increased economy; increased O₂ utilization. | Increased capacity during work. | Increase in recovery of O₂ capacity. |
| 1. Work economy       |                                               |                               |                                   |
| 2. Maximal O₂ intake  |                                               |                               |                                   |
| 3. O₂ debt capacity   |                                               |                               |                                   |

| Lungs                  | Increased capacity. | Increase in vascularization and blood flow through lungs. | Increased ability to exchange air (during and after work). | Increased ability to absorb oxygen from a given volume of air. |
| 1. Volume              |                   |                                                                 |                             |                                                          |
| 2. Circulation         |                   |                                                                 |                             |                                                          |
| 3. Ventilation         |                   |                                                                 |                             |                                                          |
| 4. Absorption efficiency |                 |                                                          |                             |                                                          |

| Work Metabolism        | Increased ability to metabolize fats during work. | Increase in resynthesis of waste products and in capacity to make necessary nutriments and oxygen available to muscles. | Increase in speed of recovery following work. |
| 1. Fuel               |                                               |                                      |                                               |
| 2. Metabolic rate      |                                               |                                      |                                               |
| 3. Recovery            |                                               |                                      |                                               |

| Muscles                | Increase in capillarization. | Increase in cytoplasmic content of muscle fibers. |
| 1. Circulation         |                                 |                                         |
| 2. Specific physiological changes |                         |                                         |
lungs function, in addition to increased muscular strength and physical work capacity (or endurance).

Studies (Froelicher and Oberman, 1976; Paffenberger and Hale, 1975; Rosenman, Brand, Jenkins, Freedman, Straus and Wurm, 1975; Stamler and Lilienfeld, 1970) have shown that such aerobic conditioning helps to prevent or delay the onset of, lessen the severity of, and aid in the recovery from coronary heart disease (CHD). The major cause of CHD and other diseases of the cardio-vascular system, is arteriosclerosis, the formation of plaque, or fatty deposits in the coronary, neck, and cerebral arteries that narrows those arteries, preventing sufficient oxygen reaching the heart and other organs (de le Os, 1970). CHD, along with other cardio-pulmonary diseases caused by arteriosclerosis (including cardiac infarction, cerebro-vascular accident, and renal vascular disease) are the major causes of death among adults in the United States, and a leading cause of death in all the industrialized nations (de la Os, 1970; American Heart Association, 1970). Twenty-eight million people currently suffer from arteriosclerotic disease in the U.S., with a mortality rate of one million per year (American Heart Association, 1970).

Since the 1940's there has been intensive research into the physiological mechanisms underlying arteriosclerotic disease, and some epidemiological studies concerned with the correlation between the disease and certain behavioral patterns. The results of these studies indicate that there are three major risk factors and several secondary risk factors correlated with arteriosclerosis (Rosenman, et al., 1975). The three major risk factors are smoking, hypertension,
and high levels of blood serum lipids (including serum cholesterol, triglycerides, and B-lipoproteins). The secondary risk factors include level of physical activity or exercise, Type A behavior patterns, obesity, etc.

Although there are some conflicting results and methodological weaknesses, the conclusion drawn by these studies is that a low level of physical activity is correlated with a higher risk of developing CHD and other arteriosclerotic diseases. Low levels of physical activity lead to certain physiological conditions which are the pre-cursors of the diseases. Such a conclusion is weakened, however, by the fact that there is no research on the direct effect of physical activity levels on the incidence of CHD, only correlational and epidemiological studies, and that these studies are further weakened by methodological shortcomings.

Three recent reviews (Consumer Reports, 1970; Frollicher and Oberman, 1976; Walker, 1976) have pointed out the methodological problems involved, including difficulty in assessing levels of activity, confounding variables, lack of valid and reliable physiological data, and lack of standard diagnoses of cardio-vascular disease. In a review of 35 epidemiological studies, Frollicher and Oberman (1976) found unreliable measures of physical activity (usually based on occupation or self-report, with no attempt to operationally define high or low levels).

