ENDURANCE FITNESS TRAINING AND THE ELEMENTARY SCHOOL CHILD: EFFECTS ON PHYSICAL AND PSYCHOLOGICAL WELL-BEING

Sandra M. Keller

A Thesis

in

The Department

of

Psychology

Presented in Partial Fulfillment of the Requirements
for the degree of Doctor of Philosophy at
Concordia University
Montréal, Québec, Canada

August 1981

ABSTRACT

ENDURANCE FITNESS TRAINING AND THE ELEMENTARY SCHOOL CHILD:

EFFECTS ON PHYSICAL AND PSYCHOLOGICAL WELL-BEING

Sandra M. Keller, Ph.D.
Concordia University, 1981

While many studies have demonstrated that physical fitness may contribute to psychological health in adults, few have investigated the effects of fitness training on children. Thus, the activity level of seven-year-olds was manipulated to determine its impact on physical and psychological functions. Fifty-three grade two students were randomly divided into three groups: one received exercise classes four days weekly, another, music classes, and a third simply maintained the regular school curriculum. Individual test sessions were held at the beginning, middle and end of the ten-month experimental period. Physical fitness was inferred from heart rate recovery following a bicycle ergometer test, changes in percent body fat, performance on standardized tests of endurance fitness, and school absences. Psychological measures included autonomic recovery from, and performance on stress-inducing tasks, academic achievement, and also teacher evaluations of classroom behavior. Performance on the endurance tests and changes in body fat indicated that Group Exercise became significantly more fit by the study's end. No significant psychological improvements were observed. It was felt that the psychological response of children to fitness training could be better determined with more sensitive measures.

Table of Contents

Table of Contents (continued)

Technological advancement over the last century has had opposing effects on mental health and physical condition. Improved medical care, coupled with discoveries such as vaccines, have reduced morbidity (e.g., polio, tuberculosis, small pox) and mortality rates (Statistics Canada, 1980). But while North Americans are overtly healthier than those of generations past, their change in life-style has actually produced a general decline in fitness level (Lorin, 1978). Recent statistics reveal that 67% of Canadian adults are overweight, only 20% engage in recreational exercise, and less than 15% meet internationally accepted standards of physical fitness (Pools, Parks & Rinks, 1977; Statistics Canada, 1978). Repercussions of more sedentary life-styles have been felt in younger populations as well. There have not only been steady increases in teenage coronary heart disease and death (Shephard, Allen, Bar-Or, Davies, Degre, Hedman, Ishii, Kaneko, Lacour, diPrampero & Seliger, 1969), but the physical fitness level of North American children is significantly lower than the fitness level of their European counterparts (Asmussen, Heeboll-Nielsen & Molbech, 1964). Furthermore, Shephard (1974), Smart (1976) and Burns (1978) have reported a growing incidence of disorders with behavioral components, including childhodd obesity, alcohol abuse, hyperactivity, and learning disabilities.

Interest in the effect of physical fitness on psychological functioning has increased over the last two decades; studies suggest that physical conditioning enhances emotional well-being. Adults have demonstrated significant improvements in self-image and ability to

relax (Ismail & Trachtman, 1973; Ogilvie & Tutko, 1971). Shephard (1977) found that exercise increased work efficiency and job satisfaction. Furthermore, subjects have reported a heightened sense of happiness and well-being (Heinzelmann, 1975). Unfortunately, most of the research on the interrelation between physical and psychological functioning has been conducted on adults.

Because few studies have manipulated the activity level of children, the present investigation sought to determine the effects of a physical conditioning program on seven year old students. After the term physical fitness is defined, the physiological adaptations to fitness training will be reviewed. Tests of physical fitness, as well as the fitness level of Canadian school children will be examined next. Both the definition and quantification of psychological fitness will then be presented, followed by a review of the studies on the interrelation between physical and psychological well-being.

Endurance Fitness

Because physical fitness is multi-faceted, the term has traditionally been defined as some arbitrary combination of strength, flexibility, endurance, balance, speed, or coordination (Fowler & Gardner, 1963). However, recent consensus (Astrand & Rodahl, 1977; Mathews & Fox, 1976; Shephard, 1977) has indicated that the most appropriate index of physical fitness is endurance or aerobic capacity.

Endurance fitness refers to a state of cardiorespiratory efficiency, which is reflected in the body's ability to sustain physical

activity for prolonged time periods (Scheuer & Tipton, 1977). The energy required for physical work is initially derived from anaerobic metabolism, in which the primary fuel source is glycogen, a simple sugar (Mathews & Fox, 1976). In the absence of oxygen, the catabolism of glycogen yields lactic acid. An accumulation of lactic acid, however, produces muscular fatigue (Fitts, 1977), thereby limiting anaerobic metabolism to relatively short time periods.

If physical activity continues for more than several seconds, the metabolism gradually shifts from anaerobic to aerobic modes. Glycogen is still the major fuel source, but glycolysis now occurs in the presence of oxygen such that lactic acid production is inhibited. Thus, the by-products are carbon dioxide and water, both of which can be readily processed by the body (deVries, 1971).

During recovery from exercise, the lactic acid that has accumulated prior to the aerobic changeover is burned by the muscles or else reconverted by the liver into its precursor, glycogen. Hill (1924) suggested that the extra energy requirements of these tasks create an oxygen debt which is paid through the continued deep respiration and elevated heart rate at the end of exercise.

Endurance training can increase aerobic capacity or maximal oxygen uptake, thereby accelerating the rate at which the cardiovascular system can provide oxygen to the working muscles (Scheuer & Tipton, 1977). Thus, aerobically trained persons can sustain physical activity for longer periods of time than the untrained, with less effort, and with less of an oxygen debt (Katch & Danielson, 1976).

Exercises which demand large quantities of oxygen, such as walking, running, cycling, and swimming, are considered the most effective in improving endurance fitness (Cooper, 1968). Optimal training effects, however, depend on the frequency, intensity, and duration of training. Skinner (1975) recommends 20 to 30 minutes a day, two to four days a week, at approximately 60 to 75% of the individual's maximal oxygen uptake.

Physiological Adaptations to Endurance Training

There has been ample documentation of the effects of endurance training on the cardiovascular, respiratory, muscular, and metabolic systems of adults (see Table 1). In contrast, the physiological adaptations of children have not only received less attention, they have remained less conclusive as well.

Andrew, Becklake, Guleria, and Bates (1972) demonstrated that swim training significantly increased children's lung volume and diffusing capacity. However, Hamilton and Andrew (1976), as well as Eriksson and Koch (1973), failed to replicate these findings in trained 11 to 17 year olds. Changes in maximal oxygen uptake, though, have been found to be more consistent across studies. As in adults, pre- and post-pubertal children respond to endurance training with increased aerobic capacity (Astrand, Engstrom, Eriksson, Karlberg, Nylander, Saltin, & Thoren, 1963; Ekblom, 1969). No sex differences are evident in younger children, but by around age 14, boys show a higher maximal oxygen uptake than girls (Adams, Linde, & Miyake,

Table 1

The Physiological Effects of Endurance Training on Adults[1]

DURING MAXIMAL EXERCISE	DURING INACTIVE STATES
Cardiovascular System	
Increased maximal oxygen uptake	Cardiac hypertrophy
Decreased heart rate	Increased post-exercise heart rate recovery time
Increased maximal cardiac output	Increased stroke volume
Increased stroke volume	Decreased heart rate
	Possibly reduced blood pressure
Respiratory System	
Increased minute ventilation[2]	Increased lung volumes (e.g., vital capacity[3]; residual volume[4]; etc.)
Increased diffusion capacity	
Muscular System	
Increased oxygen utilization by peripheral musculature	Increased muscle tone & strength
	Increased myoglobin concentration
Body Composition	
	Decreased body fat
	Decreased body weight

1. Summarized from Astrand & Rodahl, 1977; deVries, 1974; Fox, 1979; Karpovitch, 1966; Mathews & Fox, 1976; Scheuer & Tipton, 1977.

2. Minute ventilation: volume of air inspired and expired per minute.

3. Vital capacity: maximal volume of air forcefully expired after a maximal inspiration.

4. Residual volume: volume of air remaining in the lungs after a maximal expiration.

1961; Bengtsson, 1956). Discrepant findings also confound the literature on changes in stroke volume (i.e., the amount of blood pumped by the heart per beat). Some researchers (Andrew et al., 1972; Hamilton & Andrew, 1976) reported no differences in stroke volume between trained and untrained pre-pubertal boys, while others (Eriksson & Koch, 1973) found increased stroke volume in trained 11 to 13 year olds. In addition, Hamilton and Andrew (1976) reported that training increased stroke volume in post-pubertal boys, which corroborates with the findings of Ekblom, Astrand, Saltin, Stenberg, and Wallstrom (1968).

Many early studies also examined the influence of endurance training on children's heart rate recovery from exercise. This is based on the principle that the greater the individual's physical work capacity, the faster the heart rate's deceleration to resting levels (Gallagher & Brouha, 1943). Almost without exception, fit children have been found to recover faster than unfit children from performance on the step test (Gallagher & Brouha, 1943); bicycle ergometer (Gallagher, Gallagher, & Brouha, 1943), and running tasks (Boas, 1931). In contrast to the adult literature, no data were available on changes in either resting heart rate or blood pressure.

Tests of Physical Fitness

Initially, ambiguity surrounded the definition of physical fitness, which in turn hindered the development of precise physical fitness tests. Both problems, however, have been resolved as consensus over the definition and quantification of fitness has been reached.

Three tests have subsequently gained popularity for testing endurance, including the step, treadmill and bicycle ergometer (Astrand & Rodahl, 1977; deVries, 1971). This section describes the physical characteristics and procedures employed with these tests, as well as their relative advantages and inconveniences.

The step test consists simply of climbing and descending a step at a constant rate set by a metronome. Although the test has the advantage of requiring minimum skill, it does have several drawbacks. Ease of performance is highly weight-dependent (Shephard & Olbrecht, 1970), and some subjects cannot synchronize themselves to the beat of the metronome. As they near exhaustion, they fail to straighten their hip and knees, and consequently do not lift their center of gravity the full height of the step. Accuracy is further lost among shorter subjects who find the step too high for optimal performance (deVries, 1971; Keller, 1980).

A second popular instrument used to assess physical endurance is the treadmill. This apparatus consists of a motor-driven conveyor belt, on which the subject walks or runs. Both the speed and incline of the belt are adjustable. The treadmill has an important advantage over other tests in that it uses a skill with which everyone is familiar. However, restricted running on a hard and slippery incline is both unnatural and somewhat frightening to many individuals (Shephard, 1977). The subject's gross body movements also impede proper instrumentation (deVries, 1971).

A third instrument used for assessing aerobic capacity, the

bicycle ergometer, is a stationary bicycle whose front or back wheel is driven by the subject's pedaling. A friction belt or an electromagnetic braking system provides the resistance against which the subject pedals; both can be adjusted to vary the workload (Mathews & Fox, 1976).

There are two main difficulties with the bicycle ergometer. First, friction is diminished as the brake becomes hot with prolonged pedaling, thus requiring frequent calibration. Second, weaknesses of the knee muscles may limit performance more often than general exhaustion (Weiser, Kinsman, & Stamper, 1973). Several merits of the bicycle ergometer, on the other hand, stem from the fact that the subject performs the test sitting down. Not only does this reduce anxiety and free performance from the influence of body weight, but the upper body's relative lack of movement facilitates instrumentation (Ellestad, 1975).

The step test, treadmill, and bicycle ergometer can all be used to assess aerobic capacity either directly or indirectly. The direct method requires the subject to work to exhaustion while breathing into a gasometer (Chapman & Mitchell, 1965). The ratio of carbon dioxide output to oxygen intake is then determined; higher ratios indicate superior fitness levels. While a direct measure of aerobic capacity is considered the most accurate, the prodedure is time consuming and physically demanding of the subject. In addition, it is difficult to ascertain when the individual has reached his maximal oxygen uptake level (Astrand & Rodahl, 1977; Williams, 1972). In

contrast, the indirect method is easier to both administer and perform, and also accomodates a wider age and ability range. Based on the assumptions that (1)heart rate is linearly related to oxygen uptake, and (2)a constant maximum heart rate exists for a given population (Astrand & Ryhming, 1954), aerobic capacity may be measured indirectly by predicting oxygen uptake from heart rate change during submaximal exercise.

There is much controversy over which of the three ergometric measures provides the best index of physical fitness. For example, Kavanagh (1976) considers the treadmill to be the most accurate instrument, while Astrand and Rodahl (1977) prefer the bicycle ergometer, and Kasch, Phillips, Ross, Carter, and Boyer (1966) advocate use of the step test. Despite these personal differences, strong correlations have been reported between the step test and bicycle ergometer (Ryhming, 1954), and the step test and treadmill (Kasch et al., 1966). It was therefore felt that any of the three instruments would be appropriate for use in the present study. However, the bicycle ergometer was selected since young students served as subjects. Not only have children been found to enjoy the novelty of pedaling a stationary bike, but the bicycle is also less anxiety-inducing than both the step and treadmill (Shephard, 1977).

The Physical Fitness of Canadian Children

The Canadian Association for Health, Physical Education and Recreation (CAHPER), under the sponsorship of the Department of

National Health and Welfare, Canada, recently launched a longitudinal study to establish norms on the physical work capacity of Canadian children, and also to develop a battery of physical fitness tests suitable for use within the school systems across Canada. This project (Howell & Macnab, 1968) spanned a three-year period in which data were collected from over 2,000 children aged seven to seventeen. The Canada Fitness Award test which resulted from this research was introduced into the schools in 1967. It consists of six subtests, including speed sit-ups, flexed arm hang, standing long jump, and shuttle as well as distance runs. In 1980, CAHPER instituted a second phase of testing not only to update norms, but also to modify items on the Canada Fitness Award test.

Results from the entire Canadian sample indicated that at all ages, boys had significantly higher physical work capacity than girls (as measured by heart rate change during a twelve-minute cycling task). In addition, two distinct patterns were recognized: boys' fitness levels were relatively constant at all ages, whereas fitness decreased appreciably for girls after age 12. An examination of body weight revealed virtually no sex differences from ages seven to eleven. At 12 and 13 years, however, girls were slightly heavier than boys, and from ages 14 to 17, boys' weight rose considerably faster than girls'. Correlations between physical work capacity and body weight were for the most part statistically significant.

Shephard, Allen, Bar-Or, Davies, Degre, Hedman, Ishii, Kaneko, Lacour, diPrampero, and Seliger (1969) measured the physical work

capacity and related physiological parameters of school children in Toronto. Subjects performed progressive sub-maximal exercise tests on both the treadmill and bicycle ergometer. Girls demonstrated poorer aerobic capacity, less muscular strength, and more body fat than boys. Compared to the CAHPER sample, values for the Toronto children's maximal oxygen uptakes and body weight were both substantially higher.

Rather than just passively measure the growth and development of school children, Jéquier, Lavallée, Rajic, Beaucage, LaBarre, and Shephard (1977) experimentally manipulated physical activity level. Children in an experimental group received five hours of physical training a week, while those in a control group, only a single 40 minute period. Subjects ranged from six to twelve years of age and represented both urban (Trois-Rivières) and rural (Pont-Rouge) communities. Test sessions consisting of physical and psychological assessment occurred once a year for eight years.

The average aerobic capacity of this sample was much larger than that reported by Howell and Macnab. Specifically, between ages six and eleven years, the Quebec boys' maximal oxygen uptakes were significantly greater than the girls'; values for the urban children were higher than those for the rural from ages nine to eleven years. Subjects in the experimental group had larger aerobic capacities than those in the control group at ages ten and eleven. The experimental group also exceeded the control group on various tests of physical strength, while no differences were observed between the urban and

rural samples.

Shephard, Lavallée, Larivière, Rajic, Brisson, Beaucage, Jéquier, and LaBarre (1974; 1975) also assessed the cardiorespiratory fitness of francophone school children. Boys and girls nine to twelve years of age were chosen at random from an urban (Trois-Rivières) and rural (Champlain) region. Fitness was measured both at rest and during treadmill walking to voluntary exhaustion. Maximal oxygen uptake was higher for boys than girls, and also for urban than rural children. Height, weight, and percent body fat failed to distinguish the samples, but the urban subjects demonstrated greater muscular strength.

The similarity of measures facilitated the comparison of results to those obtained by Shephard et al. (1974; 1975) with Toronto students. The Quebec children had greater maximal oxygen uptakes than the Toronto children, and the francophones (both urban and rural) were smaller than the anglophones. The absolute stroke volume for francophones was the same as the anglophones', but when calculated on a per kilo basis, the francophones' was higher.

Shephard and his colleagues (1974; 1975) also compared their results to those gathered earlier on Eskimo children from the Canadian arctic. The Eskimos were found to have greater physical work capacity, more muscular strength, and a smaller percent body fat than both anglo- and francophones.

The fitness status of Canadian children can be put into better perspective when their data are compared with international samples. While Canadians do not differ from American (Kramer & Lurie, 1964)

or Czechoslovakian children (Seliger, 1971), their results are significantly inferior to the Swedish children tested by Astrand (1952). Not only is the average Canadian child considerably heavier, but the boys' average fitness levels approximate those of the Swedish children classified as the most unfit. The average Canadian girl's aerobic capacity is even worse than the poorest members of Astrand's sample. The Canadian children also have poorer muscular strength than Danish children (Asmussen, Heeboll-Nielsen, & Molbech, 1964). Differences in life-style, such as diet and choice of leisure activities, have been implicated as the largest contributory factors to these discrepant fitness levels (Shephard, 1977).

Psychological Fitness

Man's earliest conjectures about psychological fitness have included the notion that a subtle relation exists between emotional states and bodily activity (Grings & Dawson, 1978). One of the most influential theories describing this interrelationship was developed independently in the 1880s by the American psychologist William James and the Danish physiologist Carl Lange. The essence of the James-Lange theory is that "bodily changes follow directly the perception of the exciting fact, and that our feeling of the same changes as they occur IS the emotion (James, 1892, p. 375). In other words, emotion is the result rather than the cause of bodily reactions. Despite its simplicity, this theory endured for nearly 50 years.

To illuminate the inadequacy of a purely visceral theory of

emotion, Cannon (1927) advanced a neurophysiological explanation. This was expanded by Bard in 1928, and is today referred to as the Cannon-Bard Theory of Emotion. The essence of this theory is that emotions are not simply the perception of visceral arousal, but rather the result of thalamic processes mediated by thalamico-cortical tracts. In addition to his emphasis on the role of the thalamus, Cannon was among the first to stress the contribution of the endocrine system to the production of emotions (Candland, Fell, Keen, Leshner, Plutchik, & Tarpy, 1977): arousal of the autonomic nervous system (e.g., increased heart rate, blood pressure, respiration rate, etc.) mobilizes the body for 'fight or flight', while the endocrine glands release adrenalin to help maintain these elevated functions.

Given the different emphases of these two theories, a Cannon-James controversy ensued. This concerned not only the sequence of events which produce an emotion, but also the relevance of physiological arousal. James regarded visceral changes as both necessary and sufficient conditions for the production of an emotional state, whereas Cannon questioned the importance of their very existence within a theory of emotion.

Several contemporary theorists have sought to resolve the Cannon-James controversy by proposing an interaction between the physiological and cognitive components of emotion. In a series of studies, Schachter and colleagues (Latané & Schachter, 1962; Schachter & Singer, 1962; Schachter & Wheeler, 1962) demonstrated that phyisological arousal, although a necessary component of emotion, is not sufficient in itself

to produce an emotional state. Rather, an individual will describe his bodily sensations as emotion only to the extent that appropriate cognitions are available to him.

Another recent approach to the study of emotions advocates that it is not the amount of autonomic change or lability which defines the level of emotional arousal, but rather the recovery from these altered states. This belief stems from Cannon's (1932) principle that when a biological system is pushed beyond optimal levels of functioning, it triggers self-regulatory mechanisms which act to restore order. Several authors have employed a recovery index. Johansson (1976) found that urinary excretion of adrenalin and noradrenalin returned more rapidly to baseline levels under conditions of mental relaxation than under conditions of emotional stress. Malmo (1975) distinguished anxious from non-anxious subjects by the rate at which muscle tension recovered from a mild stressor.

In summary, early theorists established that emotional arousal is associated with physiological arousal. Assessment of autonomic activity during emotional situations is consequently gaining popularity as an objective measure of emotionality. Such autonomic monitoring, as well as the more traditional methods of psychological assessment, will be reviewed below.

Assessment of Psychological Fitness

The earliest tests of psychological fitness were devised to measure sensitivity to sensory stimuli. The rationale for these

tests (e.g., the Galton whistle for determining the highest audible pitch) was based on the belief that sensory discrimination provides an index of intellectual capacity. Tests of personality, however, developed only after the identification of mental retardation (Anastasi, 1976). Since then, a proliferation of techniques has been devised to measure personality states and traits.

The earliest approach to personality assessment was based on clinical diagnoses. This consisted simply of comparing individuals exhibiting psychological abnormalities to those in apparently good health. A second approach has been to administer personality inventories on which the subject chooses, from an array of statements, those which he feels are applicable to him (Davison & Neale, 1974). While such tests are advantageous over others for providing quantitative information, many (e.g., the Minnesota Multiphasic Personality Inventory) were designed to detect psychopathology and are therefore inappropriate measures of "normal" personalities (Rushall, 1973).

Self-report questionnaires surveying mood and personality states (e.g., the Taylor Manifest Anxiety Scale) have also been employed to distinguish normal from abnormal psychological functioning. These questionnaires, however, require the subject to report emotions experienced in past situations, and may therefore elicit imprecise responses. The usefulness of these questionnaires is further limited by the fact that they fail to control for the subjects' expectations.

A fourth instrument used for assessing psychological fitness is the projective personality test. In the Thematic Apperception Test,

for example, the subject must invent a story about an ambiguous picture. Because projective tests are relatively unstructured, it is believed that the individual will project underlying personality traits without the confound of response sets (Anastasi, 1976).

Another technique used to measure psychological fitness is to infer emotional arousal from autonomic indices. This practice is based on two concepts: (1)the longstanding knowledge (James, 1892) that the subjective experience of emotion is accompanied by physiological changes, and (2)Cannon's (1932) principle of homeostasis that the system autonomically recovers from these changes. The use of autonomic indices as a measure of psychological fitness is currently gaining wider recognition. While Grings and Dawson (1978) have reviewed the various autonomic changes which accompany emotion (e.g., increased blood pressure, heart rate, and muscle tension), Johansson (1976) and Malmo (1975) have demonstrated that the critical measure of well-being is not the magnitude of autonomic response, but rather the rapidity with which autonomic activity returns to baseline levels. The notion of autonomic recovery was therefore used in this present study as an index of psychological fitness.

Physical Fitness and Academic Achievement

The first investigations into the relation between physical fitness and academic achievement were conducted on college students. Weber (1953) compared the grade point averages (GPA) of male college freshmen to performance on tests of muscular strength and endurance.

Results indicated that high levels of physical fitness correlated significantly with high academic achievement. In a similar study, Arnett (1968) examined the academic records of female college freshmen who had undergone compulsory fitness testing at the beginning of the school year. Significant differences in GPA were found among those students who were classified as high, fair, and low in physical fitness level. In other words, those women who achieved high GPA's scored significantly better on the fitness items than those with low GPA's. Another correlational study on sophomore college women (Hart & Shay, 1964) also revealed that the subjects who achieved high GPA's fell into high fitness categories.

Despite the consistent findings that the physically fit achieve greater success at school than the unfit, the correlational nature of these studies limits the generalization of results. By not manipulating fitness level, the authors failed to control for potential confounding variables, such as personality predispositions to fitness. Thus, whether good physical fitness is the cause or the effect of academic success was never clarified. Unfortunately, no studies have since been published which specifically address this issue.

While the relation between physical fitness and academic achievement has not stimulated much research on adults, it has stimulated even less research on children. Moreover, the majority of these studies examined motor proficiency rather than aerobic capacity, which is the component of physical fitness emphasized in the present investigation.

Plack (1968) studied the relation between reading achievement and selected motor skills in first, third, and fifth graders. Both reading comprehension and vocabulary correlated with the motor skills of throw and catch, and zig-zag runs. Kirkendale and Ismail (1970) were able to accurately classify preadolescent children as high, medium, or low academic achievers based on their ability to execute intricate hopping patterns with coordinated arm swings. Ismail and Gruber (1965) found that balance and coordination items could predict academic success. Thomas and Chissom (1972) obtained significant correlations between academic achievement and selected perceptual-motor measures in children ranging from kindergarten through the third grade.

