FIELD DEPENDENCE-INDEPENDENCE AND PHYSICAL ACTIVITY AMONG ADOLESCENTS

by

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ABSTRACT

Given the established relationship between field dependence-independence (FDI) and sport, motor learning, and physical education, FDI is expected to have some impact on physical activity involvement. The purpose of the study was to investigate the impact of FDI on adolescents' physical activity level. The foci of the study were to examine if there were any significant difference (1) in levels of physical activity, and (2) in physical activity behaviors, between FD and FI adolescents in a randomly selected school day.

One hundred and thirty-eight students in Clarke Middle School participated in the data collection of the study. The portable Rod-and-Frame Test (PRFT) and Self-Administered Physical Activity Checklist (SAPAC) were used to examine FDI status and physical activity level of the participants. Of the 138 participants, top one-third scorers ($\underline{n}$ = 46) on PRFT were classified as field-dependent (FD) students, and bottom one-third scorers ($\underline{n}$ = 46) as field-independent (FI) students. The differences in physical activity levels and in physical activity behaviors between FD and FI groups were examined with two-way ANOVA.

It was found with the study that (a) FI adolescents had a considerably higher level of physical activity than FD adolescents in a randomly selected school day, (b) after school period was the time for FI adolescents to demonstrate higher level of physical activity involvement than FD adolescents, (c) there were much more FI adolescents than FD adolescents who were involved in organized sports and this contributed greatly to enhancing FI adolescents' level of physical activity, and (d) FI adolescents were more likely than FD adolescents to participant in physical activities that were more related to sports and expended more energy. The results indicate that FDI is a factor that influences physical activity level of adolescents, and that FI adolescents have a tendency to be more involved in sport and physical activity than do FD adolescents.

INDEX WORDS: Field dependence-independence, Adolescents, Physical activity level, Physical activity behaviors

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TABLE OF CONTENTS

APPENDICES

LIST OF TABLES

LIST OF FIGURES

FIGURE Page

CHAPTER 1

INTRODUCTION

According to Witkin's field dependence-independence theory, people, in general, tend to rely on oneself or the field as the primary referent for behavior (Witkin & Goodenough, 1977; Witkin et al., 1977). The people who have a tendency to rely on self as a primary referent for their behavior are called field-independent (FI) individuals. These people rely more on internal referents, are impersonally oriented, and lack social skills and interpersonal competencies. In addition, FI individuals tend to be relatively cold and distant in relations with others, but are more able to separate themselves from others and the environment. Furthermore, FI individuals have a greater accuracy in personal perception, a more articulated body concept, and, especially, have a stronger cognitive restructuring ability (Witkin & Goodenough, 1981). In contrast, on the other end of the continuum, individuals having a tendency to rely on the field (i.e., others and environment) as a primary referent for their behavior are called field-dependent (FD) people. These people usually function less autonomously and seem likely to adhere to the field (i.e., given situations, circumstances). They are interpersonally oriented, pay more attention to and use more social cues, and favor situations that bring them into contact with others over solitary situations. According to Witkin and Goodenough (1981), FD individuals show more social behaviors and attributes important for effective interpersonal relations, and are better able to get along with others.

The characteristics of field dependence-independence (FDI) are evident in perceptual, intellectual, educational, vocational, and social domains (Witkin, 1964, 1965;

Witkin, Goodenough, and Karp, 1967; Witkin et al., 1977). That is, relatively FD and FI people have self-consistent individual differences in diverse domains with regard to characteristics that they bear respectively. Further, both FD and FI individuals have qualities that are adaptive in particular circumstances (Witkin & Goodenough, 1981). Research findings suggest that people with different degrees of FDI are likely to favor and do better in different domains. For example, there has been extensive research on the relationship between FDI and educational-vocational preferences, choices, and performance (Witkin et al., 1976, 1977; Witkin, Moore, Goodenough, & Cox, 1977). Generally speaking, FD people are found to favor and be more competent in careers requiring interpersonal associations such as educational and social work. FI people are found to favor and be more competent in careers requiring cognitive restructuring ability with solitary situation such as sciences, engineering, architecture and arts (Alvi, Khan, Hussain, & Baig, 1988; Crutchfield, Woodeorth, & Albrecht, 1958; Davis, 1990; Frank, 1986; Fritz, 1992; Koroluk, 1987; Leino & Puurula, 1983; Savage, 1983; Wieseman, Portis, & Simpson, 1992; Witkin, 1964, 1965; Witkin & Goodenough, 1977; Witkin et al., 1967; York & Tinsley, 1986; Zhang, Zheng, Xiao, & Wang, 1988).

Sport, motor learning, and physical education are another areas that have consistently been found to have certain relationships with FDI. Since FI individuals have a tendency to rely on internal frames, including vestibular and proprioceptive information, it was hypothesized that individuals with higher athletic skills or abilities must rely on accurate body information to make rapid postural adjustments while moving through space, and therefore were more FI than their counterparts with poorer athletic skills (Meek & Skubic, 1971). This hypothesis has gained support from the studies

comparing FDI between athletes (varsity athletes and above) and non-athletes (Brady, 1995; Liu, 1988; 1991; McLeod, 1985; Rotella, & Bunker, 1978), and from studies comparing FDI among secondary school students as well (Docherty & Boyd, 1982; Guyot, Fairchild, & Hill, 1980; McLeod, 1987; Meek & Skubic, 1971; Raviv & Nabel, 1990; Shugart, Souder, & Bunker, 1972; Svinicki, Bundgaard, Schwensohn, & Westgor, 1974).

FD individuals have also been found to be slower or less effective in motor learning. Specifically, studies have shown that FD learners are less effective in learning Alaskan Yo-Yo (Jorgensen, 1972), ball catching (MacGillivary, 1979), gymnastics (Swinnen, 1983; Swinnen, Vandenberghe, & Van Assche, 1986), trampoline (Swinnen, 1984), and ice hockey (Goulet, Talbot, Drouin, & Trudel, 1988). The slower motor learning rates on the part of FD learners were attributed to their less effective use of internal information (MacGillivary, 1979) and less cognitive restructuring ability as well (Swinnen, 1983, 1984).

Because of the clearly-established relationships of FDI to athletic skills/abilities and motor learning rates, physical educators recently became concerned with the possible learning behavior problems of FD students in physical education classes. Ennis and Chepyator-Thomson (1990) initiated a study in this aspect and found that FD children, as opposed to their FI peers, experienced more learning behavior problems. First, FD children had more difficulty attending to and remembering directions, especially for the order of the criteria for a good performance. Second, they were less able to understand why they had to perform certain tasks. This was especially true when the tasks were

related to abstract movement concepts or were repetitive and monotonous. Third, they were uncomfortable with having to work alone.

FD children's learning behaviors were accompanied with lack of attention, inability of following the teacher's instruction, off-task activities, disruption of others, being inactive in work, and being close to the teacher and other students. Consequently, FD students experienced less success in the physical education class, both academically and behaviorally, as compared to FI students (Ennis, Chen, & Fernandez-Balboa, 1991). In addition, in the complicated novel motor task learning environment, it was found that FD children would like to choose less effective strategies to simplify the relatively complex motor task to be accomplished, indicating their less competence in the physical education class compared with FI children (Ennis & Lazarus, 1990). In summary, FD individuals were found, in comparison with FI individuals, to be less athletically skilled, slower and less effective in learning novel motor tasks, and experienced more difficulties in the physical education class.

Given that FD individuals tend to be less competent in the sports, motor learning, and physical education settings, FD individuals might have less positive attitude toward, and low interest in, physical activities. Correspondingly, they might be less physically active in and beyond physical education classes. Unfortunately, no research has been found to gain such knowledge.

Lifestyle or chronic illnesses, such as coronary artery disease, have become the leading sources of death in the United States (Rowland, 1999; U.S. Department of Health and Human Services, [USDHHS], 1991). Physical inactive people are almost twice as likely to develop coronary heart disease as people who participate in regular physical

activity (Powell, Thompson, Caspersen, & Kendrick, 1987). In fact, the American Heart Association (Fletcher et al., 1992) and "Healthy People 2000" (USDHHS, 1991) have classified physical inactivity as a primary risk factor for heart disease comparable to high blood pressure, high blood cholesterol, and cigarette smoking. Consequently, physical activity is considered as "the shortcut for the control of chronic diseases, much like immunization had facilitated progress against infectious diseases" (McGinnis, 1992, p. S196).

Unfortunately, adolescence is a period in which the level of physical activity declines substantially (Morrow, Jackson, & Payne, 1999; Pate, Corbin, & Pangrazi, 1998; Rowland, 1999; Sallis, 1993; USDHHS, 1996). Further, some studies suggest that the level of physical activity in adolescents is likely to carry over into adulthood (Beunen et al., 1992, 1994; Raitakari, Parkka, Taimela, Rasanen, & Vilkari, 1994; Rowland, 1999; Telama, Yang, Laakso, & Viikari, 1997; Vanreusel et al., 1993). With less competence in sports, motor learning, and physical education settings, FD adolescents might constitute a population subgroup that could be most likely to develop and remain sedentary lifestyle. According to Ennis and her colleagues (Ennis et a., 1991; Ennis & Chepyator-Thomson, 1990; Ennis & Lazarus, 1990), one-fourth of the public school students might fall into FD category. With such a big portion of FD students in the public school, the lack of the knowledge of their physical activity levels might keep these students at risk for health problems now and later on in life.

Statement of the Problems

Given the established relationship between FDI and sports, motor learning, and physical education settings, it is natural and reasonable to go one step further

investigating the relationship between FDI and physical activity participation. Accordingly, the purpose of the study was to investigate the impact of FDI on adolescents' physical activity level. The foci of the study were (a) to examine if there were any significant differences in levels of physical activity between FD and FI adolescents in a randomly selected school day, and (b) examine if there were any significant differences in physical activity behaviors between FD and FI adolescents in a randomly selected school day. The hypotheses were that (a) there would be significant differences in levels of physical activity between FD and FI adolescents in a randomly selected school day, and (b) that there would be significant differences in physical activity behaviors between FD and FI adolescents in a randomly selected school day.

Significance of the Study

The health benefits resulting from regular physical activity involvement and the consequences from physical inactivity have been confirmed with official documentation (Bar-Or, 1995; Corbin & Pangrazi, 1992; Rowland, 1999; USDHHS, 1996). Recently, the life-long physical activity participation has been given priority over the development of physical fitness for adolescent's health (Morrow et al., 1999; Rowland, 1999; USDHHS, 1996). Meanwhile, the amount of physical activity for adolescents diminishes sharply with increasing age (Morrow et al., 1999; Pate et al., 1998; Rowland, 1999; Sallis, 1993; USDHHS, 1996). In fact, adolescence has been regarded as a "risk factor" for physical inactivity by some leading researcher (Rowland, 1999).

Many studies have been conducted in attempt to identify and understand the influences on physical activity habits of adolescents (Dishman & Sallis, 1994; Sallis, 1993; Sallis & Owen, 1998; USDHHS, 1996). It is now clear that the decline of

biological drive for physical activity during maturation explains a big portion of adolescent's drop out of physical activity (Rowland, 1998, 1999; Sallis, 1993), and that hereditary predisposition also predicts the adolescent's physical activity level to a considerable degree (Pérusse, Tremblay, Leblanc, & Bouchard, 1989).

In addition, peer acceptance, social support, access to exercise facilities, feelings of self-competence, sexual attractiveness, and enjoyment are all identified as non-genetic factors influencing adolescent's physical activity level (Bungum &Vincent, 1997; Douthitt, 1994; Garcia et al., 1995; Janz & Mahoney, 1997; Stucky-Ropp & DiLorenzo, 1993). Some factors such as socioeconomic status, gender, and ethnicity have been identified as subgroup-specific determinants either to facilitate or impede physical activity for different groups of adolescent population (USDHHS, 1996).

Despite the rich information available, the influences on physical activity of adolescents are not entirely clear (Sallis, 1993), and the declining of adolescent's physical activity level remains a serious problem. Continuous study for determinants of physical activity for various population subgroups is encouraged (USDHHS, 1996). Given the consistency in the direction of the findings regarding the impacts of FDI on sport, motor learning, and physical education settings, it is reasonable to investigate if FDI influences adolescents' physical activity level. No literature has been located in this aspect.

Some evidence supports the notion that the adolescent's physical activity habits, as well as health risk factors, are likely to continue into the adult years (Beunen et al., 1992, 1994; Raitakari et al., 1994; Rowland, 1999; Telama et al., 1997; Vanreusel et al., 1993). Consequently, there is an emergent understanding that adolescent period is critical for young adults' adoption and promotion of lifetime physical activity habits (Rowland,

1999; Sallis & Patrick, 1994; USDHHS, 1996). The promotion of physical activity during adolescent period, however, depends largely on the better understanding of the various influences on physical activity habits of adolescents (Sallis, 1993). Not only will the investigation into the impact of FDI on physical activity level of adolescents add new knowledge to the field, but will, most importantly, contribute to the interventional programs specific for the possibly ignored adolescent population, FD adolescents, who might most likely be physically inactive.

Delimitation of the Study

This study was delimited to the following:

1. Participants were students enrolled in a middle school during 2001-2002 year.
2. The portable Rod and Frame Test [PRFT] (Oltman, 1968) was used to assess the participants' FDI status.
3. The questionnaire of Self-Administered Physical Activity Checklist [SAPAC] (Myers, Strikmiller, Webber, & Berenson, 1996; Sallis et al., 1996) was used to assess the participants' physical activity level in a randomly selected school day.
4. A researcher-generated demographic inventory was used to obtain the following information: name, gender, age, ethnicity, involvement of organized sports.
5. A researcher-generated rating scale was used to evaluate each final participant's sport skill level and interest in physical education and physical activity. The rating scale was completed by the physical education teachers in the middle school.

Limitations of the Study

The findings of the present study should be taken with the consideration of the following limitations:

1. The convenient sampling (intact groups of participants) method, rather than random sampling, was used. This might decrease the extent to which the results could be generalized.
2. Although the participants were required to try their best in the related assessments and to be honest in the related questionnaires, some intervening factors, such as motivation and willingness, might prevent some from doing so, thus reducing the validity of the data collection.

Assumptions of the Study

1. PRFT was a valid and reliable instrument to assess participants' FDI with the emphasis on the use of either internal or external information (Oltman, 1968).
2. SAPAC was a basically valid and reliable instrument to assess participants' levels of physical activity (Myers et al., 1996; Sallis et al., 1996).
3. All participants were cooperative and honest in terms of data collection.

Definition of Terms

1. Field dependence-independence: the tendency to rely on self/body or field (given situation, circumstance) as primary referents for behavior (Witkin & Goodenough, 1977, 1981).
2. Field-dependent individuals: the individuals who have relatively strong tendency to rely on the external frames (given situation, circumstance) as primary referents for their behaviors, have relatively poorer cognitive restructuring ability, and have relatively higher interpersonal competencies/interests. Operationally, the individuals who get bigger deviations in establishing the upright at the Rod-and-Frame Test

(RFT, including PRFT) are FD individuals. In the present study, the top one-third scorers on PRFT were operationally identified as FD individuals.

3. Field-independent individuals: the individuals who have relatively strong tendency to rely internal frames as primary referents for their behaviors, have relatively higher cognitive restructuring ability, and have relatively lower interpersonal competencies/interests. Operationally, the individuals who get smaller deviations in establishing the upright at the RFT (including PRFT) are FI individuals. In the present study, the bottom one-third scorers on PRFT were operationally identified as FI individuals.
4. Physical activity: bodily movement produced by the contraction of skeletal muscle that increases energy expenditure above the basal level (USDHHS, 1996). Operationally, physical activity is any body movement in the forms of walking, jogging, running, aerobic dancing, stair climbing, swimming, bicycling, ballgames, etc.
5. Physical activity level: the amount of physical activity. In this study, physical activity level was operationally indicated by minutes of physical activity, minutes of moderate to vigorous physical activity (MVPA), energy expenditure as expressed by MET, MVPA energy expenditure, weighted energy expenditure, and MVPA weighted energy expenditure in a randomly selected school day.
6. MET: One MET refers to the metabolic energy expenditure when sitting quietly (resting metabolic rate), which equals one kcal (kilocalorie) per kilogram of body weight per hour, technically expressed as "1 kcal · kg body weight^{-1} · h^{-1}". The energy expenditure expended in different physical activities can be expressed as multiples of

the resting MET (one MET), or as the ratio of the associated metabolic rate for the specific activity divided by the resting metabolic rate (one MET). That is, an activity with 2 METs requires two times the resting metabolic rate (Montoye, Kemper, Saris, & Washburn, 1996).

Abbreviation Used in the Study

1. EFT: Embedded Figure Test
2. FD: field dependent, or field dependence
3. FDI: field dependence-independence
4. FI: field independent, or field independence
5. GEFT: Grouped Embedded Figure Test
6. MET: resting metabolic rate
7. MVPA: moderate to vigorous physical activity
8. PRFT: portable Rod-and-Frame Test
9. RFT: Rod-and-Frame Test
10. SAPAC: Self-Administered Physical Activity Checklist.

CHAPTER 2

REVIEW OF RELATED LITERATURE

Introduction

This chapter focuses on the review of related literature and is divided into seven areas: (a) the construct of field dependence-independence; (b) field dependence-independence and education; (c) field dependence-independence and sports, motor learning, and physical education; (d) critical issues of field dependence-independence; (e) critical issues regarding physical activity and adolescents; and (f) summary.

The Construct of Field Dependence-Independence

The construct of FDI initially stem from Witkin and his colleagues' research (Saracho, 1997). According to Witkin et al. (1977), FDI is contrasting ways of processing information. People who have tendency to rely on the field or background (external frames) for their information processing are classified as FD people. On the other end of the continuum are FI people who tend to rely on self (internal frames) as a primary referent for their information processing. Interpersonal competence is regarded as an outgrowth of reliance on external referents, and FD individuals are assumed to be more socially oriented and more likely to identify themselves with the environment. Cognitive restructuring is seen as an offshoot of reliance on internal referents, and FI individuals are assumed to be more competent in cognitive restructuring skills and more likely to detach themselves from the environment (Davis & Frank, 1979; Witkin & Goodenough, 1981). FDI as measured by Rod-and-Frame Test, FDI as measured by Embedded Figures Test, and the characteristics of FDI are reviewed in this section.

Field Dependence-Independence as Measured by Rod-and-Frame Test

In the 1940s, when Witkin and his colleagues were seeking to determine how people located the upright position as quickly and accurately as they ordinarily did, participants were found to be markedly different from one another in their performance on the space orientation tasks used in their experiments (Witkin, 1959; Witkin & Goodenough, 1981). The Rod-and-Frame Test (RFT) was one used in these experiments. In administering RFT, the participant sat in a completely darkened room facing a luminous tilted rod surrounded by a luminous tilted square frame. The participant was asked to adjust the tilted rod until he or she considered the rod was physically vertical. Some participants were so influenced by the tilted frame that they could not adjust the rod to a position close to verticality. Other participants, in contrast, apparently relied mainly on their body (the kinesthetic position of the body) as a reference and could adjust the rod to a relatively vertical position ignoring the influence of the tilted frame. The difference in relying on self or context (field) on the part of the participants was highly consistent in other two space orientation tasks, the Body-Adjustment Test (BAT) and the Rotating-Room Test (RRT). In these two tasks, as in the RFT, misleading visual or postural cues were presented, and individuals' scores on these tests vary depending on the extent to which they use internal or external frames for their information processing (Witkin, 1959; Witkin & Goodenough, 1981). As a result, individuals relying mainly on self to adjust the tilted rod in the RFT were classified as "field-independent" individuals, and those influenced very much by the tilted frame in the RFT were classified "field-dependent" individuals (Witkin & Goodenough, 1981).

In 1968, a portable rod-and-frame apparatus came into being (Oltman, 1968). This small apparatus requires no a completely darkened room for administration, and is small enough to be taken to schools, psychiatric wards, and any other locations where the target participants are conveniently available. Because of its enhanced availability and portability, the portable rod-and-frame apparatus has been used widely afterward.

Field Dependence-Independence as Measured by Embedded Figures Test

While the above orientation tasks assessed reliance for spatial perception on body or field, they could, according to Witkin and Goodenough (1981), also be conceived to involve separation of an item (rod) from an organized field (frame). Consequently, the Embedded-Figures Test (EFT) was designed and used by Witkin (1949, 1950). In administering EFT the participant was asked to identify simple figures within more complex patterns. The participant can not see both simple forms and complex figures simultaneously since the simple forms are printed on the back cover of the EFT booklet and the complex figures on the booklet pages. The participant can, however, look back at the simple form whenever needed. It was hypothesized that the individuals who could separate the rod from the frame in the RFT (FI individuals) could identify a simple figure within a more complex pattern more easily, consistency with spaces. The hypothesis was supported (Witkin & Goodenough, 1981). The finding suggested that a more general dimension of FDI might be conceived as involving individual differences in ease or difficulty in separating an item from an organized field or background (Witkin, 1959; Witkin & Goodenough, 1981; Witkin et al., 1954).

Another version of EFT, the Group-Embedded-Figures Test (GEFT), was developed to meet the group testing (Oltman, Raskin, & Witkin, 1971). GEFT has been

developed as closely as possible on the individually administered EFT with respect to mode of presentation and format, and is a satisfactory substitute for the EFT in research requiring group testing (Witkin, Oltman, Raskin, & Karp, 1971).

Although the RFT (including portable RFT) and EFT (including GEFT) are two most frequently utilized tests for assessing FDI, most researchers realize that, consciously or unconsciously, the two instruments emphasize different aspects of FDI. "The RFT is thought to reflect differences in perception of the upright due to reliance on visual versus vestibular cues while the EFT is thought to reflect differences in cognitive restructuring abilities" (Davis & Cochran, 1989, p. 32).

Characteristics of Field Dependent/Independent Individuals

Many studies have investigated and described the characteristics of FD and FI individuals (Goodenough, 1976; Mezoff, 1982; Saracho, 1997; Thompson & Thompson, 1987; Witkin et al., 1977; Witkin & Goodenough, 1977, 1987; Witkin, Moore, Goodenough et al., 1977). In general, FD individuals have a tendency to rely on the field or external frames as a primary referent for their information processing. They function less autonomously and seem likely to adhere to the field more than FI individuals. They are interpersonally oriented, pay more attention to and use more social cues. They favor situations that bring them into contact with others over solitary situations. They show more of social behaviors and attributes important for effective interpersonal relations, and are better able to get along with others than FI individuals.

By contrast, FI individuals have a tendency to rely on self or internal frames as a primary referent for their information processing. They have greater individual autonomy of external reference. They are impersonally oriented and relatively lacking social skills

and interpersonal competencies. They are generally cold and distant in relations with others, and more able than FD individuals to separate themselves from others and environment. They have stronger cognitive restructuring ability, and like to be involved in tasks requiring analysis and reasoning. Table 1 provides a more detailed list regarding the characteristics of FD and FI individuals. The three main dimensions of the construct of FDI (Davis & Cochran, 1989; Davis & Frank, 1979; Goodenough, 1986; Saracho, 1997; Witkin & Goodenough, 1981) are associated with all the items in Table 1: (a) rely on external frames (FD individuals) or internal frames (FI individuals) for information processing, (b) have poorer cognitive restructuring ability (FD individuals) or stronger cognitive restructuring ability (FI individuals), and (c) have higher interpersonal competencies/interests (FD individuals) or lower interpersonal competencies/interests (FI individuals).