However, while the correlational and epidemiological studies may be considered inconclusive, the data from the research into the physiological effects of exercise is clear (Leon and Blackburn, 1979;
Rosenman et al., 1975). In addition to physiological changes which are directly related to a lessened risk of arteriosclerosis, physical activity also affects the incidence or level of some of the other risk factors correlated with CHD. It reduces blood pressure and leads to the creation of new capillary arteries, thus reducing hypertension; it reduces hyperlipidemia, even in the absence of dietary changes, although this is a very temporary effect, seen only for the duration of the exercise behavior; it reduces obesity (given the same caloric intake); and it reduces "stress" (by affecting the adrenergic system, which controls the production of cathecalamine which is thought to be implicated in the levels of stress that affect a person physiologically).

Assessing the exact role of aerobic exercise and physical fitness is thus difficult, given the multiplicity of variables and the complexity of the relations between them. In effect, though, the conclusion most researchers in the area have drawn is that aerobic exercise can help prevent or lessen the severity of arteriosclerotic diseases, especially CHD. As Stamfer and Lilienfeld (1974, p. 89) state, "Regular exercise, particularly those forms of endurance exercise which enhance cardio-vascular fitness, have a role to play in the prevention of arteriosclerotic disease."

Behavior Analysis and Exercise Behavior

These findings raise the question for behavior analysts of how to increase the frequency and duration of aerobic exercise for at-risk populations, and how to design effective programs to increase
physical activity as a preventive measure for all segments of the population.

Programs to increase physical activity as a preventative measure should begin as early as possible. As Turner and Ball (1976) point out, "Since arteriosclerosis frequently starts in youth, preventive measures should begin early. Children could be brought up virtually free from coronary risk factors." (p. 146). In addition to the health-related reasons for generating such behavior early, it is possible that early acquisition of the behavior may be a factor in long-term maintenance.

In developing behavioral programs for children to generate and maintain exercise behaviors, two factors are important. First is the need for physiological data to determine age norms (for blood pressure, resting and recovery heart rate, maximal oxygen intake, etc.) which could then serve as one of the goals of, and a means of assessing the medical effectiveness, of such programs.

The first concern, the evaluation of the physiological effect of training programs, can be done in two ways. First, direct measurement of physiological changes could be used to determine the efficiency of physical fitness training programs. Second, certain clinical measures that have been shown to be highly correlated with such physiological changes could be used. The lesser cost and intrusiveness of the second alternative would be an advantage in an applied setting. Such clinical measures include the 12 minute Walk-Run Test (the distance that a person can run and/or walk in 12 minutes). The 300 yard Walk-Run Test (the duration needed for a
person to walk and/or run 300 yards). These tests have been shown to be highly correlated (98%) with physical fitness as defined by physiological data (Cooper, 1980), in studies involving adults and adolescents. However, a Report to the President's Council on Physical Fitness (1980) stated that, because of the difficulty of "motivating" preschoolers to engage in sustained running, there was a lack of normative data based on such clinical tests and others requiring sustained exertion.

The current study involved an attempt to generate sustained running, for 12 minutes, as a first step in the gathering of normative, parametric data to be used as one means of assessing behavioral programs designed to generate exercise behavior.

Previous attempts to increase exercise behavior or general physical activity level have made use of the techniques of contingency management. Iwata (1974) used the Premack Principle to increase the number of calisthenic exercises engaged in by the developmentally disabled adults in a residential setting. Free games were contingent on the number, duration, and quality of exercises performed, which subsequentially increased.

Rushall and Pettinger (1969) evaluated the reinforcing effect of two types of consequences, social interactions involving praise and attention, and "extrinsic" rewards, including candy and money, on the number of laps swum in one hour by older children (aged 10-15) on a swimming team. They found that social interactions functioned as reinforcement more with the older children than the younger, while candy and money had a more reinforcing effect on the
younger children's behavior.