A study by Ismail and Gruber (1967) represents one of the few attempts to experimentally manipulate activity level. They established two groups of fifth and sixth graders, matched for intellectual capacity and randomly designated as experimental and control. Subjects in the experimental group received 30 minutes of organized physical education instruction two, three, or five days a week, depending on the individual school's curriculum. Classes consisting of activities designed to develop muscular strength and endurance, neuro-muscular proficiency (e.g., coordination, balance, rhythm), and cardiovascular endurance, extended over one full schoolyear. Subjects in the control group participated in daily supervised free-play recess periods. Analysis of performance on the Stanford Achievement Test revealed that the children who had received instruction in physical education

were three to five months ahead of the control subjects in both reading and arithmetic.

This study, however, is beset with two major difficulties. First, change in fitness level was not calculated over the course of the program. If no physical benefit was derived, the authors are not justified in concluding that the physical education classes had a significant effect on the children's academic achievement. The second problem concerns the fact that baseline data on the Stanford Achievement Test were also not presented. This raises the possibility that the subjects receiving fitness training could have scored higher than the control group not only after the study, but before it as well.

Although it is well documented that mentally retarded children are inferior to normal children in general fitness level (Maksud, Coutts, & Hamilton, 1971) and also motor proficiency (Howe, 1959; Malpass, 1960; Widdop, 1970), extensive research has established that capacity for physical improvement is the same for both populations (Campbell, 1974; Funk, 1971; Lillie, 1968; Ross, 1969). This is often obscured, however, by the fact that retardates' repeated frustration and failure in academic pursuits diminish general effort and expectancy to succeed (Solomon & Prangle, 1967). Accomplishments in physical training may therefore act to restore self-confidence and generate success to other areas such as academic achievement. Few studies, however, have investigated this possibility. Oliver (1958) divided educable mentally retarded (EMR) boys into two groups: one participated in physical conditioning classes five days a week,

while a control group continued with the school's regular physical education classes twice weekly. A battery of psychological and physical tests were administered to all subjects before and after the ten-week experimental period. Analyses of performance on the physical tests revealed that the experimental group significantly improved in fitness level as measured by jumping, running, push-ups, and sit-ups. Results from psychological tests indicated that they also significantly increased in verbal and overall academic achievement. The authors further reported that the boys attained greater self-confidence, leadership ability, and social adjustment.

Despite seeming confirmation of the hypothesis, Corder (1966) recognized the possibility that the Hawthorne effect (Roethlisberger & Dickson, 1939), which describes how mere participation in an experiment can influence subjects' behavior, may have contaminated Oliver's findings. In an attempt to control for this confound, Corder (1966) randomly assigned EMR boys to one of three groups: one received physical education classes five days a week for one month while a second maintained the regular school curriculum. An officials group, whose duties were to rate and record the progress of the boys from the training group, was established to control for a Hawthorne effect. All three groups performed the Wechsler Intelligence Scale for Children and also tests of physical fitness. Post test fitness scores revealed significant improvements in the training group; there were virtually no differences between the control and officials groups. Consistent with Oliver's findings, significant

differences in IQ gains distinguished the training from the control group. However, the experimental children failed to achieve significantly higher IQ scores than the officials group. This latter finding suggests that a Hawthorne effect may have been operating.

These studies demonstrate that although the initial physical performance level of retarded children is well below that of children with average intelligence, training can produce significant improvement. However, whether generalization to mental characteristics occurs is less certain. The fact that some tests require considerable intelligence for understanding the mode of execution may in itself interfere with the retardate's performance and thus cause him to be erroneously labeled as less proficient.

The Effect of Physical Fitness on Psychological Well-Being

The first studies on physical-psychological relations simply compared physical fitness levels of psychiatric and mentally healthy persons. McFarland and Huddleson (1936) found psychotics and neurotics to be significantly less fit than unselected and athlete controls. Linton, Hamelink and Hoskins (1934) demonstrated a negative correlation between physical fitness and schizophrenia. Although these studies demonstrated that individuals with poorer psychological adjustment were in poorer physical health, neither determined the causal relationship between physical and psychological well-being. The authors' failure to state whether the patients were hospitalized or not further confounds the data as confinement in hospital may

cause fitness level to deteriorate.

An increasing number of studies on the interaction between physical and psychological well-being has emerged in the last two decades. Despite reports that improved levels of physical fitness increase self-image, feelings of well-being, and ability to relax (Ismail & Trachtman, 1973; Ogilvie & Tutko, 1971), these studies have been severely criticized (Hammett, 1967; Rushall, 1973). The typical approach was to repeatedly administer personality inventories to athletes or individuals enrolled in physical fitness programs. Results on these personality tests were then correlated with results on tests of physical fitness. Not only is this research correlational, but the study of athletes does not permit the generalization of results to the population at large. Such sampling also introduces the question of whether individuals with certain personality structures gravitate toward athletics, or whether athletic participation actually influences personality dynamics. In addition, many of the psychological assessment tools were inappropriate since they were not intended for use in non-clinical populations.

Despite such shortcomings, popular belief still holds that exercise benefits both the healthy and the infirm. Folkins, Lynch and Gardner (1972) had students enroll in a four-month jogging, golf or archery course. Scores on the Gough and Heilbrun Adjective Check List, and also the Zuckerman and Lubin Multiple Affect Adjective Check List indicated that the female exercisers experienced a significant decrease on the anxiety and depression scales, and a signifi-

cant increase in self-confidence.

Ismail and Trachtman (1973) similarly conducted physical conditioning programs with university faculty and staff. Comparison of pre- and post-exercise scores on the Cattell 16 Personality Factor Questionnaire revealed that the men felt significantly more self-sufficient, resolute, imaginative, and emotionally stable.

While both studies suggest that exercise training benefits healthy individuals, they drew their evidence from self-report questionnaires. Recently, a more objective approach to the study of physical-psychological relations has emerged; namely, the measure of autonomic responses to emotionally stressful tasks. Cox, Evans and Jamieson (1979) determined the aerobic capacity of students and then measured heart rate reaction to, and recovery from, psychological stress (i.e., false feedback on performance of perceptual and intelligence tests, as well as experimenter harassment). Although aerobic capacity was not found to be related to the magnitude of response to stress, subjects with the highest aerobic capacities recovered the most quickly.

The evidence that physical fitness improves psychological well-being has prompted the use of physical training for rehabilitation purposes. Folkins (1976) studied the psychological effects of a three-month exercise program on men at high risk of coronary artery disease. Their fitness levels significantly increased, and their anxiety and depression scores significantly decreased. An inactive control group failed to demonstrate change on any measure.

In order to counteract the influence of self-selection, Heinzelmann (1975) experimentally manipulated physical fitness by randomly assigning men at coronary risk to either an exercise program or an inactive control group. After 18 months, men adhering to the exercise program reported improved work performance and satisfaction, increased stamina and energy, feelings of better health, and greater tolerance to stress. Changes in life-style included better eating, sleeping, and leisure activity habits.

The psychological effects of physical fitness training have also been amply documented on post-coronary patients. With few exceptions, subjects report increased stamina and sense of well-being, decreased anxiety and depression, and restored morale and self-confidence (Kavanagh, 1976; Rechnitzer, 1972; Prosser, Carson, Gelson, Tucker, Neophytou, Phillips & Simpson, 1978).

Because aerobic conditioning improves cardiovascular efficiency, exercise programs have been used in the rehabilitation of asthma as well. Scherr and Frankel (1958) enrolled asthmatic children in a fitness program with the aim of improving personality adjustment, pulmonary function, and control of the asthma. Classes included respiratory exercises, gymnastics, calisthenics, judo, wrestling, and boxing. All children demonstrated both social and physical improvements over the course of the program. They increased home, school, and church activities, adjusted better to others in daily functions, and suffered fewer and less severe asthmatic attacks. Moreover, none required hospitalization after entering the program,

whereas one-half of the group had been hospitalized during the previous year.

In an eight-month study by Petersen and McElhenney (1965), asthmatic children not only experienced significant increases in pulmonary and cardiovascular efficiency, they developed greater emotional stability, sociability, self-assertion, and enhanced peer relationships as well. Similar physical and psychological benefits have been reported by Millman, Grundon, Kasch, Wilkerson and Headley (1965).

In conclusion, recent standardization of both the definition and measurement of physical fitness has facilitated the study of fitness training. Research has established that the parameters of frequency, intensity, and duration must be satisfied in order to improve the functioning of the cardiorespiratory, muscular, and metabolic systems. Not only has normative data been gathered on the fitness level of both adults and children, but international comparisons reveal the generally poor physical condition of North Americans.

The emergence of personality questionnaires, and more recently, physiological indices of emotionality, have permitted investigations into the influence of fitness training on psychological well-being. Studies to date suggest that exercise may play a preventative, and also a rehabilitative role in mental health. Methodological weaknesses, however, question the validity of some of the findings in this area of research. This fact, coupled with the poor physical

status of Canadian children, therefore prompted the present study.

Present Study

The purpose of this investigation was to determine the physical and psychological effects of a ten-month fitness program on second grade children. The project involved a repeated measures design in which subjects were randomly divided into three groups: one received physical conditioning, another, musical training, and a third simply maintained the regular school curriculum which included half-hour physical education classes twice weekly.

All subjects were individually tested at the beginning, middle, and end of the study. In each session, the measures of physical fitness consisted of skinfold thickness, and heart rate change during a graded bicycle ergometer test. Performance on a stress-inducing task, as well as change in heart rate and skin conductance during the task, provided the measures of psychological well-being. The school teachers were required to complete questionnaires which surveyed the children's classroom behavior three times throughout the study as well. The Stanford Achievement Test was assigned both at the beginning and end of the year, while data on absenteeism, the Canada Fitness Award test, and academic achievement were collected in June from the school records.

On the basis of prior investigations into the physical adaptations to endurance training (e.g., Johnson, Brouha & Darling, 1942), it was hypothesized that the exercisers would gradually exhibit

faster heart rate recovery times from the bicycle test as they progressed through the study. The two control groups, in contrast, were expected to recover at consistently slow rates. Group Exercise was also expected to have fewer illness-related absences (e.g., flu, colds) than Groups Music and Inactive. It was further predicted that changes in percent body fat, and performance on the Canada Fitness Award test would distinguish the exercisers from both control groups.

Since physically fit college students have repeatedly been found to obtain higher GPA's than unfit students (e.g., Arnett, 1968; Hart & Shay, 1964), greater improvement in academic achievement (as measured by both the Stanford and school report cards) was expected to differentiate those students receiving extra physical education classes from those maintaining the regular gym schedule. It was also predicted that the exercisers' behavior would be rated more positively than the control groups' by the end of the study. If improvement in physical fitness accelerates autonomic recovery (e.g., Cox, Evans & Jamieson, 1979), Group Exercise was expected to recover more quickly from the stress-inducing tasks as their fitness levels improved. In contrast, the two control groups, whose fitness remained static, were expected to manifest consistently high levels of stress in each test session. Actual performance scores on the stress tests were expected to distinguish the three groups as well. Since there has been relatively little documentation of the physical and psychological adaptations of school children to endurance training, all data were additionally examined for possible sex differences.

Method

Subjects

Subject recruitment involved several stages. First, letters requesting co-operation in this study (see Appendix A) were mailed to the following anglophone school boards: Baldwin-Cartier, South Shore Regional, Lakeshore, Montreal Catholic, and Protestant School Board of Greater Montreal. All but the Protestant School Board favorably acknowledged receipt of the letter. Next, the four School Board Directors circulated copies of the letter to the elementary school principals under their jurisdiction. Only the Baldwin-Cartier School Board replied that it had principals who were willing to accomodate the study in their schools. An organizational meeting with the School Board Director, and visits to the two interested school principals were then arranged. Both principals agreed to two stages of work: first, a pilot study from February to June 1979, and then the full implementation of the program to begin the following September. Unfortunately, one school could not avail its gymnasium four days of the week; for this reason, the project was restricted to one school only, namely, St. John Fisher Elementary School in Pointe Claire, Quebec.

In May, 1979, the grade one students brought home letters requesting permission to participate in the study the next year. These letters (see Appendix B) described to their parents both the purpose and methodology of the program. Questions concerning the child's health status, musical ability, and current participation in physical

activities were also included. Parents were further asked to consent to the random assignment of their child into any of the three groups.

Only nine percent of the responses were negative. Of these, five children were unable to obtain parental permission to partake in the study (one mother did not want her son "to be used as a guinea pig"; the four others refused comment). A sixth child was unwilling to join the project because he would have to eat lunch in school. One other student was deleted from the sample because his parents specified group placement.

A total of 53 children combined from all the grade two classes at St. John Fisher School entered the study. None was found to have a physical abnormality which would endanger himself or affect performance. Ages ranged from 6.11 to 7.11 years. The students were divided according to sex, and then randomly assigned to groups. As token payment for their participation in this study, all subjects received small gifts (e.g., toy rings) at the end of each test session. In addition, a meeting was held in June with parents and School Board officials to discuss the project and its outcome.

Materials and Apparatus

Performance on a Bodyguard bicycle ergometer, model 990, served as the test of physical fitness. One slight modification of the bike consisted of affixing ¾ inch thick wooden blocks to the pedals so that the children could reach them more easily. A Quinton-Monark electronic metronome paced the subject's pedaling. Heart rate and

skin conductance were recorded on a Beckman polygraph, model R511-A. Dynatrace disposable pregelled silver/silver chloride electrodes, taped to the subject's chest and back, were used to measure heart rate. Wire passed through 1½ square inch pieces of sponge moistened in saline served as the skin conductance electrodes. These were secured to the subject's palm and wrist with elastic bands fastened with velcro strips. Both skin conductance and heart rate were monitored on DC mode which records sustained changes from baseline. Skinfold thickness was measured with a Lange caliper, and height and weight with an Ohaus medical scale.

Canada fitness award test. Scores were also collected from the Canada Fitness Award test which the Canadian government issues annually to the public schools. Crests of achievement (e.g., bronze, silver, gold, and excellence) are awarded on the basis of the level of achievement the participant reaches in each of six subtests. At the grade two level, these tests include 50 and 600 meter runs, speed sit-ups, flexed arm hang, shuttle run, and standing long jump. At the grade one level, the Canada Fitness Award test is comprised of 50 and 300 yard runs instead of the longer distances required of the older children; all other items are identical. For purposes of this present study, performance on the runs and overall performance level were examined. The remaining four tests were excluded from the analysis since they did not pertain to aerobic capacity.

Stress-inducing tasks. The stress-inducing tasks used in this present study (see Appendix C) were modified subtests of the Wechsler Intelligence Scale for Children (WISC). The purpose of the WISC is to provide both a global index of intelligence, and also qualitative information regarding learning disabilities and mental retardation (Wechsler, 1949). However, the use of the WISC subtests as a measure of intelligence was only of secondary importance in this present study; their main purpose was to induce emotional stress. Several strategies were employed to render the test situation stressful: (1)a three-minute time limit was imposed (pilot work had indicated that this time was insufficient for the successful completion of any of the tasks); (2)an interval timer, which was placed directly in front of the subject, clicked loudly every second, and buzzed when the three minutes had elapsed; (3)continuous feedback on the student's performance was provided throughout the test; and (4) the subject was restricted to working with his non-dominant hand only.

One subtest employed in this study was block design, which consisted of four plastic blocks painted red on two sides, white on another two, and half red and half white on the remaining two. Five cards with geometric designs incorporating all four blocks were presented to the subject in order of increasing difficulty. Twenty, 25, 30, 50, and 55 seconds were allotted to reproduce each successive pattern.

Block design was first introduced in 1923 as a non-verbal measure of intelligence, was later incorporated into the Wechsler

Adult Intelligence Scale, and subsequently modified for the WISC. This test examines the reproductive aspect of visual-motor coordination, and perceptual organization, involving both analysis and synthesis. According to Glasser and Zimmerman (1967), block design also measures awareness of relations between observed and sensed forms (i.e., figural relations), ability to re-interpret a figural complex so that a prescribed figural unit is apparent (i.e., figural redefining), and also ability to rapidly identify the figural entities which meet a stated criterion (i.e., figural selection).

Digit span, a second task employed in this study, consisted of 50 random series of four- to seven-digit numbers. Only single digit numbers, which never appeared twice in any given series, were used. Two practice sequences preceded the test proper. All stimuli were prepared and presented on a cassette tape recorder. The task was to repeat each sequence of numbers without error in the three-second pause which separated each series.

Digit span takes its origins from the Stanford-Binet Test of Intelligence. It was designed to measure verbal memory, attention span, and also immediate auditory recall (i.e., short-term memory). The subtest consists of both a forward and backward version, although subjects in this present study were required to repeat digits forward only.

A modified picture completion test was comprised of seven slides of incomplete pictures. The subject was required to identify the essential part missing from the pictures. The first two slides

were projected for 15 seconds each, the remainder for 30.

The concept of identifying an essential missing element from a picture was developed during World War One by the United States Army for psychological testing (Glasser & Zimmerman, 1967). It was later adapted by Binet, and more recently by Wechsler, for general use as a test of intelligence. Picture completion measures the subject's capacity to identify familiar objects and to isolate essential from non-essential elements. The test also provides an examination of attention span and concentration.

Academic achievement. Data on academic achievement were obtained from two sources: the grade two report cards issued by the school (see Appendix D), and four subtests of the Stanford Achievement Test (Institute of Psychological Research, Montreal). The children's report cards were issued by the school four times throughout the year. Marks were collected for language arts (phonics, vocabulary, oral reading, comprehension, spelling, and oral expression), mathematics computation, French comprehension, science, music participation and physical education. All other courses listed on the report cards were excluded from the present analysis as they were either non-academic or because full-year instruction was not available at the grade two level.

The second source of academic performance was the Stanford Achievement Test. Primary Level I was administered at the beginning of the study, while Primary Level II was administered at the end.

On the first of two consecutive days, the children completed reading and mathematics concepts, each of which had a 25 minute time limit. On the following day, they were assigned vocabulary (20 minutes) and mathematics computation (30 minutes). All other subtests of the Stanford were eliminated either because the children's curriculum did not include instruction in those subjects at the grade two level, or because the subtest was not provided at both Levels I and II. The four tests were administered by the teachers in the regular classroom setting, and were later hand scored by the experimenter using the respective scoring keys provided with the test manuals.

The reading subtest, Primary Level I, consisted of 15 illustrated paragraphs with multiple choice answers; Level II consisted of 16 paragraphs. The items were arranged in order of increasing difficulty such that the paragraphs were first composed of only one or two sentences, and gradually increased to seven. The purpose of the reading test is to measure the student's ability to comprehend both explicit and implicit meaning. Explicit meaning refers to the identification of details which have been clearly presented in the paragraph, while implicit meaning assesses the child's ability to make deductions on the basis of stated facts (Madden, Gardner, Rudman, Karlsen & Merwin, 1973).

Mathematics concepts consisted of 32 items at Level I, and 35 items at Level II. These questions measure competence with numbers and notation, symbols of operations, and geometric figures. The school teachers dictated all questions in order to free subjects'

performance from the influence of reading ability.

The vocabulary subtest, at both Levels I and II, consisted of 37 multiple choice questions read by the teachers. Half of the items were selected from school textbooks in mathematics, science, and social sciences, while the other half were more general terms, such as those frequently used in the language arts.

Mathematics computation, Primary Level I, was composed of 32 questions which required the student to add and subtract. The 37 items included in Primary Level II involved addition, subtraction, and also multiplication.

Behavioral questionnaire. A ten-item questionnaire (see Appendix E) was administered to the children's school teachers at the beginning, middle, and end of the program. Questions surveyed diversified behaviors in the classroom, including alertness, anxiety, attention span, confidence, ability to get along with others, imagination, interest in school work, leadership ability, shyness, and quality of work. Teachers rated each child on a seven-point scale ranging either from "Very Poor" to "Excellent" or from "Very Low" to "Very High".

Treatments

Exercise and music classes were held at St. John Fisher School for one-half hour during the lunch break. Children in Group Exercise wore their regular gymnastic attire (i.e., running shoes and shorts). Instruments for the music group were provided by the school. A third

group received no experimental treatment; instead, these subjects maintained the usual school curriculum. The author visited the fitness and music classes on an impromptu basis throughout the year to monitor the quality of instruction.

Exercise. The children received four exercise classes a week in addition to the regular physical education classes provided by the school. These were held either indoors in the school gymnasium or, weather permitting, outdoors in the schoolyard. The exercise program was designed to emphasize endurance fitness. The classes generally consisted of 15 minutes of exercises and running, and 15 minutes of relays and games. Running time was gradually increased as the children progressed through the program. The relays and games were intended to develop general locomotor skills including hopping, skipping, and jumping. Group effort was emphasized in order to discourage competition and maximize self-challange. Classes were taught by two physical education specialists who work full-time for the School Board. Neither, however, was the children's regular gym teacher.

Music. The music group assembled twice a week in an empty classroom. In one session, the children learned to play the recorder and a variety of percussion instruments (e.g., drums, tambourines, maracas). They were also taught fundamental conducting skills and musical concepts such as rhythm, tone, and accompaniment. The second weekly class emphasized music appreciation. In addition to listening to classical recordings, the students received brief lessons on the

history of music and musical instruments. The teaching responsibilities for the music classes were divided between two instructors who taught alternate classes; neither was on staff at St. John Fisher School.

Procedure

The study spanned one complete school year (i.e., from September 1979 to June 1980). One group of subjects received 30-minute exercise classes four days a week, and another, 30-minute music classes twice a week; a third group did not undergo experimental manipulation of any kind. Individual test sessions were conducted in September 1979, February and June 1980 in a makeshift laboratory at the school. Test procedures for the three sessions were identical except that task presentation was counterbalanced across subjects and sessions. Heart rate was recorded continuously throughout the bicycle ergometer test of physical fitness, as were both skin conductance and heart rate during the stress-inducing tasks.

Upon entering the test room, the subject was requested to remove his shoes, shirt, and any jewelry he was wearing. Height and weight were then recorded. Next, skinfold thickness was determined at the following ten sites as described by Allen, Peng, Chen, Huang, Chang and Fang (1956): cheek, chin, chest, ribs, triceps, abdomen, suprailiac, subscapula, knee, and calf (see Figure 1). All measures were taken on the subject's left side.