Table 1

Characteristics of Field-Dependent and Field-Independent Individuals

FD individuals	FI individuals
Tend to use global approach toward tasks	Then to use analytical approach toward tasks
Take longer time to solve problems whose materials require structuring	Are more able to solve problems whose materials require structuring
Feel difficult to separate an item from its background.	Are more able to separate an item from its background

Are more influenced by environment and others.	Are less influenced by environment and others. Tend to keep a distance from environment and others
Tend to be consistent with authority figures or peers	Are more independent of authority and have a tendency to stay alone
Tend to use external sources for self-definition, and require externally defined goals and reinforcements.	Are more dependent on their own values and standards, tend to have self-defined goals and reinforcements
Tend to use external locus of control	Tend to use internal locus of control
Tend to be friendly, considerate, warm, affectionate, polite, tactful accommodating, and non-evaluative	Tend to be inconsiderate, rude, demanding, ambitious, manipulative, and impersonal
Are more attentive to social cues, more emotionally open, prefer to be physically close to people.	Show both physical and psychological distancing from people, prefer nonsocial situations and are socially detached, and are impervious to outside information
Are people- and affiliation-oriented, prefer interpersonal circumstances, seek relations with others	Are idea-and task-oriented, prefer highly intellectual activities, value cognitive pursuits, are concerned with ideas and principles other than with people
Favor subjects that relate most directly to people interaction, such as the social sciences, clinical psychology, psychiatric nursing, and public relationship.	Favor impersonal, theoretical, and abstract subjects, such as mathematics, physical science, architecture, experimental psychology, and surgical nursing
Favor occupations that involve interpersonal contact and interaction, such as elementary school teaching, advertising and selling, business administration, and customer service	Prefer occupations that mainly involve cognitive processing, such as architecture, engineering, astronomy, mechanics, and laboratory work
Less able to use kinesthetic and proprioceptive information, have less articulated body concept.	More able to use kinesthetic and proprioceptive information, have more articulated body concept

Field Dependence-Independence and Education

Because of its association with daily life, the availability of its theoretical framework, and the convenient and effective procedures for its assessment, FDI has received greatest research attention since its inception (Witkin & Goodenough, 1981). In particular, the studies on FDI in education constitute a substantial part in the literature. In this section, the influences of FDI on academic preference, career differentiation, academic achievements in school, electronic-learning, and general learning and memory will be reviewed.

Field Dependence-Independence and Academic Preference and Career Differentiation

The typical and classic research regarding the relationship between FDI and academic preference was done by Witkin and his colleagues during 1970s (Witkin et al., 1977; Witkin & Goodenough, 1977). Consistent with FDI theory, it has been found that relatively FI college and graduate students favor impersonal, analytical domains, and FD individuals favor interpersonal, non-analytical domains. Specifically, FI students are likely to specialize in such fields as mathematics, the sciences, experimental psychology, art, architecture, engineering, mathematics-and-science teaching, and surgical nursing. FD students tend to choose such fields as elementary school teaching, clinical psychology, social work, and psychiatric nursing (Witkin et al., 1977; Witkin & Goodenough, 1977). One of the most impressive studies regarding the relationship between FDI and academic evolution is a 10-year longitudinal study conducted by Witkin and his colleagues (1977). It was found that college students tended to shift their academic choices, over time, toward greater compatibility with their FDI status. Thus, FD students who identified mathematics or the natural sciences as their preliminary majors at

college entry tended to shift out of these domains by the time of college graduation or graduate school; FI students who made these same preliminary choices were likely to remain with them.

Consistent with the above picture for academic choices is the evidence on career differentiation. That is, again, relatively FI individuals tend to favor occupations that are impersonal and analytical, and FD individuals tend to favor occupations that are interpersonal and non-analytical (Baker, 1971; DeRussy & Futch, 1971; Kangas, 1971; Paeth, 1973; Swan, 1974; Witkin et al., 1976). In a comprehensive review done by Witkin and Goodenough (1977), it was found that FI individuals showed similar vocational interests to those of people in the mathematics and science domains, teachers of mathematics and science, arts, physicians, dentists production managers, carpenters, forest servicemen, farmers, mechanics. FI individuals have also repeatedly been found to have strong interest in the theoretical, the abstract, and the artistic based professions.

In contrast, FD individuals present a different picture in their responses to vocational interest inventories. They frequently express interest in the welfare-humanitarian-helping domains, such as ministerial work, rehabilitation counseling, social work, elementary school teaching and teaching of social studies, “persuasive” activities such as advertising and selling, and administrative roles of a kind in which dealing with people is important (such as city school superintendent, personnel director, community recreation administrator).

Studies have also shown that engineers, architects, Air Force captains, mathematics and science teachers, and airplane pilots are quite field independent (Barrett & Thornton, 1967; Cullen, Harper, & Kidera, 1969; DiStefano, 1970). In contrast, social

studies teachers and social workers tend to be field dependent (Braun, 1971; DiStefano, 1970).

There are even some studies dealing with vocational achievement in relation to FDI, and their results are consistent with expectations. One study showed that professional architects who were selected as outstandingly creative by their peers were field independent, whereas writers similarly selected were field dependent (MacKinnon, 1962). In another study, high achieving surgical student nurses were found to be field independent, and high achieving psychiatric student nurses were found to be field dependent (Quinlan & Blatt, 1972). Also in another finding, men who were successful in naval flight training were significantly more FI than unsuccessful trainees (Kennedy, 1972).

Many subsequent researchers (Alvi et al., 1988; Cano, 1999; Davis, 1990; Frank, 1986; Fritz, 1992; Kelleher, 1997; Koroluk, 1987; Leino & Puurula, 1983; Miller, 1997; Murphy, Doucette, & Kelleher, 1997; Savage, 1983; Smith & Easterday, 1994; Wieseman et al., 1992; York & Tinsley, 1986; Zhang et al., 1988) have continued the studies regarding the relationship between FDI and academic preference as well as career differentiation, and they have produced the similar results to those found by the previous studies.

Field Dependence-Independence and Academic Achievements in Schools

Although the difference between FD and FI individuals are pervasive and evident, FDI was viewed as value neutral by Witkin and his colleagues. “Field-dependence-independence appears to be more related to the ‘how’ than to the ‘how much’ of cognitive functioning” (Witkin, Moore, Goodenough et al., 1977, p. 24). “Field-

dependent and field-independent people differ more consistently in how the learning or memory process occurs than in how effective the process is" (Goodenough, 1976, p. 688). The value neutrality of FDI is also reflected by the "fact" that each pole of the FDI continuum has qualities that are adaptive in particular circumstances (Witkin & Goodenough, 1981).

The value neutral point of view, however, has been challenged by the increasing evidence that FI individuals might have some advantages over FD individuals in academic learning/memory aspect, and questioned directly by many researchers (Davis & Cochran, 1989; Davis & Frank, 1979; Ennis et al., 1991; Páramo & Tinajero, 1990; Saracho, 1997).

The evidence is continuously increasing that FI students are more likely to have higher academic performance in schools. Martinetti (1994) found a relationship between FDI and academic achievement. High achievers scored high on the EFT, while low achievers indicated the reverse pattern. The areas most extensively studied and most consistently reflecting this trend are mathematics, science, and reading achievement (Davis & Cochran, 1989).

Mathematics, with its requirement of analytical reasoning, a FI characteristic, is the area in which FI students have the most advantage. Roberge and Flexer (1983) examined the effects of FDI on the total mathematics achievement test scores and those scores on subtests of computations, concepts, and problem-solving, finding that FI students did better than FD students on mathematics as a whole, and on concepts and problem-solving tests. Mrosla, Black, and Hardy (1987) found that FD students were those with low achievement in a geometry course. The similar findings were obtained in

other studies (Clark, Ward, & Lapp, 1988; Kornbluth & Sabban, 1982; Vaidya & Chansky, 1980; Van & Malcolm, 1985; Witkin, Moore, Goodenough et al., 1977) as well.

The science learning modes usually focus on intellectual activities that require extraction, restructuring, and application in different context (Wollman, 1986). It has also been found that FI children tend to obtain better performance in natural sciences (Corral, 1982; Niaz, 1989; Shymansky & Yore, 1980; Wagner, Cook, Friedman, 1998; Witkin, Moore, Goodenough et al., 1977; Wollman, 1986; Yore, 1986), and social sciences (Corral, 1982; Satterly, 1979).

In the reading area, Black (1985) contends that the individual's ability to process, organize, and reconstruct separate segments of incoming textual information and then to develop some awareness of text structure may have a definite impact upon the comprehension of expository and literary test. Therefore, FI individuals, who usually have higher cognitive restructuring ability, are more able than FD individuals to restructure text (Witkin, Dyk, Faterson, Goodenough, & Karp, 1962). Davey's (1989) study showed the FI readers outperformed FD readers on tasks with high memory demands and with requirements for efficient restructuring skills. Demick & Koerber's (1993) study revealed that, among variables studied (including age, gender and FDI), the FDI was the best predictor of children's reading readiness with the positive relation between FI and reading achievement. Fehrenbach (1994) made comparison in FDI between 30 gifted and 30 average secondary-level readers, finding that the former was significantly FI than the latter on FDI measurement. Davis (1987) made a meta-analysis of 25 correlational studies revealing a moderate relationship which indicated that FI

children tend to be more efficient readers. FI students' higher reading comprehension level has also been demonstrated by other studies (Baber, 1977; Davey, 1990; Davey & Menke, 1989; Davis & Cochran, 1989; Drane, Halpin, & Halpin, 1989; Eiland, danserreau, & Brooks, 1986; Fehrenbach, 1987; Roach, 1985; Roberge & Flexer, 1984; Rosa, 1994; Rounds, 1979; Schuman, 1987; Vivaldo-Lime, 1997).

In fact, the evidence appears that FI students have performed better not just in specific subjects but in almost all subjects studied. Páramo and Tinajero (1990) investigated more than one hundred school students and found FI students performed better in all subjects involved in the study: Spanish, mathematics, natural sciences, social sciences, and over-all marks. Several years later, Tinajero and Páramo (1997) conducted a similar study with more than four-hundred students comparing achievements in Spanish, Galician, English, mathematics, natural sciences, social sciences, and overall mark. Again FI students were found to perform better in all subjects than FD students. Several other studies have also supported the findings in terms of that FDI is related to overall academic achievement (Buenning & Tollefson, 1987; Ismail & Kong, 1985).

It has been considered that schools are more oriented toward the FI style and FI students are more likely to get benefits from schools (Kagan & Zahn, 1975; Reiff, 1996; Saracho, 1989, 1997). It is because that the skills required in school tasks are consistent with FI characteristics: analytical capacity and the ability to develop strategies for organizing and restructuring information (Kagan & Zahn, 1975; Mrosla et al., 1987; Vaidya & Chanky, 1980; Yore, 1986).

Field Dependence-Independence and Electronic-Learning

A new area regarding FDI and its impact that prompts tremendous investigations is electronic-learning (e-learning), including distance education and other computer-related learning. Because of its characteristics of isolation, independence, limited direction, and limited interpersonal interaction between students and instructors, distance education may not be equally suited to all learners (Stein, 1960; Thompson, 1984, Wedemeyer & Childs, 1961; Wedemeyer, 1971; Woolsey, 1974), and many researchers have investigated characteristics associated with distance education. These characteristics, in fact, are associated with the cognitive style of field-independence (Thompson & Knox, 1987).

Wedemeyer & Childs (1961) have reported that the individuals who are thought to be better suited to distance learning have been characterized as highly motivated, self-disciplined, systematic, and able to work with minimum direction. Morstain (1974) investigated whether selected characteristics distinguished persons preferring independent study, such as distance learning, from those persons preferring traditional classroom instruction. He found that persons indicating a preference for independent study were more likely to have primary responsibility for decisions affecting his/her own education. Persons preferring traditional classroom instruction were more likely to indicate that the faculty should have primary responsibility for such decisions. Other studies have found that students who are better suited to independent study programs, such as distance education, are more likely to be those who have a greater need for autonomy in their learning, and control over the pace of learning, as well as a lesser need for the provision of structure and for opportunities for interaction with the instructor and

other students (Diaz & Cartnal, 1999; Flinck, 1979; Glatter & Wedell, 1971; Miller, 1995; Miller & Honeyman, 1993; Pascal, 1973; Thompson & Knox, 1987).

FI individuals were also found to have some advantage in distance learning. Miller (1997b) found that FI learners in a distance education program had more positive response of regarding the likelihood of enrolling in additional courses through distance education technologies. Luk (1998) reported two studies examining the relationship between FDI and academic learning in the context of distance learning. Results of both studies revealed that FI learners performed significantly better than FD learners, suggesting that FD was a good predictor of poorer academic achievement for participants.

Other forms of e-learning, such as computer-assisted instruction (CAI), hypermedia-based instruction (HBI), and technology-based education, share the same characteristics of distance learning. HBI, for example, is an learning environment that challenges the user's abilities to select information, make connections with existing knowledge, organize his/her approach to accomplishing tasks and monitor the process. The persons that would benefit from HBI are those who can perform effectively in the type of self-regulated and self-directed environment of a hypermedia system (Gay, Trumbull, & Mazur, 1991). Repman, Rooze, & Weller (1991) states that students with different FDI are served differently by hypermedia-based instruction. That is, the relation between the students' information-accessing behavior with HBI and their measured cognitive style tends to be the opposite for FI students and FD students. In the environment of disorientation and lack of structure, which is the typical condition of HBI, FD students are less likely to impose a meaningful organization (Witkin, Moore,

Goodenough et al, 1977), and frequently failed to take advantage of learner control in selecting options (Carrier, Davidson, Higson, & Williams, 1984). As a result, the same pattern as with distance learning occurs in terms of the relationship between FDI and other forms of electronic-learning.

Weller, Repman, and Rooze (1994) examined the relationship of FDI and HBI performance at two public junior high schools. They designed the study in such a way that different interactivities associated with FD and FI individuals' characteristics were taken into account. The results showed that FI students learned more effectively than FD students (a) regardless of whether or not advance organizers were present and (b) regardless of whether or not structural organizers were present. Leader & Klein (1994) investigated the effects of interface tools and learners' FDI on performance in searches for information within a hypermedia database. FI participants were found to have significantly better achievement than FD participants in information searching. In Lin and Shivers' study (1996), five hypertext-based instructional treatments using different linking strategies (linear, hierarchical, hierarchical-associative, associative, and random) with the same content were created for five groups of participants. The results of the study indicated that, overall, students with higher scores on GEFT outperformed students with lower scores on the GEFT.

The research on other computer-related learning reveals the same pattern. Post (1987) found a positive relationship between FI and students' achievement in computer-assisted instruction. The similar results were obtained when Lawrence (1994) examined the effect of learning style on performance in using computer-based instruction in office systems, and when Hansen (1997) investigated the relationship between FDI and the

achievement in technology-based education. Futher, the studies by Chou and Lin (1998), Clark (1995), Meng and Patty (1991), Stevens (1983), and Wingenbach (2000) have all produced the results that FI individuals are more likely to obtain higher achievements in electronic-learning.

Field Dependence-Independence and General Learning and Memory

Many studies have revealed the differences in general learning and memory between FD and FI individuals. It has been argued that FI individuals' working memory capacity is bigger than that of FD individuals. The working memory capacity can be used to store information, to perform various cognitive operations, to search long-term memory, and to organize appropriate response. When the amount of working memory capacity already allocated is high, then any additional activity may exceed the information-handling capability of the system. In this case, there may be a delay in responding (hence an increase in task time) or a loss of information (hence an increase in errors).

This mechanism of working memory mirrors the information processing involved in EFT (Robinson & Bennink, 1978). When EFT is administered, the participant is required to hold some information (the simple figure) in mind while scanning and analyzing the complex figure (the participant can not see the simple figure and complex figure at the same time), comparing the simple figure with portions of the complex figure, and tracing the target in the complex form. Since all these activities happen almost simultaneously, it is presumed that the limited capacity of working memory is fully committed while doing the EFT. As a result, individuals with larger working memory capacity are more likely to get better results in EFT.

Robinson and Bennink (1978) conducted a study to compare the capacity of working memory between FD and FI college students by increasing memory load and complexity of semantic processing required. They found that FD participants made more errors and took longer to perform the difficult semantic modification tasks, reflecting their relatively small working memory capacity as compared to FI individuals. Bennink and Spoelstra (1979) employed language comprehension to investigate differences in working memory capacity between FD and FI undergraduate students. The results indicated that, in the high memory load condition, a significant decline appeared in performance for FD participants on both inference and recognition. Another way to verify FD-FI difference in working memory processing capacity is to test FD-FI differences in the speed and accuracy of inference processing via a sentence verification task. This study was done by Cochran and Davis (1987), and FI participants were found to perform better, indicating their relatively larger working memory capacity.

In addition to working memory capacity, cognitive style of FI seems superior to that of FD in other aspects of information processing. Davis and colleagues published three reports of literature review with respect to the relationship between FDI and learning/memory (Davis & Cochran, 1982, 1989; Davis & Frank, 1979). They summarized the FD-FI differences in selective attention, encoding, and long-term memory. Selective attention is an information-processing paradigm with dichotic listening, signal detection, and visual search tasks. FD individuals generally are found to be less efficient than FI individuals. They have a difficult time selectively attending to relevant cues, particularly in the presence of distracting cues. They also seem to be less flexible in deploying visual search strategies. These might partially account for the fact

that FD individuals are less effective in EFT. Encoding is the process to move new information from short-term to long-term memory. There are little or no differences between FI and FD learners when a limited amount of information is to be processed. However, when larger amounts of information must be analyzed or integrated, then the performance of FI individuals is more accurate and efficient. In long-term memory, the reviews also suggest that FI individuals outperform FD individuals.

Goodenough (1976) published a report based on a thorough review regarding FDI as factor in learning and memory, and the following are among the conclusion: (a) FD subjects are dominated by the salient cues in concept attainment problems, whereas FI individuals sample more fully from the available cue set; (b) FD individuals tend to use "spectator" approaches to learning, whereas FI individuals more often use "participant" approaches; (c) FD is related to the performance effectiveness of negative reinforcement and FI is related to performance effectiveness under conditions of intrinsic motivation. These findings are consistent with the findings that FI students are more likely to obtain higher academic achievement in school.

Literature also shows that FDI is associated with many other aspects of effective learning and information processing. For example, FI individuals have been found to be more capable in schema utilization (Spiro & Tirre, 1980; Tourrette, 1989a, 1989b; Witkin et al., 1971), information retrieval (Adejumo, 1983; Brooks, Dansereau, Spurlin & Holley, 1983; Frank, 1983; Frank & Keene, 1993; Ohnmacht, 1966; Pierce, 1980; Strawitz, 1984; Ward & Clark, 1987; Zawel, 1970), information organization/restructuring (Annis, 1979; Annis & Davis, 1978; Moore, Gleser, & Warm, 1970; Nebelkopf & Freyer, 1970; Rickards, Fajen, & Sullivan, 1997; Stasz, Shavelson,

Cox, & Moore, 1976), advance organizer utilization (Satterly & Telfer, 1979), and note taking (Frank, 1984)

In summary, FDI is closed associated with education. While FI individuals are likely to choose impersonal, analytical domains as their academic major and career, FD individuals favor interpersonal, non-analytical domains. FI individuals are more competent than FI individuals in school performance, computer-related learning, and general learning and memory. In some instances there is no difference between FI and FD learners, but rarely is there any evidence showing that FD learners are more efficient than FI in learning and memory. FDI has become a factor that must be taken into account if effective instruction is to happen.

Field Dependence-Independence and Sport, Motor Learning, and Physical Education

Another area of focus regarding FDI is in sport, motor learning, and physical education settings. One of the characteristics mentioned above regarding FDI is that FI people, compared with FD people, have a more articulated body concept, or body image. Although different definitions are provided (Faterson and Witkin, 1970; Frostig & Horne, 1964; Jourard and Secord, 1954; Secord & Jourard, 1953), the central meaning of the body concept is, from the perspective of FDI, the extent to which the body is experienced as segregated or separate from "field" (Kane, 1972). When the RFT is administered to assess FDI, it is easily understood that the individuals who can adjust the rod to a relatively vertical position ignoring the influence of the tilted frame are those whose body is experienced as clearly segregated from the field, or those who have a relatively articulated body concept. These people, as mentioned before, are classified as FI people.

As with education, FI individuals are consistently found to have advantage in sport, motor learning, and physical education settings.

Field Dependence-Independence and Sport Skills/Abilities

Since FI people have a more articulated body concept and rely more on proprioceptive information in assessing their own body position on the RFT, it is hypothesized that people with higher skills in athletic activities or higher motor ability must rely on accurate proprioceptive information to make rapid postural adjustments while moving through space, and are more FI than their low-level counterparts (Meek & Skubic, 1971). Along this line of thought several studies were conducted to compare FDI between national level or university varsity athletes and non-athletes.

As early as 1978, Rotella and Bunker made a comparison in FDI between twenty senior male tennis players and a non-athlete group of similar age. As expected, the senior tennis players were found to be significantly more FI than the non-athlete group. In McLeod's (1985) study, RFT was administered to 120 subjects who were either participating in varsity sports in swimming, gymnastics, basketball, volleyball and soccer, or non-participants. The comparison indicated that varsity athletes were more FI than non-participating subjects. More recently, a study by Brady (1995) involved university athletes who participated in Division II of the NCAA and a similarly sized group of non-athletes. The results revealed that highly athletic skilled and physically active individuals are more FI than the less athletic skilled and less fit ones. A similar finding was found in Liu's (1988, 1991) studies when RFT scores of elite male high jumpers were compared with those of non-athletes. It seems that the only exception to this issue is the studies by

Cano and Marquez (1995), and Raviv and Nabel (1988). The results they found were just opposite to ones mentioned above.

The similar comparisons were also made among public school students, who were obviously much more homogeneous in their sport skills and sport abilities than national level or varsity athletes and non-athletes. Despite the homogeneity, however, the findings were consistent with those in which national/varsity athletes were involved. In their study Meek and Skubic (1971) found the highly skilled high school females were significantly more FI than the poorly skilled participants. In another study with junior high school females, Shugart, Souder and Bunker (1972) selected 30 girls who got RFT scores at the two extreme ends of the continuum of FDI (15 FD and 15 FI participants), then a test for dynamic, non-locomotor balancing ability was administered to them. The data analysis revealed that the FI group performed significantly better on the stabilometer test of balancing ability. Still with high school students as participants, Docherty and Boyd (1982) examined the relationship between FDI and several sport skills via a multiple regression analysis. Results again supported the above-mentioned hypothesis by showing that the ability of an individual to differentiate visually a simple object from a complex background does account for a small but significant proportion of the variance in motor performance of volleyball, tennis, and badminton.

Raviv and Nabel (1990) conducted a study with ninety-four high school students, boys and girls. Of these students, 33 were active in individual sports, 31 were in team sports, and 30 were non-athletes. It was found that high school student athletes, both in individual sports and in team sports, were characterized by FI, while non-athletes were relatively FD. Consistent with these findings are the studies by McLeod (1987) and

Svinicki et al. (1974) in which public school students were involved. Again student athletes were found to be more FI than their non-athlete counterpart.