Mackenzie and Rushall (1974) also investigated lap swimming with older children. They arranged to have peer and coach praise and attention contingent on the completion of a specified number and type of laps. In addition to increased number of laps swum, they found improved attendance, less off-task behavior, and more time for the coaches, freed of supervisory tasks, to devote individual training and assessment. Johnston, Kelley, Harris and Wolf (1966) reported the use of contingent attention to increase the rate of physical activity of a young child during school recess. Using a reversal ABAB design, the experimenters were able to demonstrate control of climbing and other physical activities involving playground equipment. The rate of such behavior increased from 1% of the recess time to 80% when adult attention and interaction was contingent on the behavior.

Other studies have concentrated not on the frequency or duration of physical activity, but on the quality or skill level with which a physical activity or series of activities is performed. Komaki and Barnett (1977) used positive reinforcement to improve the quality of execution of certain football plays by nine and ten year old boys. Using a behavior analysis of the plays' component moves, the experimenters increased the quality of performance of those moves by using reinforcement contingent on that quality, regardless of the outcome of the play.

Hardiman, Goetz, Renter and LeBlanc (1975) used contingent
attention to reinforce a child's performance of six large-motor activities, over four levels (proximity to equipment, touching equipment, unskilled performance, skilled performance).

These studies indicate that positive reinforcement techniques are effective in generating and maintaining physical activity among adults and older children. The current study assessed the effectiveness of a token economy (where tokens were exchanged for small toys and various activities) in generating sustained physical activity, running for 12 minutes, among younger children, aged two to three.
CHAPTER II

EXPERIMENT I

Method

Subjects

Four preschool children, aged two to three, one female and three males, served as subjects. The children were enrolled at the Child Development Center, a day care/preschool facility of the Department of Psychology of Western Michigan University. All of the children had a physical exam prior to being asked to serve as subjects. None had any physical disabilities or other contraindications to distance running.

Setting/Apparatus

The experimenters ran the study at two locations of the Child Development Center (the center moved to a new building during the course of the study). The experimenters used an empty classroom in the first building and a gymnasium in the second. In both settings a red line on the floor approximately three feet from the walls marked off a running track. The classroom, in the first building, measured 30 feet by 20 feet; the gymnasium, in the second building, measured 62 feet by 40 feet.

The experimenters used stopwatches to time the duration of the running behavior, a kitchen timer with a bell to signal the end of the required running time, data sheets for recording information,
and tokens exchangeable for various toys and activities.

Procedure

The experimenters conducted the sessions once a day, Monday through Friday, at the same time each day. A multiple baseline across subjects, changing criteria, ABA design was used.

During Baseline (Phase 1) the subjects were asked to run for 12 minutes, until a kitchen timer bell rang. General instructions given during Baseline and all subsequent phases were: 1) "Stay on the track; and 2) "You can walk or run, but no stopping until you hear the bell." There was no experimenter arranged reinforcement contingent on the duration of running during Baseline. The children were given praise and thank-you statements for participating in the study (i.e. following the general instructions).

During Intervention (Phase 2), tokens were given contingent on running for a specified number of minutes. Again, the general instructions were given to the subjects, with the additional statement that if they ran until the timer rang they would receive a token which they could later exchange for toys or activities of their choice. The criteria for receiving a token increased from running 1 minute, to 2 minutes, to 3, 6, 8, 10, and 12 minutes. The criteria were changed when stability was reached in any level; stability was defined as three consecutive sessions where the duration criteria were met and the distance run during the sessions did not vary by more than one lap per minute.

The third phase involved a return to baseline conditions. The
subjects were given the general instructions to run or walk until the bell rang but were told that the tokens were no longer being given for running.

Subject 1 started baseline on Day 1 of the study; Subject 2 on Day 6; Subject 3 on Day 11; and Subject 4 on Day 16.