Prior to affixing the heart rate electrodes, the skin at the

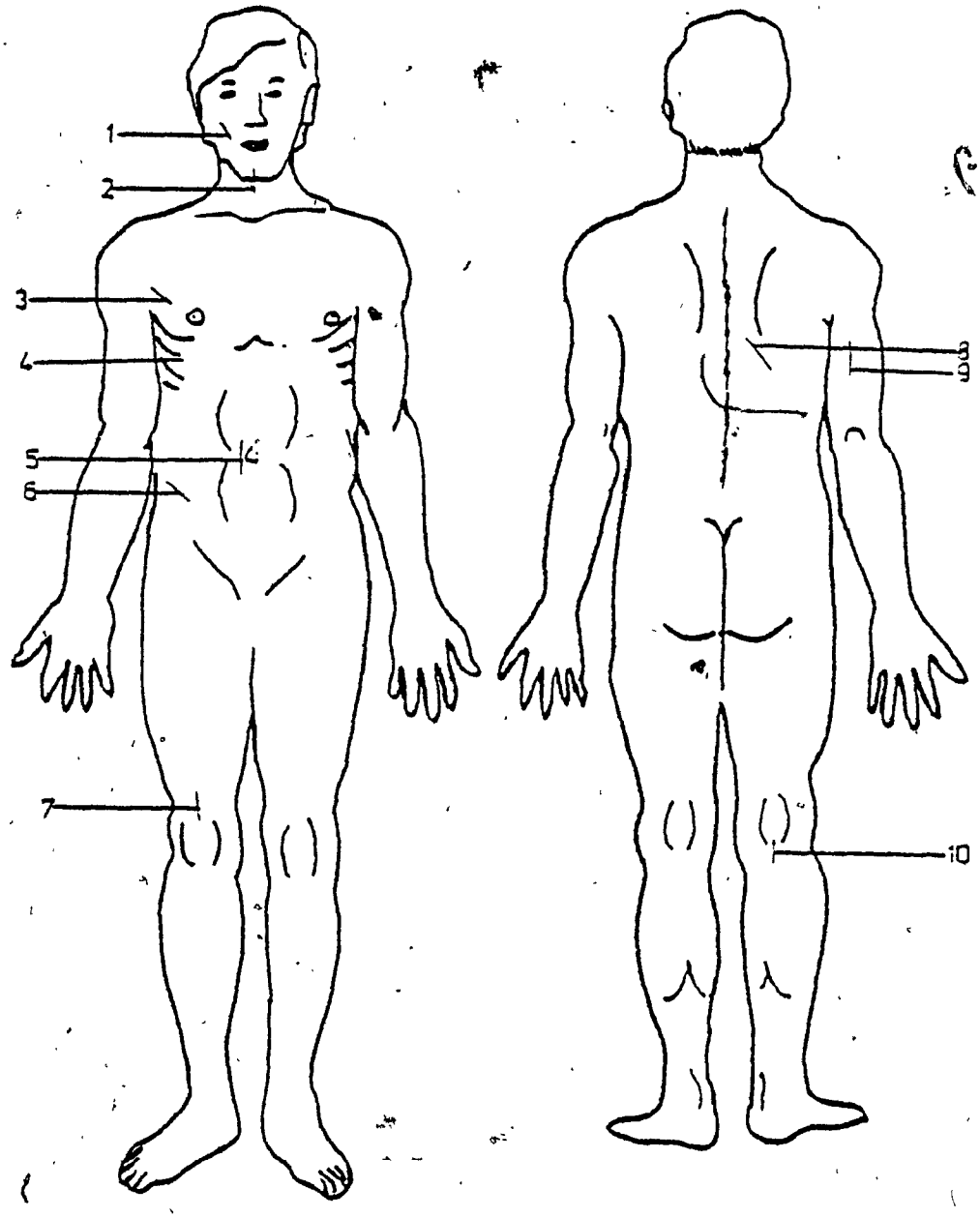


Figure 1. Skinfold thickness measurements at (1) cheek, (2) chin, (3) chest, (4) ribs, (5) abdomen, (6) suprailiac, (7) knee, (8) subscapula, (9) triceps, and (10) calf.

electrode sites was lightly abrased and then cleansed with alcohol. The electrodes were placed according to Blackburn, Taylor, Okamoto, Rautaharju, Mitchell, and Kerkhof (1967): one was taped over the upper part of the sternum (manubrium sterni), and another in the space between the fifth and sixth ribs, approximately three inches to the left of the mid-line. The third (ground) electrode was taped to the subject's back, under the scapula (see Figure 2).

Before administering the test of physical fitness, the height of the bicycle seat was adjusted such that the subject's knee was slightly bent when the pedal was in its lowest position (deVries, 1971); toe straps were secured around the child's feet. The cycling task was then explained, with instructions to maintain a pedaling frequency of 50 revolutions/minute. A metronome, with a synchronously flashing red light, was set at 100 beats/minute to help pace the child's pedaling. The test consisted of alternate two-minute work and two-minute rest periods. The initial workload was set at a resistance of 25 watts. After a rest, the subject resumed pedaling against a resistance of 50 watts. A second rest period was then followed by the final work period, during which the resistance was set at 75 watts. Heart rate was recorded continuously throughout the test. Upon its completion, the subject remained sitting quietly on the bicycle while heart rate continued to be recorded for ten minutes.

Preparatory to the stress-inducing task, the skin conductance electrodes were moistened in saline and then attached to the palm

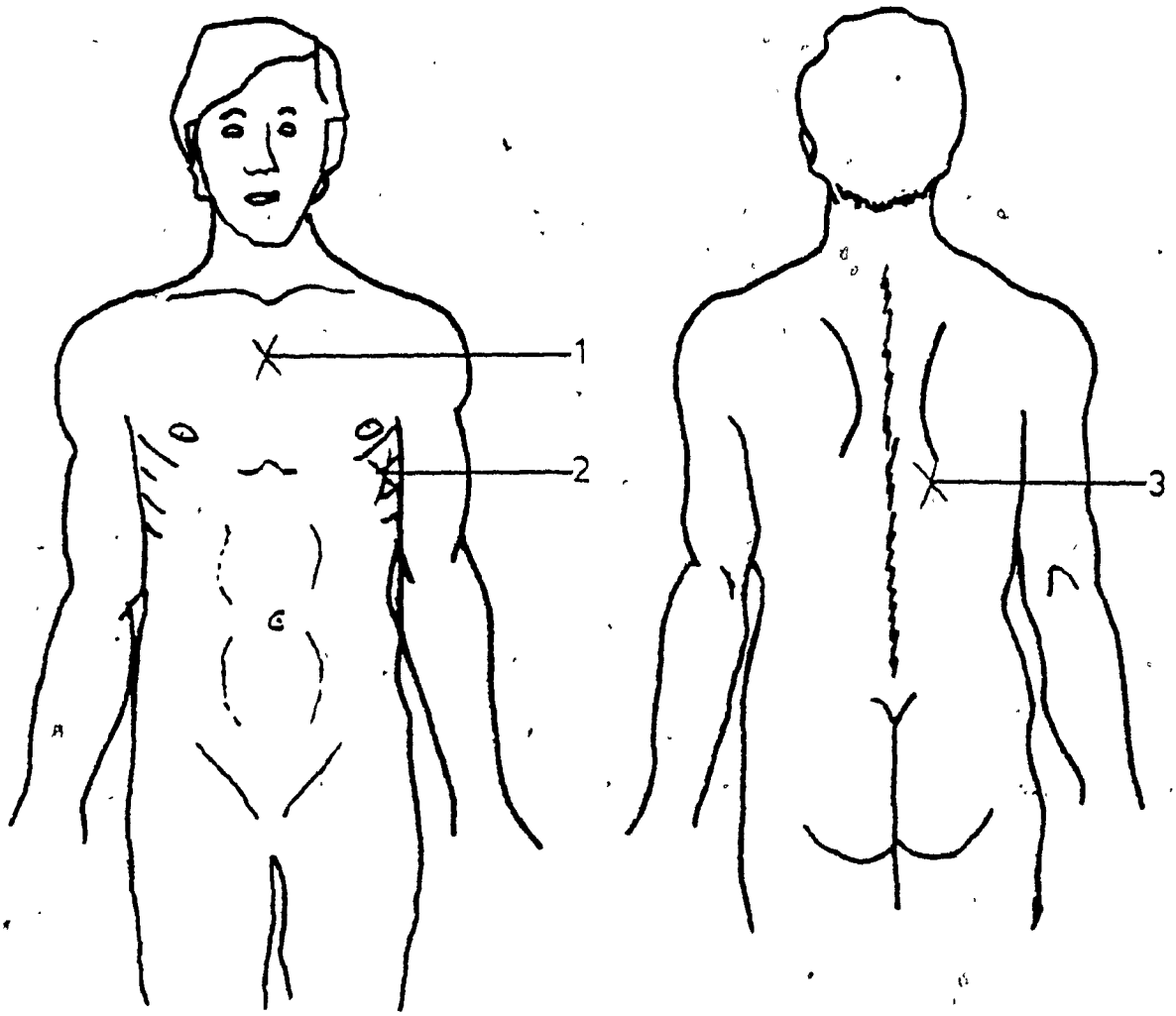


Figure 2. Heart rate electrode placement at (1) sternum, (2) ribs, and (3) scapula.

and wrist of the subject's dominant hand. Heart rate electrodes were affixed as for the bicycle test. Instructions for one of the tasks were then given, followed by a demonstration and practice trial. The time meter was then set to buzz when three minutes had elapsed. When all testing was completed, the electrodes were removed, the child redressed, and a small toy was offered as payment for his co-operation.

Results

Appendix F contains individual subject's data for basal, maximum, and recovery heart rates for the bicycle ergometer test. Magnitude of recovery scores (i.e., maximum heart rate minus recovery heart rate) are presented in Appendix G. Appendix H contains individual data for percent body fat, while Appendix I contains awards earned on the Canada Fitness Award test. Individual performance scores on the stress-inducing tasks appear in Appendix J as standard or T scores. Grades from the children's report cards, and also from the Stanford Achievement Test are contained in Appendices K and L respectively. Teachers' ratings on the behavioral questionnaire for each of the three test sessions are presented in Appendix M. Standard deviations for heart rate data, percent body fat, school report cards (physical education), and performance scores on the stress-inducing tasks appear in Appendix Q.

Most of the data were subjected to the analysis of variance (ANOVA). As one assumption underlying the ANOVA is that the variances in the populations from which the samples were drawn must be equal (Ferguson, 1966), tests for homogeneity of variance were performed. These indicated that the assumption of homogeniety was satisfied. Furthermore, because specific predictions were made concerning the outcome of the individual measures, one-tailed probabilities were used throughout the analysis.

Measures of Physical Fitness

Post-test heart rates, reflecting the rapidity with which heart rates returned to basal level following the bicycle test, provided one index of physical fitness (see Figure 3). A 3 x 3 x 3 x 2 (Groups x Sessions x Minutes x Sex) repeated measures ANOVA was performed on the first three minutes of recovery (see Table 2). Since further deceleration of heart rate had ceased beyond this time, the remaining seven minutes of the post-test period were excluded from the analysis. Significant effects were found for Minutes ($F(2,54) = 66.32$, $p < .001$), Sex ($F(1,27) = 10.08$, $p < .01$), and the Minutes x Sex interaction ($F(2,54) = 9.39$, $p < .001$). To determine in which minute(s) of recovery boys and girls differed from each other, subsequent one-way ANOVA's on each minute were calculated. F-ratios were significant for Minute 1 ($F(2,54) = 31.01$, $p < .01$), Minute 2 ($F(2,54) = 20.16$, $p < .01$), and Minute 3 ($F(2,54) = 7.92$, $p < .01$). These results indicated that the boys' heart rates were significantly lower than girls' during the first three minutes of recovery (see Figure 4).

An examination of basal heart rates failed to reveal any systematic pattern for the three groups. The magnitude of recovery, however, appeared to distinguish subjects (see Figure 5). Heart rate at each of the first three minutes of recovery was therefore subtracted from maximum heart rate attained at the completion of the bicycle test (i.e., maximum heart rate minus first minute of recovery; maximum heart rate minus second minute of recovery; maximum heart rate minus third minute of recovery). These scores were then subjected to a

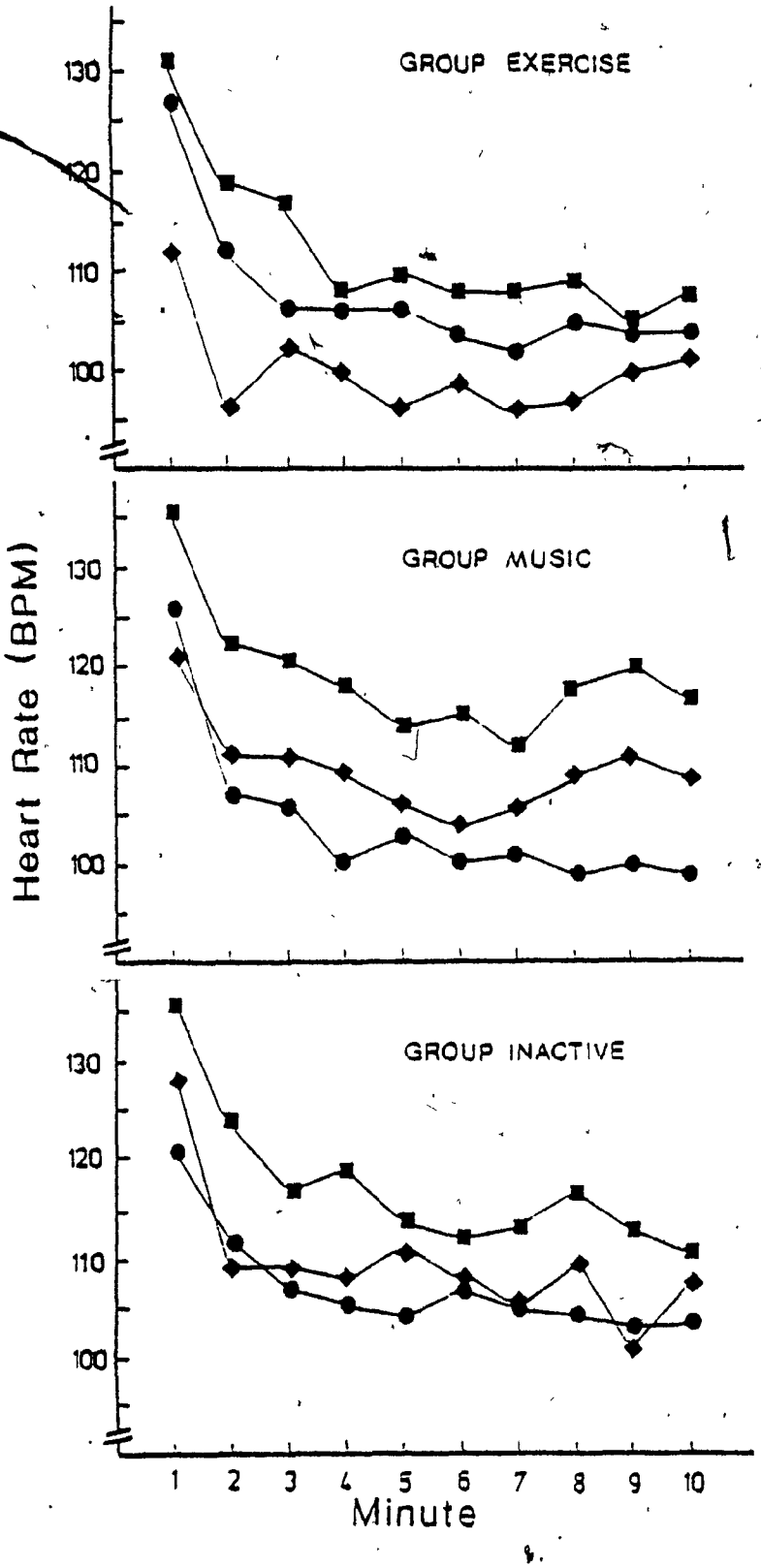


Figure 3. Mean recovery heart rates for Groups Exercise, Music and Inactive in Sessions 1 (●), 2 (■) and 3 (◆).

Table 2

Summary of Four-Way Repeated Measures Analysis of Variance on Heart Rate Recovery Times

Source of Variance	SS	df	MS	F
Between Subjects				
Group	1859.60	2	929.79	.66
Sex	14001.40	1	14001.40	10.07**
Group x Sex	5699.31	2	2849.66	2.05
Error (between)	37516.90	27	1389.51	-
Within Subjects				
Session	9244.72	2	4622.36	9.60***
Group x Session	2166.84	4	541.70	1.12
Session x Sex	87.90	2	43.95	.09
Group x Session x Sex	1133.32	4	283.33	.58
$Error_1$	25998.30	54	481.45	-
Minute	13573.70	2	6786.87	66.32***
Group x Minute	322.55	4	80.63	.78
Minute x Sex	1921.68	2	960.83	9.38***
Group x Minute x Sex	344.15	4	86.03	.84
$Error_2$	5525.79	54	102.32	-
Session x Minute	537.78	4	134.44	1.91
Group x Session x Minute	430.22	8	53.77	.76
Session x Minute x Sex	295.69	4	73.92	1.05
Group x Session x Minute x Sex	317.38	8	39.67	.56
$Error_3$	7563.86	108	70.03	-

** $p < .01$ *** $p < .001$

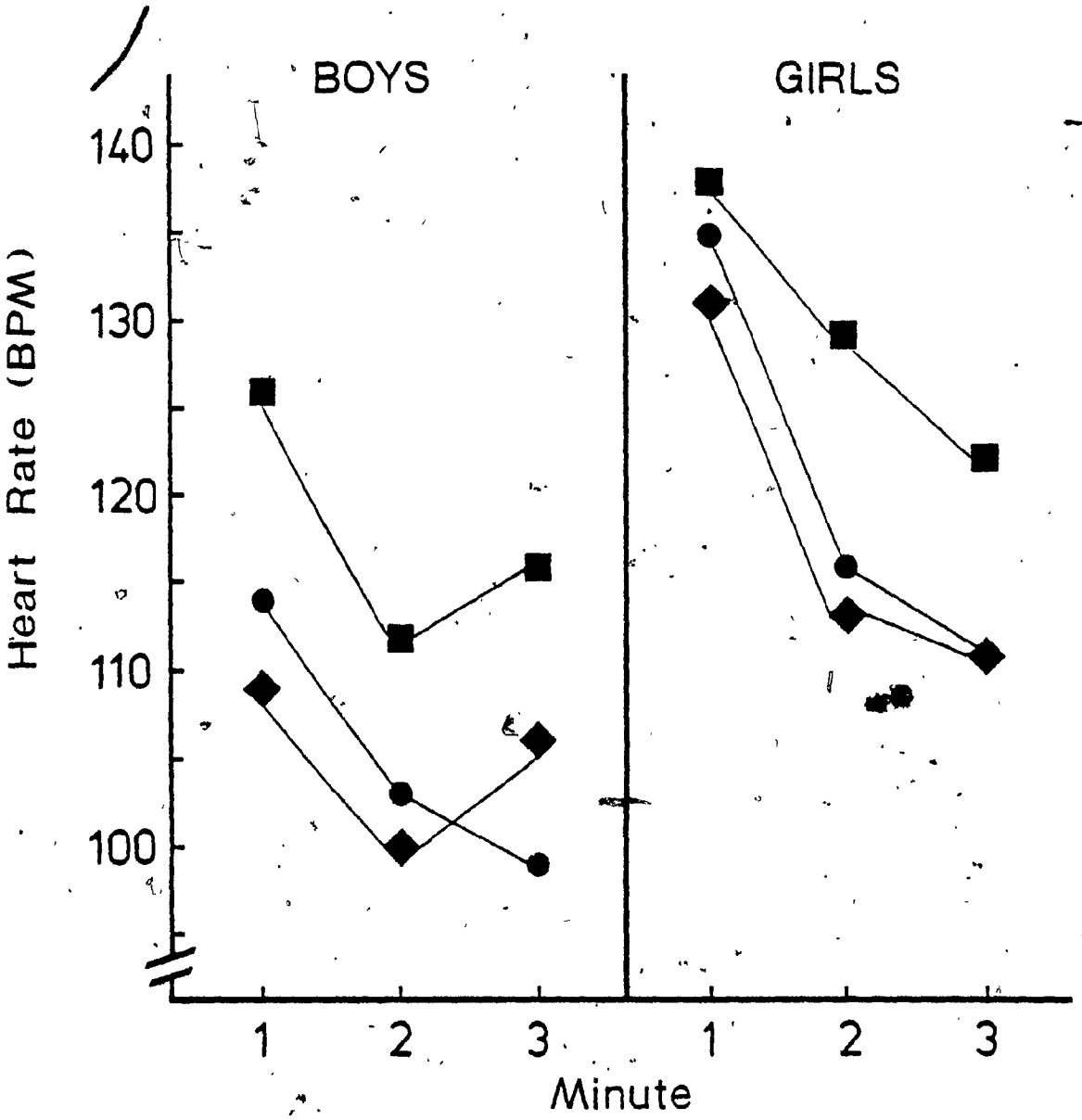


Figure 4. Mean recovery heart rates at Minutes 1, 2, and 3 for boys and girls in Sessions 1 (●), 2 (■) and 3 (◆).

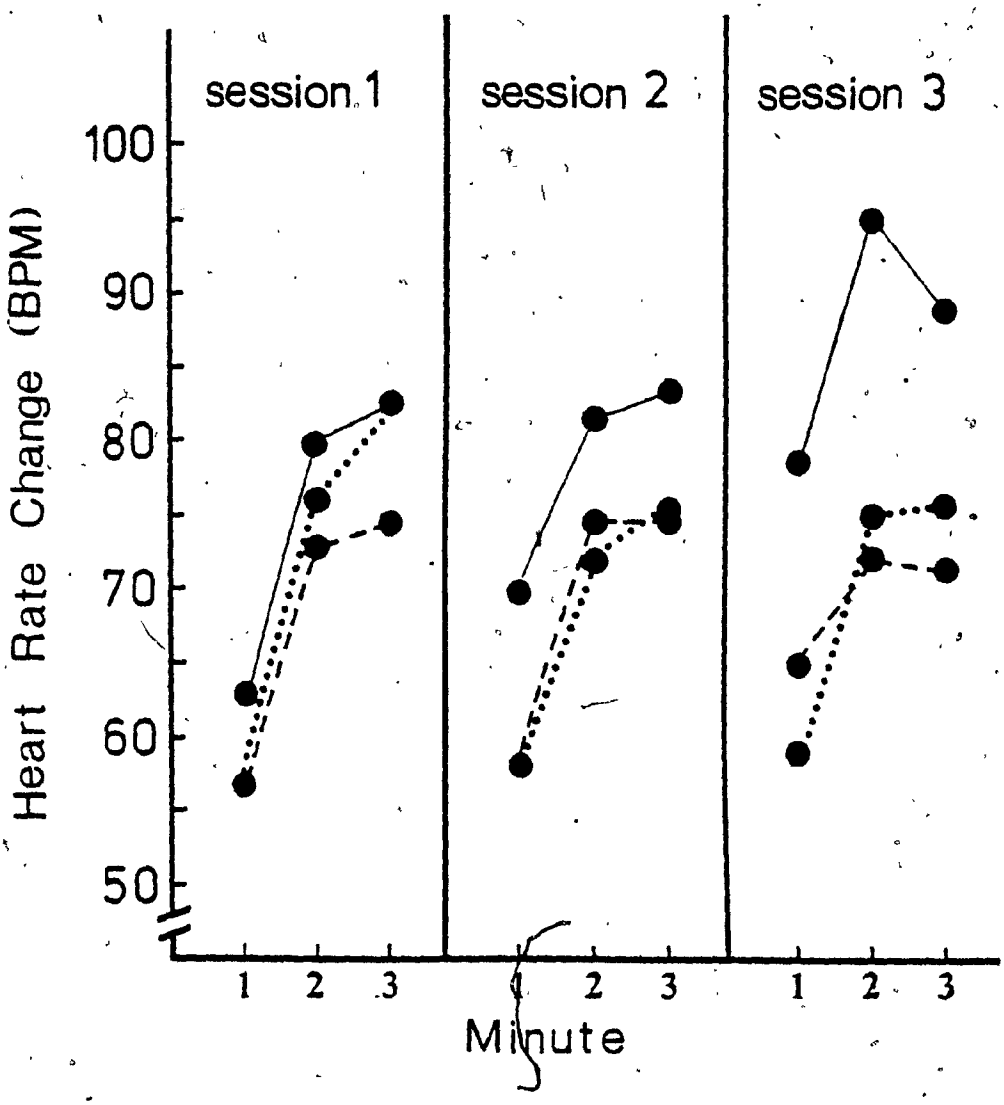


Figure 5. Mean magnitude of recovery scores (i.e., maximum heart rate minus recovery heart rate) for Groups Exercise (———), Music (– – –) and Inactive (•••••) across the three test sessions.

3 x 3 x 3 x 2 (Groups x Sessions x Minutes x Sex) repeated measures ANOVA (see Table 3). A significant Groups x Sex interaction was revealed ($F(2,26) = 3.34$, $p < .05$). Subsequent Tukey tests indicated that the magnitude of recovery for boys in Group Exercise was significantly greater than that of boys in both Groups Music and Inactive (HSD = 12.01, $p < .05$). A significant main effect of Minutes was also found ($F(2,52) = 67.93$, $p < .001$), as well as a significant Minutes x Sex interaction ($F(2,52) = 8.62$, $p < .001$). One-way ANOVA's indicated that the magnitude of recovery was significantly greater for the boys than the girls in Minute 1 ($F(2,52) = 10.36$, $p < .01$).

To quantify changes in body composition, percent body fat was calculated three times throughout the study. Chi square tests revealed that significantly more subjects from Group Exercise reduced their body fat than subjects in Groups Music and Inactive ($\chi^2(2) = 9.20$, $p < .01$).