It seems that research on the relationship of FDI to athletic skills/abilities produced consistent results. The people with highly athletic skills and abilities are more FI than those with poorly athletic skills and abilities.

Field Dependence-Independence and Motor Learning

Consistent with the findings in sports setting is the findings in motor learning. It is reasonable to consider that individuals who can rely more on proprioceptive information in assessing their own body position in RFT and other spatial orientation tests should have advantage in motor learning. For their thesis and dissertation, Jorgensen (1972) and MacGillivary (1979) examined the relationship between FDI and motor learning. In Jorgensen's study, university participants were required to learn a novel movement task, the Alaskan Yo-Yo. The results indicated that the rate of learning for groups was significantly different and in favor of FI participants. In MacGillivary's study, the learning of a ball catching task was used. Ninety male high school students selected for their high and low FDI were randomly assigned to one of three viewing time treatments: 150, 250, and 350 msec. The hypothesis of a relationship between perceptual style and learning on the ball catching task was upheld for two of the three viewing time treatments (150 and 250 msec). FI participants demonstrated a significantly greater rate and amount of learning than the FD participants for these two treatments.

In addition to RFT, EFT is also considered to be related to the rate of motor learning. Since EFT characterizes the cognitive restructuring ability, individuals obtaining higher scores on various EFT are regarded to have higher cognitive

restructuring ability and will be more successful in learning situation in which the inherent structure is lacking. In motor learning, when students are initially presented with a new sport skill, students are usually unaware of the idea about the relationship of the parts to the whole skill, experiencing the new skill as an item lacking a clear inherent structure.

In addition, individuals who learn new motor skills rarely have textbooks available. Instead, learners depend mainly on the teacher for information of new sport skills via presentation and demonstration. This source of information is, of course, not always available when needed. Thus, learners are left to analyze the new task for themselves, imposing structure on a "field" with little inherent structure and apprehending it as organized in order to learn it. In such conditions of learning new motor skills, FI individuals who have higher cognitive restructuring ability should show somewhat advantages according to FDI theory (Swinnen, 1983, 1984). Along this line the research was carried out and the results, for the most part, were consistent with FDI theory.

Swinnen is one of the most contributing investigators to this aspect. One of his studies (1984) involved learning new motor skills on the trampoline. The study was designed so that only some global demonstrations and verbal presentation of the skills were presented with no detailed information of movement parts being given, leaving organization and structuring of the task-to-be-learned to the participants. Thirty-nine boys and 45 girls of 15-year-old high school students were included as participants who were not familiar with the trampoline and not able to carry out the selected movements. The hypothesis of Swinnen's study was that FI participants would show a faster learning rate

than FD participants in an unstructured learning situation. This hypothesis was supported in the study for boys, although not for girls. Two years later, Swinnen and colleagues (Swinnen et al., 1986) conducted another similar study with more than one hundred participants of 13-year-old boys and girls. Again, the hypothesis was confirmed for boys only. Another study (Goulet et al., 1988) provided the same result that FI participants tended to learn faster in motor learning.

As with the research on the relationship of FDI and sport skills/abilities, the research on the relationship of FDI to motor learning yielded highly congruent results, which suggest that FI individuals can learn novel motor skills faster and better than can FD individuals. For understandable reasons, the studies regarding sports and motor learning associated with FDI have been expanded to the physical education setting, which is reviewed in the following section.

Field Dependence-Independence and Physical Education

Since it has gradually become unambiguous regarding the relationship of FDI to athletic skills/ability and motor learning, physical educators have started to pay attention to possible problematic learning behaviors in physical education classes on the part of FD students, and to their possible disadvantaged position. FD students, as already presented previously, tend to have less analytical and restructuring ability, and view the task as a whole without attempting to discern distinctions. Further, they also tend to have less memory storage capacity and mental energy in relation to FI students. These limitations might also make FD students less likely to be successful in highly analytical physical education class environments (Ennis & Chepyator-Thomson, 1990).

Ennis and her colleagues (Ennis et al., 1991; Ennis & Chepyator-Thomson, 1990; Ennis & Lazarus, 1990) carried out a series of studies identifying FD children's specific learning behaviors in physical education classes. In fact these studies can be considered as a large study with different emphases on each individual study. The participants involved were all children in second-grade physical education classes.

In the first two studies (Ennis et al., 1991; Ennis & Chepyator-Thomson, 1990), the Logsdon et al. (1984) curriculum was chosen intentionally as the learning environment because it was considered by the authors as an analytical based curriculum. This curriculum is within the movement analysis model that emphasizes the examination of the movement process and analysis of various physical activities, which involve a lot of basic concepts in disciplinary areas such as kinesiology and exercise physiology. Further, instructional strategies used in most programs based on the movement analysis model are typically self-directed learning and problem solving based (Jewett, Bain, & Ennis, 1995) for which FD children usually do not feel comfortable (Saracho, 1997).

It was found that, compared with FI children, FD children had some learning behavior problems within the analytical concept-based curriculum (Ennis & Chepyator-Thomson, 1990), First, FD children experienced difficulty attending to and remembering directions. When the teacher was giving presentation and directions, FD children "had difficulty focusing on the lesson without touching or talking to other students" (p.178). As a result, they were unable to respond correctly when questions regarding prior directions or the serial order of tasks were asked, and could not work through the tasks in a prescribed sequence without watching other classmates working first.

The second salient learning problems observed with FD children was their inability to understand why they had to perform certain tasks. It was especially true when the tasks were related to abstract movement concepts or were repetitive and monotonous, such as hitting the balls with the paddles against walls, and ball-dribbling task. When those tasks were assigned, FD children thought that these tasks were not meaningful and the purpose of practicing them were obscure. This perspective tended to result in "off-task behaviors that were disruptive to the educational environment" (p.179) unless the teacher remained close enough providing them with positive and supportive feedback. FD children's third observed learning problem was that they were uncomfortable with having to work alone because of their social orientation. They tried from time to time to diverge from their tasks to join other children when required to work alone and this decreased their on-task time and learning rate.

As a consequence, FD children experienced much less success and much more nonsuccess in the physical education class (movement analytical curricula) than FI children, especially in the academic area (Ennis et al., 1991). It was also found that physical education teachers selected FD children to respond and demonstrate less often than FI children (Ennis et al., 1991).

Ennis and Lazarus (1990) did the third study in the series to observe and analyze FD children's learning behaviors in the physical education settings. Due to the limitation of memory storage capacity and mental energy on the part of the FD children, it was hypothesized that they would choose less effective strategies, which require less memory storage capacity and mental energy, to accomplish a product-oriented motor performance in a complex environment (Ennis & Lazarus, 1990). This complex novel motor task

learning environment was intentionally designed in their study. The motor task for the children to accomplish was to intercept a ball that had been rolled down a 3 feet ramp. The children began moving from a marker in front and to the side of the base of the ramp as soon as the ball was released at the top of the ramp, and were encouraged to intercept the ball as quickly as possible.

The results revealed that, compared with FI children, FD children consistently chose an angle of approach toward the ball that allowed them to have more time to monitor the speed and the direction of the moving ball, and their own moving speed to the ball, reflecting their limitation to processing multiple information within a short time period. When the action of interception of the ball was analyzed, it was found that FD children reduced a complex open task to a closed task in which they could separate the task and thus complete it more easily. Instead of intercepting the ball while running, the FD children broke down the task into three parts: "(a) running to appropriate location to wait for the ball's arrival, (b) turning to face the ramp, and (c) intercepting the ball" (P. 43). This suggested that FD children found it difficult to integrate running with intercepting, which requires larger working memory capacity and more mental energy for information processing and decision making. This phenomenon indicates, when encountering a complicated environment that requires high-level information processing, FD children tend to use a less effective learning strategy to simplify the complex motor task (Ennis & Lazarus, 1990).

Ennis and her colleagues' study series suggest less effective learning behaviors in the physical education settings on the part of the FD children. These less effective learning behaviors are typically evident when analytical concept-based curriculum is

involved that requires highly analytical and restructuring ability, and when a complex motor task learning environment is provided that requires high information procession ability. The findings of FD children's less effective learning behaviors are in accordance with and parallel the results reviewed in the previous sections that FD individuals are less athletic skilled and slower in motor learning.

In summary, FI individuals are found to be more competent in sport, motor learning, and physical education settings. This might result from FI individuals' stronger tendency to use internal information as a primary referent as measured by RFT (in sports setting as reviewed above, for example). This could result from FI individuals' stronger cognitive restructuring ability as measured by EFT as well (in physical education setting as reviewed above, for example). Still, this could also result from the both (in motor learning setting as reviewed above, for example). In any case, the consistency in the direction and magnitude of the findings regarding FDI and sport, motor learning, as well as physical education suggests strongly that FDI could be an influential determinant in individuals' physical activity participation, which is an important factor associated with individuals' health condition.

Critical Issues in Field Dependence-Independence

The construct of FDI initially occurred shortly after World War II and has a history of more than fifty years during which thousands of studies have been conducted. During its evolution of period, some aspects of FDI theory have been confirmed and others changed due to the newly emerging evidence. The following aspects, either confirmed or changed, are particularly relevant to, and assumptions of, the present study in terms of FDI theory.

The Stability of an Individual's Field Dependence-Independence

Witkin and his colleagues, as well as most researchers of FDI, have treated FDI as a trait. As with other personalities, not only has FDI substantial impacts on many aspects of an individual, it is relative stable in the lifetime of an individual. That is, FDI tends to be stable both across situations and over time. A person who responds in a FD manner in one situation tends to respond in a similar manner in different situations, which has been presented and demonstrated so far. Also, a person who responds in a FI manner at one time tends to respond in a like manner at a later period of time (Davis & Cochran, 1989; Witkin, Moore, Goodenough et al., 1977). The developmental direction of an individual's FDI is from a relatively FD to a relatively FI mode of functioning, until about 17 years (Witkin et al., 1954; Witkin et al., 1962; Witkin et al., 1967). In fact, a relatively stable position on the FDI continuum is set at 8 to 10 years old of the individual. Children tend to maintain their same relative position of FDI within their age group as they grow older, even though the whole group will become more FI with age. That is, the child's FDI tends to be established early in life, and to remain relatively stable afterward (Bauman, 1951; Faterson & Witkin, 1970; Witkin, 1959; Witkin et al., 1967). In the present study, FDI was treated as a psychological trait, and the individual's FDI was considered stable over time when it had been established in childhood.

Neutrality vs. Non-neutrality of Field Dependence-Independence

Neutrality of FDI was considered as one of the essential characteristics of FDI by Witkin and his colleagues (Goodenough, 1976; Witkin & Goodenough, 1981; Witkin, Moore, Goodenough et al., 1977; Witkin, Moore, Oltman et al., 1977). That is, with regard to value judgments, FDI was bipolar, and each pole had adaptive value under

specified circumstances. In other words, FDI appeared to be more related to the "how" than to the "how much" of cognitive functioning, and FD individuals and FI individuals differed more consistently in how the learning or memory process occurred than in how effective the process was. Witkin and his colleagues thought that the neutrality of FDI was particular important because it could distinguish FDI from intelligence and other ability dimensions. An example of description regarding value neutral in terms of FDI provided by Witkin and his colleagues (Witkin, Moore, Goodenough et al., 1977) is as follows:

> …Whereas the psychiatric group proved to be relatively field dependent, the surgical group was relatively field independent. This outcome is not surprising when we consider the tasks to be performed in psychiatry and surgery. Effective work in psychiatric nursing leans heavily on an interest in people and on social sensitivity. In contrast, surgical nursing does not call particularly on social interests and sensitivities; too often the surgical nurse's encounter with a patient is limited to a small segment of the patient's exposed abdomen! Success as a surgical nurse is likely to depend more on skill in quickly disembedding the correct forceps from a complex array of instruments on a surgical tray. This job description is in line with the makeup of the relatively field-independent individual (p. 16).

However, it seems that the neutrality of FDI was true and remains true only in the academic preference and career differentiation area. With the newly emerging evidence, neutrality perspective has been seriously challenged by the facts that FI individuals have some advantages over FD individuals in academic learning/memory aspect (Davis &

Cochran, 1989; Davis & Frank, 1979; Ennis et al., 1991; Páramo & Tinajero, 1990; Saracho, 1997), and that schools are more oriented toward the FI style and FI students are more likely to get benefits from schools (Kagan & Zahn, 1975; Reiff, 1996; Saracho, 1989, 1997). These facts have been presented in detail in previous sections. By contrast, FD individuals' advantage over FI individuals has seldom, if any, been identified and reported.

In the present study, it was hypothesized that middle school FD students level of physical activity is lower than that of FI students. FI is considered a possibly positive factor to facilitate physical activity participation, which means that FI individuals have an advantage over FD in terms of physical activity participation and health promotion and maintenance.

The change from neutrality to non-neutrality in terms of FDI might be one of the most important evolutions in FDI theory that has happened after initial establishment of the construct of FDI by Witkin and his colleagues. In fact, Witkin (Witkin & Goodenough, 1981) himself predicted possible future evolutions of the FDI in 1979 before his death:

> Though it has changed very much in its lifetime, field-dependence theory is still very much in evolution. We can therefore be quite sure that, just as it has changed in the past, it will appear quite different in the future under the impetus of newly emerging evidence. An evolving theory is inevitably characterized by lacunae and uncertainties. This is surely true of field-dependence theory at this moment. These lacunae and uncertainties in

themselves provided an impetus for research which can serve to advance the theory (p. x).

Differences in Field Dependence-Independence as Measured by Rod-and-Frame Test and Embedded Figures Test

According to Witkin et al. (1977), FD and FI individuals differ in contrasting ways of processing information. People who have tendency to rely on the field or background (external frames) for their information processing are classified a FD individuals, and those who tend to rely on self (internal frames) as a primary referent for their information processing are FI individuals. Interpersonal competence is regarded as an outgrowth of reliance on external referents, and cognitive restructuring is seen as an offshoot of reliance on internal referents. Therefore, FDI can be considered to have three dimensions (Davis & Cochran, 1989; Davis & Frank, 1979; Goodenough, 1986; Saracho, 1997; Witkin & Goodenough, 1981): (a) rely on external frames (FD individuals) or internal frames (FI individuals) for information processing, (b) have poorer cognitive restructuring ability (FD individuals) or stronger cognitive restructuring ability (FI individuals), and (c) have higher interpersonal competencies/interests (FD individuals) or lower interpersonal competencies/interests (FI individuals).

The construct of FDI is most frequently operationally defined by RFT and EFT for quantification. In other words, the most two frequently used instruments for measuring FDI are RFT (including portable RFT, or PRFT) and EFT (including GEFT, and other versions of RFT). Earlier theoretical versions of FDI (Witkin, 1959; Witkin et al., 1954, 1962) assumed that RFT and EFT measured the same thing. For example, Witkin (1959) claimed that the two instruments shared the similarity in separating an

item (the rod or simple figure) from a field (the frame or complicated figure). Witkin et al. (1954) initially reported a correlation of .68 between the two measures. As a result, RFT and EFT has been used indiscriminately and interchangeably from time to time (Brady, 1995; Kogan, 1983).

In psychometric theory, there is the concept of "trait-method unit" which suggests that different instruments measuring the same psychological construct might somewhat differ in what they measure (Campbell & Fiske, 1959). In any given psychological measuring device, there are certain features or stimuli introduced specifically to represent the trait that it is intended to measure. At the same time, there are other features which are characteristic of the method being employed, features which could also be present in efforts to measure other quite different trait, or different aspects of the trait. Any test, or rating scale, or instrument, almost inevitably elicits systematic variance in response due to both groups of features (Campbell & Fiske, 1959). Given the distinct administration procedures and underlying rationales between RFT and EFT (refer to the previous sections of "Field Dependence-Independence as Measured by Rod-and-Frame Test" and "Field Dependence-Independence as Measured by Embedded Figures Test"), many researchers have questioned the interchangeable use of the two instruments.

After examining more than 350 articles that involved the use of two or more instruments measuring FDI, Arbuthnot (1972) pointed out the mean *r* for RFT and EFT was .54 and the two instruments shared only about 29% of their variance. Davis' (1987) review on reading ability revealed that the average correlation for reading and RFT was .19, but was .38 for reading and EFT, indicating that the relationship between reading and EFT was considerable stronger than that between reading and RFT. It is argued that

although cognitive restructuring (measured by EFT) and perception-of-the-upright (measured by RFT) are related, the former is more closely linked to logical reasoning and general intellectual functioning, and therefore is more likely to be related to reading comprehension (Linn & Swiney, 1981). In fact, in their most recent version of FDI theory, Witkin and Goodenough (1981) admitted that the two instruments measured related but different aspects. The RFT is thought to reflect differences in perception of the upright due to reliance on internal versus external cues while the EFT is thought to reflect differences in cognitive restructuring abilities.

Furthermore, the association between EFT and intelligence was reported by Witkin and his colleagues (Witkin et al., 1962). Many other empirical data also indicate that FDI as measured by EFT has been related to performance on various tests of skill (Flexer & Roberge, 1980), to scores obtained on the Wechsler Intelligence scales (Coates, 1975; Goodenough & Karp, 1961; Shore, Hymovitch, & Lajoie, 1982), to Cattell's "fluid intelligence" (Hulfish, 1978), and to other intellectual facets (Linn & Kyllonen, 1981; Saracho, 1983, 1984, 1985, 1986; Schimek, 1968; Tourrette, 1989a).

Some studies (Mrosla et al., 1987; Vaidya & Chanky, 1980; Yore, 1986) have suggested that FDI as measured by EFT must make an important contribution to performance in school, "since the skills required in school tasks are the same as those involved in the tests used to evaluate this dimension of cognitive style; analytical capacity and the ability to develop strategies for organizing and restructuring information." (Páramo & Tinajero, 1990, p. 1084). In fact, FDI has been operationally defined by EFT in almost all the studies reviewed previously yielding findings that FI is positively related to academic achievement in school. The relationships between FDI and

electronic-learning as well as memory have also been reviewed previously and FI individuals are found to be more effective in electronic-learning and completing memory-related tasks. Again, EFT has exclusively been chosen in all these electronic-learning and memory-related research. To find out if EFT and RFT have the same association with academic achievements in school, Tinajero & Páramo (1997) deliberately utilized both EFT and RFT in their study. The results indicated that FI boys and girls performed better than FD ones in all of the academic subjects considered, but this superiority was only manifested in the cognitive restructuring dimension of FDI as measured by the EFT. It seems that most researchers realize that EFT and RFT emphasize different dimensions of FDI, and they have chosen EFT when the property of their research is mainly associated with cognitive restructuring ability and intelligence.

While EFT is mostly related to cognitive restructuring ability, RFT is considered to reflect differences mainly in perception of the upright due to reliance on internal versus external cues (Witkin & Goodenough, 1981). When Meek and Skubic (1971) made the hypothesis that highly skilled individuals in various activities must have a more accurate body awareness and therefore more FI than non-athletes, this hypothesis was made with the apparent intention to use RFT as the operational definition of FDI. Since it is RFT, instead of EFT, that requires accurate body awareness (sense of verticality) to be classified as FI individuals. Naturally, Meek and Skubic chose RFT deliberately in their study of comparing FDI between athletes and non-athletes, and the hypothesis was supported.

In practice, most researchers deliberately selected RFT as the measurement of FDI when athletic performance was involved in their studies. Table 2 lists a review of

Table 2

Studies Investigating the Relationship between Field Dependence-Independence and Athletic Skills

No.	Researchers	Findings	Instrument	Hypothesis*
1.	Liu, W. H. (1988)	University male high jumpers were significantly more FI than a same gender and aged college students majoring in physical education	RFT	Supported
2.	Liu, W. H. (1991)	National-level male high jumpers were significantly more FI than a same gender and aged college students majoring in physical education	RFT	Supported
3.	McLeod, B. (1989)	Varsity athletes were significantly more FI than non-athletes	RFT	Supported
4.	McLeod, B., 1987	Public school student athletes were found to be significantly more FI than non-athletes	RFT	Supported
5.	Meek, F., & Skubic, V. (1987)	Highly skilled high school students were significantly more FI than the poorly-skilled ones	RFT	Supported
6.	Rotella, R. J., Bunker, L. K. (1978)	High school athletes were significantly more FI than non-athlete ones	RFT	Supported

Table 2 (continued)

No.	Researchers	Findings	Instrument	Hypothesis*
7.	Shugart, B. J., Souder, M. A., Bunker, L. K. (1972)	Male senior tennis players were significantly more FI than a similar aged non-athlete group	RFT	Supported
8.	Svinicki, J. G., Bundgaard, C. J., Schwensohn, C. H., & Westgor, D. J. (1974)	Physically active participants (mixed genders) were significantly more FI than physically inactive participants	RFT	Supported
9.	Docherty, K., & Boyd, D. G. (1982)	Highly-skilled high school students (male and female) were significantly more FI than students with low sport performance	EFT	Supported
10.	Guyot, g. W., Fairchild, L., & Hill, M. (1980)	Girls low in physical fitness was significantly more FD than the other three groups (girls high, boys low, and boys high in Physical fitness	EFT	Supported
11.	Cano, J. E., & Marquez, S. (1995)	Athletes in team sports were more FD than those not involved in sports	EFT	Opposite to hypothesis

Table 2 (continued)

No.	Researchers	Findings	Instrument	Hypothesis*
12.	Riviv, S., & Nabel, N. (1988)	Non-athletes were significantly more FI than amateur and national-level basketball athletes	EFT	Opposite to hypothesis
13.	Lee, A., Fant, H., Life, M. L., & Lipe, L. (1978)	The correlation between FDI and ball-handling skill was not significant	EFT	Failed to support
14.	Brady, F. (1995).	College athletes (mixed genders) were significantly more FI than non-athletes	RFT & EFT	Supported for RFT Failed to support for EFT
15.	Raviv, S., & Nabel, N. (1990)	Male and female high school athletes were significant more FI than a similar aged non-athlete group	RFT & EFT	Supported for RFT Failed to support for EFT

- The hypothesis was that the individuals with higher sport skills and abilities would be more FI than those with poorer sport skills and abilities

studies available since 1970s investigating the relationship between athletic performance and FDI. Most researches (first eight studies in Table 2) chose RFT, and results of their studies were all in agreement with the hypothesis made by Meek and Skubic (1971). Of the five studies (number 9 to 13 in Table 2) that involved the use of EFT, two studies (number 9 and 10) yielded the same results as those when RFT were applied, two (number 11 and 12) ended up with the opposite results, and one (number 13) got no differences. The researchers in the last two studies in Table 2 intentionally utilized both EFT and RFT to compare the results with sport-related participants. In Brady's (1995) study, it was found that athletes were significantly more FI than non-athletes on RFT, but no significant difference between the groups on EFT, and no correlation between the two measures was obtained. Raviv and Nabel (1990) got the same results when both RFT and EFT were used. Thus, RFT is considered more suitable for sport-related participants than EFT since the former involves the use of proprioceptive information that is critical in sports (Brady, 1995; Raviv & Nabel, 1990).