Interobserver reliability of the data collected on duration of running was assessed once per week, according to the following formula:

\[
\text{number of agreements (within 5 sec.)} \times 100 \over \text{number of agreements} + \text{number of disagreements}
\]

The mean percentage of interobserver agreement was 100%.

Results

Figure 1 shows the results of Experiment 1; the distance run is plotted against sessions. During Phase 1 (instructions alone), none of the subjects ran for 12 minutes. Table 2 shows the mean distance and duration run by the subjects during this phase. (They walked the remainder.)

Table 2

<table>
<thead>
<tr>
<th>Mean Distance and Duration Run, Phase 1, Exp. I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance</td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td>Subject 1</td>
</tr>
<tr>
<td>Subject 2</td>
</tr>
<tr>
<td>Subject 3</td>
</tr>
<tr>
<td>Subject 4</td>
</tr>
</tbody>
</table>

During Phase 2, (instructions plus tokens), each subject met
Figure 1. Number of laps run

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the criteria of running until the bell rang on the first session of each level and continued to meet criteria for the remainder of that level. Stable responding was seen for all subjects within three or four sessions at the shorter criteria and five or six sessions at the longer criteria.

During Phase 3 (instructions only; no tokens), the subjects showed an immediate decrease, in both the duration and distance run, to previous baseline levels.

Discussion

This study showed that preschool children will run continuously for a clinically significant duration, given a token system using a changing criteria design. One area that remains to be investigated is the role of the changing criteria component. The token system alone may be sufficient to "motivate" children to run for 12 minutes without the gradual increase in length of run required.

The distance that a person can run or walk in 12 minutes is highly correlated with physiological factors related to physical fitness in general, and cardio-vascular conditioning in particular, in adults and adolescents. Medical studies are now needed to determine if it is also as highly correlated in preschool children. If so, this technique can be used both to assess the physical fitness of individual children and to evaluate training programs designed to enhance that fitness.

A further standard often applied to training programs is their cost-effectiveness. In school settings this often refers to the
amount of direct teacher interaction necessary for a group training program to run effectively. Decreasing such time, it is argued, frees the teacher to devote his or her attention to assessing the needs of, and helping individual students. The second study addressed this concern.
CHAPTER III

EXPERIMENT II

Introduction

Self-recording techniques were first used to gather data in settings the experimenters did not have access to (Kazdin, 1974), but researchers began to use and study the techniques when it became clear that they could have reactive effects on the behavior being recorded. Kazdin points out two problems with externally controlled contingencies: that much behavior may be missed by the external agent and thus unconsequated, and that the agent may become an S\(^D\) or \(S\) for the occurrence of the response. Others (O'Leary and Dubey, 1979; Rosenbaum and Drabman, 1979) point out that self-control techniques, especially self-recording, could overcome these drawbacks and additionally free the teacher or agent for more individual training and assessment.

Self-recording techniques, where a subject records the quality of his/her responses, have been used with elementary aged children (Glynn and Thomas, 1974; Glynn, Thomas and Shee, 1973; Johns, Trapp and Cooper, 1977), with adolescents (Krapczyk and Livingston, 1973; McKenzie and Rushall, 1974; Santogrossi, O'Leary, Romanczycy and Kaufman, 1978; Seymour and Stokes, 1976), and with adults (Bristol and Sloane, 1974; Foxx and Hake, 1977; Horton, 1975). Target behaviors have included on-task academic behavior (Bristol and...
Sloane, 1974; Glynn and Thomas, 1974; Glynn et al., 1973; Santogrossi et al., 1973), reading (Knapczyk and Livingston, 1973), arithmetic (Hundert and Blucker, 1978; Nelson, Lipinski and Boykin, 1978), gas consumption (Foxx and Hake, 1977), teaching (Horton, 1975), manding praise from supervisors (Seymour and Stokes, 1976), and swimming (McKenzie and Rushall, 1974).