A 3 x 3 x 2 (Groups x Sessions x Sex) repeated measures ANOVA was also computed for percent body fat data (see Table 4). A significant Groups x Sessions interaction was revealed ($F(4,60) = 7.30$, $p < .001$). A trend analysis was subsequently conducted (see Figure 6), revealing that the trends of the sessions means for the three groups differed significantly in their linear components ($F(2,66) = 14.93$, $p < .01$). A test of deviance from horizontality (Rodger, 1965) was then computed. From the linear equation that best fit the data, the following slopes were determined: for Group Exercise, -.027;

Table 3

Summary of Four-Way Repeated Measures Analysis of Variance on Magnitude of Heart Rate Recovery

Source of Variance	SS	df	MS	F
Between Subjects				
Group	6461.60	2	3230.80	3.11
Sex	847.16	1	847.16	.81
Group x Sex	6937.10	2	3468.95	3.34
Error (between)	26975.10	26	1037.51	-
Within Subjects				
Session	697.68	2	348.84	.69
Group x Session	2138.68	4	534.67	1.05
Session x Sex	1860.78	2	930.39	1.84
Group x Session x Sex	799.42	4	199.85	.39
$Error_1$	26252.70	52	504.86	-
Minute	12635.70	2	6317.86	67.92***
Group x Minute	227.51	4	56.87	.61
Minute x Sex	1603.00	2	801.50	8.61***
Group x Minute x Sex	268.98	4	67.24	.72
$Error_2$	4836.64	52	93.01	-
Session x Minute	417.06	4	104.26	1.54
Group x Session x Minute	451.56	8	56.44	.83
Session x Minute x Sex	427.00	4	106.75	1.57
Group x Session x Minute x Sex	233.66	8	29.20	.43
$Error_3$	7037.37	104	67.66	-

*** $p < .001$

Table 4

Summary of Three-Way Repeated Measures Analysis of Variance on Percent Body Fat

Source of Variance	SS	df	MS	F
Between Subjects				
Group	15.702	2	7.851	.525
Sex	11.535	1	11.535	.771
Group x Sex	7.547	2	3.773	.252
Error (between)	448.518	30	14.950	-
Within Subjects				
Session	.867	2	.433	1.469
Group x Session	8.628	4	2.157	7.302***
Sex x Session	.269	2	.134	.456
Group x Sex x Session	1.078	4	.269	.912
Error (within)	17.723	60	.295	-

*** $p < .001$

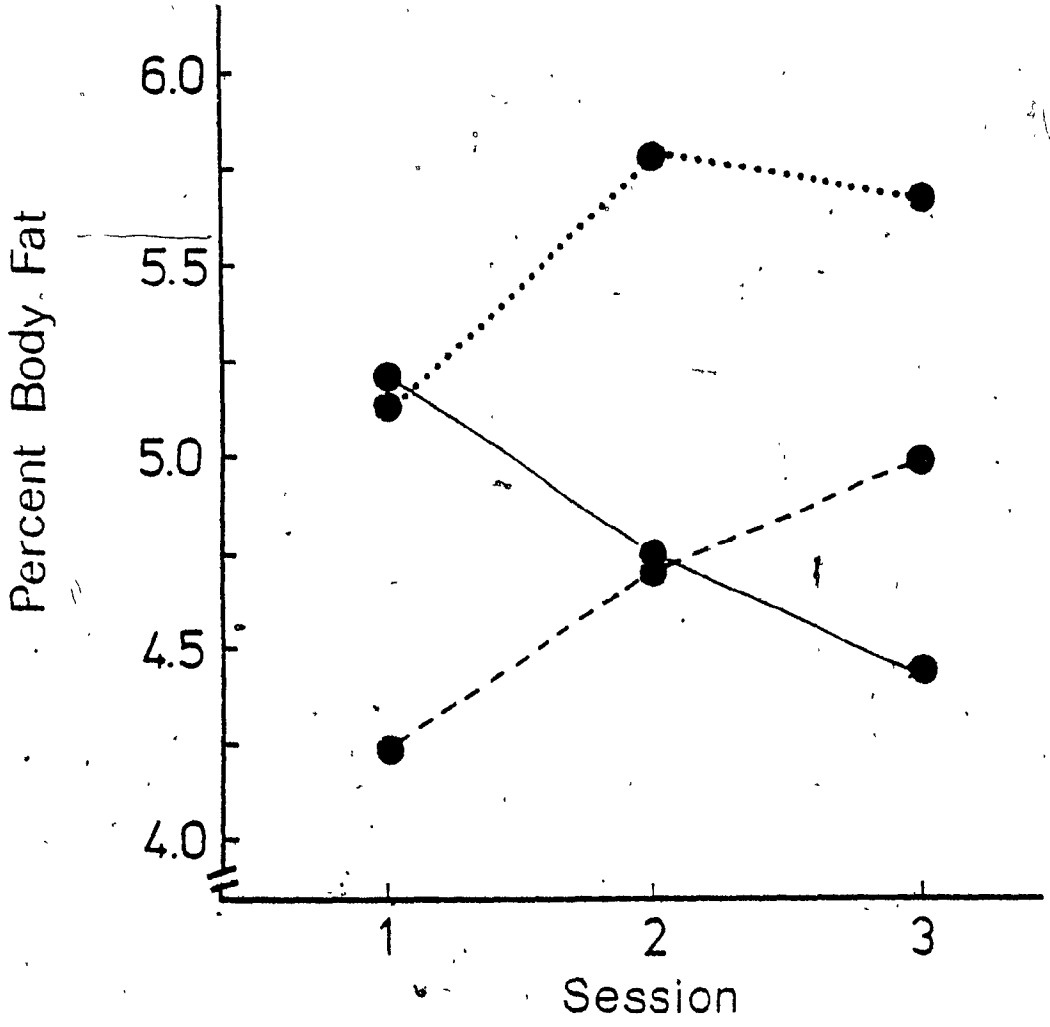


Figure 6. Mean percent body fat for Groups Exercise (———), Music (– – –) and Inactive (•••••) across the three test sessions.

$$\% \text{ Body Fat} = 0.7\ (\text{Weight}) \sqrt{\frac{T \times S \times .739}{\text{Weight}}} - .003$$

$$T = (\text{Sum of the ten sites} - 40)/20$$

$$S = (\text{Weight}^{.425} \times \text{Height}^{.725} \times 71.84)/10^4$$

Group Music +.038; and Group Inactive, +.022. These data therefore indicated that over the three test sessions, both control groups increased in body fat (i.e., positive slope), while Group Exercise decreased (i.e., negative slope).

Rate of absenteeism (see Appendix N) was determined for the entire school year. After obtaining month-by-month reports from the children's teachers, parents were telephoned in order to ascertain which of the absences were illness-related. Five subjects were excluded from the analysis because they had undergone corrective or cosmetic surgery, or because they had been on extended vacations.

Children adhering to the exercise program missed an average of 6.71 days of school; Group Music, 9.50 days; and Group Inactive, 12.50 days. A one-way ANOVA, however, indicated that these group means were not statistically different. As well, no sex differences were evident.

In order to evaluate performance on the Canada Fitness Award test, the frequency of Excellence awards was calculated for the 50 and 600 meter runs, as well as for overall performance (see Figure 7). Of the students awarded Excellence in the 50 meter run, 53% were from Group Exercise, 23% were from Group Music, and 15% were from Group Inactive. Excellence in the 600 meter run was awarded to 87% of the subjects from Group Exercise, 54% from Group Music, and 62% from Group Inactive. Crests for excellent achievement in overall performance were earned by 50% of Group Exercise, 23% of Group Music, and 7% of Group Inactive. Chi square tests revealed that Group Exercise earned significantly more Excellence awards in all three tests com-

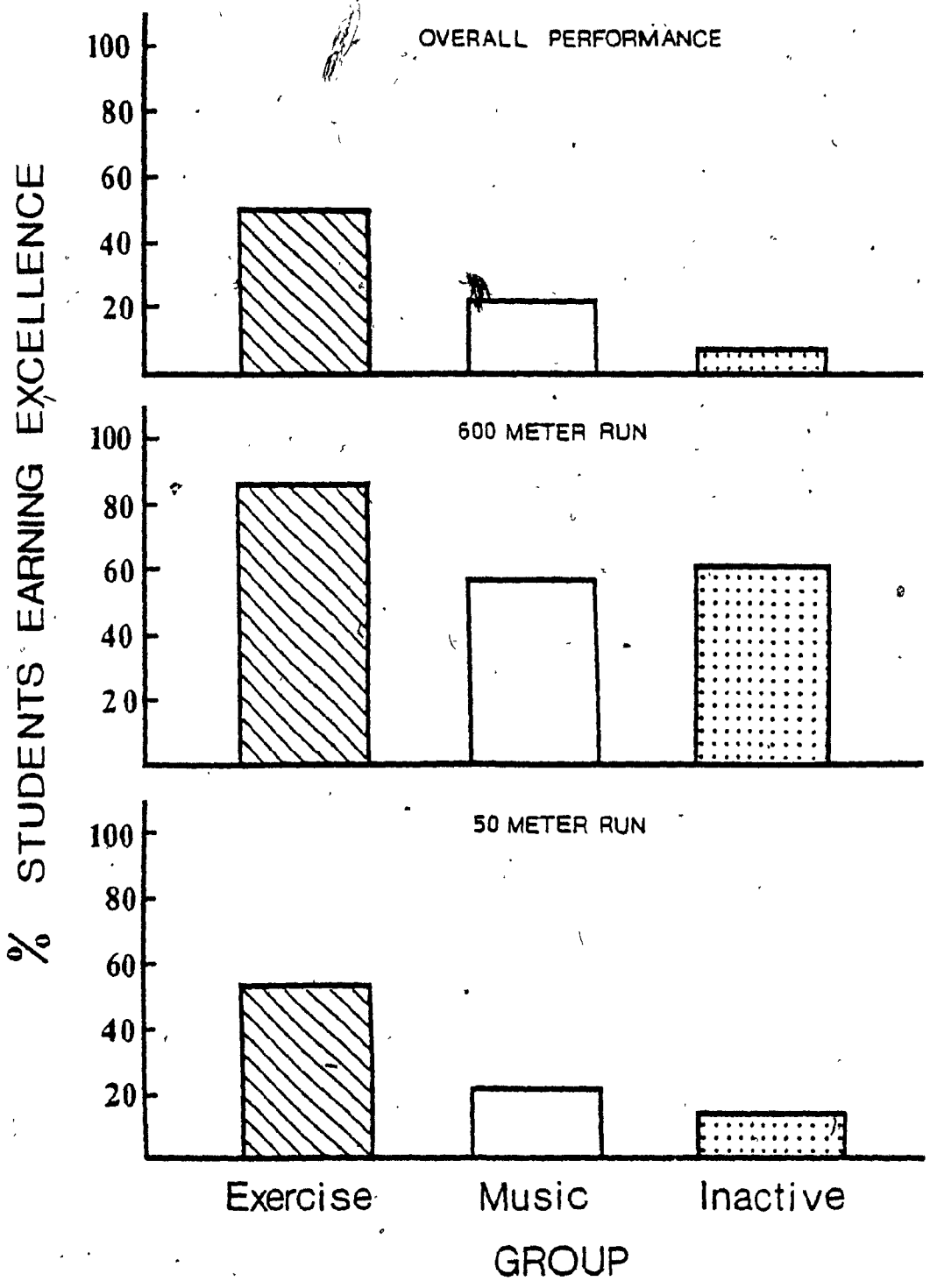


Figure 7. Mean percentage of students from Groups Exercise (\\\\), Music ( ) and Inactive (::::) earning Excellence awards on the 50 and 600 meter runs and in overall performance on the Canada Fitness Award test.

bined than either of the control groups ($\chi^2(2) = 19.38$, $p < .01$). In addition, significantly more subjects in Group Exercise were awarded Excellence in overall performance than subjects in the other two groups ($\chi^2(2) = 6.53$, $p < .05$).

Baseline performance from the previous year was examined as well. However, scores were not available for three of the students as they had spent the previous year in another school district. In contrast to the results from grade two, no significant group differences were evident in the first grade. None of the subjects in any of the three groups earned an Excellence award on the 50 yard run. Excellence in the 300 yard run was awarded to 15% of Group Exercise, 33% of Group Music, and 31% of Group Inactive. While only one subject in Group Music earned an Excellence crest in overall performance, no subject from either Group Exercise or Group Inactive achieved overall Excellence.

Measures of Psychological Well-Being

Several indices of emotional arousal were considered during pilot study. These included skin conductance and heart rate lability three minutes before, during and after the stress-inducing task. Lability during the task appeared to provide the best index. The polygraph curves were therefore divided in half, and a ratio calculated comparing the lability score of the second half of the test (i.e., the last one-and-a-half minutes) to the score of the entire test.

The choice of a lability ratio was derived from the observation that absence of arousal tends to produce relatively flat polygraph curves with little lability. Greater arousal, on the other hand, produces longer and more curvilinear tracings.

The length of the polygraph curves was traced with a map measurer (model 102, Harrison Company, Montreal). Lability scores less than 50% represent a decrease in the second half of the test (i.e., recovery from arousal), whereas ratios greater than 50% indicate an increase in fluctuation (i.e., increased arousal). Lability ratios of 50% represent no change in arousal level.

Appendix O contains individual subject's data for skin conductance lability ratios. A 3 x 3 x 2 (Groups x Sessions x Sex) repeated measures ANOVA (see Table 5) revealed a significant main effect of sex ($F(1,29) = 4.77$, $p < .05$) indicating that overall, the girls recovered significantly faster than the boys.

Appendix P contains individual subject's ratios calculated from heart rate lability during the stress-inducing tasks. A 3 x 3 x 2 (Groups x Sessions x Sex) repeated measures ANOVA (see Table 6) failed to reveal any significant trends.

Not only was autonomic reactivity recorded during the stress-inducing tasks, but actual performance was rated as well. Because the distribution of scores was unequal (i.e., block design permitted a maximum score of 5; picture completion, 7; and digit span, 55), the performance scores of each given test were ranked across groups and sessions. However, transforming the raw scores into standard scores,

Table 5

Summary of Three-Way Repeated Measures Analysis of Variance on Skin Conductance During Stress-Inducing Tasks

Source of Variance	SS	df	MS	F
Between Subjects				
Group	.0041	2	.0020	1.8571
Sex	.0053	1	.0053	4.7683*
Group x Sex	.0025	2	.0012	1.1272
Error (between)	.0324	29	.0011	-
Within Subjects				
Session	.0057	2	.0028	1.7474
Group x Session	.0029	4	.0007	.4536
Sex x Session	.0031	2	.0015	.9474
Group x Sex x Session	.0081	4	.0020	1.2424
Error (within)	.0955	58	.0016	-

* $p < .05$

Table 6

Summary of Three-Way Repeated Measures Analysis of Variance on Heart Rate During Stress-Inducing Tasks

Source of Variance	SS	df	MS	F
Between Subjects				
Group	.000224	2	.000112	1.1532
Sex	.000009	1	.000009	.0925
Group x Sex	.000062	2	.000031	.3236
Error (between)	.002334	24	.000097	-
Within Subjects				
Session	.000578	2	.000289	1.8474
Group x Session	.001054	4	.000263	1.6836
Sex x Session	.000006	2	.000003	.0205
Group x Sex x Session	.000567	4	.000141	.9056
Error (within)	.007515	48	.000156	-

rather than ranks, seemed more appropriate (Ferguson, Note 3). A Z' or T score, with an arbitrary mean of 50 and a standard deviation of 10 (Ferguson, 1966) was therefore employed (see Figure 8).

When difference scores were calculated (i.e., the standard score of Session 3 minus the standard score of Session 1), the performance of both Groups Music and Inactive was found to deteriorate (means of -16 and -40 respectively), while the performance scores of Group Exercise increased over the course of the study (mean of +63). A three-way repeated measures ANOVA (Groups x Sex x Sessions), however, indicated that these differences were not statistically significant (see Table 7).

To assess academic achievement, letter grades on the children's report cards were first converted to quality points, such that a grade of "A" received 4 points, a "B" received 3 points, a "C" received 2 points, a "D" received 1 point, and any grade lower than "D" received 0 points. Grade point averages were then calculated for each of the six subjects by dividing the total number of quality points by the total number of credits earned. A series of three-way ANOVA's (Groups x Sessions x Sex) were subsequently run. A significant Sessions effect was found for all academic subjects except French ($p < .001$ in all cases), thus indicating that the students obtained significantly higher marks at the end of the school year. The ANOVA on physical education (see Table 8) also revealed a significant Groups x Sex interaction ($F(2,27) = 8.97$, $p < .001$). Tukey post-hoc tests indicated that girls in Group Exercise improved sig-

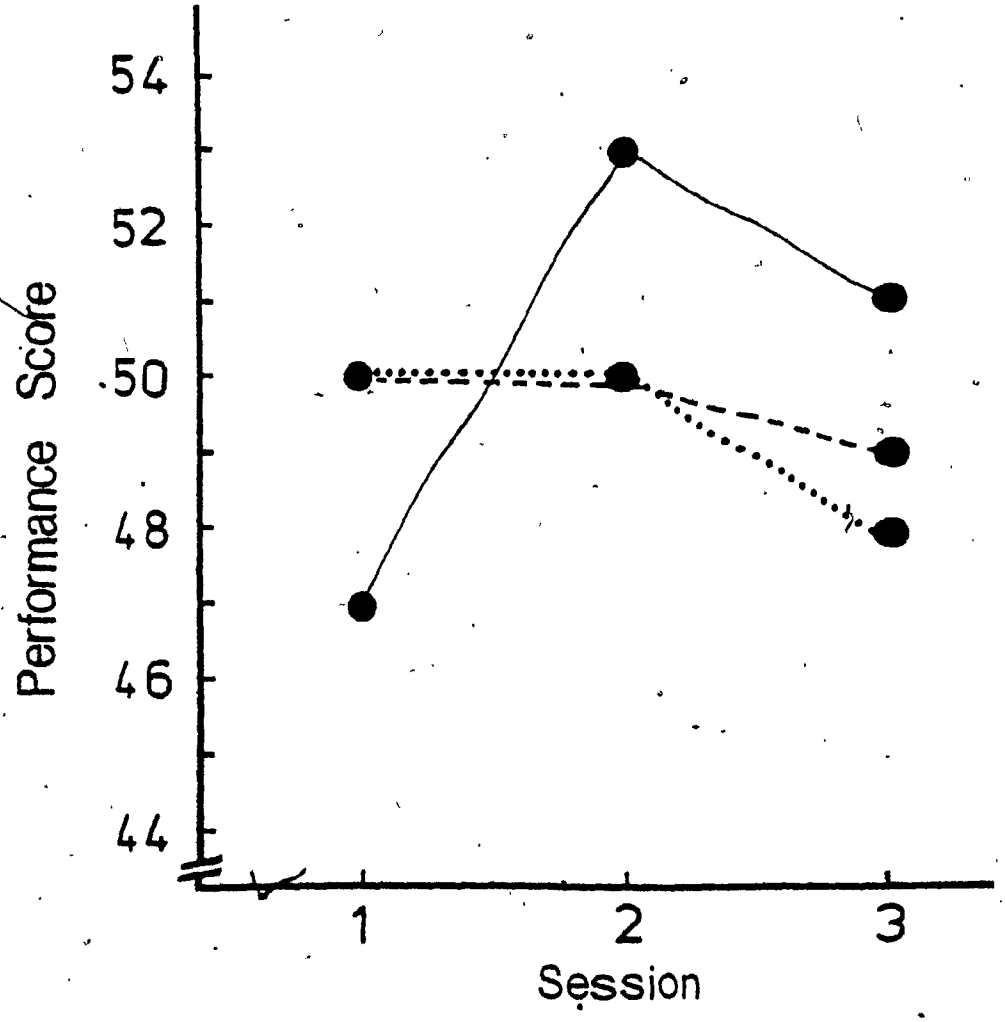


Figure 8. Mean performance scores of Groups Exercise (——), Music (– – –) and Inactive (·····) on the stress-inducing tasks across the three test sessions.

Table 7

Summary of Three-Way Repeated Measures Analysis of Variance on Performance on Stress-Inducing Tasks (Standard Scores)

Source of Variance	SS	df	MS	F
Between Subjects				
Group	11.896	2	5.948	.042
Sex	259.422	1	259.422	1.842
Group x Sex	544.965	2	272.483	1.935
Error (between)	4223.950	30	140.798	-
Within Subjects				
Session	197.757	2	98.878	.859
Group x Session	242.563	4	60.640	.526
Session x Sex	162.122	2	81.061	.704
Group x Session x Sex	292.240	4	73.059	.634
Error (within)	6904.110	60	115.069	-

Table 8

Summary of Three-Way Repeated Measures Analysis of Variance on Report Card Grades: Physical Education

Source of Variance	SS	df	MS	F
Between Subjects				
Group	2.265	2	1.132	6.270**
Sex	.295	1	.295	1.633
Group x Sex	3.241	2	1.620	8.970***
Error (between)	4.877	27	.180	-
Within Subjects				
Session	1.877	1	1.877	20.947***
Group x Session	.606	2	.303	3.381*
Group x Sex	.071	1	.071	.799
Group x Session x Sex	.411	2	.205	2.296
Error (within)	2.419	27	.089	-

* $p < .05$ ** $p < .01$ *** $p < .001$

nificantly more in physical education than boys over the course of the school year (see Figure 9). There were no significant sex differences in the two control groups.

The academic variables were gathered not only from the school files, but from four subtests of the Stanford Achievement Test as well. Raw scores, or number of correct responses, were converted to grade equivalent scores which indicate the grade level at which the student is performing. For example, a grade equivalent score of 2.8 means that the child is achieving the level of work appropriate for the eighth month of the second grade. These scores were then subjected to three-way ANOVA's (Groups x Sessions x Sex). Significant main effects of Sessions were found for both the vocabulary ($F(1,27) = 89.93$, $p < .001$) and the reading ($F(1,26) = 52.93$, $p < .001$) subtests (see Tables 9 and 10). Specifically, all groups improved significantly in vocabulary and reading skills over the course of the study. The ANOVA on reading additionally revealed a significant Sessions x Sex interaction ($F(1,26) = 4.46$, $p < .05$). Tukey post-hoc tests indicated that the girls improved to a significantly greater extent than the boys ($p < .01$). The ANOVA on mathematics concepts revealed a significant Sex effect ($F(1,27) = 11.20$, $p < .001$), with boys obtaining significantly higher scores than girls (see Table 11). No significant differences were evident on mathematics computation.

Changes on the behavioral questionnaire were negligible across the three test sessions. When the data were examined for sex differences, no systematic pattern was detected.