When similar research is expanded to the motor learning setting, however, some studies involved the use of EFT, and the rationales of using EFT were provided as well. Since EFT is associated with cognitive restructuring ability, and since the novice motor skills to be learned are initially unstructured or ambiguous to the learners, it is argued that relatively FI individuals as measured by EFT would use their stronger restructuring ability to provide the structure to the material lacking a clear inherent structure, thus learning faster (Swinnen, 1984). As already reviewed earlier, several studies in this aspect have been conducted and the results are consistent with the argument (Goulet et al., 1988; Swinnen, 1983, 1984; Swinnen et al., 1986).

The same thing has happened with research on FDI in physical education in terms of the use of EFT. Ennis and Chepyator-Thomson (1990) hypothesized that FI school pupils as measured by EFT would have more troubles in analytical concept-based physical education curriculum that requires highly analytical and restructuring ability, and that requires high information procession ability. The hypothesis has been supported by the findings (Ennis et al., 1991; Ennis & Chepyator-Thomson, 1990; Ennis & Lazarus, 1990).

In summary, it seems reasonable to consider that EFT is mainly associated with cognitive restructuring ability and intelligence, and RFT is mainly associated with the use of internal versus external information. When the main concern of the study is with cognitive restructuring ability and intelligence, EFT is usually selected as the operational definition of FDI. When athletic ability is involved in the study, RFT is usually used as the operational definition of FDI. This summary provides the guidance for the present study in terms of the selection of the instrument.

Critique of the Bias of Field Dependence-Independence as Measured by EFT

Although EFT has not been used in large scale to compare the differences in FDI among different ethnic groups, the available research tends to lead to the impression that EFT is against ethnic minorities. That is, ethnic minorities tend to have lower scores in EFT, indicating lower cognitive restructuring ability in comparison with white American. For example, Asian and Hispanic students were found to be more FD than white students when EFT scores were compared (Hansen, 1995; Kagan & Zahn, 1975, Ramirez & Price-Williams, 1974; Shade, 1981). Perney (1976) found that black children were significantly FD than white children when measured by EFT. Shade (1981) reported the same results

with freshmen university students. Cognitive restructuring ability as measured by EFT is related to math achievement, and children of ethnic minorities who are considered to be FD receive lower math scores (Davis, 1986; Rancifer & Pinchback, 1990; Stiff & Harvey, 1988).

In fact, since the early 1970s, serious debates have flourished about the meaning of tests for the placement and classification of individuals. The focus of the debates, however, is on more widely-used intelligence and standardized tests such as IQ and SAT-I, for which the ethnic minorities gain consistently lower scores (Kaplan & Saccuzze, 2001). So far, there is absence of the reported critical thinking on the bias of EFT. However, some factors can be identified that might be associated with the bias of EFT, and other intelligence and standardized tests as well.

Most experts agree that tests measure not just aptitude but also the effects of cumulative experience, and social environment would determine the individual's experience and, therefore, influence the performance on tests (Kaplan & Saccuzzo, 2001). It is very evident that ethnic minority and white American grow up in different social environment and receive different education, especially when we track back into the eighteenth and nineteenth century. Let's take African-American as example.

In addition to the squalid living conditions, enslaved Africans in the South were denied an education by law before the Civil War. Freed Africans in northern states still experienced discrimination and segregation in education. Segregated schools provided an inferior education to ensure that Africans accepted a low economic status and were an inexpensive source of labor (Spring, 1997). In 1863, only 7 percent of the African-American population was literate (Levine, 1977). It was not until no more than 40 years

ago that the Civil Rights Act of 1964 was enacted and the power of federal regulations was extended in the areas of voting rights, public accommodations, education, and employment to African-American and other ethnic minorities. Even after 1964 Civil Rights Act, school desegregation moved at a slow pace in both the South and the North (Spring, 1997).

EFT was designed in late 1940s (Witkin, 1949, 1950), which was a time that there was a brutal segregation system still in effective and African-American and other ethnic minorities were struggling for their basic civil rights. In the establishment of norm and validation of EFT, participants of different age and gender were involved, but no different ethnicity was mentioned (Witkin et al., 1971). In fact, there are no such concepts such as race and ethnic minority to be found in the EFT manual. Obviously, EFT was developed without the consideration of African-Americans and other ethnic minorities, and mostly reflects the cultural aspects of Anglo Americans.

Even in the present time when the United States is proud of its democracy, freedom and equality, the dominated groups are still facing serious problems in their struggle for equality (Mehan, Villanueva, Hubbard, & Lintz, 1996; Spring, 1997). For example, the average socioeconomic status (SES) of ethnic minorities is much lower than that of the White (Kaplan & Saccuzzo, 2001). Family incomes, however, is considered as one of the best predictors of performance on standardized tests (Kaplan & Saccuzzo). For example, the performance of SAT for college-bound seniors in 1999 was significantly positively related to family income: the higher the family income, the higher the SAT score (College Board, 1999).

With the improvement of the environment, it is expected to see the improvement in intelligence and standardized test scores. With the improved environment in the last fifty years, the average IQ scores have increased 16 points in African Americans (Flynn, 1999). However, low SES may still influence the average scores that African-Americans receive in comparison with white Americans on standardized IQ tests and SAT-I Math (Kaplan & Saccuzzo, 2001). The environmental factors might also explain the differences in EFT between ethnic minorities and the White. In fact, many have argued that the differences in test performances between ethnic minorities and white Americans are due to environmental factors (Turkheimer, 1991; Zuckerman, 1990).

Another factor that may influence ethnic minorities' achievement on cognitive tests could be that ethnic minorities are negatively stereotyped. Steele (1997) argues that doing well requires identification with one's school and other features of the school environment. In one experiment (Steele, 1997), African-American and white students took a test that included the hardest verbal items from the GRE. When half of the students were told they were taking a test of intellectual abilities, white students scored significantly higher than African-American students. However, another half of the students were randomly assigned to take the same test but under condition where there was no threat. In this threat-free condition, African-American and white students performed equivalently. A related experiment showed that simply having African-American students complete a demographic questionnaire that asks about their race and family income also suppresses performance (Aronson et al., 1999).

When comparing the difference in FDI between ethnic minorities and the White, EFT is usually administered in the exact same condition as mentioned above. Ethnic

minority individuals have unwillingly to expose their race and other SES information for the use of data comparison. Such stereotyping can create self-doubts that explain some of the difference in test performance (Aronson et al., 1999).

Since intelligence and standardized tests are considered to have a cultural loading in favor of white population by some critics (Williams, 1974), some psychologists deliberately developed the intelligence tests that is cultural-laden in favor of African-American, trying to convince that white population would poorly score as well, if culturally deprived. The Chitling Test (Dove, 1968) and the Black Intelligence Test of Cultural Homogeneity (Williams, 1974) are examples of such tests. When Williams (1974) administered the test to black and white American groups, the black group outperformed considerably (Kaplan & Saccuzzo, 2001). Although little convincing validity data on these tests are available, they do tell us something about the cultural loading in tests.

In summary, history and social environment factors might contribute greatly to the difference in intelligence tests (including EFT) between ethnic minorities and white Americans. Some other factors, such as stereotyping and cultural loading, could also be the contributors. This should be kept in mind when EFT is used to compare the difference that is associated with the cognitive restructuring ability between ethnic groups.

Critical Issues Regarding Physical Activity and Adolescents

Of the issues that are associated with physical activity and adolescents, the following are particular relevance to the present study: (a) the health benefits of physical activity in adolescents, (b) influences on physical activity of adolescents, and (c) the

development of habitual physical activity in adolescents. The literature associated with these issues is briefly reviewed here.

The health benefits of physical activity in adolescents

Compared with the beneficial effects to health of physical activity during adult years, relatively less evidence is available regarding the effects of physical activity during childhood and adolescence on adult health. The evidence, however, begins to accumulate at least at the following aspects: osteoporosis, abnormal plasma lipoprotein profile, and hypertension (Bar-Or, 1995).

The great majority of bone build-up occurs during adolescence (Bar-Or, 1995). Attaining a sufficiently high peak bone mass during the growing years is one of the key factors against osteoporosis in the later years (Bailey & Martin, 1994). Studies suggest that enhanced physical activity during childhood and adolescence will result in a higher peak bone mass. Adolescent athletes in gymnastics (Cassell, Benedict, Uetrect, Ranz, & Specker, 1993; Grimston & Hanley, 1992; Robinson, Snow-Harter, Gillis, & Shaw, 1993), soccer (McCulloch et al., 1992), and volleyball (Risser et al., 1990) were found to have higher bone mass than non-athlete counterparts. Margulies et al. (1993) found that young males who experienced extremely demanding basic military training for 14 weeks increased the bone mass significantly. Some retrospective studies (Talmage & Anderson, 1984; Tylavsky, Anderson, Talmage, & Taft, 1992) produced the result of a significant relationship between adolescent activity and adult bone mass.

The evidence indicates that the process leading to coronary atherosclerosis, which becomes clinically manifest as coronary heart disease in adult life, is initiated during childhood (McGill, 1968, 1984). This makes researchers to investigate the strategies of

delaying or slowing the negative process. It seems that the most consistent findings regarding the impact of physical activity on improvement of blood lipid comes from some cross-sectional studies in which adolescents, in trained group and untrained group, are researched. Smith, Methrey, and Sparrow (1986) conducted a study in which trained group experienced a two-year running program (27 miles per week on average). The results demonstrated a 32% increase of high-density lipoprotein (HDL) cholesterol, a 13% decrease of low-density lipoprotein (LDL) cholesterol, and a 38% decrease of triglycerides in trained group (HDL cholesterol functions to prevent coronary heart disease from happening, LDL cholesterol and triglycerides are considered to facilitate the incidence of coronary heart disease). The correlation between the three dependent variable and VO2max were .39, -.33, and -.18, respectively.

Atomi, Kuroda, Asami, & Kawahara (1986) conducted a similar study with the trained group experiencing a three-year soccer training (three hours a day, six days a week). The results indicated that adolescents in the trained group had a significant decrease in triglycerides and an increase in HDL cholesterol. The data from the untrained group remained the same or changed in a negative direction. The findings were confirmed by other similar studies (Macek et al., 1989; Nizankowska-Blaz & Abramowicz, 1983; Valimaki, Hursti, Pihlakoski, & Viikari, 1980; Wanne, Viidari, & Valimaki, 1984).

Physical activity is also generally effective in reducing either or both systolic and diastolic pressure for hypertensive adolescents (Alpert & Wilmore, 1994). Hansen, Froberg, Hyldebrandt, and Nielsen (1991) used a controlled trial to yield a significant reduction in systolic blood pressure for hypertensive adolescents at the end of an eight-

month training period. Other available documents almost all demonstrated that physical activity could result in reduction in blood pressure for adolescents with high blood pressures (Danforth et al., 1990; Frank, Farris, Ditmarsen, Voors, & Berenson, 1982; Hagberg et al., 1983, Hagberg, Ehsani et al., 1984; Hagberg, Goldring et al., 1984).

Influences on Physical Activity of Adolescents

Adolescence is a period in which the level of physical activity diminishes (Morrow et al., 1999; Pate et al., 1998; Rowland, 1999; Sallis, 1993; USDHHS, 1996). Many studies have been conducted in an attempt to identify and understand the influences on physical activity habits of adolescents (Bungum &Vincent, 1997; Dishman & Sallis, 1994; Douthitt, 1994; Garcia et al., 1995; Janz & Mahoney, 1997; Rowland, 1998, 1999; Sallis, 1993; Sallis & Owen, 1998; Stucky-Ropp & DiLorenzo, 1993; USDHHS, 1996). Rowland (1998, 1999) provides the evidence that the decline of the level of physical activity during adolescent period results from the decline of biological drive. That is, during early childhood, daily energy expenditure through physical activity is largely biologically-driven. As the child grows, such inherent drive for exercise energy expenditure declines, and extrinsic factors affecting levels of physical activity become more influential. Rowland (1999) identified some negative extrinsic factors, including becoming old enough to drive, having more money and access to fast foods, and increasing exposure to cigarette smoking and drugs. *A Report of the Surgeon General* (USDHHS, 1996) reviews the environmental and perceptual determinants of adolescent unstructured physical activity, which is summarized in Table 3.

With respect to subgroup-specific determinants of physical activity, sex-specific differences are investigated most frequently (USDHHS, 1996). The results indicate that

boys are more competition-motivated than girls, and girls are more weight-management-motivated than boys (Kelder, Perry, Peters, Lytle, & Klepp., 1995; Tappe, Duda,

Table 3

Environmental and Perceptual Determinants of Adolescent Unstructured Physical Activity

Environmental and Perceptual Determinants
Self-efficacy
Perceptions of physical activity and sports competence
Expectations about the outcomes of physical activity
Perceived benefits from physical activity
Perceived barriers to physical activity
Intention to be active
Enjoyment
Favorable attitudes toward physical activity
Sexual attractive
Parental physical activity
Physical activity of friends and siblings
Parental or adult support
Friend's support
Access to play spaces and facilities
Availability of equipment
Time spent outdoors

Menges-Ehrnwald, 1990). In addition, boys have higher levels of self-efficacy than girls (Trost et al., 1996) and higher levels of perceived competence (Tappe et al., 1990). Additionally, socioeconomic status and ethnicity are another two subgroup-specific determinants, which have been found to have direct relationship with adolescent level of physical activity (USDHHS, 1996).

Personal attributes have been considered as one of the four broader factors (the other three factors are heredity, other lifestyles, and environment) that contribute to physical activity (Corbin & Frank, 2000). Little attempts, however, have been found to identify determinants of adolescent physical activity that is associated with personal attributes. Given its pervasive and consistent influences on many aspects of individuals, especially on the sport, motor learning, and physical education settings as reviewed earlier, FDI might be another subgroup-specific determinants of adolescent physical activity.

The Development of Habitual Physical Activity in Adolescents

The recent evidence suggests that, for adolescents, development of habitual physical activity may be much more important than getting immediate benefits from physical activity. Adolescents are less susceptible than adults to the chronic disease status associated with physical inactivity, and the relationship of physical activity to physical fitness is relatively low among teens (Corbin & Pangrazi, 1992; Morrow et al., 1999). In many cases, physically inactive children and adolescents obtain higher scores in fitness tests than more physically active peers (Pangrazi & Corbin, 1990; Rate, Dowda, & Poss, 1990). It is because heredity plays a considerable role in individual's ability to improve fitness as a result of physical activity (Bouchard, Dionne, Simoneau, & Boulay, 1992), and this partially explains why *A Report of the Surgeon General* (USDHHS, 1996) has less direct evidence of health benefits for youth than for adults.

Additionally, most chronic diseases are a result of life-long processes, surfacing clinically in the older adult years. "This observation has prompted an emphasis on promoting exercise habits in children and adolescents as the starting point of a life-style

of regular exercise that will be maintained through to adulthood" (Rowland, 1999, p. 1). Consequently, introduction and maintenance of physical activity has replaced an emphasis on improving physical fitness to threshold levels (Corbin, Pangrazi, & Welk, 1993).

Unfortunately, as pointed out earlier, adolescence is a time in which physical activity declines dramatically. Some evidence supports the notion that the adolescents' physical activity habits, as well as health risk factors, are likely to continue into the older years (Beunen et al., 1992, 1994; Raitakari et al., 1994; Rowland, 1999; Telama et al., 1997; Vanreusel et al., 1993). Therefore, adolescent years are considered to be a critical period for adoption and promotion of lifetime physical activity habits (Rowland, 1999; Sallis & Patrick, 1994; USDHHS, 1996).

Summary

FDI is the tendency to rely on self or field as primary referents for information processing. FD people have tendency to rely on external frames for their information processing, are assumed to be more competent in interpersonal and social skills, but less competent in cognitive restructuring skills. FI people tend to rely on internal frames as a primary referent for their information processing, are assumed to be more competent in cognitive restructuring skills, but less competent in interpersonal and social skills. EFT and RFT are the two most fluently used instruments to assess FDI.

FD and FI individuals have contrasting characteristics that are pervasive and consistent in many aspects. FD individuals favor interpersonal, non-analytical domains, and FD individuals like impersonal and analytical domains in terms of academic preference and career differentiation. With their higher cognitive restructuring ability and

favor of impersonal situation, FI individuals tend to obtain higher academic achievements in schools, show more interests in distance learning and other computer-related learning, and demonstrate higher competence in general learning and memory. FI individuals' more effectiveness in using proprioceptive information and higher cognitive restructuring ability also make them more competent in sport, motor learning, and physical education.

Several issues are critical to the present study in terms of FDI theory. First, the developmental direction of an individual's FDI is from a relatively FD to a relatively FI mode of functioning, until about 17 years. A relatively stable position on the FDI continuum is set at 8 to 10 years old of the individual. Second, neutrality of FDI has been challenged by newly emerging evidence, and FI individuals are considered to have advantages over FD individuals in academic learning/memory aspect and in sport, motor learning, and physical education. Third, although RFT and EFT can both be used to assess FDI, the former is thought to reflect differences in perception of the upright due to reliance on internal versus external cues while the latter is thought to reflect differences in cognitive restructuring abilities. Fourth, as with IQ and other standardized measurements, EFT (including GEFT) has a bias that is against ethnic minority groups. This might mainly be due to historical and environmental factors.

The health benefits of physical activity in adolescents are accumulating. It has been demonstrated that physical activity can benefit adolescents by reaching a higher peak bone mass, improving blood lipid profiles, and reducing blood pressure for hypertensive adolescents.

Because of the decline of biological drive, the level of physical activity diminishes dramatically in adolescents. The identified extrinsic factors influencing

adolescent physical activity are self-efficacy, enjoyment, peer support, etc. Gender, socioeconomic status, and ethnicity are subgroup-specific determinants of adolescent physical activity. Personal attributes are also considered as factors to influence adolescent physical activity, although little attempts have been made to investigate determinants associated with personal attributes.

The development of habitual physical activity in adolescents may be more important than getting immediate benefits from physical activity because of a relatively low correlation between physical activity and fitness in adolescents, and because most chronic diseases are a result of life-long process, manifesting clinically in the late years. Given the decline in adolescent physical activity and possible continuation of adolescent physical activity habits into adult, it is critical to develop and promote adolescent physical activity habits.

CHAPTER 3

RESEARCH METHODS

The purpose of the study was to investigate the impact of FDI on adolescents' physical activity level. The foci of the study were (a) to examine if there were any significant differences in levels of physical activity between FD and FI adolescents in a randomly selected school day, and (b) examine if there were any significant differences in physical activity behaviors between FD and FI adolescents in a randomly selected school day. The hypotheses were that (a) there would be significant differences in levels of physical activity between FD and FI adolescents in a randomly selected school day, and (b) that there would be significant differences in physical activity behaviors between FD and FI adolescents in a randomly selected school day.

Design of the Study

A cross-sectional design was utilized to investigate the impact of FDI on adolescents' physical activity level. The participants were grouped by FDI status, by gender, and by the cross-classification of FDI and gender to compare variables that were generated from SAPAC. In any comparison, FDI and gender were independent variables, and the variables generated from SAPAC were dependent variables.

Participants

One hundred and forty six (146) students at a middle school in the Southeast participated the data collection and eight of them were eliminated because of invalid data. Of the remaining 138 participants, top one-third scorers ($n = 46$) on PRFT were classified

as FD students, and bottom one-third scorers (n = 46) as FI students. These 92 FD and FI students were the final participants whose data were analyzed.

The number of the final participants was roughly consistent with the sample size estimation made before data collection according to the following information. Since the statistics that were used in the present study were 2 X 2 ANOVA and independent-sample t-test (refer to the section of "Procedure" below) and a statistic power of .80 was considered as reasonable for the research design (Keppel, 1991), sample size estimates (Cohen, 1977) with different effect sizes at statistic power of .80 and alpha level of .05 for 2 X 2 ANOVA and t-test are listed in Table 4.

Table 4

Sample Size Estimate (u = 1, α = .05, power = .80)

f	d	n (2 X 2 ANOVA)	n (T-Test)
.10	.20	197	> 300
.25	.50	33	64
.30	.60	23	44
.40	.80	13	25

In the above table, f refers to Cohen's f statistic, d refers to standardized mean difference, n (2 X 2 ANOVA) refers to the cell size for each of the four cells, and n (t-test) refers to the group size for each of the two groups. Effect size is considered as small when f = .10 or d = .20, medium when f = .25 or d = .50, and large when f = .40 or d =

.80 (Cohen, 1977). The choice of effect size should, ideally, be based on earlier research (Keppel, 1991). Since no research similar to the present study is available, the choice of effect size for the present study will partially be on the base of Cohen's classification plus the consideration of previous relevant research. Most researchers would not choose a small effect size because it would require a considerably big sample in order to achieve a desirable power. Underestimating the effect size somewhat, however, is suggested because the corresponding sample size will be big enough to afford reasonable power for the proposed study (Keppel, 1991). If the fact is also taken into account that almost every study comparing FDI between individuals with different athletic skills resulted in a significant difference (refer to Table 2), the effect sizes f of 3.0 to 4.0 were ones with the design of the present study. The selected effect size justified the sample size of the final participants mentioned above.

Instrumentation

Portable Rod-and-Frame Apparatus

The portable Rod-and-Frame Apparatus (Oltman, 1968) was used to collect the participants' data of FDI. The apparatus is an adaptation by Oltman to the Witkin's (Witkin et al., 1954) original Rod-and-Frame Apparatus, which has been a widely used instrument to assess individuals' FDI. The portable Rod-and-Frame Apparatus is the same in construction as Witkin's apparatus, mainly comprising of a rotatable square frame and a rotatable rod, which is surrounded by the frame. Its size (table-top size) is much smaller than Witkin's apparatus, thus enhancing its portability and availability. Its validity ($r = .89$) against Witkin's Rod-and-Frame Apparatus and reliability ($r = .95$) have been established (Oltman, 1968). The administration of the portable Rod-and-Frame

Apparatus involves the use of the body's visual and proprioceptive information to perceive the body's spatial orientation, and thus is considered more suitable than EFT or GEFT when the property of the research is associated with potential sport ability (Brady, 1995; Raviv & Nabel, 1990). In fact, it has been widely used in studies involving sport ability (Barrell & Trippe, 1975; Brady, 1995; Cano & Marquez, 1995; Chu, 1988; Docherty & Boyd, 1982; Guyot et al., 1980; Lee, Fant, Life, & Lipe, 1980; Li, 1989; Liu, 1988, 1991, 1999; MacGillivary, 1979; Mcleod, 1985, 1987; McMorris & MacGillivary, 1988; Meek & Skubic, 1987; Meng & Zheng, 1988; Qiu & Bei, 1988; Riviv & Nabel, 1988, 1990; Rotella & Bunker, 1978; Shugart et al., 1972; Svinicki et al., 1974; Wu, 1991).

Self-Administered Physical Activity Checklist (SAPAC)

The ASPAC (Appendix G) is a 24-hour recall of selected physical activities and sedentary activities using a checklist format, and was developed recently for the project of the Child and Adolescent Trial for Cardiovascular Health (CATCH). The CATCH, involving 96 schools, was a multicenter school-based health promotion study with the goals of administering and evaluating food service, physical education, classroom curricula, and family education interventions to improve cardiovascular risk profiles in school children and adolescents. The test-retest reliability of .65 and the validity of .60 against HRM on the part of SAPAC were reported by the developers (Sallis et al., 1996). Since SAPAC just involves the recall of physical activity on a single day (the previous day), not for a week or a month, the cognitive requirement of SAPAC administration is reduced considerably. Its step-by-step administration procedure also contributes to its reliability. The SAPAC has been used for both elementary (Sallis et al., 1996) and

secondary (Myers et al., 1996) schools, and was recommended by Sallis (personal communication, 2001) for the present study.