The technique has been used most often to maintain the rate or accuracy of a behavior already established by an external agent (Glynn et al., 1973; Santogrossi et al., 1973; etc.). Its effect when added to other procedures is usually seen to be minimal; Salzberg (1972) showed no increase in the rate of math problems completed when a self-recording procedure was added to a token economy system; Knapczyk and Livingston (1973) also showed no increase in the accuracy of reading assignments when self-recording was added. However, the results of other studies (Horton, 1975; Seymour and Stokes, 1976) would seem to indicate that self-recording can enhance the effect of a weak consequence.

O'Leary and Dubey (1981), in a review of the literature, conclude that self-recording effectiveness depends on three factors: 1) accuracy of the self-recording; 2) task difficulty; 3) history of the subject and current establishing operations. Some studies (Hundert and Blucher, 1978; Wood and Flynn, 1978) have shown no increase in the reactive effect of accurate self-recording (i.e. matching of the subjects' data with that of the observer/experimenter). However, Peacock, Lyman and Rickard (1978) presented data that indi-
cated that accuracy of recording is a factor in increasing the reactivity of self-recording only with easy tasks; with difficult tasks, increasing accuracy had no effect on the target behavior.

Cautela's (1971) analysis of the reactive effect of self-recording stressed the automatic reinforcing or punishing effects of the self-recorded data and/or collateral self-statements. Most other researchers seem to have adopted, if only implicitly, this analysis, although there are variations in emphasis. It is possible, however, that the self-recording response or its products could also serve as antecedent stimuli for subsequent target responses, especially if the target responses being recorded are components of a large or difficult task. Glynn and Thomas (1974) found that self-recording on-task academic behavior by third graders had no effect in increasing the behavior, until they added a cue as to which behavior was "on-task" at any time. McKenzie and Rushall (1974) found that self-recording boards detailing the number of laps swum and type of stroke required to complete a training session served to increase the number of complete sessions emitted.

Horton (1975) found that elementary teachers' rate of specific praise increased only if discrimination training was included with the self-recording. Seymour and Stokes (1978) found that token economy system increased work behavior only after self-recording was added. It is possible that the self-recording of a target behavior results in a higher rate of reinforcement and thus increases the rate of responding; it is also possible that the data sheets or whatever recording procedure is being used serves as a prompt not
only to record, but also to emit the target behavior or behaviors in the future.

If the target behavior is difficult, self-recording of the components may serve to make the behavior easier by acting as a "job aid" or "reminder." This study was an attempt to determine if a self-recording procedure could serve as a prompt for subsequent behavior and thus increase the rate of correct responding on a difficult task.

Experiment I showed that simple contingency management techniques are sufficient to generate and maintain distance running with preschool children. The second study investigated whether the use of a self-recording device increased the number of correct responses when the subjects were instructed to run a certain number of laps, rather than for a certain length of time.

Method

Subjects

Five preschool children, aged three to four, four boys and one girl, from the Child Development Center, served as subjects. None of the subjects had previously served in an experiment of this type. Each had previous training in counting (both rote and object counting) and could count at least as high as ten. None of the subjects had previous training in self-recording.

Setting/Apparatus

The experimenters ran the study in the gymnasium of the Child Development Center (second building); setting and apparatus were
as described in Experiment I, with the addition of self-recording boards, felt covered boards, to which small (1 inch) squares of felt could be attached, hung at the children's shoulder height on the walls near the running track.

**Procedure**

The experimenters conducted the study once a day, Monday through Friday, for a variable amount of time, depending on how long it took the subjects to finish running. The experimenters used an ABAC design. During Phase 1 (Baseline) the experimenters asked the subjects to run a specified number of laps and told them that tokens were contingent upon doing so. Regardless of whether the subjects met the running criteria, they received the tokens. A correct response consisted of properly following instructions and running the required number of laps. An incorrect response consisted of a failure to follow instructions and running too few or too many laps.