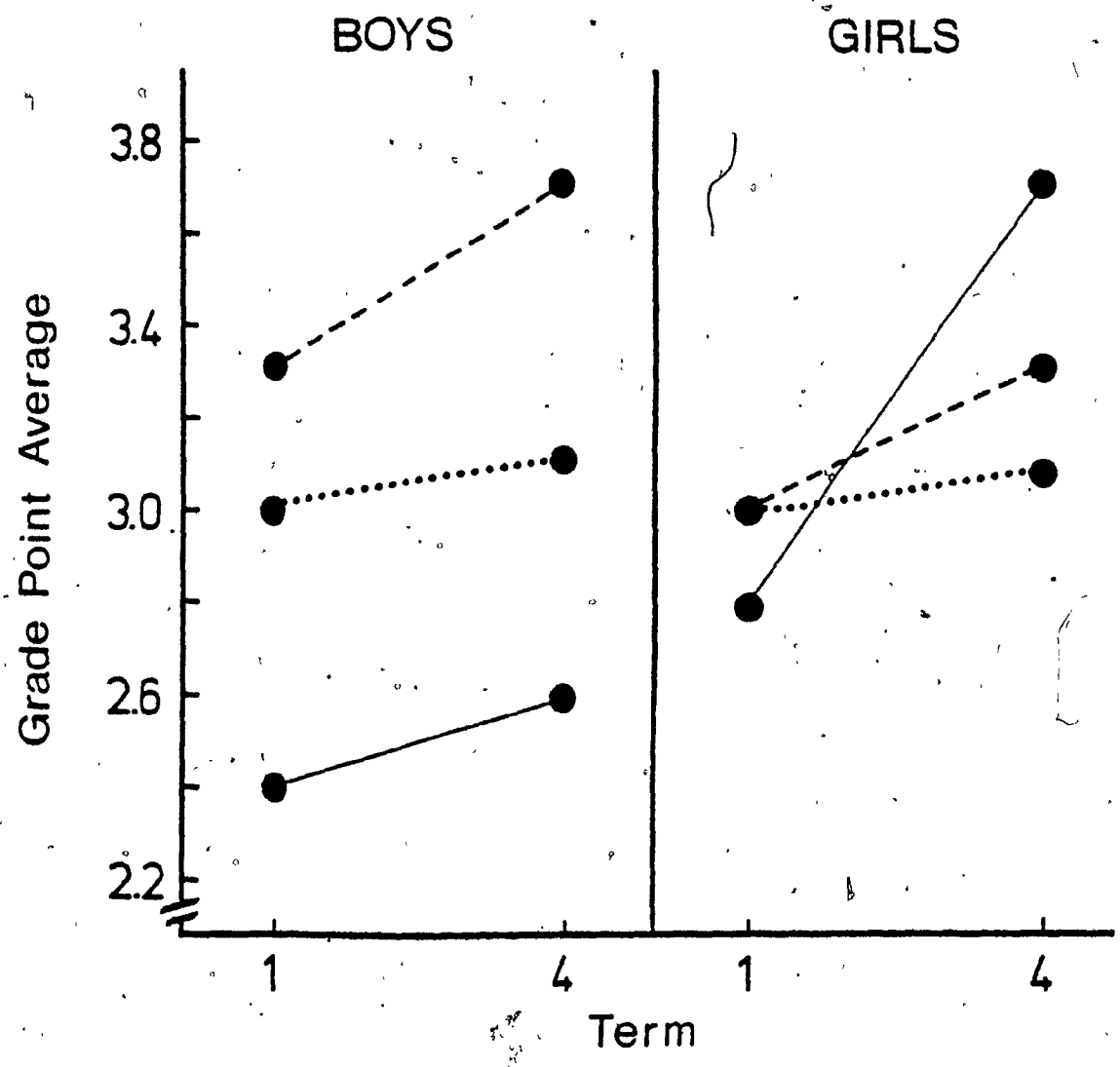


Figure 9. . Mean GPA's in physical education earned by the boys and girls in Groups Exercise (——), Music (– – –) and Inactive (•••••) on their school report cards.

Table 9

Summary of Three-Way Repeated Measures Analysis of Variance on Stanford Achievement Test: Vocabulary

Source of Variance	SS	df	MS	F
Between Subjects				
Group	.859	2	.429	.544
Sex	.171	1	.171	.217
Group x Sex	.056	2	.028	.035
Error (between)	21.328	27	.789	-
Within Subjects				
Session	17.960	1	17.960	89.934***
Group x Session	.658	2	.329	1.648
Sex x Session	.025	1	.025	.126
Group x Sex x Session	.718	2	.359	1.800
Error (within)	5.391	27	.199	-

*** $p < .001$

Table 10

Summary of Three-Way Repeated Measures Analysis of Variance on Stanford Achievement Test: Reading

Source of Variance	SS	df	MS	F
Between Subjects				
Group	2.794	2	1.397	2.199
Sex	.001	1	.001	.002
Group x Sex	.140	2	.070	.110
Error (between)	16.521	26	.635	-
Within Subjects				
Session	17.473	1	17.473	52.933***
Group x Session	.749	2	.374	1.135
Sex x Session	1.472	1	1.472	4.461*
Group x Sex x Session	1.054	2	.527	1.597
Error (within)	8.582	26	.330	-

* $p < .05$ *** $p < .001$

Table 11

Summary of Three-Way Repeated Measures Analysis of Variance on Stanford Achievement Test: Mathematics Concepts

Source of Variance	SS	df	MS	F
Between Subjects				
Group	7.029	2	3.514	4.849
Sex	8.116	1	8.116	11.198**
Group x Sex	.316	2	.158	.218
Error (between)	19.569	27	.724	-
Within Subjects				
Session	.709	1	.709	2.391
Group x Session	.803	2	.401	1.352
Sex x Session	.569	1	.569	1.916
Group x Sex x Session	.950	2	.475	1.600
Error (within)	8.015	27	.296	-

** $p < .01$

Discussion

Group Exercise demonstrated significant improvement in physical fitness as measured by the Canada Fitness Award test and percent body fat data. The exercisers also showed a tendency toward improvement in absenteeism and heart rate recovery following the bicycle ergometer test. Although no significant effects were revealed in general psychological well-being or academic achievement, the performance of Group Exercise tended to improve on the stress-inducing tasks over the course of the study.

Specifically, scores on the Canada Fitness Award test indicated that the children adhering to the exercise program earned significantly more Excellence awards in overall performance than Groups Music and Inactive; they performed better on the 50 and 600 meter runs as well. The absence of group differences on the previous year's records suggests that the exercisers' superior fitness level can be attributed to the experimental program.

Changes in skinfold thickness over the three test sessions indicated that Group Exercise decreased in percentage of body fat during the school year, while Groups Music and Inactive increased. Thus, endurance training was effective in converting the exercisers' fat weight to lean weight.

Analysis of school attendance rates further revealed that Group Exercise tended to show fewer illness-related absences than both control groups. The finding that Group Music also missed less days

than Group Inactive, however, somewhat detracts from this finding. Since selection into the program was considered a special priviledge by the children receiving the extra classes (i.e., both physical education and music) and their parents, they may have become more conscientious about school attendance. This possibility is reflected in the fact that subjects in the exercise and music groups attended 82% of the classes over the course of the year.

Heart rate analysis also revealed a trend for Group Exercise to recover more quickly from the bicycle ergometer test by the end of the study. Specifically, in the third test session, the exercisers' heart rates were lower in each of the ten minutes of the recovery phase than they had been in Sessions 1 and 2. Both control groups, in contrast, recovered more slowly in Session 3 than Session 1. Moreover, the magnitude of heart rate recovery for the boys in Group Exercise was significantly greater than that of the boys in Groups Music and Inactive. However, no group differences were found for the girls.

A second sex difference was revealed in the heart rate data: overall, the boys recovered significantly faster from the bicycle test than the girls. As this finding is consistent with the literature (Howell & Macnab, 1968; Jéquier et al., 1977; Shephard et al., 1974), it does not necessarily indicate that the boys' cardiac efficiency was greater as a function of training. In fact, when one assesses the magnitude of recovery in Session 3 relative to the recovery in Sessions 1 and 2, it becomes apparent that the girls in

Group Exercise improved more than the boys over the course of the study. This sex difference was also evident in the exercisers' report card grades in physical education; that is, the girls in Group Exercise improved significantly more in physical education than the boys.

The finding that Group Exercise derived significant physical benefits from a ten-month conditioning program demonstrates that the currently poor physical status of Canadian children can be improved. Thus, increased emphasis on physical education within the school system may serve to instill positive health habits during the children's formative years, and decelerate the growing incidence of childhood obesity, hypertension, and other conditions associated with coronary artery disease.

While the exercise program increased the subjects' physical fitness levels, effects on their psychological well-being were more equivocal. Changes in performance on the stress-inducing tasks failed to reach statistical significance, but they did suggest a distinct pattern: the performance scores of Group Exercise tended to increase from Session 1 to Session 3, whereas the scores of Groups Music and Inactive decreased. Moreover, subjects assigned to the exercise program attained the lowest mean score in the first test session, but scored the highest in both Sessions 2 and 3.

Other measures did not reveal psychological improvements. As discussed earlier, the rationale for using recovery ratios was based on the finding (Keller, 1980) that exercisers recover significantly

faster than non-exercisers from the stress induced by contrived tasks. The present results, however, indicated that neither the skin conductance nor the heart rate recovery ratios of Group Exercise decreased across the test sessions. Moreover, the absolute range of the ratios for all three groups was appreciably smaller than those reported previously. The failure to replicate these earlier results may therefore suggest that the tasks were not stressful enough, although results from pilot study indicated that the strategies employed to stress the subjects, such as presenting each task in an abbreviated time period so as to produce frequent errors, were effective. In addition, informal observations by the experimenter during the study proper revealed that the subjects became upset while performing the stress tasks (e.g., they strained forward and squirmed in their seats), and some children even complained of task difficulty.

A second possibility may be that young children do not respond physiologically to stress. As there have been so few studies on arousal in children, one can only speculate that the factors which influence autonomic reactivity are different in adults and children. For example, Elliott (1964) found that performance on reaction time tasks correlated significantly with heart rate and palmar resistance among adults but not among six-year-old children. He attributed these results to age differences in psychological responses to an experimental situation, including capacity to inhibit competing responses, desire to impress the experimenter, and ability to remain still for prolonged time periods. Darley and Katz (1973) further

speculated that differences in physiological activity between children and adults are due to such characteristics as task motivation and fear of failure. In addition, it has been reported (Bialer, 1961; Elliott, 1964) that delayed rewards motivate adults to achieve, but cause the performance of children to actually deteriorate. The fact that no incentives were offered to the subjects in the present study suggests that they were not sufficiently motivated and hence displayed little autonomic activity. It also seems probable that children in grade two are simply too young to respond to the aforementioned components of stress.

Although the students' report cards provided the most convenient index of academic achievement, the criteria employed to generate grades were predominantly subjective. As pilot testing had indicated that this may have prevented a realistic evaluation of the children's progress, a standardized test was chosen to supplement the data on scholastic grades. Results on the Stanford Achievement Test, however, did not yield the group differences that had been hypothesized. Despite the claim (Arnett, 1968; Plack, 1968; Weber, 1953) that the physically fit achieve greater success at school than the unfit, it is important to emphasize that the studies cited earlier were either correlational, or else examined components of fitness other than endurance (e.g., coordination, balance, etc.). Moreover, the one study that did manipulate activity level (i.e., Ismail & Gruber, 1967) was so flawed by inadequate measures that the validity of results is questionnable.

Because so little data have been published on academic achievement and endurance training in school children, this author contacted various heads of school boards in an attempt to obtain a better understanding of the present results. This quest revealed that, indeed, several programs on daily physical education had been conducted across Canada. For the most part, however, none was successful in improving academic achievement. For example, Martens (Note 3) revised the curriculum in Victoria, British Columbia schools to include three to five hours of physical education a week. After four years, academic achievement was "at least as high" as before the program. Sinclair and Appleby (Note 4) conducted a two-year daily physical education program in British Columbia as well. Students in grades one, three, five and seven were administered the Gates-MacGinitie Reading Comprehension Test in September and May of both years. Data analysis revealed no significant differences between the experimental and control groups. In Scarborough, Ontario, Dilling and Weiss (Note 5) provided physical education on a daily basis to students of the second, fifth and eighth grades. Again, experimental subjects performed no better than controls on standardized achievement tests. Children in grades one, three and five participated in the second year of this project (Brenner, Note 6). Academic measures included the mathematics problem-solving subtest of the Metropolitan Achievement Test, and also listening skills from the Sequential Tests of Educational Progress. A comparison of pre- and post-scores did not indicate significant change for the first graders on either test.

While the older children did improve significantly in mathematics problem-solving, none of the subjects gained in listening skills. Mironuck and MacKenzie (Note 7) reported that although a physical education program for grade seven students in Regina, Saskatchewan also failed to produce significantly higher academic achievement, grades compared "favourably" with previous years.

The authors of these projects concluded that despite significantly less academic instruction per week, the children were able to maintain their pre-experimental achievement levels. Interpretation of these data as positive rather than negative may therefore be applied to the present results as well. A greater proportion of the school year was devoted to physical education, yet neither the extra physical exertion nor the shorter lunch break caused the students' academic standards to deteriorate.

In seeking an explanation why fitness training does not improve children's academic grades, Martens (Note 8) suggested that the standard achievement tests may not be sophisticated enough to detect changes in the students' progress. It is also possible that elementary school children may simply be too young to demonstrate increases in achievement level. Support for this latter hypothesis stems from the studies on college students. Despite their correlational designs, all consistently indicated that the more fit subjects had higher GPA's. If data on high school students demonstrated a trend toward higher academic achievement, more concrete evidence of an age shift could be established. Unfortunately, such data are lacking.

Martens further postulated that instead of being a direct consequence of training, higher school grades may represent a by-product of training. In other words, physical fitness may enhance certain intellectual processes that may serve an adjunctive role in improving grades. These processes have been identified as memorization, categorization, language communication, evaluation, and problem solving (New Brunswick Department of Education, Note 9).

A factor which may have influenced the outcome of this present study is that the Stanfords were written in a non-competitive atmosphere. This was accomplished by having the teachers administer the tests in the regular classroom setting. The teachers were further instructed to assure the children that neither parents nor school administrators would see the test results. These attempts to dispel anxiety may inadvertently have acted to diminish the children's motivation to work as hard as possible.

The majority of studies on adult fitness classes have demonstrated significant improvement in life-style and feelings of well-being (Heinzelmann, 1975; Ismail & Trachtman, 1973; Collingwood, 1972). The consistency of these findings prompted the present hypothesis that school children in an experimental exercise program would derive the same benefits and thus improve classroom climate. Teachers' evaluations of the students' behavior, however, revealed no systematic pattern of change. While contrary to the findings on adults, these results replicate the general outcome of the Canadian studies on daily physical education (Brenner, Note 6; Dilling &

Weiss, Note 5; Longstaff, Note 10). Despite the fact that the behavioral questionnaire did not yield significant changes in the present study, informal reports by the parents indicated that the children were more cooperative, relaxed, and enthusiastic about school and home activities. Martens (Note 3) and also Sinclair and Appleby (Note 4) similarly noted improvement in teacher/student communication, the children's attitudes towards school, and overall emotional domain.

The experimental program was found to benefit the girls in Group Exercise more so than the boys. This finding, however, is not surprising in light of the children's conduct throughout the year. Reports from the gym teachers, and also informal observations by the author revealed that the boys frequently engaged in disruptive activities, such as ignoring teacher directions, aggressing toward peers, and soliciting teacher attention. As a consequence, the boys were repeatedly removed from the group (e.g., sent to the principal's office; requested to sit on bench) so that much of their class time was actually spent in inactivity. The girls, on the other hand, displayed generally compliant behavior, and therefore suffered no interruption of class participation. Lower rates of class attendance (i.e., 77% vs. 87%) further suggest that the boys were less enthusiastic about the program than the girls.

The finding that the boys had difficulty conforming to the exercise classes is not unique to this present study. Research on sex differences has consistently demonstrated that young boys are less likely than girls to comply to adults' directions. For example,

Serbin, O'Leary, Kent and Tonick (1973) observed children in the classroom and found that the boys were not only significantly more aggressive, they also ignored teachers' requests significantly more often than the girls. Minton, Kagan and Levine (1971) studied maternal control and obedience in the subjects' homes. Observations revealed that boys committed significantly more violations of maternal standards than girls did. In addition, boys were less likely than girls to obey their mothers immediately. Hertzid, Birch, Thomas and Mendez (1968) similarly found that girls taking an intelligence test made a concentrated effort to follow instructions while boys either ignored or forgot them. Thus, young boys are generally more aggressive, dominant, and also less compliant toward teachers and parents than young girls (Maccoby & Jacklin, 1975).

In evaluating the overall results of the present study, it would appear that one year's duration may not have been long enough to elicit significant psychological change. Extension of the program, however, was unfeasible. Not only were the facilities unavailable for any greater length of time, but the teachers remained resistant to the project throughout the entire year. Since positive teacher attitudes have been cited as a major contributor to program success (Dilling & Weiss, Note 5), continuation may have proved futile. Moreover, longer studies of two (e.g., Sinclair & Appleby, Note 4) to four (e.g., Martens, Note 3) years' duration also failed to demonstrate significant changes in psychological well-being. As proposed by Folkins (1976) as well as Stewart and Gutin (1976), when subjects are

young and generally fit to begin with, further increases in physical fitness may not produce psychological gains.

Whereas the majority of studies on physical-psychological relations have allowed subjects to select their treatment group (e.g., Folkins, Lynch & Gardner, 1972), or have chosen individuals already participating in some physical activity (Hammett, 1967), the present study experimentally manipulated fitness level. This overcame not only the problems of self-selection, but also the limitations set by correlational designs by permitting directional statements about the influence of physical fitness on psychological functioning. As well, the present study employed an objective measure of emotional stress (i.e., autonomic reactivity), thereby avoiding the interpretative difficulties encountered with the subjective paper-and-pencil tests typically employed in previous research. The inclusion of a music group to control for a possible Hawthorne effect further distinguishes this from earlier investigations. Moreover, differences between fit and unfit subjects are usually determined from performance on contrived, experimentally-induced stress tests. The present examination of academic grades, however, provides greater insight into one's ability to cope with real life stressors.

In conclusion, the present study demonstrates that aerobic conditioning increases the physical fitness level of seven year old students. Although the data do not support the hypothesis that fitness training also produces psychological gains in school children, it is possible that the WISC tasks were not stressful enough to induce

arousal and that neither the Stanford Achievement Test nor the behavioral questionnaire was sensitive enough to detect changes in the children's progress. Thus, it remains to be demonstrated that the patterns of psychological improvement typical of adults could also be produced in children.

Reference Notes

1. Keller, S.M. The effects of physical fitness on physical and psychological stress. Unpublished manuscript, Concordia University, 1976.

2. Ferguson, G. Personal communication, November 21, 1980.

3. Martens, F.L. The Blanshard project: An elementary school program emphasizing physical education. Unpublished manuscript, University of Victoria, 1979.

4. Sinclair, G. & Appleby, J. Physical education pilot project. Unpublished manuscript, 1979. (Available from The Board of School Trustees of School District No. 39, 1595 West 10th Ave., Vancouver, British Columbia).

5. Dilling, H.J. & Weiss, D. Fitness and our youth: An evaluation of activity programs as educational aids and promoters of total health. Unpublished manuscript, 1975. (Available from The Board of Education for the Borough of Scarborough, 140 Borough Drive, Scarborough, Ontario).

6. Brenner, L. An evaluation of the PEP program. Unpublished manuscript, 1973. (Available from The Board of Education for the City of North York, 15 Oakburn Crescent, Willowdale, Ontario).

7. Mironuck, E.M. & MacKenzie, N.J. Sherwood school project. Unpublished manuscript, 1974. (Available from The Regina Board of Education, 1870 Lorne Street, Regina, Saskatchewan).

8. Martens, F.L. Personal communication, August 13, 1980.

9. New Brunswick Department of Education Learning to move and moving to learn. Unpublished manuscript, 1978. (Available from The New Brunswick Department of Education, P.O. Box 6000, Fredericton, New Brunswick).

10. Longstaff, G. Daily physical education project. Unpublished manuscript, 1977. (Available from School District No. 43, 550 Poirier St., Coquitlam, British Columbia).

References

Adams, F. H., Linde, L. M., & Miyake, H. The physical working capacity of normal school children. Pediatrics, 1961, 28, 55-64.

Allen, T. H., Peng, M. T., Chen, K. P., Huang, T. F., Chang, C., & Fang, H. S. Prediction of total adiposity from skinfolds and the curvilinear relationship between external and internal adiposity. Metabolism, 1956, 5, 346-352.

Anastasi, A. Psychological testing. New York: MacMillan, 1976.

Andrew, G.M., Becklake, M. R., Guleria, J. S., & Bates, D. V. Heart and lung functions in swimmers and nonathletes during growth. Journal of Applied Physiology, 1972, 32, 245-251.

Arnett, C. Interrelationships between selected physical variables and academic achievement of college women. Research Quarterly, 1968, 39, 227-230.

Asmussen, E., Heeboll-Nielsen, K., & Molbech, S. Muscle strength in children. In E. Jokl & E. Simon (Eds.), International research in sport and physical education. Springfield, Ill.: Thomas, 1964.

Astrand, P.-O. Experimental studies of physical working capacity in relation to sex and age. Copenhagen: Munksgaard, 1952.

Astrand, P.-O., Engstrom, L., Eriksson, B. O., Karlberg, P., Nylander, I., Saltin, B., & Thorén, C. Girl swimmers. With special reference to respiratory and circulatory adaptation and gynaecological and psychiatric aspects. Acta Paediatrica Supplementum, 1963, 147, 1-75.

Astrand, P.-O., & Rodahl, K. Textbook of work physiology (2nd ed.). Montreal: McGraw-Hill, 1977.

Astrand, P., & Ryhming, I. A nomogram for calculation of aerobic capacity (physical fitness) from pulse rate during submaximal work. Journal of Applied Physiology, 1954, 7, 218-221.

Bar-Or, O., & Shephard, R.J. Cardiac output determination in exercising children - methodology and feasibility. Acta Paediatric Scandinavica Supplementum, 1971, 217, 49-52.

Bengtsson, E. The working capacity in normal children, evaluated by submaximal exercise on the bicycle ergometer and compared with adults. Acta Medica Scandinavica, 1956, 154, 91-109.

Bialer, I. Conceptualization of success and failure in mentally retarded and normal children. Journal of Personality, 1961, 29, 303-320.

Black, P. (Ed.) Physiological correlates of emotion. New York: Academic Press, 1970.

Blackburn, H., Taylor, H. L., Okamoto, N., Rautaharju, P., Michell, P. L., & Kerkhof, A. C. Standardization of the exercise electrocardiogram. A systematic comparison of chest lead configurations employed for monitoring during exercise. In M. J. Karvonen & A. J. Barry (Eds.), Physical activity and the heart. Springfield, Ill.: Thomas, 1967.

Boas, E. P. The heart rate of boys during and after exhausting exercise. Journal of Clinical Investigation, 1931, 10, 145-152.

Burns, A. Y. School health education - Some notes on the findings of a current CEA survey on school health. Canadian Association for Health, Physical Education and Recreation Journal, 1978, 45, 15-17;38.

Campbell, J. Improving the physical fitness of retarded boys. Mental Retardation, 1974, 12, 31-35.

Candland, D. K. (Ed.) Emotion: Bodily change. Toronto: Van Nostrand, 1962.

Candland, D. K., Fell, J. P., Keen, E., Leshner, A. I., Plutchik, R., & Tarpy, R. M. Emotion. Monterey, California: Brooks/Cole, 1977.

Cannon, W. B. The James-Lange theory of emotions: A critical examination and an alternative theory. American Journal of Psychology, 1927, 39, 106-124.

Cannon, W. B. The wisdom of the body. New York: Norton, 1932.

Chapman, C. B., & Mitchell, J. H. The physiology of exercise. Scientific American, 1965, 212, 88-96.

Collingwood, T. R. The effects of physical training upon behavior and self attitudes. Journal of Clinical Psychology, 1972, 28, 583-585.

Cooper, K. H. Aerobics. Toronto: Evans, 1968.

Corder, W. O. Effects of physical education on the intellectual, physical, and social development of educable mentally retarded boys. Exceptional Children, 1966, 32, 357-364.

Cox, J. P., Evans, J. F., & Jamieson, J. L. Aerobic power and tonic heart rate responses to psychosocial stressors. Personality and Social Psychology Bulletin, 1979, 5, 160-163.

Darley, S. A., & Katz, I. Heart rate changes in children as a function of test versus game instructions and test anxiety. Child Development, 1973, 44, 784-789.

Davison, G. C., & Neale, J. M. Abnormal psychology. Toronto: Wiley, 1974.

deVries, H. A. Laboratory experiments in physiology of exercise. Iowa: Brown, 1971.

deVries, H. A. Physiology of exercise. Iowa: Brown, 1974.

Doerr, H. A., & Hokanson, J. E. A relation between heart rate and performance in children. Journal of Personality and Social Psychology, 1965, 2, 70-76.

Edson, T. Physical education: A substitute for hyperactivity and violence. Journal of Health, Physical Education and Recreation, 1969, 40, 79-81.

Ekblom, B. Effect of physical training in adolescent boys. Journal of Applied Physiology, 1969, 27, 350-355.

Ekblom, B., Astrand, P.-O., Saltin, B., Stenberg, J., & Wallstrom, B. Effect of training on circulatory response to exercise. Journal of Applied Physiology, 1968, 24, 518-528.

Ellestad, M. H. Stress-testing: Principles and practice. Philadelphia: Davis, 1975.

Elliott, R. Physiological activity and performance: A comparison of kindergarten children with young adults. Psychological Monographs, 1964, 78 (10, Whole No. 587).

Eriksson, B.O., & Koch, G. Effect of physical training on hemodynamic response during submaximal and maximal exercise in 11 - 13 year old boys. Acta Physiologica Scandinavica, 1973, 87, 27-39.

Fabricius, H. Effect of added calisthenics on the physical fitness of fourth grade boys and girls. Research Quarterly, 1964, 35, 135-140.