Demographic Inventory

A researcher-generated demographic inventory (Appendix C) was used to collect the participants' following information: gender, grade, race, and current involvement of organized sports.

Evaluation Sheet

A researcher-generated sheet rating or evaluating each participant's sport skill level and their interest in physical education and physical activity (Appendix D) were used. The sheet was completed by the physical education teachers in the middle school for the validation of PRFT and SAPAC.

Procedures

There were 345 students participating physical education class in a middle school in the Southeast during the period of the data collection (November to December, 2001). With the help of the physical education teachers, the informed consent forms (Appendix A) were distributed to all these (n = 345) students' parents at beginning of the November 2001. The parents of 146 students singed and returned the informed consent forms, with the return rate of 42.3%.

The Data Collection of Portable Rod-and-Frame Test

There were six periods of physical education classes on each school day during the data collection period, and PRFT was administered individually during the originally scheduled physical education class. At the beginning of each physical education class, eight to ten students whose parents returned the consent forms were called out and sat on

the bench in the school gym, waiting for the test. The portable Rod-and-Frame Apparatus was placed on a table in a quite hall way next to the gym. One participant came to the testing table each time.

The apparatus was a rectangular box. One side of the box was open for the participant to look into. On the other side there was a square frame with a rod in the middle of it. Both the square frame and the rod could be tilted separately or together to either side, to the same side or to opposite sides, by the tester. The participant could also rotate the rod. The participant was asked to sit upright on a chair, putting his/her eyes against the opening of the apparatus and looking into the box. All that the participant could see were the tilted rod and tilted square frame. Then the instruction (Appendix E) with the demonstration for operating the apparatus was provided by the tester, making sure the participant understood how to operate the instruction. The participant was told to adjust the tilted rod until he or she considers that the rod was vertical (Appendix F). Eight trials were given to the participant, with frame and rod tilted of 28º in the following sequence: frame, left (L), L, right (R), R, L, L, R, R; rod, L, R, R, L, L, R, R, L (Witkin et al., 1954). The participant's score was the mean of the absolute deviations in degrees from the verticality over the eight trials. High scores reflected relatively FD performance, and low scores relatively FI performance. The top one-third scorers (with relatively higher scores) were classified as FD individuals, and the bottom one-third scorers (with relatively lower scores) as FI individuals.

The Data Collection of Self-Administered Physical Activity Checklist (SAPAC)

The SAPAC was administered after the individual PFRT was done around the middle of December 2001. The class room for SAPAC measurement was arranged

beforehand and could accommodate up to 25 participants each time. About 20 students were administered in one period of physical education class, until all the 146 participants were done. The test days were any school days except Mondays to make sure the previous days were school days.

The SAPAC consisted of 24 physical activities, space of listing up to three other activities, and an additional section for reporting TV/video viewing and video/computer game playing (Appendix G). The tester first provided explanations for physical activity, time estimation, and actual time active. Then participants were guided to recall and report the minutes they spent in each activity during three time periods (before, during, and after school) of the previous day. They were instructed to report the time they were "actually" active and not to include the time they were resting or waiting to play. Participants were also required to recall and report the perceived exertion (intensity rating) for every activity reported (breathe hard or feel tired: none, some, or most of the time). Following the administration protocol (Appendix H), the tester guided and led participants step-by-step through the administration with an overhead projector. After the data reduction of the SAPAC, the following six variables were used for the data analysis (Myers et al, 1996; Sallis et al., 1996)

1. Minutes of physical activity.
2. Minutes of moderate to vigorous physical activity (MVPA).
3. MET score (min of physical activity / 60 min × MET value).
4. MVPA MET score (min of MVPA / 60 min × MET value).
5. Weighted MET score (min of physical activity / 60 min × MET value × weighted intensity rating).

6. Weighted MVPA MET score (min of MVPA / 60 min × MET value × weighted intensity rating).

MET (an abbreviation of metabolic) is the way to express energy expenditure in relation to body weight. One MET refers to the metabolic energy expenditure when sitting quietly (resting metabolic rate), which equals one kcal (kilocalorie) per kilogram of body weight per hour, technically expressed as "1 kcal · kg body weifht^{-1} · h^{-1}". The energy expenditure expended in different physical activities can be expressed as multiples of the resting MET (one MET), or as the ratio of the associated metabolic rate for the specific activity divided by the resting metabolic rate (one MET). That is, an activity with 2 METs requires two times the resting metabolic rate, and an activity with 4 METs requires four times the resting metabolic rate, and so on (Montoye et al, 1996). The MET value associated with different physical activities is listed in the published compendium of physical activity (Ainsworth, Jacobs, & Leon, 1993), which has been developed to facilitate the coding of physical activities and to promote comparability of coding across studies involving self-report measures of physical activity. The MET value associated with different physical activities appearing in the SAPAC is listed in Appendix I. The activities with 4.4 METs and less are classified as light in intensity, 4.5 to 5.9 METs as moderate, and 6.0 METs and above as vigorous (Ainsworth et al., 1993, Myers et al, 1996; Sallis et al., 1996).

The formula used to calculate the EMT score was "min of physical activity / 60 min × MET value". If one participant reported 40-min engagement in basketball (6 METs), for example, the energy expenditure of the engagement would be 40 min / 60 min × 6 METs, i.e., 4 METs. That is, the energy expenditure of the engagement in 40-

min basketball was 4 kcal per kilogram of body weight per hour, expressed as "4 kcal · kg body weifht^{-1} · h^{-1}", or 4 METs. Since MET has taken into account the body weight, it is possible to compare energy expenditure as expressed by MET among individuals of different body weight. Among exercise physiologists, it is almost universally accepted to use METs to express energy expenditure in relation to body weight (Montoye et al., 1996). Correspondingly, the formula to calculate MVPA MET score was "min of MVPA / 60 min × MET value".

The use of the weighted intensity ratings was intended to take into account the actual intensity of participating in a given activity (Sallis et al., 1996). Although all the activities have corresponding METs in the compendium of physical activity, people might engage in a given activity with different exertion. The participant's intensity rating, based on the participant's reported exertion or intensity rating (i.e., breathe hard or feel tired: none, some, or most of the time), might reflect individual differences in intensity of a given activity. Different weighting rules with different reported exertions were applied to activities of different METs. If an activity was light to moderate (i.e., with 5.9 METs or less), the corresponding MET value was multiplied by 1.1 if reported exertion (intensity rating) was out of breath "some" of the time and by 1.25 if reported exertion was out of breath "most of the time". If the activity was vigorous (with 6.0 METs or above), the corresponding MET value was multiplied by 1.25 when reported exertion was out of breath "most of the time". However, when the reported exertion was out of breath "none" of the time, the activity was less vigorous than it "should be", and the MET value was multiplied by 0.75 (Sallis et al., 1996).

The formula to calculate weighted physical activity MET score was "min of physical activity / 60 min × MET value × weighted intensity rating". For a reported 40-min engagement in basketball (6 METs) with being out of breath "most of the time", the energy expenditure derived from the weighted MET would be 40 min/60 min × 6 METs × 1.25, i.e., 5 METs. Correspondingly, the formula to calculate weighted MVPA MET score was "min of MVPA of physical activity / 60 min × MET value × weighted intensity rating".

The Data Collection of Demographic Inventory

The Demographic Inventory (Appendix C) was completed with the administration of SAPAC. This is, the administrations of SAPAC and Demographic Inventory took place at the same time.

The Data Collection of Evaluation Sheet

After the data collection for students was done, the evaluation sheets (Appendix D) were given to the three physical education teachers. The participants were evaluated on five-point scales regarding their sport ability and interests in physical education and physical activity. The participants' current involvement of any organized sports was also reflected in the evaluation sheet. The physical education teachers completed the evaluation sheet without the knowledge of participants' scores on PFRT and SAPAC.

Treatment of Data

The problems associated with the present study were whether there would be any significant differences in levels of physical activity and physical activity behaviors between FD and FI adolescents in a randomly selected school day. The hypotheses were

that there would be significant differences in levels of physical activity and physical activity behaviors between FD and FI adolescents in a randomly selected school day.

Top one-third scorers (n = 46) and bottom one-third scorers (n = 46) on PRFT were the final participants whose data were analyzed. A 2 × 2 (gender X FDI status) ANOVA was used to detect differences between FD and FI participants in the following six variables derived from SAPAC data: minutes of physical activity, minutes of moderate to vigorous physical activity (MVPA), MET score, MVPA MET score, weighted MET score, and weighted MVPA MET score. In addition, descriptive data regarding physical activity behaviors between the two groups were compared as well.

Since multiple dependent variables were related to the independent variables (FRFT score and gender) with the hypothesis test (ANOVA), Bonferroni method for control of familywise Type 1 Error was used. That is, the alpha value for each of the dependent variables was .05 / number of dependent variables (Green, Salkind, & Akey, 1997).

For validating PRFT and SAPAC, the rating score of the evaluation sheet completed by the physical education teachers was correlated with PRFT and SAPAC with Spearman correlation. An alpha level of .05 was used for the significance testing.

CHAPTER IV

RESULTS

The purpose of the study was to investigate the possible impact of FDI status on adolescents' level of physical activity. The foci of the study were (a) to examine if there were any significant differences in levels of physical activity between FD and FI adolescents in a randomly selected school day, and (b) examine if there were any significant differences in physical activity behaviors between FD and FI adolescents in a randomly selected school day. The hypotheses of the study were that (a) there would be significant differences in levels of physical activity between FD and FI adolescents in a randomly selected school day, and (b) that there would be significant differences in physical activity behaviors between FD and FI adolescents in a randomly selected school day.

One hundreds and forty six students in a middle school in the Southeast whose parents signed and returned the informed consent forms were involved in the data collection. The PRFT, SAPAC, and the Demographic Inventory were administered for all these 146 students. Data were eliminated for 8 students (5.5%). Of these 8, two reported no physical activity on the previous school day, three did not attend the school on the previous day, and three demonstrated unusual big deviations in PRFT scores (more than 20 degrees from the verticality), suggesting not understanding how to operate PRFT. For the remaining 138 participants, top one-third scorers ($\underline{n} = 46$) on PRFT were classified as FD individuals, and the bottom one-third scorers ($\underline{n} = 46$) on PRFT as FI individuals.

These 92 students (46 FI and 46 FD) were final participants of the study for whom the Evaluation Sheets were also completed by the physical education teachers, and whose data were analyzed.

The results of data analysis were organized as follows: (a) subject characteristics, (b) levels of physical activity, (c) levels of physical activity at different percentiles, (d) percentiles at different levels of physical activity, (e) patterns of physical activity, (f) participation in organized sports, (g) physical activity preference, and (h) reliability, validity, and assumptions of the hypotheses tests.

Subject Characteristics

Ninety-two final participants' basic demographic characteristics in terms of gender, grade, and ethnicity are summarized in Table 5, which also contains the demographic data for FI individuals and FD individuals separately.

The age range for the 92 final participants was 10-15 years, with M =12.66 and SD = 1.07. As mentioned earlier, this age range is still in the course of FDI development (Witkin et al., 1954; Witkin et al., 1962; Witkin et al., 1967). In order to be sure that age would not be the factor to influence the membership of FI group (n =46) and FD group (n =46) and their physical activity levels, age analysis was done first to eliminate this possible influence. The mean age for FI group was 12.83 years with SD of 1.02. The mean age for FD group was 12.50 years with SD of 1.13. The results of the independent t-test indicated no significant difference (t = 1.47, df = 90, p > .05) in age between FI individuals and FD individuals.

The mean PRFT scores for FI group and FD group was 1.25 with SD of .30, and 4.72 with SD of 2.93, respectively. There was a very significant difference ($t = 7.99$, $df = 45.9$, $p < .0001$) in PRFT scores between FI individuals and FD individuals.

Table 5

Demographic Characteristics of Participants

	Final Participants (n = 92)		FI Individuals (n = 46)		FD Individuals (n =46)	
Variable	n	%	n	%	n	%
Gender						
Male	46	50.0	24	52.2	22	47.8
Female	46	50.0	22	47.8	24	52.2
Grade						
Six	22	23.9	9	19.6	13	28.3
Seven	35	38.0	16	34.8	19	41.3
Eight	35	38.0	21	45.7	14	30.4
Ethnicity						
White	39	42.4	20	43.5	19	41.3
Black	36	39.1	16	34.8	20	43.5
Hispanic/Latino	8	8.7	5	10.9	3	6.5
Pacific/Asian	2	2.2	1	2.2	1	2.2
Other	7	7.6	4	8.7	3	6.5

Levels of Physical Activity

The first hypothesis of the present study was that there would be significant differences in levels of physical activity between FD and FI adolescents in a randomly

selected school day. Since other studies (Armstrong, Balding, Gentle, & Kirby, 1990; Myers et al., 1996) indicated the differences in levels of physical activity between middle school boys and girls, the gender was also taken into account in the present study for a possible factor to influence the participants' levels of physical activity. As a result, the comparison was done among the four groups of cross-classification of FDI status and gender: male-FI, male-FD, female-FI, and female-FD. The six variables compared were:

1. Minutes of physical activity.
2. Minutes of moderate to vigorous physical activity (MVPA).
3. MET score (min of physical activity / 60 min × MET value).
4. MVPA MET score (min of MVPA / 60 min × MET value).
5. Weighted MET score (min of physical activity / 60 min × MET value × weighted intensity rating).
6. Weighted MVPA MET score (min of MVPA / 60 min X MET value × weighted intensity rating).

The 2 × 2 (gender × FDI status) ANOVA was conducted with each of the six dependent variables. Since multivariate analysis was involved (the six dependent variables were associated with the same independent variables of gender and FDI status), Bonferroni method for control of familywise Type 1 Error was used. That is, the alpha value with each of the six dependent variables was .05 / 6, i.e., .0083 (Green, Salkind, & Akey, 1997). The results of the analysis for each of the six variables were summarized in Table 6, Table 7, Table 8, Table 9, Table 10, and Table 11.

The results indicated no interactions between gender and FDI status for each of the six variables of physical activity. The F values and p values of interaction for the

Table 6

Two-Way ANOVA Results for Total Minutes of Physical Activity

Group	n	M	SD
Male-FI	24	117.25	112.82
Male-FD	22	55.95	38.05
Female-FI	22	134.09	109.99
Female-FD	24	69.79	56.31

Source	SS	df	MS	F	p	η^2
Gender	5401.33	1	5401.33	.37	.395	.008
FDI Status	90529.20	1	90529.20	12.25	.001	.122
Gender X FDI	51.78	1	51.78	.01	.93	.000
Residual	650139.23	88	7387.95			
Total	744376.74	91				

Table 7

Two-Way ANOVA Results for Total Minutes of MVPA

Group	n	M	SD

Male-FI	24	97.67	110.27
Male-FD	22	40.91	31.80
Female-FI	22	96.22	80.28
Female-FD	24	35.00	42.07

Source	SS	df	MS	F	p	η^2
Gender	309.91	1	309.91	.057	.812	.001
FDI Status	79891.13	1	79891.13	14.74	.000	.143
Gender X FDI	114.66	1	114.66	.02	.885	.000
Residual	476931.02	88	5419.67			
Total	557832.12	91				

Table 8

Two-Way ANOVA Results for Total MET Score

Group	n	M	SD
Male-FI	24	11.69	12.29
Male-FD	22	4.76	3.60
Female-FI	22	11.68	9.32

Female-FD	24	5.23	4.45

Source	SS	df	MS	F	p	η^2
Gender	1.21	1	1.21	.02	.895	.000
FDI Status	1028.41	1	1028.41	15.02	.000	.146
Gender X FDI	1.28	1	1.28	.02	.892	.000
Residual	6024.25	88	68.46			
Total	7054.02	91				

Table 9

Two-Way ANOVA Results for Total MVPA MET Score

Group	n	M	SD
Male-FI	24	10.61	12.15
Male-FD	22	3.92	3.36
Female-FI	22	9.49	7.66
Female-FD	24	3.20	3.73

Source	SS	df	MS	F	p	η^2

Gender	19.39	1	19.39	0.33	0.568	.004
FDI Status	967.33	1	967.33	16.42	.000	.157
Gender X FDI	.91	1	.91	.02	.901	.000
Residual	5184.12	88	58.91			
Total	6785.56	91				

Table 10

Two-Way ANOVA Results for Total Weighted MET Score

Group	n	M	SD
Male-FI	24	12.75	13.45
Male-FD	22	5.10	4.01
Female-FI	22	11.97	9.16
Female-FD	24	5.44	4.63

Source	SS	df	MS	F	p	η^2
Gender	1.14	1	1.14	.02	.903	.000
FDI Status	1154.17	1	1154.17	15.03	.000	.146
Gender X FDI	7.04	1	7.04	.09	.763	.001
Residual	6757.33	88	76.79			
Total	7925.03	91				

Table 11

Two-Way ANOVA Results for Total Weighted MVPA MET Score

Group	n	M	SD
Male-FI	24	11.59	13.19
Male-FD	22	4.23	3.79
Female-FI	22	9.59	7.52
Female-FD	24	3.21	3.80

Source	SS	df	MS	F	p	η^2
Gender	52.10	1	52.10	.79	.377	.000
FDI Status	1083.54	1	1083.54	16.37	.000	.157
Gender X FDI	5.58	1	5.58	.084	.772	.001
Residual	5823.52	88	66.18			
Total	6987.58	91				

six variables were $F_{(1, 88)} = .01$, $p = .93 > .05$; $F_{(1, 88)} = .02$, $p = .89 > .05$; $F_{(1, 88)} = .02$, $p = .89 > .05$; $F_{(1, 88)} = .02$, $p = .90 > .05$; $F_{(1, 88)} = .09$, $p = .76 > .05$; $F_{(1, 88)} = .08$, $p = .77 > .05$; respectively. Further, there were no significant main effects of gender as

- $F_{(1, 88)} = .73$ and $p = .40 > .05$ for total min of PA,

- $\underline{F}_{(1, 88)} = .06$ and $\underline{p} = .81 > .05$ for total min of MVPA,
- $\underline{F}_{(1, 88)} = .02$ and $\underline{p} = .90 > .05$ for total MET score,
- $\underline{F}_{(1, 88)} = .33$ and $\underline{p} = .57 > .05$ for total MVPA MET score,
- $\underline{F}_{(1, 88)} = .02$ and $\underline{p} = .90 > .05$ for total weighted MET score, and

$\underline{F}_{(1, 88)} = .79$ and $\underline{p} = .38 > .05$ for total weighted MVPA MET score.

The mean effects of FDI status, however, were significant for all the six dependent variables with

- $\underline{F}_{(1, 88)} = 12.25$ and $\underline{p} = .001 < .0083$ with η^2 of .12 for total min of PA,
- $\underline{F}_{(1, 88)} = 14.74$ and $\underline{p} = .000 < .0083$ with η^2 of .14 for total min of MVPA,
- $\underline{F}_{(1, 88)} = 15.02$ and $\underline{p} = .000 < .0083$ with η^2 of .15 for total MET score,
- $\underline{F}_{(1, 88)} = 16.42$ and $\underline{p} = .000 < .0083$ with η^2 of .16 for total MVPA MET score,
- $\underline{F}_{(1, 88)} = 15.03$ and $\underline{p} = .000 < .0083$ with η^2 of .15 for total weighted MET score, and
- $\underline{F}_{(1, 88)} = 16.37$ and $\underline{p} = .000 < .0083$ with η^2 of .16 for total weighted MVPA MET score

In fact, the mean differences of levels of physical activity between FD and FI groups were so contrast, as indicated in Table 12, that the differences could even be detected by intuition, with the FI group almost always being twice as much as the FD group on each of the six means. The effect sizes as demonstrated by η^2 values for FDI factor (Table 6 to Table 11) were all large (.14 or above) except one for min of PA (.12 > .06), which was medium (Green, Sallkind, & Akey, 1997).

Since there were no gender by FDI status interactions and no significant main effects involving the factor of gender for all the six dependent variables, the significant main effects of FDI status can be directly interpreted. Thus the first hypothesis was

supported that there were significant differences in levels of physical activity, as demonstrated with the six physical activity variables, between FD and FI adolescents in a randomly selected school day. Specifically, FI adolescents had significantly higher levels of physical activity than did FD adolescents.

Table 12

Means and Standard Deviations on Six Dependent Variables for FD and FI Groups

Variables	Group	n	M	SD
Min of PA	FI	46	125.30	110.56
	FD	46	63.17	48.43
Min of MVPA	FI	46	96.98	96.04
	FD	46	37.83	37.22
MET Score	FI	46	11.69	10.85
	FD	46	5.00	4.03
MVPA MET Score	FI	46	10.07	10.16
	FD	46	3.54	3.54
Weighted MET	FI	46	12.38	11.48
	FD	46	5.28	4.30
Weighted MVPA MET	FI	46	10.63	10.79
	FD	46	3.70	3.79

Levels of Physical Activity at Different Percentile Ranks

The percentile rank of a given score is the percentage of the total scores that fall below the given score. For example, if the score at percentile rank of 50 of the total

minutes of PA for FD group is 47, then the 50 percent of the participants in FD group would have the total minutes of PA that is less than 47. This also means that the other 50 percent of the participants in FD group would have the total minutes of PA of not less than 47. The comparison of the levels of physical activity at the different percentiles between the two groups would reveal a more detailed and meaningful picture in terms of their levels of physical activity, thus a better understanding of the impact of FDI status on adolescents' levels of physical activity.

This comparison was made at the percentiles ranks of 10, 25, 50, 75, and 90 for each of the six dependent variables between FI and FD groups. The results are graphically summarized in Figure 1 to Figure 6 for each of the following six variables of physical activity respectively: min of PA, min of MVPA, MET score, MVPA MET score, weighted MET score, and weighted MVPA MET score.

The results provided a vivid contrast in terms of the levels of physical activity between two groups. The levels of physical activity, as expressed by the six variables, of FI group tended to be higher than those of FD group from percentile rank of 10. They became almost twice, even triple, as much as those of FD group at percentile ranks of 50, 75, and 90 across all the six variables. For example, the ratios of minutes of PA between the two groups were 29:25 at 10 percentile rank, 58:25 at 25 percentile rank, 104:48 at 50 percentile rank, 140:80 at 75 percentile rank, and 285:141 at 90 percentile rank (Figure 1). A piece of information that was clearly conveyed to us was that almost 50 percent of the participants in FI group had physical activity levels that twice as much as those in FD group.