During Phase 2, the experimenters introduced individual felt boards, which served as self-recording devices. The felt boards were attached to the wall within easy reach of the children running past. The experimenters told the subjects the number of laps they were to run and told them to place the same number of small felt squares on their board. They were told to pull one square off the board each time they ran past it (completed a lap). The experimenters conducted one training session in the use of the boards, instructing and demonstrating the procedure; the subjects then practiced three times. All subjects followed the procedure accurately during the training session. During Phase 2 a correct response consisted of
running the specified number of laps, whether or not the boards were used correctly (an incorrect number of squares placed on the board, failure to pull one off, or pulling off too many). An incorrect response consisted of failing to run the specified number of laps. Subjects received tokens for both correct and incorrect responses.

During Phase 3 the experimenters returned to Baseline conditions and removed the felt boards. They continued to instruct the specified number of laps and to give tokens for both correct and incorrect responses.

Criterion for advancing to each successive phase was stability within each phase. Stability was defined as a steady percentage of correct responding over time, determined by visual inspection of the graphed data.

Reliability of the data collected was defined using the following formula:

\[
\text{Reliability} = \frac{\text{number of agreements}}{\text{number of agreements} + \text{disagreements}} \times 100
\]

The mean percentage of interobserver agreement was 100%.

Results

Table 3 shows the results of Experiment II. During Phase 1 (Baseline) each of the subjects correctly followed instructions only once in nine sessions. The subjects responded correctly when the instructions given were to run one lap; on other trials, when the number of laps instructed exceeded one, none of the subjects met the requirement.
Table 3
Percentage of Correctly Followed Instructions, Exp. 2

<table>
<thead>
<tr>
<th>Subject</th>
<th>Phase 1</th>
<th>Phase 2</th>
<th>Phase 3</th>
<th>Phase 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject 1</td>
<td>12.5%</td>
<td>100%</td>
<td>0%</td>
<td>60%</td>
</tr>
<tr>
<td>Subject 2</td>
<td>11.0%</td>
<td>100%</td>
<td>0%</td>
<td>40%</td>
</tr>
<tr>
<td>Subject 3</td>
<td>11.0%</td>
<td>93.2%</td>
<td>20%</td>
<td>20%</td>
</tr>
<tr>
<td>Subject 4</td>
<td>12.5%</td>
<td>81.2%</td>
<td>0%</td>
<td>50%</td>
</tr>
<tr>
<td>Subject 5</td>
<td>11.0%</td>
<td>100%</td>
<td>0%</td>
<td>75%</td>
</tr>
</tbody>
</table>

Phase 2 introduced the use of self-recording boards. Subject 1 responded correctly 100% of the time. Subject 2 81.5% of the time, Subject 3 82.3% of the time, Subject 4 88.2% of the time, and Subject 5 100% of the time.

Phase 3 (return to Baseline) consisted of five sessions of no self-recording boards; one subject (S3) responded correctly 20% of the time. The other subjects showed 0% correct responding.

Phase 4 (no boards, tokens for correct responding only) showed an increase in the amount of correct instruction-following, although not to the level seen in Phase 2. Subject 1 responded correctly 75% of the time, Subject 2 50% of the time, Subject 3 20% of the time, Subject 4 40% of the time, and Subject 5 60% of the time.

Discussion

This study demonstrated that the use of a self-recording procedure, when added to a difficult task, can increase the likelihood that the task will be performed accurately. The subjects found the task difficult, as is seen in the data from Phase 4 of the study. Even
under a strong contingency for emitting the behavior (tokens only for correct responding), the rates of accurate instruction-following never reached the levels shown in Phase 2, where the self-recording boards, in the absence of such a contingency, controlled high rates of accurate responding.