Fantino, E. Emotion. In G.S. Reynolds & J.A. Nevin (Eds.), The study of behavior. Glenview, Ill.: Scott Foresman, 1973.

Ferguson, G. Statistical analysis in psychology and education (2nd ed.). Toronto: McGraw-Hill, 1966.

Fitts, R. The effects of exercise-training on the development of fatique. In P. Milvy (Ed.), The marathon. New York: The New York Academy of Sciences, 1977.

Folkins, C. H. Effects of physical training on mood. Journal of Clinical Psychology, 1976, 32, 385-388.

Folkins, C. H., Lynch, S., & Gardner, M. M. Psychological fitness as a function of physical fitness. Archives of Physical Medicine and Rehabilitation, 1972, 53, 503-508.

Fowler, W. M., & Gardner, G. W. The relation of cardiovascular tests to measurements of motor performance and skills. Pediatrics, 1963, 32, 778-789.

Fox, E.L. Sports physiology. Philadelphia: Saunders, 1979.

Frick, M. H., Konttmen, A., & Saraja, H. S. Effects of physical training on circulation at rest and during exercise. American Journal of Cardiology, 1963, 12, 142-147.

Funk, D. C. Effects of physical education on fitness and motor development of trainable mentally retarded children. Research Quarterly, 1971, 42, 30-34.

Gallagher, J. R., & Brouha, L. A method of testing the physical fitness of high school girls. Revue Canadienne de Biologie, 1943, 2, 395-406.

Gallagher, J. R., Gallagher, C. D., & Brouha, L. A practical bicycle ergometer test of fitness for adolescents. Yale Journal of Biology and Medicine, 1943, 15, 679-688.

Glasser, A. J., & Zimmerman, I.L. Clinical interpretation of the Wechsler intelligence scale for children. New York: Grune and Stratton, 1967.

Grings, W. W. & Dawson, M. E. Emotions and bodily responses: A psychophysiological approach. New York: Academic Press, 1978.

Gruber, J. J. Implications of physical education programs for children with learning disabilities. Journal of Learning Disabilities, 1969, 2, 593-599.

Gruber, J. J. & Ismail, A. H. Recent developments in mind-body relationships. Education, 1968, 89, 57-63.

Hamilton, P., & Andrew, G. M. Influence of growth and athletic training on heart and lung functions. European Journal of Applied Physiology and Occupational Physiology, 1976, 36, 27-38.

Hammett, V. B. O. Psychological changes with physical fitness training. Canadian Medical Association Journal, 1967, 96, 764-768.

Hardy, H. L., Clarke, H. L., & Brouha, L. Testing physical fitness in young women. Revue Canadienne de Biologie, 1943, 2, 407-415.

Hart, M. E., & Shay, C. T. Relationship between physical fitness and academic success. Research Quarterly, 1964, 35, 443-445.

Heinzelmann, F. Psycho-social implications of physical activity. Proceedings of the National Conference on Employee Physical Fitness. Recreation Canada: Ottawa, 1975.

Hertzid, M. E., Birch, M. G., Thomas, A., & Mendex, O. A. Class and ethnic differences in the responsiveness of preschool children to cognitive demands. Monographs of the Society for Research in Child Development, 1968, 33, (Serial No. 117).

Hill, A. V. Muscular activity and carbohydrate metabolism. Science, 1924, 60, 505-514.

Howe, C. E. A comparison of motor skills of mentally retarded and normal children. Exceptional Children, 1959, 25, 352-354.

Howell, M. L., & Macnab, R. B. J. The physical work capacity of Canadian children aged 7 to 17. Ottawa: Canadian Association for Health, Physical Education and Recreation, 1968.

Ismail, A. H., & Gruber, J. J. Motor aptitude and intellectual performance. Columbus, Ohio: Merrill Books, 1967.

Ismail, A. H., & Gruber, J. J. The predictive power of coordination and balance items in estimating intellectual achievement. Proceedings of the first international Congress of Psychology of Sport, Rome, 1965.

Ismail, A. H., & Kirkendall, D. R. Personality and motor aptitude variables as discriminators in preadolescent children. American Corrective Therapy Journal, 1970, 29, 159-163.

Ismail, A. H., & Trachtman, L. E. Jogging the imagination. Psychology Today, 1973, 9, 79-82.

James, W. Psychology: Briefer course. New York: Henry Holt & Co., 1892.

Jéquier, J. C., Lavallée, H., Rajic, M., Beaucage, C., LaBarre, R., & Shephard, R. J. The longitudinal examination of growth and development: History and protocol of the Trois-Rivieres regional study. In H. Lavallée & R. J. Shephard (Eds.), Frontiers of activity and child health. Quebec: Pelican, 1977.

Johansson, G. Subjective wellbeing and temporal patterns of sympthetic - adrenal medullary activity. Biological Psychology, 1976, 4, 157-172.

Johnson, R. E., Brouha, L., & Darling, R. C. A test of physical fitness for strenuous exertion. Revue Canadienne de Biologie, 1942, 1, 491-503.

Johnson, W. R., Fretz, B. R., & Johnson, J.A. Changes in self-concepts during a physical development program. Research Quarterly, 1968, 39, 560-565.

Karpovitch, P. Physiology of muscular activity. London: Saunders, 1966.

Kasch, F., Phillips, W., Ross, W., Carter, J., & Boyer, J. A comparison of maximal oxygen uptake by treadmill and step test procedures. Journal of Applied Physiology, 1966, 21, 1387-1388.

Katch, F. E., & Danielson, G. Bicycle ergometer endurance in women related to maximal leg force, leg volume, and body composition. Research Quarterly, 1976, 47, 366-374.

Kavanagh, T. Heart attack? Counter-attack! Toronto: Van Nostrand Reinhold, 1976.

Keen, E. N., & Sloan, A.W. Observations on the Harvard step test. Journal of Applied Physiology, 1958, 13, 241-243.

Keller, S. M. Physical fitness Hastens recovery from psychological stress. Medicine and Science in Sports and Exercise, 1980, 12, 118 (Abstract).

Kirkendall, D. R., & Ismail, A. H. The discriminating power of non-intellectual variables among three discrete intellectual groups. In G. Kenyon & T. Grogg (Eds.), Contemporary psychology of sport. Chicago, Ill.: The Athletic Institute, 1970.

Klimt, F., & Voigt, G. B. Investigations on the standardization of ergometry in children. Acta Paediatric Scandinvica Supplementum, 1971, 217, 35-36.

Kramer, J. D., & Lurie, P. R. Maximal exercise tests in children. American Journal of Diseases of Children, 1964, 108, 283-297.

Latané, N., & Schachter, S. Adrenaline and avoidance learning. Journal of Comparative and Physiological Psychology, 1962, 65, 369-372.

Lillie, D. L. The effects of motor development lessons on mentally retarded children. American Journal of Mental Deficiency, 1968, 72, 803-808.

Linton, J. M., Hamelink, M. H., & Hoskins, R. G. Cardiovascular system in schizophrenia studied by the Schneider method. Archives of Neurology and Psychiatry, 1934, 32, 712-722.

Lipton, E. D. A perceptual-motor development program's effect on visual perception and reading readiness of first-grade children. Research Quarterly, 1970, 41, 402-405.

Littell, W. M. The Wechsler intelligence scale for children. Review of a decade of research. Psychological Bulletin, 1960, 57, 132-156.

Lorin, M. I. The parents' book of physical fitness for children. New York: Atheneum, 1978.

Maccoby, E. E., & Jacklin, C. N. The psychology of sex differences. Stanford, California: Stanford University Press, 1975.

Madden, R., Gardner, E. F., Rudman, H. C., Karlsen, B., & Merwin, J. C. Stanford achievement test. New York: Harcourt Brace Jovanovich, 1973.

Maksud, M. G., Coutts, K. D., & Hamilton, L. H. Oxygen uptake, ventilation, and heart rate: Study in Negro children during strenuous exercise. Archives of Environmental Health, 1971, 23, 23-28.

Maksud, M. G., & Hamilton, L. H. Physiological responses of EMR children to strenuous exercise. American Journal of Mental Deficiency, 1974, 79, 32-38.

Malmo, R. B. On emotions, needs, and our archaic brains. Montreal: Holt, Rinehart & Winston, 1975.

Malpass, L. F. Motor proficiency in institutionalized and non-institutionalized retarded children and normal children. American Journal of Mental Deficiency, 1960, 64, 1012-1015.

Mandler, G. Emotion. In R. W. Brown, E. Galanter, E. H. Hess & G. Mandler (Eds.), New directions in psychology, Vol. 1. Toronto: Holt, Rinehart & Winston, 1962.

Mathews, D. K., & Fox, E. L. The physiological basis of physical education and athletics. Toronto: Saunders, 1976.

McFarland, R. A., & Huddleson, J. H. Neurocirculatory reactions in the psychoneuroses studied by the Schneider method. American Journal of Psychiatry, 1936, 93, 567-599.

Millman, M., Grundon, W. G., Kasch, F., Wilkerson, B., & Headley, J. Controlled exercise in asthmatic children. Annals of Allergy, 1965, 23, 220-225.

Minton, C., Kagan, J., & Levine, J. A. Maternal control and obedience in the two-year-old. Child Development, 1971, 42, 1873-1894.

Myers, C. R. The official YMCA physical fitness handbook. New York: Popular Press, 1975.

Ogilvie, B. C., & Tutko, T.A. If you want to build character, try something else. Psychology Today, 1971, 10, 60-63.

Oliver, J. N. The effect of physical conditioning exercises and activities on the mental characteristics of educationally sub-normal boys. British Journal of Educational Psychology, 1958, 28, 155-165.

Petersen, K. H., & McElhenney, T. R. Effects of a physical fitness program upon asthmatic boys. Pediatrics, 1965, 35, 295-299.

Plack, J. J. Relationship between achievement in reading and achievement in selected motor skills in elementary school children. Research Quarterly, 1968, 39, 1063-1068.

Pools, Parks and Rinks, Vol. 20 (ISSN 0384-5206), Montreal, 1977.

Prosser, G., Carson, P., Gelson, A., Tucker, H., Neophytou, M., Phillips, R., & Simpson, T. Assessing the psychological effects of an exercise programme for patients following myocardial infarction: A pilot study. British Journal of Medicine Psychology, 1978, 51, 95-102.

Radloff, R., & Helmreich, R. Groups under stress: Psychological research in Sealab II. New York: Appleton-Century-Crofts, 1968.

Rechnitzer, P. A. Rehabilitation after myocardial infarction. Modern Medicine of Canada, 1972, 27, 957-960.

Robb, G. P., Bernardoni, L. C., & Johnson, R. W. Assessment of individual mental ability. Toronto: Intext Educational Publishers, 1972.

Rodger, R. S. Intermediate statistics. Sydney, Australia: Halstead Press, 1965.

Roethlisberger, F. J., & Dickson, W. J. Management and the worker. Cambridge, Massachusetts: Harvard University Press, 1939.

Ross, S. A. Effects of an intensive motor skills training program on young educable mentally retarded children. American Journal of Mental Deficiency, 1969, 73, 920-926.

Rushall, B. S. The status of personality research and application in sports and physical education. The Journal of Sports Medicine and Physical Fitness, 1973, 13, 281-290.

Ryhming, I. A modified Harvard step test for the evaluation of physical fitness. Arbeitsphysiologie, 1954, 15, 235-250.

Sattler, J. M. Assessment of children's intelligence. Toronto: Saunders, 1974.

Schachter, S. The interaction of cognitive and physiological determinants of emotional state. In C. D. Spielberger (Ed.), Anxiety and behavior. New York: Academic Press, 1966.

Schachter, S., & Singer, J. E. Cognitive, social and physiological determinants of emotional state. Psychological Review, 1962, 69, 379-399.

Schachter, S., & Wheeler, L. Epinephrine, chlorpromazine and amusement. Journal of Abnormal and Social Psychology, 1962, 45, 121-128.

Scherr, M. S., & Frankel, L. Physical conditioning program for asthmatic children. Journal of the American Medical Association, 1958, 168, 1996-2000.

Scheuer, J., & Tipton, C. M. Cardiovascular adaptations to physical training. Annual Review of Physiology, 1977, 39, 221-251.

Schneider, E. C. A cardiovascular rating as a measure of physical fatique and efficiency. Journal of the American Medical Association, 1920, 74, 1507-1510.

Seliger, V. Physical fitness of the Czechoslovak 12- and 15-year old population. Acta Paediatric Scandinavica Supplementum, 1971, 217, 37-41.

Serbin, L. A., O'Leary, K. D., Kent, R. N., & Tonick, I. J. A comparison of teacher response to the preacademic and problem behavior of boys and girls. Child Development, 1973, 44, 796-804.

Shephard, R. J. Endurance fitness (2nd ed.). Toronto: University of Toronto, 1977.

Shephard, R. J. The working capacity of schoolchildren. In R. J. Shephard (Ed.), Frontiers of fitness. Springfield, Ill.: Thomas, 1971.

Shephard, R. J., Allen, C., Bar-Or, O., Davies, C. T. M., Degre, S., Hedman, R., Ishii, K., Kaneko, M., LaCour, J. R., diPrampero, P. E., & Seliger, V. The working capacity of Toronto schoolchildren. Canadian Medical Association Journal, 1969, 100, 560-566; 705-714.

Shephard, R. J., Lavallée, H., Lariviere, G., Rajic, M., Brisson, G. R., Beaucage, C., Jequier, J. C., & La Barre, R. La capacité physique des enfants canadiens: Une comparaison entre les enfants canadiens-français, canadiens-anglais, et esquimaux: Part I. Consommation maximale d'oxygene et débit cardiaque. L'Union Médicale du Canada, 1974, 103, 1767-1777.

Ibid., Part II. Anthropométrie et volumes pulmonaires. L'Union Médicale du Canada, 1975, 104, 259-269.

Shephard, R. J., & Olbrecht, A. J. Body-weight and the estimation of working capacity. South African Medical Journal, 1970, 44, 296-298.

Skinner, J. S. Physiological implications of physical activity. Proceedings of the National Conference on Employee Physical Fitness. Recreation Canada: Ottawa, 1975.

Smart, R. G. The new drinkers: Teenage use and abuse of alcohol. Addiction Research Foundation of Ontario: Toronto, 1976.

Solomon, A., & Pangle, R. Demonstrating physical fitness improvement in the EMR. Exceptional Children, 1967, 34, 117-118.

Statistics Canada. Culture statistics: Recreational activities 1976 (Catalogue 87-501 Occasional), 1978.

Statistics Canada. Vital statistics: Deaths 1977 (Catalogue 84-206 Annual), 1980.

Stewart, K. J., & Gutin, B. Effects of physical training on cardiorespiratory fitness in children. Research Quarterly, 1976, 47, 110-120.

Thomas, J. R., & Chissom, B. S. Relationships as assessed by canonical correlation between perceptual-motor and intellectual abilities for pre-school and early elementary age children. Journal of Motor Behavior, 1972, 4, 23-29.

Weber, R. J. Relationship of physical fitness to success in college and to personality. Research Quarterly, 1953, 24, 471-474.

Wechsler, D. Wechsler intelligence scale for children: Manual. New York: The Psychological Corporation, 1949.

Weiser, P. C., Kinsman, R. A., & Stamper, D. A. Task-specific symptomatology changes resulting from prolonged submaximal bicycle riding. Medicine and Science in Sports, 1973, 5, 79-85.

Widdop, J. A comparative study of the motor performance of educable retarded and normal children. In G. Kenyon, & T. Grogg (Eds.), Contemporary psychology of sport. Chicago, Ill.: The Athletic Institute, 1970.

Williams, M. H. Fitness evaluation with emphasis on submaximal and maximal methods of assessing aerobic capacity. American Corrective Therapy Journal, 1972, 26, 85-88.

Young, P. Motivation and emotion. New York: J. Wiley & Sons, 1961.

Zimmerman, I. L., & Woo-Sam. J. Research with the Wechsler intelligence scale for children: 1960-1970. Psychology in the Schools, 1972, 9, 232-271 (Special Mongraph Supplement).

Appendix A

Letter Sent to the School Boards

January 4, 1979

Dear Sir:

The purpose of this letter is to request permission to conduct a physical fitness program in some of the elementary schools under the jurisdiction of your School Board. This project will constitute the research for my Doctoral thesis in the Department of Psychology at Concordia University. Specifically, I propose to study the inter-relationship between physical fitness and academic achievement. The project will involve 60 students enrolled in the second grade. Forty children will be assigned to a physical fitness program, and twenty to group piano or recorder lessons. Fitness classes will be held three days a week, for 20 minutes during the lunch break, and will consist of endurance (cardiovascular) activities, including running relays, hopping, skipping, yard dashes, and so on. Music classes will assemble once a week for 30 minutes during the lunch break. All exercise and music classes will extend over one full school year (i.e., from September 1979 until June 1980), and will be taught by teachers on staff at each school. Salaries can be offered, although arrangements will first be made with the School Board and/or respective principal.

All children will be tested before the start of the program, in December, and again at the end of the school year. Physical fitness will be assessed from two minutes of pedalling a bicycle ergometer, while psychological fitness, from a five-minute perceptual task (e.g., paper-and-pencil mazes). Heart rate and galvanic skin response (i.e., palmar sweating) will be recorded on a physiograph throughout both tasks. Height, weight, and percent body fat will also be recorded in each test session. All testing will occur inside a portable laboratory contained in a University trailer. This trailer will remain parked in each school's parking lot for the duration of the testing period.

Data on absenteeism and academic achievement will be gathered from the children's report cards issued in June and December 1979, and June 1980. Questionnaires to assess changes in classroom behavior (e.g., concentration, sociability, etc.) will be administered to the students' teachers before and after the program.

As soon as schools become available to me, I will obtain class lists from the grade two teachers, and then send letters to the parents. These will include detailed explanations of both the purpose and methodology of the program. Results of the study will be mailed to all parents at its completion.

Appendix A (continued)

I would like to emphasize that this study will not interfere in any way with the children's daily school activities. All classes will be structured within the lunch break. Arrangements will be made with each child's parents to schedule the test sessions at their convenience. These can be held during the lunch break, after school, or on the weekend.

I would also like to stress the benefits that this proposed study may bring to the children involved. It will not only offer them a learning experience not available through the current school curriculum, but research has established that regular physical training enhances both physical and psychological functioning. As well as increasing concentration, imagination, and reducing tension and hyperactivity, several studies have suggested that exercise improves academic achievement. Changes in these and other areas have important implications for students and teachers alike.

I hope that you can offer me the opportunity to conduct this study in your schools. If you have any questions, I can be reached at 879-4155. I look forward to hearing from you soon.

Sincerely,

Sandra Keller, M.A.

Appendix B

Letter Sent to the Parents

Dear Parents:

Concordia University is presently conducting a physical fitness program with some of the second grade children at St. John Fisher School. As the study has been well received by both students and administrators alike, it will be offered to all second grade children next year. It is the purpose of this letter to ask your permission to enroll your child in this program.

The study will extend from September 1979 to June 1980. Your child will be randomly assigned to one of three groups: A physical training group will meet four days a week for 30 minutes during the lunch break. Classes will consist of structured physical activities, such as running relays, tag, and so on, and will be taught by a physical education teacher. A second group of children will be assigned to music classes which will assemble twice a week for half an hour during the regular lunch break. The children will learn to play the recorder and a variety of percussion instruments. A third group of students will simply maintain the usual physical education and academic curricula throughout the year.

Individual test sessions will be conducted at St. John Fisher in September, February and June. These will include a standardized test of physical fitness on a bicycle ergometer, and one three-minute perceptual task (e.g., paper-and-pencil mazes). Heart rate and galvanic skin response (i.e., palmar sweating) will be recorded on a physiograph throughout these tasks. Data on classroom behavior and academic achievement will also be gathered.

I would like to emphasize that this study is being organized as a learning experience for your child. It has not only been suggested that learning to play a musical instrument may expand one's intellectual capacity, but recent studies have demonstrated that regular exercising may increase imagination, concentration, and tolerance to stress. This program will hopefully benefit your child in these, and other areas.

I would also like to bring to your attention the fact that the children are invited to eat their lunches in school the days they attend classes; teachers will supervise them during the entire lunch break.

Appendix B (continued)

If you wish your child to join this study, kindly indicate so on the attached form and return it immediately. If you have any questions regarding the study, please do not hesitate to contact me. I can be reached at Concordia University at 879-4155.

Thank you for your support.

Sincerely,

Sandra Keller, M.A.

Appendix B (continued)

C O N S E N T F O R M

____ I permit my child _____ (name) to participate in Concordia's program regardless of which group (s)he is randomly assigned to.

____ I do not wish my child _____ (name) to participate in Concordia's program because _____

_____.

If your child will be participating in the program, please complete the following questions:

1. Does your child suffer from any physical ailments? (for example, asthma, heart murmur, joint problems, etc). Please specify.

_____

_____

2. Is your child currently taking any medication on a regular basis? If so, please indicate the purpose, dose and name of the medicine.

_____

_____

3. Does your child currently participate in any physical activity on a regular basis? (for example, ballet, hockey, etc.). If so, how often does (s)he attend sessions? How long does each session last?