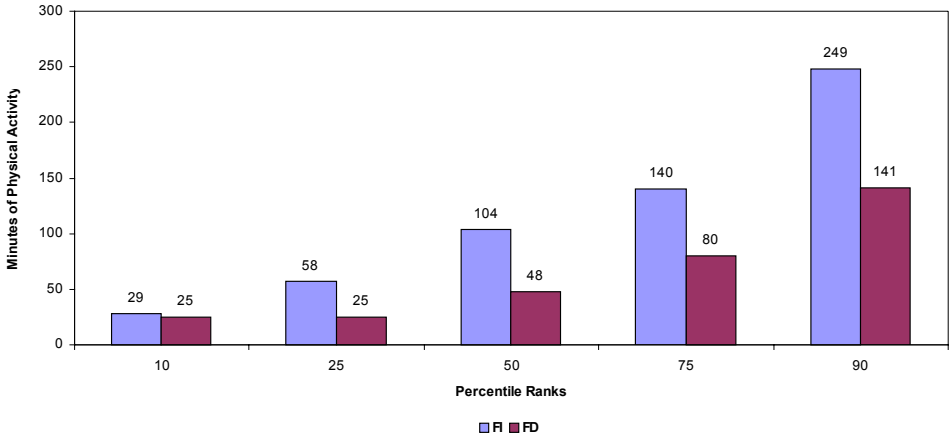

Figure 1 Comparison of Minutes of Physical Activity at Different Percentiles between FI and FD Groups

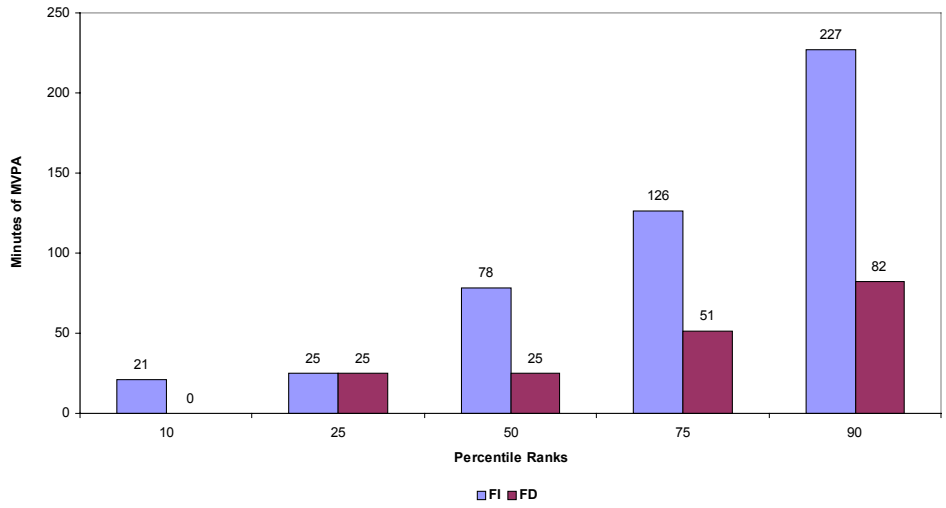

Figure 2 Comparison of Miuntes of MVPA at Different Percentiles between FI and FD Groups

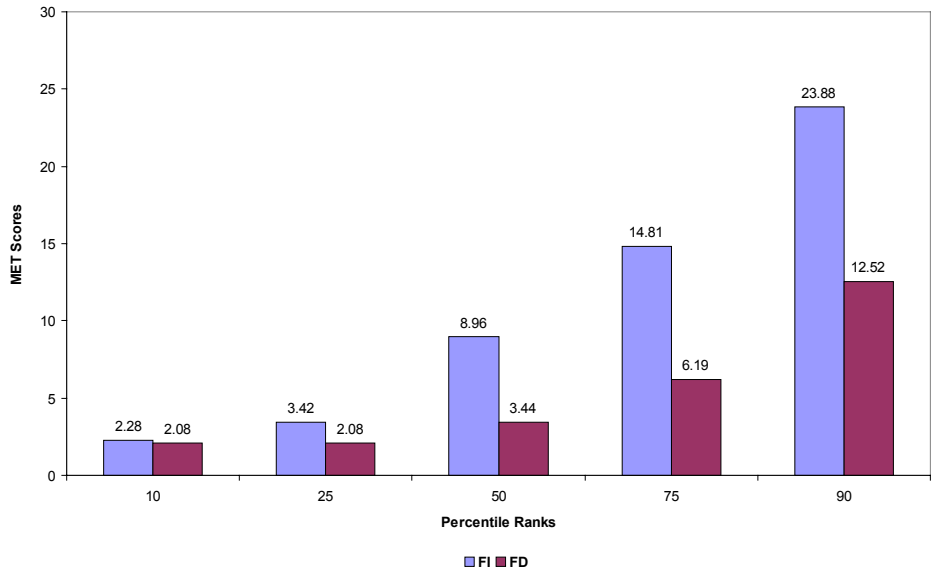

Figure 3 Comparison of MET Scores at Different Percentiles betwseen FI and FD Groups

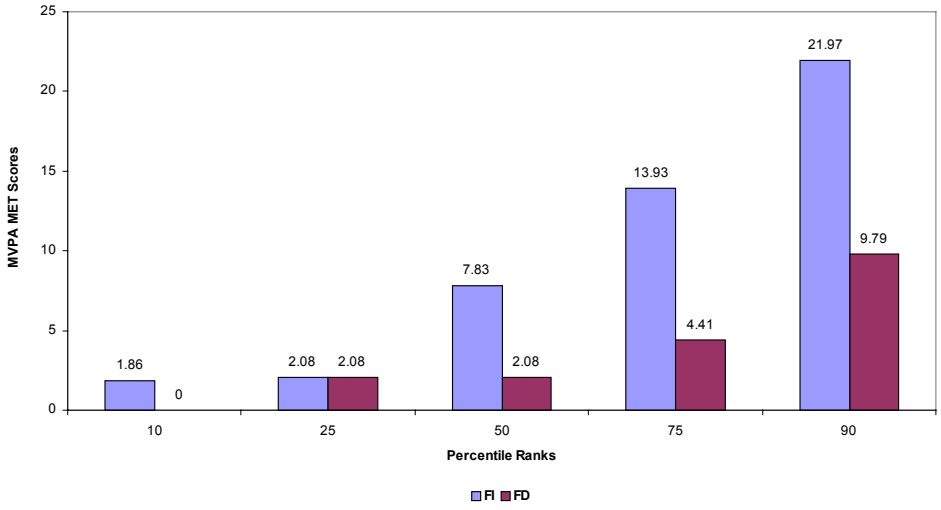

Figure 4 Comparison of MVPA MET Scores at Different Percentiles between FI and FD Groups

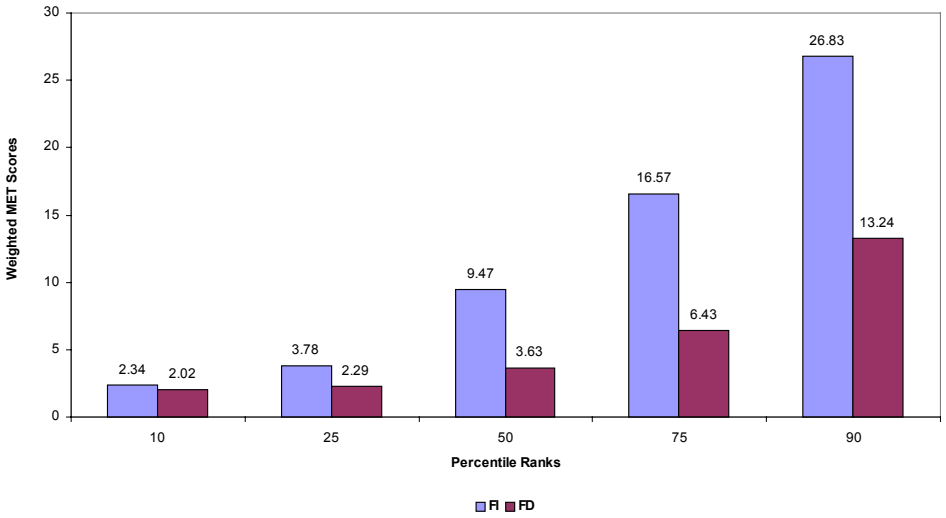

Figure 5 Comparison of Weighted MET Scores at Different Percentiles between FI and FD Groups

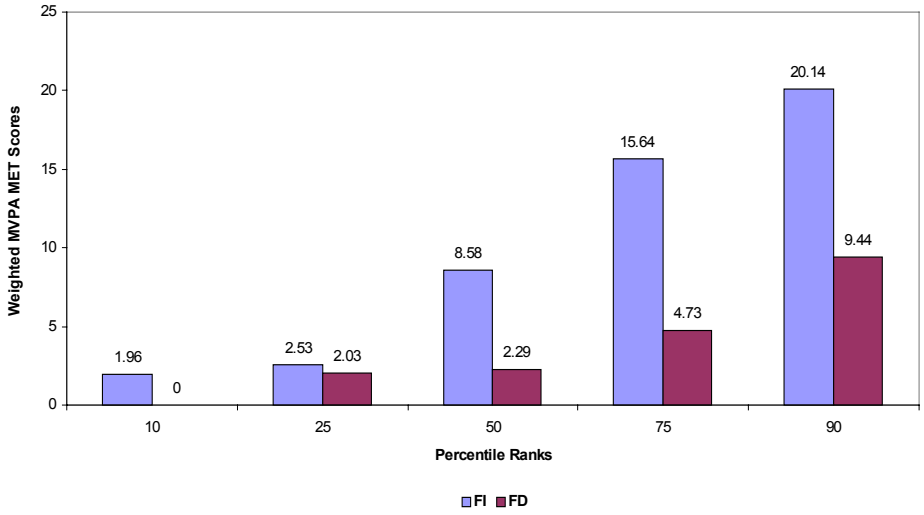

Figure 6 Comparison of Weighted MVPA MET Scores at Different Percentiles between FI and FD Groups

Percentiles at Different Levels of Physical Activity

The revised recommended amount of daily physical activity is the involvement of moderate to vigorous physical activity (MVPA) for cumulative 30 minutes, and adding more time in MVPA will add additional health and functional benefits (USDHHS, 1996). It was desirable to compare the percentiles at which the participants in two groups met this recommended physical activity level. The comparison was done at 30, 45, 60, and 75 minutes of MVPA respectively, and the results are summarized in Figure 7.

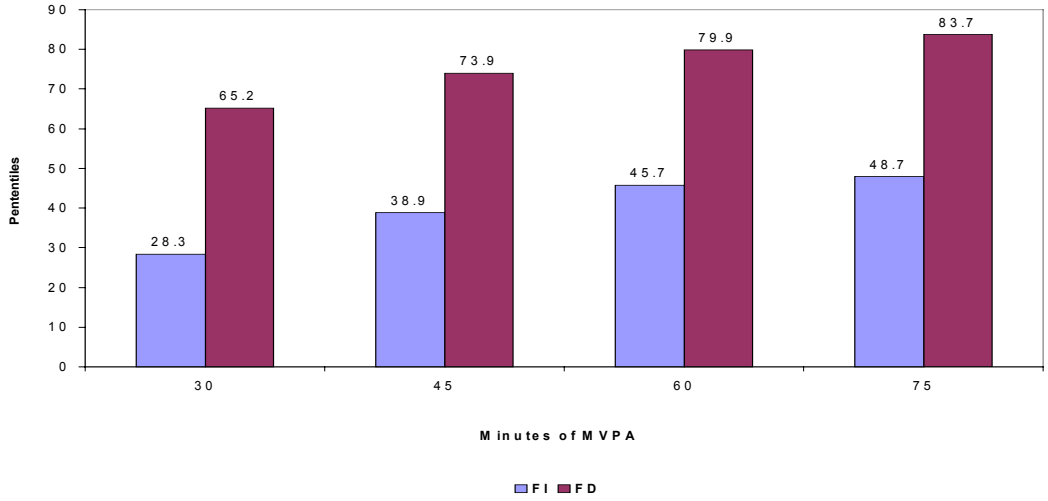

Figure 7 Comparison of Percentiles of Minutes of MVPA Between FI and FD Groups

The results indicated that the percentiles for 30 minutes of MVPA was 28.3 for FI group and 65.2 for FD group. This means, while more than 70 percent (100 – 28.3) participants in FI group met the recommended minimum level of physical activity (30-minute MVPA), only 34.8 (100 – 65.2) percent in FD group met this standard. This contrast was 61.1 (100 – 38.9) percent vs. 26.1 (100 – 73.9) percent for 45 minutes

MVPA, 54.3 (100 – 45.6) percent vs. 20.1 (100 – 79.9) percent for 60 minutes MVPA, and 51.3 (100 – 48.7) percent vs. 16.3 (100 – 83.7) percent at 75 minutes MVPA.

Pattern of Physical Activity

The second hypothesis of the present study was that there would be significant differences in physical activity behaviors between FD and FI adolescents in a randomly selected school day. Physical activity behaviors were reflected in the pattern of physical activity, participation in organized sports, and physical activity preference in the present study. This section is the report of the results of pattern of physical activity.

The participants reported their physical activities in three different times (before school, during school, and after school) of the previous day. Investigation into the patterns of daily physical activity would reveal how different parts of the school day contributed to the levels of total physical activity for FI and FD adolescents respectively.

Two of the six variables of physical activity, minutes of physical activity and MET scores, were involved in testing the possible differences in patterns of physical activity between FI and FD individuals. Again, the comparison was done among the four groups of male-FI, male-FD, female-FI, and female-FD. The variables compared were:

1. Minutes of physical activity before school
2. Minutes of physical activity during school
3. Minutes of physical activity after school
4. MET scores before school
5. MET scores during school
6. MET scores after school

The 2 X 2 (gender X FDI status) ANOVA was conducted with each of the six variables. Again, Bonferroni method for control of familywise Type 1 Error was used, and significant alpha level for each of the six dependent variables was .05 / 6, i.e., .0083. The results of the analysis for each of the six variables were summarized in Table 13, Table 14, Table 15, Table 16, Table 17, and Table 18.

Table 13

Two-Way ANOVA Results for Minutes of Physical Activity before School

Group	n	M	SD
Male-FI	24	11.96	20.22
Male-FD	22	5.00	9.26
Female-FI	22	9.00	12.68
Female-FD	24	4.79	10.68

Source	SS	df	MS	F	p	η^2
Gender	57.55	1	57.55	.29	.589	.003
FDI Status	715.64	1	715.64	3.66	.059	.040
Gender X FDI	43.40	1	43.40	.22	.639	.003
Residual	17208.92	88	195.56			
Total	18044.652	91				

Table 14

Two-Way ANOVA Results for Minutes of Physical Activity during School

Group	n	M	SD
Male-FI	24	29.17	17.30
Male-FD	22	27.27	12.12
Female-FI	22	34.55	25.54
Female-FD	24	29.79	18.56

Source	SS	df	MS	F	p	η^2
Gender	357.97	1	357.97	1.00	.321	.011
FDI Status	253.63	1	253.63	.071	.403	.008
Gender X FDI	46.94	1	46.94	.13	.719	.001
Residual	31589.11	88	358.97			
Total	32222.55	91				

Table 15

Two-Way ANOVA Results for Minutes of Physical Activity after School

Group	n	M	SD
Male-FI	24	76.13	101.22
Male-FD	22	20.72	27.26

Female-FI	22	90.55	97.60
Female-FD	24	35.21	48.20

Source	SS	df	MS	F	p	η^2
Gender	4793.88	1	4793.88	.84	.363	.009
FDI Status	70374.40	1	70374.40	12.27	.001	.122
Gender X FDI	.02	1	.02	.00	.998	.000
Residual	504680.40	88	5735.01			
Total	578390.87	91				

Table 16

Two-Way ANOVA Results for MET Score before School

Group	n	M	SD
Male-FI	24	1.19	2.25
Male-FD	22	.71	1.37
Female-FI	22	.66	.99
Female-FD	24	.33	.72

Source	SS	df	MS	F	p	η^2
Gender	4.82	1	4.82	2.24	.138	.025

FDI Status	3.84	1	3.84	1.78	.185	.020
Gender X FDI	.14	1	.14	.06	.801	.001
Residual	189.67	88	2.16			
Total	198.56	91				

Table 17

Two-Way ANOVA Results for MET Score during School

Group	n	M	SD
Male-FI	24	2.28	1.29
Male-FD	22	2.08	.60
Female-FI	22	2.81	2.48
Female-FD	24	2.11	1.05

Source	SS	df	MS	F	p	η^2
Gender	1.81	1	1.81	.80	.375	.009
FDI Status	4.57	1	4.57	2.01	.160	.022
Gender X FDI	1.47	1	1.47	.64	.424	.007
Residual	200.26	88	2.28			
Total	700.74	92				

Table 18

Two-Way ANOVA Results for MET Score after School

Group	n	M	SD
Male-FI	24	8.22	10.74
Male-FD	22	1.96	2.85
Female-FI	22	8.21	8.11
Female-FD	24	2.79	3.89

Source	SS	df	MS	F	p	η^2
Gender	3.79	1	3.79	.07	.787	.001
FDI Status	782.32	1	782.32	15.12	.000	.147
Gender X FDI	3.88	1	3.88	.08	.785	.001
Residual	4553.75	88	51.75			
Total	5340.49	91				

The results indicated no significant differences in interactions ($p > .05$), gender ($p > .05$), and FDI status ($p > .05$) for minutes of physical activity before school (Table 13), minutes of physical activity during school (Table 14), MET scores before school (Table 16), and MET scores during school (Table 17). For another two variables, minutes of physical activity after school (Table 15) and MET scores after school (Table 18), no

significant difference was found in either interaction ($p > .05$) or gender ($p > .05$). Significant differences were found, however, in FDI status for both minutes of physical activity after school ($F_{(1, 88)} = .12.27$, $p = .001 < .0083$, $\eta^2 = .12$) and MET scores after school ($F_{(1, 88)} = 15.12$, $p = .000 < .0083$, $\eta^2 = .15$).

This indicates that there were significant differences in the patterns of physical activity between FI and FD adolescents. Specifically, while FI students had almost the same levels of physical activity as did FD students before and during school, the former had a significant higher level of physical activity than do the latter after school. This difference is demonstrated more clearly in graphical form in Figure 8 and Figure 9, which suggest that the significant difference in the levels of physical activity between FI and FD adolescents came mainly from physical activity involvement after school.

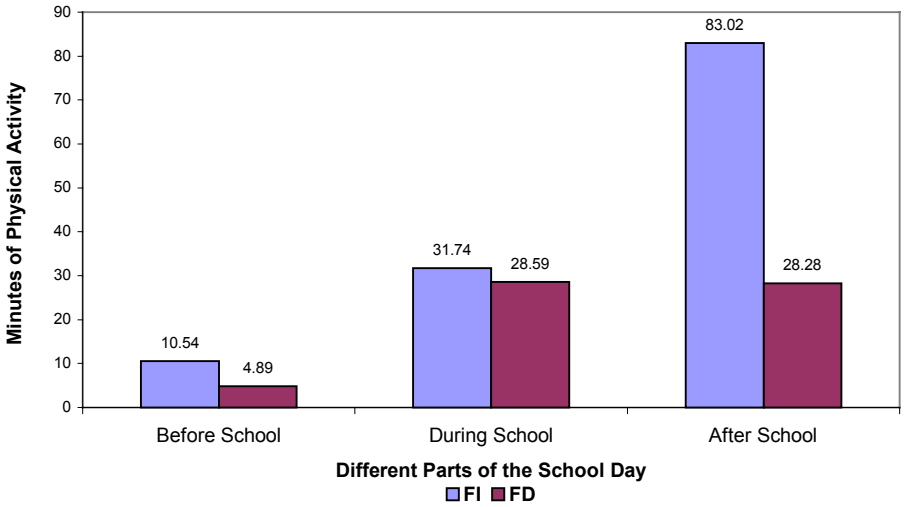

Figure 8 Comparison of Physical Activity Pattern in Terms of Mean Minutes of Physical Activity between FI and FD Groups

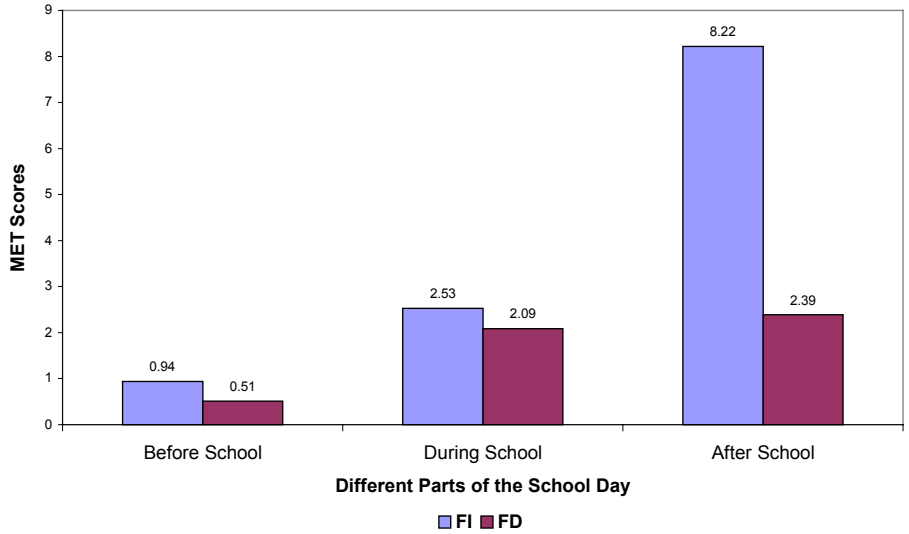

Figure 9 Comparison of Physical Activity Pattern in Terms of Mean Energy Expenditure between FI and FD Groups

A better understanding can be reached regarding how different parts of the school day contributed to the total amount of physical activity with the pies as being showed in Figure 10 and Figure 11. While the amount of physical activity after school was roughly

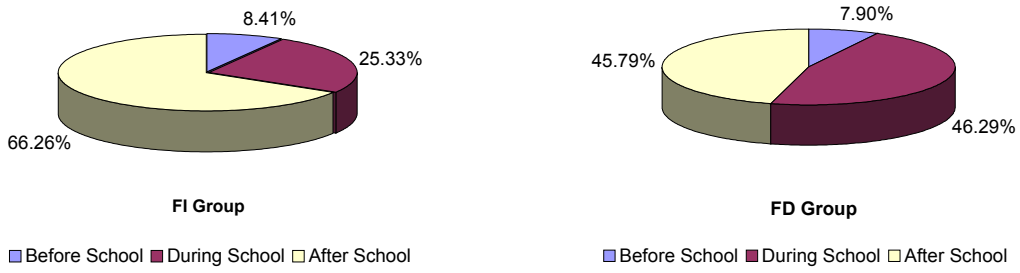

Figure 10 Comparison of the Percentage of Minutes of Physical Activity in Different Parts of the School Day between FI and FD Groups

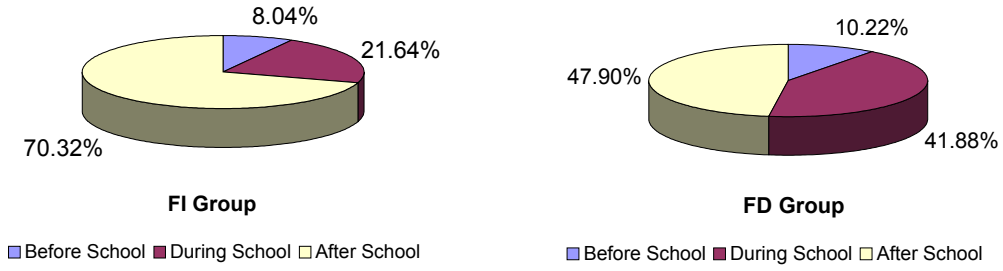

Figure 11 Comparison of the Percentage of MET Scores in Different Parts of the School Day between FI and FD Groups

the same as that during school for FD group, totally different pictures were with FI group for which the amount of physical activity after school constituted 66.26% for total minutes of physical activity (Figure 10), and 70.32% for total MET scores (Figure 11) of the day.