Previous research (Salzberg, 1972; Knapczyk and Livingston, 1973) had shown that self-recording procedures had little effect on the target behavior when added to other procedures, usually some form of contingent positive reinforcement. However, other studies (Hundert and Bucher, 1978; Seymour and Stokes, 1976) showed results that indicate that self-recording procedures may affect the rate of a target response maintained by relatively weak consequences. Furthermore, Peacock et al. (1978) concluded that as accuracy of self-recording increased, so did the rate of "easy" tasks, while having no effect on the rate of "difficult" tasks.

In this study, the self-recording procedure did have an effect on the rate of a target response, under a weak contingency, supporting the results obtained by Hundert and Bucher (1978) and Seymour and Stokes (1976). However, as the task was a difficult one, as shown by the fact that the children did not emit the behavior at a high rate even under strong contingencies, the study does not support the conclusion drawn by Peacock et al. (1978). The effect of the self-recording procedure increasing the accuracy of the subjects' response seems clear, in contrast to their finding that self-recording had no effect on rate or accuracy of hard tasks.

One possible explanation may be in the nature of the various
devices termed self-recording. In this study the self-recording device acted not only to prompt the self-recording device itself, but also probably served as a discriminative stimulus for either continuing to run (given the presence of more felt squares on the boards) or stopping (all squares removed). In this case, indeed, the accuracy of the self-recording response had a direct bearing on the target response: in Phase 2, Subject 3 showed 6.3% inaccurate responding all due to failure to self-record accurately, as did Subject 4 with 18.8% inaccurate responding.

The question of whether accuracy of self-recording affects the rate of the target response when that response is a difficult one for the subject to emit would, thus, seem to depend on the nature of the self-recording device itself. A procedure where the components of the task are recorded, thus, serving as a prompt for the emission of the next component response in the chain, would seem to serve to increase the likelihood that the whole task is emitted. A self-recording device which involved only the recording of the completion of the whole task would probably not.

The implication of this result for educators is that in designing self-recording procedures to free the teachers from direct supervisory tasks, some thought be given as to the effect of the procedure itself on the target behavior. Tasks previously considered too difficult for preschool (or school-age) children without step-by-step instructions from a teacher could conceivably be accomplished by them with the help of a self-recording device which prompted the

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next step. In this case, the simple responses of continuing to run
given one stimulus array of the self-recording device or stopping
running given a second, were used. More complex behaviors, involving
different component responses, could conceivably be accomplished by
the children given the aid of such a recording device. The area of
programmed instruction would be a fruitful source of ideas for such
devices.
CHAPTER IV

GENERAL DISCUSSION

These two studies involved the important area of cardio-vascular conditioning and general physical fitness of young children. The value of generating exercise behavior in preschoolers, for the sake of their current and future health, is evident from the research findings in the area. The incidence of mortality due to the various cardio-vascular diseases and the beneficial effects that aerobic exercise can have in the prevention and/or cure of such diseases indicates a need for research in the variables controlling the generation and maintenance of such behavior.

The first study, in response to a report to the President's Council on Physical Fitness (1980) regarding the lack of physiological data on preschoolers because of the difficulty in getting them to comply with requests to run for 12 minutes, demonstrated the effectiveness of a simple contingency management in producing compliance. The possibility of collecting such physiological data now exists, which can, in turn, be used to evaluate individual physical fitness and to design and evaluate training programs to enhance such fitness. The second study investigated the effect of a particular self-recording device in improving the accuracy with which the subjects followed directions to run a specified number of laps. Such a device can act as an antecedent stimulus for the component responses of a difficult response chain, thus, eliminating the need.
for teacher prompts for each component. The savings in teacher time could then conceivably be used in more individual training and attention for the students.

Still needed in this area are studies investigating the best method to maintain the exercise behavior in the absence of a structured setting, such as a school gym program, either by having the behavior contact natural contingencies or by generating such behavior under the control of rules.
REFERENCE NOTES

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