_____

_____

4. Does your child play a musical instrument? If so, which one(s)?

_____

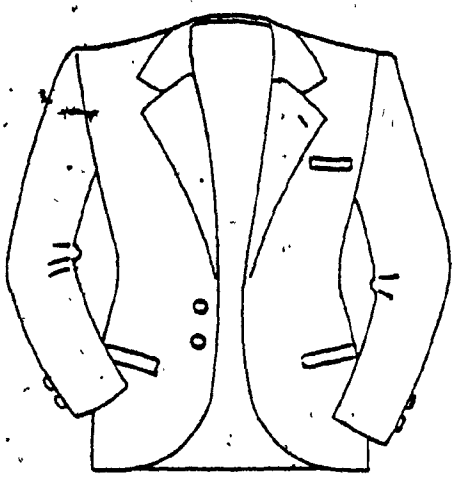
Parent's Signature _____ Telephone Number: (Home) _____

(Work) _____

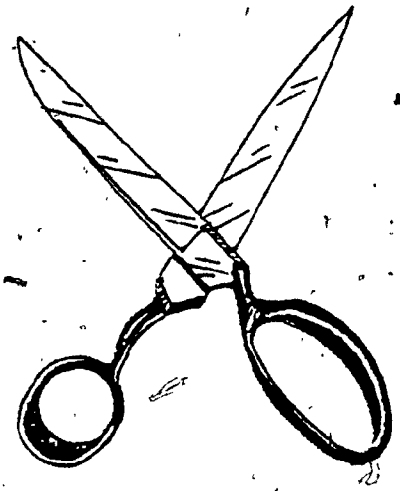
Appendix C

The Stress-Inducing Tasks

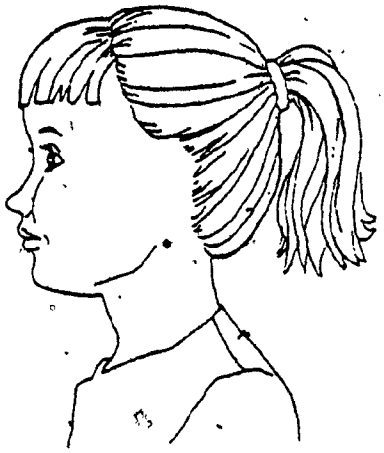
(A) Picture Completion



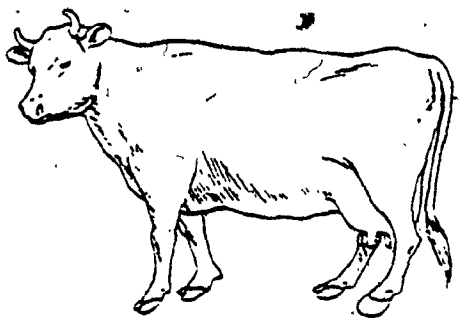
Coat.....buttonholes



Scissors.....screw

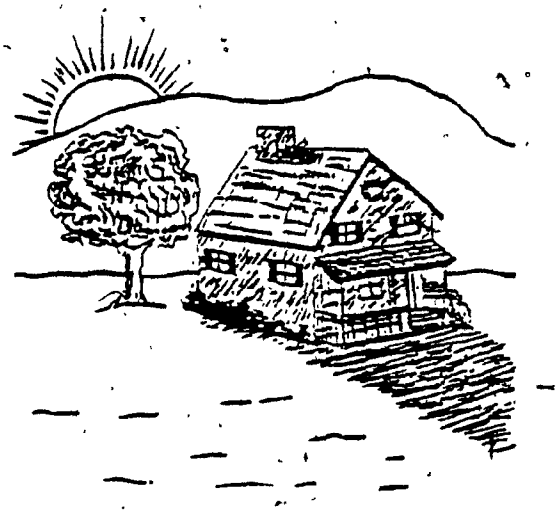


Girl.....ear

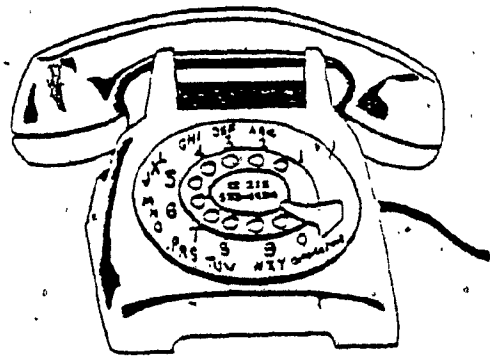


Cow.....cleft in hoof

Appendix C (continued)



House.....shadow

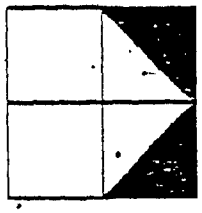


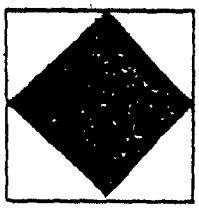
Telephone.....wire

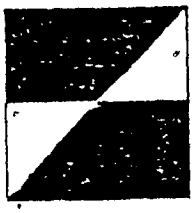
Hat.....band

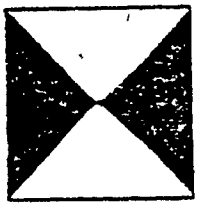
Appendix C (continued)

(B) Block Design









Appendix C (continued)

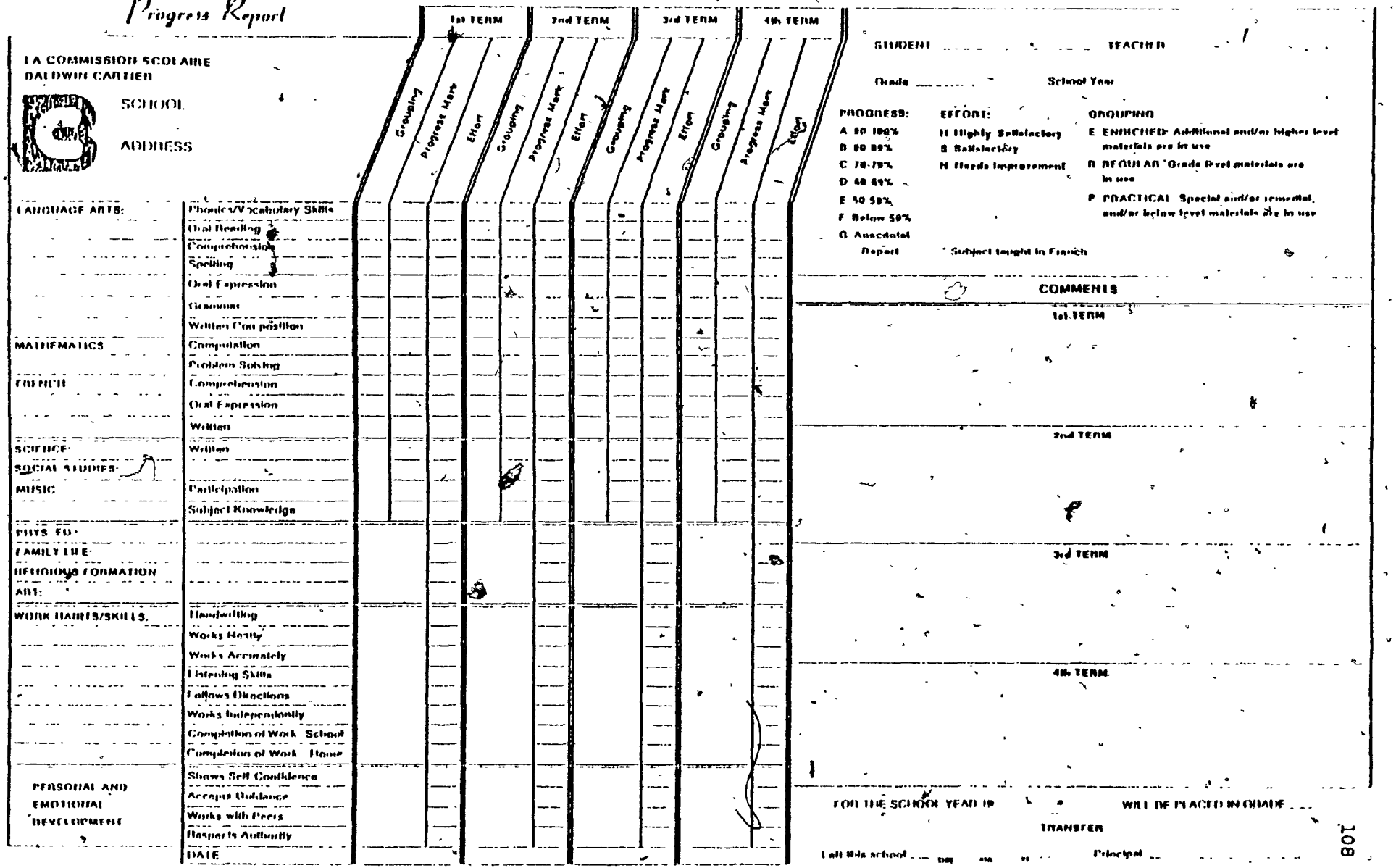
(c) Digit Span

Practice a) 9-3-7 b) 6-2-8-5

1) 8-4-2-3
2) 6-9-8-5
3) 5-3-8-2-6
4) 3-2-8-7-5
5) 7-2-4-9
6) 8-3-7-2-6
7) 4-9-1-5
8) 9-6-1-2-7
9) 4-8-3-1-5-2
10) 9-6-8-3-1
11) 7-2-9-4-8
12) 1-3-2-7-5
13) 3-8-2-9-1-6
14) 8-4-6-3-9
15) 2-5-8-4-1
16) 6-1-5-2-8
17) 1-5-2-9-6-4
18) 3-9-2-7-1
19) 4-7-9-6-2-8
20) 9-5-4-2-6
21) 8-3-7-4-9-2
22) 4-9-6-1-7-3
23) 7-9-5-2-8
24) 3-8-5-9-1
25) 8-5-2-6-9-7
26) 3-1-9-2-7-4
27) 1-6-9-2-7
28) 5-8-7-6-9
29) 9-6-3-8-5-1
30) 4-1-7-9-3-2
31) 9-8-3-1-4
32) 4-7-3-1-6-2
33) 8-2-5-9-3-6
34) 2-6-4-9-5-3
35) 4-1-8-5-2
36) 3-7-9-4-8
37) 6-2-5-3-4-7
38) 9-3-7-4-1-8
39) 7-3-9-5-2-4
40) 1-5-9-6-3-8-3
41) 5-2-8-3-9-4
42) 2-6-4-9-5-[redacted]-1
43) 5-3-8-7-1-2
44) 3-7-8-1-5-4
45) 2-5-1-6-4-9-3
46) 6-4-7-3-9-2
47) 4-1-5-8-2-6
48) 5-9-2-8-3-4
49) 7-2-8-5-9-3
50) 5-0-9-5-4-2-9-3

Appendix D

School Report Cards



Progress Report

LA COMMISSION SCOLAIRE
BALDWIN CARTIER

SCHOOL

ADDRESS

		1st TERM			2nd TERM			3rd TERM			4th TERM		
		Grouping	Progress Mark	Effort	Grouping	Progress Mark	Effort	Grouping	Progress Mark	Effort	Grouping	Progress Mark	Effort
LANGUAGE ARTS:	Phonics/Vocabulary Skills												
	Oral Reading												
	Comprehension												
	Spelling												
	Oral Expression												
	Grammar												
	Written Composition												
MATHEMATICS	Computation												
	Problem Solving												
FRENCH	Comprehension												
	Oral Expression												
	Written												
SCIENCE:	Written												
SOCIAL STUDIES:													
MUSIC:	Participation												
	Subject Knowledge												
PHYS ED:													
FAMILY LIFE:													
RELIGIOUS FORMATION													
ART:													
WORK HABITS/SKILLS	Handwriting												
	Works Neatly												
	Works Accurately												
	Listening Skills												
	Follows Directions												
	Works Independently												
	Completion of Work - School												
	Completion of Work - Home												
PERSONAL AND EMOTIONAL DEVELOPMENT	Shows Self Confidence												
	Accepts Guidance												
	Works with Peers												
	Respects Authority												
	DATE												

STUDENT _____ TEACHER _____

Grade _____ School Year _____

PROGRESS:
A 90-100%
B 80-89%
C 70-79%
D 60-69%
E 50-59%
F Below 50%
G Anecdotal Report

EFFORT:
H Highly Satisfactory
S Satisfactory
N Needs Improvement

GROUPING
E ENRICHED: Additional and/or higher level materials are in use
R REGULAR: Grade level materials are in use
P PRACTICAL: Special and/or remedial, and/or below level materials are in use

* Subject taught in French

COMMENTS

1st TERM

2nd TERM

3rd TERM

4th TERM

FOR THE SCHOOL YEAR 19__ - 19__ WILL BE PLACED IN GRADE _____

TRANSFER

I am this school _____ Principal _____

Appendix E

Behavioral Questionnaire

Student _____ Teacher _____ Date _____ Group _____

Degree of Alertness	1 VERY LOW	2	3	4	5	6	7 VERY HIGH
Level of anxiety	1 VERY LOW	2	3	4	5	6	7 VERY HIGH
Quality of attention span	1 VERY POOR	2	3	4	5	6	7 EXCELLENT
Degree of confidence	1 VERY LOW	2	3	4	5	6	7 VERY HIGH
Ability to get along with others	1 VERY POOR	2	3	4	5	6	7 EXCELLENT
Quality of imagination	1 VERY POOR	2	3	4	5	6	7 EXCELLENT
Degree of interest in his/her work	1 VERY LOW	2	3	4	5	6	7 VERY HIGH
Ability to demonstrate leadership	1 VERY POOR	2	3	4	5	6	7 EXCELLENT
Degree of shyness and timidity	1 VERY LOW	2	3	4	5	6	7 VERY HIGH
Quality of work	1 VERY POOR	2	3	4	5	6	7 EXCELLENT

Appendix F

Basal (B), Maximum (Max), and Recovery Heart Rates at 1-10 Minutes for the Bicycle Ergometer Test

GROUP EXERCISE: Session 1

			Recovery									
	B	Max	1	2	3	4	5	6	7	8	9	10
BOYS												
JL	76	190	85	78	90	98	93	91	89	94	88	102
SD	82	188	124	97	103	100	100	99	84	90	96	88
ET	84	210	127	98	103	103	95	93	103	95	107	97
BA	115	197	133	113	95	114	110	113	113	113	113	114
PL	100	183	117	113	113	98	103	98	84	93	88	94
PB	87	168	103	83	79	91	92	94	90	91	87	84
GIRLS												
DD	93	185	132	124	122	113	117	114	116	113	111	116
JF	84	192	168	156	144	132	144	132	114	144	132	144
SM	99	192	144	133	114	127	115	122	123	128	120	122
KG	84	178	128	97	93	95	100	90	93	101	95	96
TB	83	209	150	134	129	107	116	118	119	103	117	119
LD	96	180	120	120	108	108	108	108	120	120	120	108
SR	93	189	115	121	98	104	103	101	101	103	114	107

Appendix F (continued)

GROUP EXERCISE: Session 2

	B	Max	Recovery 1	2	3	4	5	6	7	8	9	10
BOYS												
JL	84	204	96	84	96	96	96	96	108	96	108	96
SD	96	192	120	96	96	96	96	108	96	96	96	96
ET	96	192	132	120	108	96	108	96	108	96	84	96
BA	84	192	108	96	108	96	108	96	84	108	96	96
PL	108	180	108	108	108	96	108	96	108	108	96	108
PH	96	204	132	120	120	108	120	132	120	120	120	120
GIRLS												
DD	108	204	156	132	144	120	120	132	132	132	132	132
JF	96	204	132	132	108	120	120	96	108	120	108	108
SM	96	216	168	156	132	132	132	144	132	132	132	132
KG	108	192	120	120	120	96	84	84	96	96	84	96
TB	108	204	156	144	144	132	132	132	-	-	-	-
LD	108	204	132	120	120	108	108	108	108	108	108	108
SR	96	216	144	120	120	108	108	96	96	96	96	108

Appendix F (continued)

GROUP EXERCISE: Session 3

			Recovery									
	B	Max	1	2	3	4	5	6	7	8	9	10
BOYS												
JL	108	204	132	120	120	108	108	108	108	96	108	120
SD	72	192	132	84	96	96	84	84	84	72	84	72
ET	72	180	96	72	84	96	84	84	96	108	96	96
BA	96	192	84	84	108	108	108	108	96	108	96	96
PL	84	180	72	72	72	72	84	72	72	84	72	84
PB	96	168	96	84	108	96	96	96	96	96	108	108
GIRLS												
DD	96	204	132	120	108	132	108	108	108	108	108	120
JF	108	192	120	108	108	96	96	96	96	96	96	96
SM	96	216	144	108	120	108	108	120	96	108	108	120
KG	108	168	96	84	84	96	96	84	96	96	108	96
TB	96	192	144	120	132	108	120	120	120	120	132	120
LD	96	216	132	108	108	108	96	108	96	96	108	108
SR	96	192	108	96	96	96	96	108	96	96	108	108

Appendix F (continued)

GROUP MUSIC: Session 1

			Recovery									
	3	Max	1	2	3	4	5	6	7	8	9	10
BOYS												
JM	108	180	108	96	108	96	97	102	96	93	94	94
MS	73	183	98	96	82	84	88	94	89	83	90	90
MP	78	165	133	123	122	107	98	83	114	97	97	97
GIRLS												
MP	87	160	144	134	124	120	124	115	114	113	113	111
CD	86	188	123	99	103	92	100	97	84	93	96	100
LH	84	194	156	96	114	96	108	114	108	108	108	102
SO	98	205	135	118	101	103	110	110	104	98	108	100
KH	108	180	132	120	120	120	120	108	108	120	104	108
JR	71	183	110	84	84	84	89	85	92	86	93	97

Appendix F (continued)

GROUP MUSIC: Session 2

	B	Max	Recovery 1	2	3	4	5	6	7	8	9	10
BOYS												
JM	120	192	132	132	144	120	132	120	120	120	120	120
MS	108	192	144	96	120	108	120	108	108	132	120	108
MP	120	204	144	144	132	132	120	132	120	120	120	132
GIRLS												
MP	120	204	168	156	144	144	144	132	132	144	156	132
CD	84	192	120	108	108	120	108	108	96	108	108	108
LH	60	204	120	96	96	96	108	96	96	96	108	120
SO	120	204	144	144	120	120	96	108	132	132	132	108
KH	96	192	156	120	120	108	108	120	120	108	120	120
JR	96	204	132	120	108	120	108	108	96	108	108	120

Appendix F (continued)

GROUP MUSIC: Session 3

			Recovery									
	B	Max	1	2	3	4	5	6	7	8	9	10
BOYS												
JM	96	168	96	108	108	96	84	108	84	96	96	96
MS	84	180	132	120	132	120	120	108	108	108	108	120
MP	84	180	120	120	120	108	96	108	96	108	108	96
GIRLS												
MP	120	192	156	144	120	132	132	132	132	132	132	132
CD	96	204	96	84	108	96	96	96	84	96	96	96
LH	108	204	144	132	132	120	132	108	120	120	132	120
SO	108	204	144	120	132	120	108	120	120	120	120	132
KH	108	192	108	108	84	108	108	108	108	108	108	108
JR	96	192	120	96	96	96	96	108	120	108	108	96

Appendix F (continued)

GROUP INACTIVE: Session 1

	B	Max	Recovery 1	2	3	4	5	6	7	8	9	10
BOYS												
SR	73	191	124	112	99	99	93	96	93	93	93	94
GM	108	185	122	120	102	97	97	109	102	107	104	99
MG	108	204	132	120	114	120	120	120	120	114	120	114
EU	69	157	80	78	78	68	72	70	80	84	77	75
GIRLS												
CI	83	216	138	105	93	98	98	98	102	98	92	101
CC	98	183	138	127	123	117	117	117	117	115	117	117
CS	77	245	133	95	84	84	94	94	93	96	94	93
CB	73	183	127	110	109	109	98	99	98	88	85	97
JT	72	168	108	108	120	108	108	120	102	96	120	108
CM	123	208	165	135	129	130	117	114	114	112	114	125
JA	120	216	156	132	132	132	132	144	132	132	132	132

Appendix F (continued)

GROUP INACTIVE: Session 2

	B	Max	Recovery 1	2	3	4	5	6	7	8	9	10
BOYS												
SR	96	204	144	132	132	132	120	108	96	108	120	108
GM	96	180	144	108	108	120	120	108	120	120	108	120
MG	96	180	108	96	108	108	108	108	108	108	108	108
EU	84	180	96	96	96	96	84	84	96	96	84	84
GIRLS												
CI	84	204	144	120	120	120	108	120	120	120	108	120
CC	108	192	120	120	108	132	108	108	120	120	108	108
CS	96	216	156	108	96	108	108	108	108	108	96	108
CB	96	204	144	144	132	120	120	108	108	120	120	120
JT	84	192	156	132	120	108	120	120	108	108	108	96
CM	120	216	168	156	132	132	120	120	132	144	132	108
JA	132	216	168	156	156	144	144	132	144	132	144	144

Appendix F (continued)

GROUP INACTIVE: Session 3

			Recovery									
	B	Max	1	2	3	4	5	6	7	8	9	10
BOYS												
SR	96	180	132	108	108	108	96	96	96	108	96	96
GM	108	192	144	120	132	120	120	132	120	120	120	132
MG	72	180	96	84	84	108	96	96	84	84	108	120
EU	72	156	72	84	84	84	72	84	84	84	96	84
GIRLS												
CI	84	180	132	96	96	96	132	120	108	108	96	96
CC	84	192	132	120	108	120	96	108	108	120	96	108
CS	84	216	144	120	120	120	108	120	108	120	108	120
CB	84	180	132	108	108	108	120	108	108	108	108	108
JT	96	192	144	108	108	96	132	108	108	132	84	120
CM	96	204	144	132	120	108	120	120	120	120	108	108
JA	132	204	156	156	144	144	144	132	144	144	132	144

Appendix G

Magnitude of Recovery Scores

(i.e., Maximum Heart Rate minus Recovery Heart Rate)

at 1, 2, and 3 Minutes of Recovery

GROUP EXERCISE

	Session 1			Session 2			Session 3		
	-1	-2	-3	-1	-2	-3	-1	-2	-3
BOYS									
PB	65	85	89	72	84	84	72	84	60
PL	66	70	70	72	72	72	108	108	108
JL	105	112	100	108	120	108	72	84	84
SD	64	91	85	72	96	96	60	108	96
ET	83	112	107	60	72	84	84	108	96
BA	64	84	102	84	96	84	108	108	84
GIRLS									
SR	68	91	85	72	96	96	84	96	96
LD	60	60	72	72	84	84	84	108	108
TB	59	75	80	48	60	60	48	72	60
KG	50	81	85	72	72	72	72	84	84
DD	53	61	63	48	72	60	72	84	96
JF	24	36	48	72	72	96	72	84	84
SM	48	59	78	48	60	84	72	108	96

Appendix G (continued)

GROUP MUSIC

	Session 1			Session 2			Session 3		
	-1	-2	-3	-1	-2	-3	-1	-2	-3
BOYS									
MS	85	87	101	48	96	72	48	60	48
JM	72	84	72	60	60	48	72	60	60
MP	32	42	43	60	60	72	60	60	60
GIRLS									
LH	38	98	80	84	108	108	60	72	72
CD	65	89	85	72	84	84	108	120	96
MP	16	26	36	36	48	60	36	48	72
JR	73	99	99	72	84	96	72	96	96
SO	70	87	104	60	60	84	60	84	72
KH	48	60	60	36	72	72	84	84	108

Appendix G (continued)

GROUP INACTIVE

	Session 1			Session 2			Session 3		
	-1	-2	-3	-1	-2	-3	-1	-2	-3
BOYS									
SR	67	79	92	60	72	72	48	72	72
GM	63	65	83	36	72	72	48	72	60
MG	72	84	90	72	84	72	84	96	96
EU	77	79	79	84	84	84	84	72	72
GIRLS									
JA	60	84	84	48	60	60	48	48	60
JT	60	60	48	36	60	72	48	84	84
CM	43	73	79	48	60	84	60	72	84
CI	78	111	123	60	84	84	48	84	84
CC	45	56	60	72	72	84	60	72	84
CB	56	73	74	60	60	72	48	72	72

Appendix H

Percent Body Fat

	GROUP EXERCISE				GROUP MUSIC				GROUP INACTIVE			
	Session				Session				Session			
	1	2	3		1	2	3		1	2	3	
BOYS												
PL	7.02	7.46	6.09		JM	4.09	5.88	6.09	KB	9.94	12.21	11.46
PB	3.97	1.82	3.79		GP	4.21	4.96	5.66	SR	5.99	6.58	7.17
IN	9.42	8.74	8.05		MP	2.52	3.72	3.34	GM	2.81	2.89	2.63
JL	3.65	3.51	3.84		MS	3.50	2.14	3.71	MG	3.37	3.75	2.74
BA	3.18	2.83	2.99						EU	3.91	4.36	4.24
SD	3.11	1.74	1.32									
ET	2.71	2.35	2.18									
GIRLS												
SR	3.39	3.11	2.52		CD	3.78	4.03	3.22	JA	3.45	3.17	3.61
LD	5.98	5.01	4.48		SO	4.58	5.41	5.70	JT	3.82	4.45	4.01
JF	9.50	10.32	10.31		KH	7.02	6.57	6.74	CS	4.24	5.11	4.91
TB	3.24	3.08	2.72		MP	3.53	4.23	4.41	CB	6.47	8.34	7.52
KG	5.47	5.20	4.35		JR	3.86	4.43	4.46	CM	6.41	5.70	5.84
DD	7.18	7.22	6.15		LH	6.81	7.00	7.43	CC	5.49	6.28	7.18
SM	5.38	3.95	3.76						CI	5.99	6.58	7.09

Appendix I

Canada Fitness Award Test

GROUP EXERCISE

	Grade Two			Grade One		
	50 meters	600 meters	overall excellence	50 yards	300 yards	overall excellence
BOYS						
LN	Bronze	Excellence	Bronze	Bronze	Bronze	Bronze
PL	Bronze	Gold	Gold	Bronze	Silver	Bronze
BA	Silver	Excellence	Silver	Bronze	Bronze	Bronze
PB	Silver	Excellence	--	Bronze	Silver	Bronze
ET	Excellence	Excellence	Excellence	Bronze	Gold	Bronze
JL	Excellence	Excellence	Excellence	Bronze	Bronze	Bronze
SD	Excellence	Excellence	Excellence	--	--	--
GIRLS						
LD	Excellence	Excellence	Excellence	Bronze	Excellence	Silver
DD	Silver	Excellence	Silver	Bronze	Silver	Bronze
KG	Excellence	Excellence	Excellence	Bronze	Excellence	Bronze
CG	Excellence	Excellence	Gold	--	--	--
TB	0	Excellence	Silver	--	Bronze	Bronze
SM	Excellence	Excellence	Excellence	Bronze	Silver	Silver
SR	Excellence	Excellence	Excellence	Bronze	Silver	Silver
JF	Silver	Silver	Silver	Bronze	Bronze	Bronze

Appendix I (continued)

GROUP MUSIC

	Grade Two			Grade One		
	50 meters	600 meters	overall excellence	50 yards	300 yards	overall excellence
BOYS						
JM	Excellence	Excellence	Excellence	Silver	Excellence	Silver
MS	Excellence	Excellence	Excellence	Bronze	Excellence	Excellence
MP	Silver	Excellence	Gold	Bronze	Silver	Silver
GP	Gold	Gold	Gold	0	Silver	Bronze
GIRLS						
CD	Excellence	Excellence	Excellence	Bronze	Silver	Gold
MP	0	Silver	Bronze	Bronze	0	Bronze
LH	Gold	Excellence	Silver	Bronze	Gold	Silver
SO	Silver	Excellence	Gold	Bronze	Bronze	Bronze
JR	Bronze	Gold	Gold	Bronze	Excellence	Silver
KH	0	0	0	--	--	--

Appendix I (continued).