In summary, the results indicated the significant different patterns of physical activity for FI and FD adolescents, and after school was the period in which significant difference in the amount of physical activity occurred between FI and FD adolescents.

Participation in Organized Sports

It was desirable to investigate the factors that could contribute to the significant difference in after-school physical activity levels between FI and FD participants. A close exam revealed the difference in the number of participants who were currently involved in organized sports between FI and FD group. While there were 20 participants out of 46 involved in organized sports in FI group, the corresponding number in FD group was 10. Chi-square analysis indicated that the numbers in organized-sport participants for the two groups were significant different ($\chi^2_{(1,\, n = 92)} = 4.95$, $p < .05$). Most of the organized-sport participants reported the corresponding organized-sport involvement (usually lasted 90

minutes or more) on the previous day. This contributed partially to the difference in physical activity levels between FI and FD groups.

Physical Activity Preference

Investigation into the physical activity preference would help understand the differences in physical activity participation between FI and FD adolescents. Since physical activities during school were mainly influenced by the contents of physical education classes and did not necessarily reflect the participants' preference, the investigation was made for the periods of before school and after school only. Table 19 provides a summary of the numbers of participants in the specified activities and a rank-order listing of activity preference for FI and FD groups before school. Table 20 is the corresponding summary for the after-school period.

Walking, running, mixed walking/running, and weight lifting ranked the first four places for FI group in before-school period. As for FD group, the top four activities were walking, mixed walking/running, indoor chores, and active games (Table 19). There was no much meaningful difference that can be detected except that indoor chores, which involves almost no athletic skills, was in the top rank (third place) for FD group. This could be a reflection that FD adolescents were likely to choose physical activities that were less associated with sport skills. In addition, the energy expenditure related to top four activities was higher in FI group (3.3 + 8.0 + 6.0 + 4.5 = 21.8 METs) than that in FD group (3.3 + 6.0 + 3.5 + 5.0 = 17.8 METs). In terms of the numbers of the participation in before-school physical activity, the FI: FD ratio was 35:22, the former was 50% more than the latter.

In after-school period, basketball, walking, running, and exercise ranked the first four places respectively for FI group, and indoor chores, walking, mixed walking/running, and dance for FD group (Table 20). A remarkable contrast is that indoor chores went up to the first place in FD group as opposed to basketball in FI group,

Table 19

Physical Activity Preference before School by Number of Participation and by Rank

	FI (n = 46)		FD (n = 46)	
Physical activity	No.	Rank	No.	Rank
Walking	11	1	8	1
Running	5	2	1	3
Mixed walking/running	4	3	2	2
Weight lifting	4	3	1	3
Exercise (push-ups, sit-ups, etc.)	3	5	1	3
Dance	2	6		
Indoor chores	2	6	2	2
Volleyball	1	8		
Skating	1	8	1	3
Racket sports	1	8		
Ball playing	1	8		
Gymnastics			1	3
Basketball			1	3
Football			1	3
Active games (chase, tag, etc.)			2	2
Outdoor play (hide and seek, ect.)			1	3
Total	35		22	

Note. There were 24 activities listed in SAPAC. The activities that participants reported no involvement are not included in this table.

Table 20

Physical Activity Preferences after School by Number of Participation and by Rank

Physical activity	FI (n = 46) No.	Rank	FD (n = 46) No.	Rank
Basketball	16	1	2	6
Walking	11	2	9	2
Running	10	3	2	6
Exercise (push-ups, sit-ups, etc.)	8	4	2	6
Skating	5	5	2	6
Mixed walking/running	5	5	6	3
Indoor chores	5	5	14	1
Football	4	8	1	12
Dance	4	8	4	4
Weight lifting	3	10	1	12
Outdoor play (hide and seek, etc.)	2	11	1	12
Combatives (judo, karate, etc.)	2	11	2	6
Outdoor Chores	2	11	1	12
Bicycling	1	12	3	5
Swimming laps	1	12		
Gymnastics	1	12	1	12
Baseball/softball	1	12	1	12
Soccer	1	12	1	12
Racket sports	1	12		
Active games (chase, tag, etc.)	1	12	2	6
Total	84		55	

Note. There were 24 activities listed in SAPAC. The activities that participants reported no involvement are not included in this table.

indicating again that the FD participants tended to participate in physical activities with less athletic skills. This could be also demonstrated by the fact that, of top four physical activities with FD group, only dance was more related to athletic skills. By contrast, there

were two physical activities (basketball and exercise) with FI group that were more related to athletic skills.

The contrast of energy expenditure between the two groups became more noticeable in after-school period. While the adolescents in FI group had an energy expenditure of 25.3 METs (6.0 + 3.3 + 8.0 + 8.0), the corresponding number for FD group was 17.3 METs (3.5 + 3.3 + 6.0 + 4.5), with a difference of 8 METs (25.3 – 17.3). Again, there were 50% more FI participation ($n = 84$) involved in after-school physical activities than FD participation ($n = 55$).

In summary, compared with FI participants, FD participants tended to participate in less athletic skill related physical activities with less energy expenditure beyond school, and there were considerably less FD participants involved in physical activities beyond school.

The results of physical activity behaviors supports the second hypothesis of the study that there were significant differences between FD and FI adolescents in physical activity behaviors in a randomly selected school day. These differences were reflected in pattern of physical activity, participation in organized sports, and physical activity preference.

Reliability, Validity, and Assumptions of the Hypothesis Tests

The reliability of PRFT was checked by split-half method (Kaplan & Saccuzzo, 2001) with Pearson correlation, and the correlation coefficient indicated high reliability ($r = .73$, $p < .000$, $r^2 = .53$). The validity of PRFT was checked with Spearman correlation against the evaluation or rating of sport skills and interest in physical education and physical activity for the participants by the three physical education teachers. The

correlation between PRFT and the rating of the participants' sport ability was significant with $\underline{r} = -.41$, $\underline{p} < .000$, $\underline{r^2} = .17$. The correlation between PRFT and the rating of the participants' interest in physical education and physical activity was also significant with $\underline{r} = -.27$, $\underline{p} < .001$, $\underline{r^2} = .08$. In addition, the rating of sport ability was also correlated to the rating of interest in physical education and physical activity. The results indicated a very high correlation between the two ratings as $\underline{r} = .81$, $\underline{p} < .000$, $\underline{r^2} = .65$.

One of the assumptions that should be met with ANOVA is homogeneity of variance, which means that a dependent variable should have about the same variance for each level of a factor. When applying to two-way ANOVA, this assumption should be met among/between groups in three comparisons: (a) the four groups of interaction between gender and FDI status, (b) the two groups of gender, and (c) the two groups of FDI status. Because of big differences in the individual's level of physical activity that demonstrated in this study and other studies (Myers et al., 1996; Sallis et al., 1996) as well, the above assumption was not met with most of the dependent variables as indicated by the results of Levene's test ($\underline{p} < .10$).

In practice, however, the perspectives regarding variance homogeneity is more complicated. A long-held belief is that violations of variance homogeneity have little or no consequences for the F test (Keppel, 1991), which is robust against most violation of the assumptions (Hensley, personal communication, 1996). This is especially true if the number of cases in each group of a factor is similar (Norusis, 1996) or equal (Green, Salkind, & Akey, 1997) and $\underline{F}_{max.}$ (the largest variance divided by the smallest variance of a dependent variable) is not bigger than 16 (Olejnik, personal communication, 1999). Keppel (1991), however, brought some evidence that actual probability of Type I error

was greater than the stated significance level (i.e., a liberal test) when $\underline{F}_{max.} > 3$. As a result, Keppel (1991) provided a way of correction to the inflation of Type I error by lowering the significance level by half if $\underline{F}_{max.} > 3$.

In the present study, the numbers of the case in each of the four cells of the interaction was 24 (male-FI), 22 (male-FD), 22 (female-FI), 24 (female-FD), not equal but very similar. The numbers of the case were equal for the two groups of gender ($\underline{n}$ = 46) as well as for the two groups of FDI status ($\underline{n}$ = 46). Significant differences of PA variables appeared only for the factor of FDI status, which had equal cases. In addition, none of the variances that was heterogeneous had a $\underline{F}_{max.} \geq 16$. If the criterion of $\underline{F}_{max.} \leq 3$ is used, the relevant significant levels should be reduced by half. A $\alpha = .0083$ was the significant level set for each dependent variable in the F test in the present study, and the half of it was .00415. All the observed significant levels with the F test in the present study were $\alpha \leq .001$, much lower than .00415.

In summary, the F test in the present study was robust enough against violation of the assumption of variance homogeneity by any currently held criterion.

CHAPTER 5

DISCUSSION

The hypotheses of the study were that (a) there would be significant differences in physical activity levels in a randomly selected school day between FD and FI adolescents, and (b) that there would be significant differences in physical activity behaviors in a randomly selected school day between FD and FI adolescents. Accordingly, the results of the study are discussed based on following topics: (a) different physical activity levels between FD and FI adolescents, (b) different physical activity behaviors between FD and FI adolescents, (c) conclusions, and (d) consideration for further investigation.

Different Physical Activity Levels between FD and FI Adolescents

The results of the present study supported the first hypothesis that there would be significant differences in physical activity levels in a randomly selected school day between FD and FI adolescents. The results corroborates other researchers' findings on the relationships between FDI and sport (Brady, 1995; Docherty & Boyd, 1982; Liu, 1988, 1991; McLeod, 1985, 1987; Meek & Skubic, 1971; Raviv & Nabel, 1990; Rotella and Bunker, 1978; Souder & Bunker, 1972; Svinicki et al., 1974), motor learning (Goulet et al., 1988; Jorgensen, 1972; MacGillivary, 1979; Swinnen, 1984; Swinnen et al., 1986), physical education (Ennis et al., 1991; Ennis & Chepyator-Thomson, 1990; Ennis & Lazarus, 1990), and supports FDI theory (Witkin & Goodenough, 1977, 1981).

Rod-and-Frame Test (RFT) operationally distinguishes FD individuals from FI individuals and reflects differences in perception of upright status due to reliance on either internal or external cues. In other words, RFT measures the extent to which people can positively use their body information (i.e., sense of verticality, vestibular and proprioceptive information) in relation to potentially being involved in sport and physical activity.

Physical activity, although not equal to sport, is closely associated with sport. In fact, sport is one of the major forms of physical activities in the present day (Corbin et al., 2000). Physical activity participation involves frequently sport engagement, especially for adolescents with sport potential, who are usually classified as FI individuals as measured by Rod-and-Frame Test (Docherty & Boyd, 1982; McLeod, 1987; Meek & Skubic, 1971; Raviv & Nabel, 1990; Svinicki et al., 1974; Souder & Bunker, 1972). In the present study, a considerable correlation ($\underline{r} = -.41$, $\underline{p} < .000$, $\underline{r}^2 = .17$) between PRFT and sport ability was obtained, again suggesting that the ability to use body information could facilitate development of sport ability, and logically, enhance the sport engagement and physical activity level of students.

FI individuals, as measured by RFT, have a tendency to use body information, which makes them more competent and confident in sport and physical activity skills, thus experiencing more enjoyment and satisfaction from physical activity. This, in turn, enhances their inclination to participate in sport and physical activity. In *Children Moving*, Graham, Holt/Hale, and Parker (2001) explains that "Fitness comes from being physically active. Being physically active comes from enjoyment of activity, competence in skills, and confidence in self" (p. 49). In the present study much more FI students (20)

than FD students (10) were involved in organized sports after school, and this enhanced the average physical activity level considerably for FI students. It is also found in the present study that FI participants tended to choose physical activities with more athletic skills (Table 19 and 20) and thus had more energy expenditure than did FD participants. This, of course, also contributed to the higher physical activity level on the part of FI students.

The differences of PA levels between FD and FI adolescents in the present study were highly significant. For example, FI students' physical activity levels were twice (some quite close to triple) as much as those of FD students as reflected by each of the six variables of physical activity (Table 12). Effect sizes demonstrated by η^2 values for FDI factor (Table 6 to Table 11) were large (.14 or above) for the five physical activity variables and medium (.12) for one. When a η^2 value is .14, this means 14% of the total variability in the dependent variable (physical activity level) is explained by the independent variable (FDI). In addition, while 71.7% of FI participants met the recommended minimum level of PAη (30-minute moderate to vigorous physical activity involvement), only 34.8% FD participants met this standard. This contrast was 61.1% vs. 26.1% for 45 minutes MVPA, 54.3% vs. 20.1% for 60 minutes MVPA, and 51.3% vs. 16.3% at 75 minutes MVPA (Figure 7).

Many studies have been conducted in an attempt to identify and understand the influences on physical activity habits of adolescents (Bungum &Vincent, 1997; Dishman & Sallis, 1994; Douthitt, 1994; Garcia et al., 1995; Janz & Mahoney, 1997; Rowland, 1998, 1999; Sallis, 1993; Sallis & Owen, 1998; Stucky-Ropp & DiLorenzo, 1993; USDHHS, 1996). There are, in summary, at least three groups of factors that are already

known to influence physical activity habits of adolescents. The first is the decline of biological drive with increasing age (Rowland, 1998, 1999). The second is the environmental and perceptual conditions that are listed in Table 3. The third is the subgroup-specific determinants of physical activity (USDHHS, 1996). They are gender, socioeconomic status, and ethnicity, which tend to either facilitate or impede physical activity participation, depending on which category one is located.

Given the considerable influence that FDI has on physical activity levels of adolescents, it is reasonable to consider FDI measured by RFT as another factor to influence physical activity levels of adolescents. Or, at least, the different levels of physical activity of adolescents could be viewed from the perspective of FDI, which might be either independent of, or interact with, other factors to influence physical activity levels. Examination of Table 5 reveals that participants were roughly equally distributed among FI and FD groups across gender, grade, and ethnicity. For example, there were 24 FI and 22 FD individuals for male, and 20 FI and 19 FD individuals for White. This might suggest that FDI could be a factor that goes across gender and ethnicity to influence physical activity level of adolescents. Or in other words, FDI could be another subgroup-specific factor that would either facilitate (FI individuals) or impede (FD individuals) physical activity participation of adolescents.

Another interesting finding with the study was that within-group difference in physical activity levels was also big, as indicated in Figure 1 to 6. While FI is conducive to sport potential and participating in physical activity, not all FI participants demonstrated high levels of physical activity. There is certainly a considerable room to improve physical activity levels for FI individuals with low level physical activity given

their sport potential. Reflective physical educators might critically think of the current curriculum and their instructional strategies and philosophy. For example, a possible way to enhance students' sport and physical activity involvement is to teach them to learn movement skills when they are young children, an approach known as "skill themes approach" (Graham et al., 2001). With this approach, students will develop competence and confidence in performing a variety of movement skills, which in turn is conducive to their participating in sports and physical activity for the rest of their life. The skill themes approach is especially beneficial for FI students because they have higher potential to learn sport skills. With this approach, all FI students are expected to have a high level of physical activity in the future.

Similarly, FD participants did not necessarily all demonstrate low level of physical activity. About 25% of FD participants (at percentile of 75) in the present study demonstrated acceptable levels of physical activity (Figure1 to 6). It would be interesting to investigate why students with relatively poorer sport potential have a relatively high level of physical activity. A possible reason could be the biological drive, although declines with increasing age, still play some role with middle school students in physical activity participation. If it is true, how to take the advantage of biological drive to get FD students to learn sports skill and thus helping them keep physically active could be another aspect that deserves investigation.

Some previous studies (Adams, Schoenborn, Moss, Warren, & Kenn, 1995; Armstrong, Balding, Gentle, & Kirby, 1990; Myers et al., 1996) indicated differences in physical activity level between boys and girls, others (Armstrong & Bray, 1991; Janz, Golden, Hansen, & Mahoney, 1992) didn't. The present study indicated no differences in

physical activity level between boys and girls. It may be that the questionnaire was used in the study and the girls recalled their physical activity with more detail.

In summary, FI adolescents demonstrated significant higher levels of physical activity than did FD adolescents. This might be because FI adolescents have a higher ability or tendency to use body information as conducive to their sports involvement and physical activity participation. FDI as measured by RFT could be considered as a factor to influence physical activity levels of adolescents across gender and ethnicity. There is room to improve physical activity levels for FI adolescents with low level physical activity given their sport potential. The possibility also exists regarding taking advantage of biological drive for being physically active to help FD adolescents learn sport skills and thus enhancing their interests in participating in physical activity in the future. Finally, no difference was indicated in terms of physical activity levels between boys and girls, and this might be that the girls recalled their physical activity with more details.

Different Physical Activity Behaviors between FD and FI Adolescents

The results of the present study also supported the second hypothesis: there were significant differences in physical activity behaviors in a randomly selected school day between FD and FI adolescents. This was first demonstrated by physical activity distribution among three parts (before, during, and after school) of the school day. While there was no significant difference in physical activity levels between FI and FD groups before and during school, the FI adolescents demonstrated significant higher levels of physical activity than did FD adolescents after school (Table 13 to Table 18).

With respect to before school period, the time for physical activity was limited. It might not be quite reasonable to expect significant differences in physical activity

between the two groups during before school period (Figure 8 and Figure 9), although the p (.059) value was quite close to significant level for the minutes of physical activity (Table 13). During school period, since physical activities lasting less than five minutes were not reported in the questionnaire (SAPAC), many shortly sustained physical activities that happened in recesses did not count. As a result, the only time for physical activity counted during school was when the students participated in physical education classes. With the same content and same allotted time for physical activity for both FI and FD adolescents in physical education classes, not much differences appeared in physical activity levels between the two groups during school period (Figure 8 and Figure 9).

However, in after school, a period that is possible for many physical activities to happen, the differences in physical activity levels between FD and FI adolescents became contrasting. Specifically, FI adolescents demonstrated three times physical activity levels as much as FD in both minutes of physical activity (83.2 vs. 28.28, Figure 8) and energy expenditure (8.22 vs. 2.39, Figure 9). FI adolescents' physical activity levels after school were also considerably higher than those during school (83.02 vs. 31.74 for minutes of physical activity, and 8.22 vs. 2.53 for energy expenditure). In contrast, FD adolescents' physical activity levels after school were about the same as those during school (28.28 vs. 28.59 for minutes of physical activity and 2.39 vs. 2.09 for energy expenditure).

When the physical activity distribution was examined further, it was found that the amount of physical activity after school constituted 66.26% for minutes of physical activity and 70.32% for energy expenditure of the whole day for FI adolescents (Figure 10 and Figure 11). However, for FD adolescents, the amount of physical activity after

school was almost the same as that during school (Figure 10 and Figure 11) for both minutes of physical activity (45.79% vs. 46.29%) and energy expenditure (47.90% vs. 41.88%). It seems that after-school period was the time for FI adolescents to enhance their physical activity levels considerably. However, FD adolescents did not take the advantage of time availability or opportunities to raise their physical active levels after school.

One important reason for contrasting differences in after-school physical activity levels was different involvement of organized sports. While there were 20 out of 46 FI adolescents participated in organized sports (varsity or club sports) after school, the corresponding portion of FD adolescents was 10 out of 46. Clearly, the stronger inclination and tendency to be involved in sports on the part of FI adolescents, who tend to have higher sport potential and ability due to their ability to use body information, may have greatly contributed to their sport engagement, hence increasing their physical activity level.

Many studies have been done investigating sport preferences of FI and FD high-level athletes (Bard, 1972; Barrell & Trippe, 1975; Chu, 1988; Drouin, Talbot, & Goulet, 1986; Kane, 1972; Liu, 1996, 1999; Liu & Qiu, 1992; McLeod, 1985; Pargman, Schreiber, & Stein, 1974; Wang, 1988). Most of these studies produced pretty consistent results (Liu, 1997). That is, the athletes in closed-skill dominated sports (most of them are individual sports such as swimming and gymnastics) are found to be more FI, and the athletes in open-skill dominated sports (such as different ball games) are more FD. The findings are considered highly consistent with FDI theory (Liu, 1997): while the athletes' decision-makings in closed-skill sports are mainly based on internal information

(proprioceptive feedback, for example), athletes in open-skill sports rely more on external situations (i.e., the movements and intention of the opponents and teammates).

No literature was available, however, with respect to physical activity preference of FI and FD ordinary people. The present study, for the first time, investigated physical activity preference of FI and FD adolescents. While the results were different from those with high-level athletes, they were in line with FDI theory.

Walking, running, mixed walking/running, and weight lifting were top four physical activities in before-school period for FI group; walking, mixed walking/running, indoor chores, and active games were for FD group correspondingly (Table 19). It is noticeable that indoor chores, which has nothing to do with sport skills, ranked third in FD group, reflecting FD adolescents' less competence in sport skills. This contrast became more obvious in after-school period. While basketball, walking, running, and exercise ranked the first four places respectively for FI group after school, indoor chores, walking, mixed walking/running, and dance were top four activities for FD group (Figure 20). Indoor chores, in after-school period, ranked up to first in FD group as opposed to basketball in FI group. Further, it seems dance was the only activity that was more or less related to athletic skills in top four activities in FD group. As for FI group, basketball and exercise could be considered sport related.

Sport-related physical activities tend to involve more energy expenditure than non-sport-related physical activities. As a result, FI adolescents had higher energy expenditures than did FD adolescents. The energy expenditure of top four activities for FI adolescents before school was 21.8 MET (3.3 + 8.0 + 6.0 + 4.5), the corresponding number for FD adolescents was 17.8 MET, with a difference of 4 MET (21.8 – 17.8).

This difference went up to 8 MET in after school period, since energy expenditure of top four activities was 25.3 MET (6.0 + 3.3 + 8.0 + 8.0) for FI adolescents and 17.3 MET (3.5 + 3.3 + 6.0 + 4.5) for FD adolescents, respectively. It seems that FI adolescents' sport potential made them get involved more in sport-related activities, which contributed not only to their enhanced minutes of physical activity, but also to their enhanced energy expenditure rate.

In summary, physical activity behaviors between FI and FD adolescents were quite different from each other. After school was the period for FI adolescents to demonstrate significant higher physical activity levels than FD adolescents, and much more FI adolescents got involved in organized sports than did FD adolescents. Further, FI adolescents tended to participant in physical activities that were more related to sports. This contributed not only to FI adolescents longer minutes of physical activity, but also to their higher energy expenditure rate compared with FD adolescents. These differences in physical activity behaviors may be related to FI adolescents' higher sport potential, which facilitated FI adolescents to get more involved in sport-related activities, hence increasing their physical activity levels in terms of both minutes of physical activity and energy expenditure.

Conclusions

The conclusions that can be drawn on the basis of the results of the present study are:

1. FI adolescents had a considerably higher level of physical activity participation than FD adolescents in a randomly selected school day.

2. After school period was the time for FI adolescents to demonstrate higher level of physical activity involvement than FD adolescents.

3. There were much more FI adolescents than FD adolescents who were involved in organized sports and this contributed greatly to enhancing FI adolescents' level of physical activity.

4. FI adolescents were more likely than FD adolescents to participant in physical activities that were more related to sports and expended more energy.