GROUP INACTIVE

	Grade Two			Grade One		
	50 meters	600 meters	overall excellence	50 yards	300 yards	overall excellence
BOYS						
KB	0	Bronze	0	0	Bronze	Bronze
EU	Excellence	Excellence	Excellence	Silver	Excellence	Silver
DC	Bronze	Excellence	Silver	Bronze	Bronze	Bronze
GM	Silver	Excellence	Silver	Bronze	Silver	Bronze
SR	Bronze	Excellence	Gold	Bronze	Excellence	Silver
MG	0	Gold	Bronze	Bronze	Bronze	Bronze
GIRLS						
CB	Silver	Silver	Silver	Bronze	0	Bronze
CM	Bronze	Silver	Silver	Bronze	Silver	Bronze
CS	Bronze	Silver	Silver	Bronze	Silver	Silver
CI	Bronze	Excellence	Silver	Bronze	Gold	Silver
JT	Excellence	Excellence	Gold	Bronze	Excellence	Bronze
JA	Bronze	Excellence	Silver	Bronze	Bronze	Bronze
CC	Bronze	Excellence	Gold	Silver	Excellence	Silver

Appendix J

Performance on Stress-Inducing Tasks: Standard Scores

GROUP EXERCISE				GROUP MUSIC				GROUP INACTIVE			
	Session				Session				Session		
	1	2	3		1	2	3		1	2	3
BOYS											
PL	37	67	38	JM	44	52	50	GM	44	39	38
PB	45	67	62	MS	67	62	52	KB	44	38	52
BA	52	44	69	MP	52	45	67	EU	58	52	46
JL	58	52	36	GP	46	38	52	SR	50	65	37
ET	55	38	52					MG	36	65	52
SD	38	85	75								
IN	46	58	59								
GIRLS											
DD	44	50	58	LH	44	53	38	CI	44	85	52
TB	45	37	43	JR	59	41	45	CM	44	39	52
SM	45	52	46	SO	52	59	36	CC	45	52	34
KG	45	59	55	CD	45	52	32	JA	45	44	50
SR	57	38	44	MP	37	43	52	JT	71	45	44
JF	45	45	37	KH	53	58	59	CS	34	38	44
LD	37	46	38					CB	80	65	59

Appendix K

Report Cards: Grade Two

GROUP EXERCISE

	Term 1						Term 4					
	Language Arts	Mathematics	French	Science	Music	Physical Education	Language Arts	Mathematics	French	Science	Music	Physical Education
BOYS												
PB	2.5	2.0	0.8	2.0	2.0	2.0	3.7	3.5	0.5	4.0	3.5	2.5
BA	3.5	3.0	3.5	3.0	2.0	3.0	4.0	4.0	4.5	4.0	3.0	3.0
IN	2.8	3.0	3.0	3.0	3.0	2.0	4.2	4.0	2.0	3.0	3.0	2.5
PL	2.2	3.0	4.0	3.0	3.0	2.5	3.2	4.5	4.0	4.0	3.0	2.5
GIRLS												
CG	3.4	3.0	3.0	3.0	3.0	3.0	4.2	4.0	3.0	3.0	3.5	4.0
KG	3.2	3.0	3.0	3.0	3.0	3.0	4.2	4.5	4.0	3.0	4.0	4.0
DD	3.0	3.0	3.0	3.0	3.0	3.0	3.8	4.5	3.0	3.0	4.0	3.0
LD	2.4	3.0	4.0	3.0	3.0	3.0	4.0	4.0	3.0	3.0	4.0	4.0
SM	2.0	2.5	3.0	3.0	2.5	3.0	3.3	3.0	2.5	4.0	3.0	4.0
TB	3.0	3.0	3.0	3.0	3.0	2.0	4.1	4.0	3.0	3.0	4.0	3.0

Appendix K (Continued)

GROUP MUSIC

	Term 1						Term 4					
	Language Arts	Mathematics	French	Science	Music	Physical Education	Language Arts	Mathematics	French	Science	Music	Physical Education
BOYS												
GP	2.8	3.0	4.0	3.0	3.0	3.0	4.0	4.0	3.0	3.0	3.0	3.5
MP	3.2	3.0	4.0	3.0	3.0	3.0	3.9	4.0	4.0	3.0	4.0	3.5
MS	3.7	3.5	4.0	3.0	2.0	4.0	4.0	4.0	4.5	4.0	3.0	4.0
JM	1.9	1.0	2.0	3.0	2.0	3.0	3.2	3.0	1.0	4.0	4.0	4.0
GIRLS												
MP	2.4	2.0	4.0	3.0	2.0	3.0	3.8	4.0	4.0	4.0	3.0	3.0
SO	3.2	3.0	4.0	3.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	3.5
KH	3.4	3.0	3.0	3.0	3.0	3.0	4.1	4.0	4.0	3.0	4.0	3.0
LH	3.2	3.0	4.0	3.0	3.0	3.0	4.0	4.0	4.0	3.0	4.0	3.5
CD	3.1	3.5	4.0	3.0	2.5	3.0	4.0	4.0	4.5	4.0	3.0	4.0
JR	3.2	3.0	3.0	3.0	3.0	3.0	4.0	4.0	4.0	3.0	4.0	3.0

Appendix K (continued)

GROUP INACTIVE

	Term 1						Term 4					
	Language Arts	Mathe-matics	French	Science	Music	Physical Education	Language Arts	Mathe-matics	French	Science	Music	Physical Education
BOYS												
KB	2.4	2.0	3.0	3.0	2.0	3.0	3.9	3.5	3.0	4.0	3.5	2.0
DC	3.4	3.0	4.0	3.0	3.0	3.0	4.2	4.0	4.0	3.0	4.0	3.0
MG	2.8	3.0	4.0	3.0	3.0	3.0	3.5	4.5	4.0	3.0	3.0	3.0
SR	2.9	2.5	3.0	3.0	1.0	3.0	3.5	3.0	4.0	4.0	2.0	3.5
GM	3.0	3.0	3.0	3.0	3.0	3.0	3.9	4.0	3.0	3.0	3.0	3.0
EU	3.0	3.0	3.0	3.0	3.0	3.0	4.0	4.0	3.0	4.0	4.0	4.0
GIRLS												
JA	2.6	3.0	4.0	3.0	3.0	3.0	3.7	4.0	4.0	3.0	4.0	3.0
CB	1.9	2.0	3.0	3.0	2.0	3.0	3.6	3.0	4.0	4.0	3.0	3.0
CC	2.4	3.0	3.0	3.0	3.0	3.0	3.9	4.0	3.0	3.0	4.0	3.5
CM	2.8	2.5	0.5	3.0	2.5	3.0	3.5	3.5	3.5	3.5	2.5	3.0
CS	3.0	2.5	1.0	3.0	2.5	3.0	3.8	4.0	4.0	4.0	4.0	3.0
CI	3.0	3.0	4.0	3.0	3.0	3.0	4.1	4.0	4.0	4.0	4.0	3.0
JT	3.6	3.0	4.0	3.0	2.0	3.0	4.0	4.0	3.0	4.0	3.5	3.0

Appendix L

Stanford Achievement Tests: Grade Equivalents

GROUP EXERCISE

	Vocabulary		Reading		Mathematics Concepts		Mathematics Computations	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
BOYS								
BA	3.3	5.0	4.0	4.0	4.5	5.3	4.5	4.1
PB	3.0	4.0	3.5	3.2	4.0	3.7	2.2	1.6
LN	3.2	4.0	3.5	3.7	6.2	4.0	2.9	3.2
PL	1.7	3.2	2.3	3.2	3.5	3.5	3.0	3.0
GIRLS								
LD	3.0	3.8	2.0	3.0	3.2	3.7	2.6	2.1
KG	3.4	3.3	2.9	4.8	3.2	4.0	2.9	2.7
CG	3.3	4.6	2.7	5.8	4.0	4.0	4.5	3.2
TB	3.2	3.4	3.5	3.6	2.2	3.2	1.9	2.4
SM	2.3	2.8	-	-	4.0	2.9	2.1	3.5
DD	2.0	3.8	2.7	4.4	4.5	4.7	4.5	3.8

Appendix L (continued)

GROUP MUSIC

	Vocabulary		Reading		Mathematics Concepts		Mathematics Computations	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
BOYS								
JM	3.4	4.0	2.0	2.5	4.5	3.5	2.4	2.7
GP	2.7	3.0	2.4	4.8	4.0	4.2	3.5	3.2
MP	2.4	2.2	2.9	3.6	3.0	4.5	3.0	3.0
MS	3.3	5.0	3.5	4.8	4.5	5.0	4.5	3.2
GIRLS								
JR	3.2	5.0	2.4	4.0	4.0	3.2	4.5	3.0
KH	2.7	4.3	2.7	5.8	3.0	2.9	2.9	3.7
CD	3.2	3.4	2.6	3.3	3.5	4.5	2.4	3.4
LH	2.1	2.4	2.4	3.7	4.5	4.5	3.9	3.2
MP	2.1	4.0	2.6	3.5	2.7	3.2	2.2	3.4
SO	2.3	3.2	2.4	4.0	4.0	3.5	3.9	2.5

Appendix L (continued)

GROUP INACTIVE

	Vocabulary		Reading		Mathematics Concepts		Mathematics Computations	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
BOYS								
KB	2.7	4.0	2.4	3.3	4.5	4.0	1.8	3.2
EU	2.2	2.4	2.7	3.1	2.4	3.2	3.0	2.8
SR	2.7	4.6	2.9	3.6	3.0	3.2	2.6	2.8
GM	2.3	3.3	2.9	3.5	3.5	3.7	3.0	3.8
DC	2.4	3.8	3.5	4.0	4.0	4.2	2.6	4.5
MG	2.4	4.0	1.8	3.2	4.5	4.0	3.9	3.4
GIRLS								
CS	2.4	3.3	2.9	3.3	2.2	3.1	2.2	3.2
JA	2.1	3.8	2.1	2.8	1.4	2.7	2.4	2.9
CB	2.4	4.3	2.5	3.1	2.7	3.5	2.0	2.3
CC	2.2	3.3	2.1	2.9	2.2	2.9	1.6	2.0
JT	3.4	5.4	2.5	4.8	2.7	3.4	3.0	3.7
CI	1.8	2.8	2.3	4.4	2.2	3.5	2.7	3.5
CM	1.8	3.4	2.3	2.7	3.0	4.0	3.0	2.9

Appendix M

Behavioral Questionnaire

GROUP EXERCISE

	Alert-ness			Anxiety			Attention span			Confi-dence			Get along with others			Imagination			Interest			Leader-ship			Shyness			Quality of work		
Sessions	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
BOYS																														
SD	5	5	6	3	3	4	6	6	5	6	6	6	6	6	6	6	6	5	6	5	6	5	6	7	3	6	6	6	6	6
ET	6	6	3	5	5	4	5	7	5	6	6	5	6	6	5	6	5	5	5	6	4	6	6	5	5	6	5	5	5	4
JL	3	6	4	7	4	5	4	4	4	4	6	5	6	3	3	4	5	5	3	4	3	4	5	4	4	5	4	4	4	4
PL	3	4	4	5	5	5	3	4	4	3	3	4	4	4	4	4	4	3	3	4	4	4	4	4	5	4	5	4	4	5
IN	3	3	3	4	3	4	3	3	4	4	4	4	4	4	4	3	3	3	4	4	4	4	4	4	5	4	3	4	3	4
PB	2	6	4	3	4	4	2	4	3	3	4	4	5	5	5	7	6	7	4	5	4	3	4	4	4	4	5	5	5	5
BA	4	5	5	5	6	5	7	7	6	7	7	7	6	7	7	5	4	5	7	7	6	5	3	4	4	4	3	7	7	7

Appendix M (continued)

GROUP EXERCISE

	Alertness			Anxiety			Attention span			Confidence			Get along with others			Imagination			Interest			Leadership			Shyness			Quality of work		
Sessions	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
GIRLS																														
SR	4	6	6	3	7	6	6	6	6	6	7	6	6	7	7	5	7	7	6	7	7	6	7	7	3	7	7	6	7	7
JP	5	4	4	5	3	5	6	6	4	5	5	4	4	5	5	4	5	4	5	6	5	3	4	3	4	4	5	3	6	5
TB	4	4	5	4	4	2	4	4	4	4	5	5	4	5	5	4	4	3	4	5	4	5	5	6	3	4	2	4	5	4
LD	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	4	4	4	4	3	4	5	4	3	4	4	4
DD	4	4	4	4	4	6	4	4	4	4	3	4	4	4	4	4	3	3	4	4	4	4	4	4	5	4	4	4	4	4
CG	5	4	4	3	4	2	5	4	5	5	5	5	5	4	4	4	4	3	6	5	5	5	4	4	3	4	2	6	5	5
KG	4	5	6	4	4	2	4	4	6	5	6	6	5	5	6	5	5	6	4	6	6	4	5	4	2	4	2	4	6	6
SM	4	5	5	5	6	6	4	6	6	5	6	5	5	7	7	4	5	5	5	6	6	3	4	5	3	4	5	4	6	5

Appendix M (continued)

GROUP MUSIC

	Alertness			Anxiety			Attention span			Confidence			Get along with others			Imagination			Interest			Leadership			Shyness			Quality of work		
Sessions	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
BOYS																														
MP	4	4	4	5	6	6	4	5	4	3	4	3	4	4	4	4	3	3	5	4	4	4	4	3	5	3	6	4	4	4
GP	4	4	4	4	4	2	4	5	4	4	5	4	5	4	4	4	3	2	5	5	4	4	4	4	4	3	2	4	4	4
JM	5	5	6	3	4	5	3	5	5	4	5	5	5	6	6	4	5	6	5	4	4	4	6	5	4	4	4	4	5	4
MS	7	7	7	6	7	7	6	7	7	7	7	7	7	7	7	6	6	6	7	7	7	6	6	7	6	6	4	7	7	7
GIRLS																														
LH	5	4	4	4	4	2	4	4	4	5	5	4	5	4	4	4	4	3	5	5	4	5	4	4	3	4	2	4	5	4
KH	2	4	4	3	3	2	3	4	4	5	4	5	5	4	3	4	5	5	3	3	3	5	4	6	3	5	2	3	4	4
SO	4	4	4	3	4	3	3	4	4	5	5	4	5	5	5	4	4	3	4	4	4	5	5	5	3	3	2	4	4	4
JR	4	4	4	4	4	2	4	5	3	5	5	4	5	5	5	4	4	3	4	4	3	6	6	5	3	3	2	4	4	4
MP	4	5	6	4	4	7	4	6	7	5	5	7	5	7	7	4	5	5	5	7	7	3	4	5	3	3	3	6	7	7
CD	4	6	7	5	5	6	6	6	7	5	6	6	7	7	7	5	5	5	7	7	7	5	4	5	5	3	4	7	7	7

Appendix M (continued)

GROUP INACTIVE

	Alert-ness			Anxiety			Attention span			Confi-dence			Get along with others			Imagination			Interest			Leader-ship			Shyness			Quality of work		
Sessions	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
BOYS																														
DC	5	4	6	3	4	2	5	5	6	5	5	6	5	5	5	4	5	5	5	5	6	5	5	6	3	4	2	6	5	5
MG	3	4	4	3	3	3	3	3	3	3	3	4	4	5	5	3	3	3	3	3	3	4	4	4	3	4	2	3	3	3
GM	4	4	4	4	5	6	4	4	4	4	3	4	4	4	4	4	3	3	4	5	5	4	3	4	4	3	6	4	4	4
EU	4	3	5	5	4	5	4	3	5	5	4	5	4	6	6	4	4	5	5	4	5	5	4	4	4	5	2	4	3	4
SR	5	4	6	4	4	5	4	4	5	5	5	5	6	6	7	5	6	6	6	5	5	4	5	6	4	4	6	6	5	6
KB	5	6	5	4	6	6	5	7	6	5	6	6	7	7	7	4	5	6	5	7	7	4	6	6	4	3	4	6	7	6

Appendix M (continued)

GROUP INACTIVE

	Alert-ness			Anxiety			Attention span			Confi-dence			Get along with others			Imagination			Interest			Leader-ship			Shyness			Quality of work		
Sessions	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
GIRLS																														
CC	3	4	4	5	5	6	3	4	3	3	3	3	4	4	4	4	4	3	4	4	4	4	3	3	5	5	2	4	4	4
CI	5	4	5	4	4	3	5	4	6	5	5	6	4	4	5	4	4	4	5	5	6	4	4	5	3	4	2	5	5	5
CB	4	6	6	4	5	6	5	6	6	5	6	5	6	7	7	4	6	5	6	6	6	3	4	4	4	4	4	5	6	6
JT	6	7	7	5	5	5	4	6	6	5	7	6	5	5	5	6	6	6	6	6	6	6	6	5	4	4	4	7	7	7
CS	5	6	7	4	6	6	5	6	7	4	6	7	6	7	7	4	5	5	6	7	7	4	5	5	4	5	5	5	6	7
CM	5	6	5	5	7	7	4	7	7	5	6	6	5	5	6	5	5	5	5	7	7	4	4	4	4	3	4	6	6	6
JA	3	4	4	2	5	5	3	4	4	3	4	4	3	4	4	2	4	3	3	4	4	2	3	4	3	4	5	3	4	4

Appendix N

School Absences

GROUP EXERCISE		GROUP MUSIC		GROUP INACTIVE	
BOYS					
PL	9.5	MP	3	KB	15
IN	13	JM	11	SR	2
JL	2	GB	3.5	GM	17
BA	16	MS	31	MG	9
SD	5			EU	4.5
ET	2				
GIRLS					
SR	2	CD	5.5	JA	20.5
LD	0.5	SO	4	JT	20.5
JF	0	KH	10	CS	11
KG	17	JR	16	CB	17
DD	11	LH	8	CM	13
SM	2.5	MP	3	CC	8.5

Appendix O

Skin Conductance Ratios During Stress-Inducing Tasks

GROUP EXERCISE

	Session 1	Session 2	Session 3
BOYS			
PL	.527	.484	.554
PB	.611	.499	.453
BA	.551	.490	.497
JL	.505	.486	.434
ET	.483	.525	.487
SD	.449	.606	.502
IN	.537	.476	.477
GIRLS			
LD	.518	.502	.427
DD	.490	.472	.486
TB	.511	.524	.529
SM	.492	.480	.468
KG	.490	.498	.450
SR	.471	.374	.528
JF	.521	.490	.514

Appendix O (continued)

GROUP MUSIC

	Session 1	Session 2	Session 3
BOYS			
JM	.493	.563	.532
MS	.504	.557	.481
MP	.536	.546	.506
GIRLS			
LH	.530	.435	.512
JR	.573	.480	.491
MP	.520	.481	.364
SO	.517	.503	.503
CD	.500	.520	.410
KH	.442	.495	.310

Appendix O (continued)

GROUP INACTIVE

	Session 1	Session 2	Session 3
BOYS			
GM	.500	.413	.486
KB	.483	.425	.514
EU	.518	.552	.471
SR	.582	.497	.462
MG	.537	.534	.515
GIRLS			
CI	.525	.474	.487
CM	.491	.457	.461
CC	.500	.530	.514
JA	.527	.513	.504
JT	.547	.503	.469
CS	.456	.500	.505
CB	.476	.511	.517

Appendix P

Heart Rate Ratios During Stress-Inducing Tasks

GROUP EXERCISE

	Session 1	Session 2	Session 3
BOYS			
PL	.509	.503	.494
PB	.505	.500	.509
IN	.507	.523	.504
JL	.496	.504	.470
BA	.502	.500	.497
SD	.499	.489	.480
ET	.504	.502	.504
GIRLS			
SR	.504	.500	.506
TB	.502	.496	.508
KG	.482	.500	.517
DD	.504	.496	.505
SM	.526	.491	.485

Appendix P (continued)

GROUP MUSIC

	Session 1	Session 2	Session 3
BOYS			
JM	.500	.499	.487
GP	.489	.509	.498
MP	.490	.506	.500
MS	.511	.495	.502
GIRLS			
CD	.500	.506	.485
SO	.484	.510	.494
MP	.518	.496	.466
JR	.485	.506	.503

Appendix P (continued)

GROUP INACTIVE

	Session 1	Session 2	Session 3
BOYS			
KB	.509	.467	.488
SR	.505	.505	.506
GM	.529	.503	.500
MG	.485	.513	.517
EU	.524	.482	.486
GIRLS			
CS	.504	.487	.501
CB	.493	.498	.504
CM	.507	.502	.508
CC	.508	.502	.493
CI	.521	.494	.488

Appendix Q

Standard Deviations

RECOVERY HEART RATES

	Minute									
	1	2	3	4	5	6	7	8	9	10

GROUP EXERCISE

Session										
1	20.82	21.96	17.54	12.06	13.89	13.30	14.49	16.26	14.58	16.26
2	21.05	19.88	15.61	13.86	13.99	19.26	14.47	13.97	16.28	13.54
3	23.81	17.97	16.64	13.52	11.12	15.01	11.45	12.15	14.38	15.13

GROUP MUSIC

Session										
1	18.57	16.69	15.56	13.53	12.69	11.94	11.09	12.35	8.08	6.55
2	15.87	21.63	16.37	14.00	14.69	12.16	14.83	15.23	15.23	9.38
3	21.63	18.11	17.08	13.11	16.97	10.00	16.97	11.66	13.42	15.62

GROUP INACTIVE

Session										
1	22.65	16.69	17.99	19.24	16.61	19.14	14.72	14.18	17.37	16.26
2	23.45	21.64	18.16	14.19	14.56	12.11	14.56	13.24	16.34	15.26
3	24.48	20.97	18.45	15.94	20.97	15.26	16.97	18.09	13.24	17.20

Appendix Q (continued)

RECOVERY HEART RATES

	BOYS			GIRLS		
	Minute			Minute		
	1	2	3	1	2	3
GROUP EXERCISE						
Session						
1	17.87	14.63	11.87	18.52	17.88	17.83
2	14.53	14.53	9.03	16.97	13.86	13.61
3	24.88	17.66	17.66	18.14	12.83	15.49
GROUP MUSIC						
Session						
1	18.03	15.59	20.29	16.02	18.54	14.73
2	6.92	24.98	12.00	19.59	22.34	16.39
3	18.33	6.92	12.00	23.59	22.45	19.59
GROUP INACTIVE						
Session						
1	23.40	20.02	14.97	18.70	15.27	18.36
2	24.74	16.97	15.09	16.77	18.88	19.24
3	33.04	18.00	22.98	9.07	19.59	15.26

Appendix Q (continued)

MAGNITUDE OF RECOVERY SCORES

Maximum Heart Rate minus Recovery Heart Rate at:

	Minute 1	Minute 2	Minute 3
GROUP EXERCISE			
Session			
1	18.79	21.51	16.34
2	16.36	17.08	14.25
3	16.69	13.38	15.13
GROUP MUSIC			
Session			
1	22.98	25.94	24.98
2	16.37	19.69	18.11
3	20.88	22.45	19.89
GROUP INACTIVE			
Session			
1	12.02	15.51	19.90
2	15.80	10.51	8.09
3	14.75	12.39	11.59

Appendix Q (continued)

PERCENT BODY FAT

	Session 1	Session 2	Session 3
Group Exercise	2.32	2.71	2.45
Group Music	1.44	1.45	1.46
Group Inactive	1.99	2.58	2.54

REPORT CARDS: PHYSICAL EDUCATION

	BOYS		GIRLS	
	Term 1	Term 4	Term 1	Term 4
Group Exercise	.48	.25	.41	.52
Group Music	.50	.29	0	.41
Group Inactive	0	.66	0	.19

PERFORMANCE ON STRESS-INDUCING TASKS

	Session 1	Session 2	Session 3
Group Exercise	6.88	13.55	12.55
Group Music	8.62	8.20	10.76
Group Inactive	13.65	14.88	7.51