Consideration for Further Investigation

Based on the present study, considerations for further investigation in the future are as follows.

1. The convenient sampling (intact subjects) method, rather than random sampling, in the present study may result in the sample that was not representative of the adolescents population. As a result, the sampling method in the present study may reduce the degree to which the findings in this study can be inferred or generalized. A similar study to this one with random sampling should be conducted to reconfirm the findings in this study.

2. A questionnaire, a relatively less reliable instrument, was utilized with the study for the measurement of physical activity level of the adolescents. More reliable instrument, such as heart rate monitor and accelerometer, could be used for the similar studies in the future.

3. The present study initially investigated the impact of FDI on adolescents' physical activity level. Many related studies could be conducted to understand better how FDI influence adolescents physical activity level, and what innovation could be made to

enhance FD adolescents' physical activity level. For example, comparing learning behaviors of FD and FI adolescents in the physical education class to identify the contents and instructional strategies that are most suitable to FD students. Another one could be comparing attitudes towards physical education and physical activity for FD and FI adolescents and investigating the way to motivate FD students to participate more in physical activity.

4. This new research line of physical activity of adolescents has potential implication in pedagogy since it may bring some improvement and reform in terms of physical education program and instruction strategies to enhance physical activity levels of public school students, especially for FD adolescents. Significant benefits are likely to accrue from the continued work in this research area. Therefore, this research line deserves attention and involvement in the future.

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APPENDIX A

INFORMED CONSENT FORM (PARENT OR GRARDIAN)

Informed Consent Form (Parent or Guardian)

I give my consent for my child _____to participate in a study titled "Field Dependence-Independence and Physical Activity among Adolescents", which is being conducted by Mr. Wenhao Liu, from the Department of Physical Education at UGA (Tel: 542-5947), under the direction of Dr. Jepkorir Rose Chepyator-Thomson, Department of Physical Education at UGA (542-4434). I understand that this participation is completely voluntary. My child can stop taking part at any time without giving any reason, and without penalty. I can ask to have the information related to my child returned to me, removed from the research records, or destroyed.

The purpose of this research is to understand the relationship between the use of body information and physical activity participation. My child will have a chance to reflect about his/her physical activity participation. In addition, my child's participation in the study may lead to a better understanding of the relationship between the use of body information and adolescents' levels of physical activity. I understand that my child will participant in the study by join in two activities. The first is to go through a test regarding the use of body information, which takes only three minutes adjusting a tilted rod to the vertical position. The second is to fill out a questionnaire (about 15-20 minutes) regarding the participation of physical activity. One example of the questions is "Did you participate in physical education class yesterday?" Both activities will take place in the regular school physical education class during Fall 2001 Semester. No discomforts, stresses, or risks are expected with the two activities.

I understand that my child's information obtained will remain confidential unless otherwise required by law, and will be utilized only for the purpose of the study. No personal information will be released to anyone other than Mr. Wenhao Liu without my expressed written consent. Mr. Liu will answer any further questions about the research, now or during the course of the research, and can be reached by telephone at (706) 542-5947, or by e-mail at <wenhao@arches.uga.edu>.

I understand the procedures described above. My questions have been answered to my satisfaction, and I agree to allow my child to participate in this study. I have been given a copy of this form to keep.

_____
Signature of the Researcher. Date

_____
Signature of Parent or Guardian. Date

For questions or problems about your rights please call or write: Human Subjects Office, University of Georgia, 606A Boyd Graduate Studies Research Center, Athens, Georgia 30602-7411; Telephone (706) 542-6514; E-mail address IRB@uga.edu.

APPENDIX B

ASSENT FORM (STUDENT)

Assent Form (Student)

I agree to participate in a study regarding the physical activity participation of adolescents. The study will be conducted by Mr. Wenhao Liu, from the Department of Physical Education at UGA (Tel: 542-5947). I understand that this participation is completely voluntary. I can stop taking part at any time without giving any reason, and without penalty.

I understand the Mr. Liu wants to get the information to know the relationship between the use of body information and adolescents' physical activity participation. I know I'll go through two simple instruments. The first is a measurement regarding the use of body information, which takes only several minutes adjusting a tilted rod to the vertical position. The second is to fill out a questionnaire (about 20 minutes) regarding the participation of physical activity. There will be no discomforts, stresses, or risks with the two measurements.
.

_____
Signature of the Researcher. Date

_____
Signature of the Student. Date

For questions or problems about your rights please call or write: Human Subjects Office, University of Georgia, 606A Boyd Graduate Studies Research Center, Athens, Georgia 30602-7411; Telephone (706) 542-6514; E-mail address IRB@uga.edu.

APPENDIX C

DEMOGRAPHIC INVENTORY

Demographic Inventory

Name_____

Gender: F___ M___ Grade: 6 ____ 7____ 8____

The date of birth: ____/____/____
M D Y

Height: feet____ and inches_____, or centimeters_____

Weight (in pounds)_____ ,or in kilograms_____

Race: Black____ White____ Pacific/Asian____ Hispanic/Latino____

Other (specify)_____

Do you currently participate in any organized sport (i.e., varsity or sport club, etc.)?

Yes___ No___

If "Yes", what organized sport are you currently involved in?

Specify_____

APPENDIX D

EVALUTION SHEET (PHYSICAL EDUCATION TEACHER)

Dear Coach,

Thank you very much for your support for my research. My research could not go so smoothly without your support. In order to demonstrate the validity of the measurements that I did for the students, I need you to evaluate each of your student's sports ability/skill and interest in participating in PE and physical activity (PA) in the following five-point scales. Please also indicate any organized sports that each student is currently participating in. This includes the joining in any organized sports for any period(s) in 2001-2002 academic year. Thank you very much.

Sports Ability/Skill Evaluation

Very poor poor average high very high
1 2 3 4 5

Interest in PE and PA Evaluation

Very low low average high very high
1 2 3 4 5

Participation in Organized Sport

Yes___ No___ (if yes) What sports_____

Names	Sport ability 1 2 3 4 5	Interest in PE & PA 1 2 3 4 5	Organized Sport Yes__ No__ What sports_____
xxxx	_ _ _ _ _	_ _ _ _ _	__ __ _____
xxxx	_ _ _ _ _	_ _ _ _ _	__ __ _____
xxxx	_ _ _ _ _	_ _ _ _ _	__ __ _____
xxxx	_ _ _ _ _	_ _ _ _ _	__ __ _____
xxxx	_ _ _ _ _	_ _ _ _ _	__ __ _____
xxxx	_ _ _ _ _	_ _ _ _ _	__ __ _____
xxxx	_ _ _ _ _	_ _ _ _ _	__ __ _____
xxxx	_ _ _ _ _	_ _ _ _ _	__ __ _____

APPENDIX E

PROTABLE ROD-AND-FRAME TEST INSTRUCTION

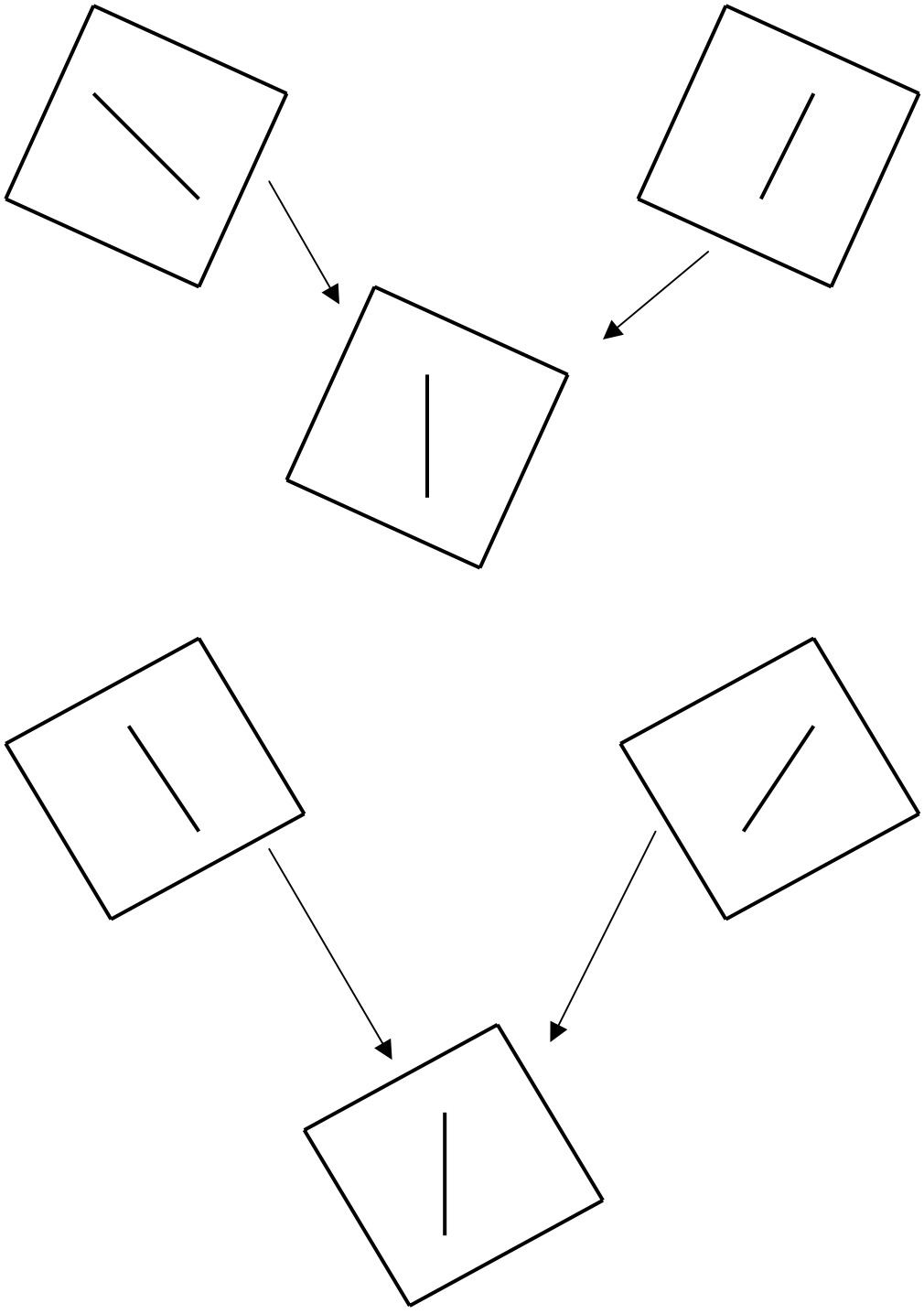
Portable Rod-and-Frame Test Instruction

Would you please put your eyes against this opening and look through it. Now you can see a tilted frame and a tilted rod. You will adjust or rotate the tilted rod with this small handle until you think that the rod is vertical (with demonstration to make sure the participant understands what he/she is going to do). When you think the rod is vertical, please say OK to me. You will do this eight times.

APPENDIX F

ADJUSTMENT OF THE TILTED ROD

Adjustment of the Tilted Rod



APPENDIX G

SELF-ADMINSTERED PHYSICAL ACTIVITY CHECKLIST (SAPAC)

Self-Administered Physical Activity Checklist (SAPAC)

(Version 9/30/1996, for Grades 6-8)

Section A: General Information

Administer Use Only		
A1.	Form Version	_0_ _9_ / _3_ _0_ / _9_ _6_ M D Y
A2.	Measurement Period	_____
A3.	Today's Date	___ ___ / ___ ___ / ___ ___ M D Y
A4.	Administrator's Initials	

A5. Did you attend school yesterday?

No…….1
Yes…….2

A6. Did you participate in physical education class yesterday?

No…….1
Yes…….2

A7. If yes, how many minutes long was physical education class?

|__|__|__| Minutes

A8. Did you participant in a recess or break yesterday?

No…….1
Yes…….2

A9. If yes, how many minutes of recess or break did you have?

|__|__|__| Minutes First Recess/Break
|__|__|__| Minutes Second Recess/Break

Section B: Activities

		None, Some, Most		None, Some, Most		None,Some, Most		
	Activity	Before School	N S M	During School	N S M	After School	N S M	
1	Bicycling							1
2	Swimming Laps							2
3	Gymnastics: bars, beam, tumbling, trampoline							3
4	Exercise: push-ups, sit-ups, jumping rope							4
5	Weight lifting							5
6	Basketball							6
7	Baseball/softball							7
8	Football							8
9	Soccer							9
10	Volleyball							10
11	Skating: ice, roller, rollerblade,							11
12	Hockey: ice floor, field							12
13	Racket Sports: badminton, tennis, paddleball							13
14	Ball Playing: four square, dodge ball, kickball							14
15	Active Games: chase, tag, hopscotch							15
16	Outdoor Play: climbing trees, hide and seek							16
17	Water Play: in pool, ocean or lake							17
18	Combatives: judo, karate, competitive wrestling							18
19	Dance							19
20	Outdoor Chores: mowing, raking, gardening							20
21	Indoor Chores: mopping, vacuuming, sweeping							21
22	Mixed walking/running							22
23	Walking							23
24	Running							24
25	Other, Name of Activity:							25
26	Other, Name of Activity:							26
27	Other, Name of Activity:							27

	Before School	**After School**
T.V./Video	H. 1 ___ ___ hours plus ___ ___ minutes	H. 2 ___ ___ hours plus ___ ___ minutes
Video Games & Computer Games	H. 3 ___ ___ hours plus ___ ___ minutes	H. 4 ___ ___ hours plus ___ ___ minutes

APPENDIX H

AELF-ADMINISTERED PHYSICAL ACTIVITY CHECKLIST PROTOCOL

Self-Administered Physical Activity Checklist Protocol

(Version 9/30/96, for Grades 6-8)

Purpose

The purpose of the self-administered physical activity checklist (SAPAC) is to collect information from students about their physical activities and selected sedentary activities occurring during the previous school day.

Equipment

SAPAC protocol, SAPAC forms, pencils (one per student plus extras), overhead projector and transparencies or posters of pages 1 and 2 of the SAPAC form, poster of N-S-M (None, Some, Most).

Preparation

- Contact school 1-2 days prior to administration to confirm schedule and use of facilities with office and teachers.
- If using transparencies, check with school to determine availability of an overhead projector.
- On the day of measurement, check in at the school office and locate the room for measurement.
- Get previous day's schedule from a school representative (school start and end times, how many minutes for recess/break, PE, lunch).
- Set up overhead projector (or posters) and N-S-M poster.
- Make sure all students have pencils and are in a good position to see the overhead (or posters) and hear instructions.
- Distribute SAPAC forms to students.

Note: Instructions to be read aloud to the students are in **bold** type. Instructions for the administrators are in plain type.

Instructions to Class

A. General Instruction:

Use the following General Introduction prior to administration of any SAPAC measurement (underscored text is considered essential elements of the introduction and must be presented at every measurement session).

Good morning/afternoon. My name is _____. Thank you for agreeing to participate in the study. We are here today to help you fill out the SAPAC form. Remember, <u>There are no right or wrong answers and no one at home or school will</u>

see your answers. Please check to make sure that your name is on the page attached to the form in front of you. If not, raise your hand.

B. Introductory Dialogue for SAPAC:

The form that I am asking you to complete today is the physical activity checklist. We want to know what physical activities students your age do. We want you to tell us what physical activities you did yesterday. Are there any questions before we start?

C. Completion of Page 1 of ASPAC Form:

1. Administrative items

Section A, items A1 to A4, should be completed by the administrator prior to questionnaire administration.

Items A5 to A9 should be read aloud by the administrator and completed by the students.

(Use a blank form on an overhead projector or poster to lead students)

A5 **Did you attend school yesterday? Circle "1" for no or "2" for yes.**
A6 **Did you participate in physical education class yesterday? Circle "1" for no or "2" for yes.**
A7 **If you circled yes, how many minutes long was physical education class?** (Use the schedule information obtained from the school representative to assist children in competing this question)
A8 **Did you participate in recess or break yesterday? Circle "1" for no and "2" for yes.**
A9 **If you circled "Yes", how many minutes of recess/break did you have? If you had amore than one recess/break period, list them separately. If you had a lunch break, fill in the number of minutes you had left after you finished eating.** (Use the schedule information obtained from the school representative to assist students in completing this question.)

D. Instructions for section B, page 2 of the form: Recording physical activities, duration and intensity.

1. Defining Physical Activity

One thing we want to learn is to learn is the amount and type of physical activity students your age do in a day. Today we are going to talk about the physical activity that you did yesterday. What day was yesterday?

Physical activity is bodily movement such as when you move your arms and legs. You do some physical activities to move from place to place, like running or walking. Some physical activities you do in one place, like jumping jacks or sit ups.

2. Time Estimation

We want you to tell us about those physical activities that were done for <u>five</u> minutes or more. So if you did an activity <u>yesterday</u>, for <u>five</u> minutes or more, we want you to write it down. You may do a physical activity for 20, 60 or more than 90 minutes.

3. Actual Time Active

Sometimes during games or physical activities you may stop and do something else, like resting or waiting in line. We want to know about the time you were actually active. We want you to write down how much time you were actually doing an activity. So, if you played basketball for 60 minutes, but you rested for 10 minutes, how many minutes did you actually play and what is the number you will write down? (Answer is 50 minutes.)

4. Checklist of Activities

Now turn to the second page. <u>But do not write anything yet</u>. This is a list of different types of physical activity. Later I will be asking you about whether you did any of them before school, during school, and after school yesterday.

For each activity, you will write the number of minutes you were actually doing the activity. But only if you did the activity for 5 minutes or more. (Demonstrate on the overhead or poster recording 10 minutes of bicycling before school.)

In addition, for each activity you did yesterday, we want you to know whether it made you breathe hard or feel tired, None, Some, or Most of the time. You will put an "N" for none, "S" for some, or "M" for most of the time in the box nest to the number of minutes. (Demonstrate putting "S" next to the 10 minutes of bicycling.)

Probable no one did all these activities yesterday, and it's OK If you did not do any of them. For every activity you did not do yesterday, or did for less than 5 minutes, put a zero in the box. (Demonstrate putting a zero for swimming laps before school.) **Anytime you put a zero, don not write N, S, or M.**

Do not count the same activity in two different places. For example, if you were running while playing soccer for 20 minutes, you would put 20 next to soccer. <u>Do not list that same 20 minutes again</u> next to running.

Items # 22, 23, and 24 ask about mixed walking/running, walking, and running you did yesterday. We walk and run many times during the day, often for less than 5 minutes continuously (such as going from class to class). Do not include these.

 # 22: Mixed walking/running is a combination of walking and running where you walk some and run some. Did you do 5 minutes or more of mixed walking and running yesterday?

 # 23: Did you walk continuously for 5 minutes or more at one time yesterday? Did you take a walk, walk to school, or walk your dog?

 # 24: Did you run 5 minutes or more at one time yesterday Did you run laps, go for a run?

If you walked your dog for 10 minutes before school and they walked to school for 15 minutes, you would add the times together and write 25 minutes in the box (# 23) for walking before school.

There may be some physical activities which you did yesterday that are not on this list. Please write these activities in the space at the bottom marked "other". Be specific. (Demonstrate with an example in "other" using the after school column. Include name of activity, number of minutes, and the letter N, S. or M.)

We still have more instructions. However, do you have any questions now?

5. Completing the SAPAC Form

You will go through this list of activities three different times. Once for before school, once for during, and the last for after school.

a. Before School

Now we will begin to fill out the checklist. Think about before school <u>yesterday</u> – From the time you woke up until the bell rang for school to start. Think about physical activities you did for five or more minutes. Did you do anything special? How did you get to school? Did you participate in any program/activities before classes started?

For the first couple of activities, use prompts 1) and 2). Periodically use prompts for: "5 or more minutes", "actually active" time, "N-S-M", to write activity time in minutes and to put a zero if they did not do the activity.

1) **Did you do _____for 5 minutes or more <u>yesterday</u> before school?**

2) **If you did, write the number of minutes and a letter (N, S or M) if you were breathing hard or felt tired for none, some or most of the time.**

Monitor students as they work towards the bottom of the column. As students are nearing completion of the "Before School" column, give directions for "During School". Students can continue to work on the checklist while these instructions are given.

b. During School

Now we are going to talk about physical activities you did during school yesterday. During school is the time between the morning bell and the last afternoon bell. Think about what you did in school yesterday. Did you d any special activities? Think about PE, recess/break and after lunch.

Monitor students as they work towards the bottom of the column. Periodically use prompts for: "5 or more minutes", "actually active" time, "N-S-M", to write activity time in minutes and to put a zero if they did not do the activity. Remind them about PE and recess/break. As student are nearing completion of the "during School" column, give directions for "After School". Students can continue to work on the checklist while these instructions are given.

c. After School

After school covers the time from when you were dismissed from school yesterday (i.e., the last school bell rang) until you went to sleep. Think about activities you did and places you went. Include activities held at school. Did you have a team practice? How did you get home? Did you play outdoors? Stop when you get to the bottom of this column.

Monitor students as they work towards the bottom of the column. Periodically use prompts for: " or more minutes", "actually active" time, "N-S-M", to write activity time in minutes and to put a zero if they did not do the activity. Remind them about after school practices.

d. TV and Video, Video and Computer Games before School

Now I am going to ask you about TB/video watching, video games and computer games before school yesterday. Look at the box at the bottom of the page.

1) TV and Video

   Think about whether you watched any TV or videos before school <u>yesterday</u>. Record this as hours plus minutes, For example, watching TV from 6:00 to 7:30 a.m. is recorded as 1 hour plus 30 minutes.

   If you watched 5 minutes or more of TV before school <u>yesterday</u>, write the hours plus minutes. If you watched less than 5 minutes, write zero.

2) Video and Computer Games

   Now think if you played any video or computer games for 5 minutes or more before school yesterday. Write the hours plus minutes you played

video games or computer games before school yesterday. If you played less than 5 minutes, write zero.

e. TB and Video, Video and Computer Games after School

1) TV and Video

Think about TV and videos you watched after school yesterday, including before, during and after dinner. Write the total number of hours plus minutes you watched. To help you remember, you may use the margin to list shows or add up the times for different programs. If you watched less than 5 minutes, write zero.

2) Video and Computer Games

Did you play any video or computer games after school yesterday? Write the hours plus minutes you played these games yesterday after school. If you played less than 5 minutes, write zero.

End of Checklist: **Now you are finished with this form. Please turn back to the first page. Thank you very much.**

APPENDIX I

LIST OF MET VALUES FOR PHYSICAL ACTIVITIES ON SAPAC

List of MET Values for Physical Activities on SAPAC

(Version 09/30/1996)

Activity on SAPAC	METs	Compendium Code #
1. Bicycling	4.0	01010
2. Swimming laps	7.0	18240
3. Gymnastics: bars, beam, tumbling, trampoline	4.0	15300
4. Exercise: push-ups, sit-ups, jumping rope	8.0	02020
5. Weight lifting	4.5	02050, 02130 (mean)
6. Basketball	6.0	15050
7. Baseball/Softball	5.0	15620
8. Football	8.0	15230
9. Soccer	7.0	15610
10. Volleyball	3.0	15720
11. Skating: ice, roller, rollerblade	9.7	15590, 15591 (mean)
12. Hockey: ice, floor, field	8.0	15350, 15360 (mean)
13. Racket sports: badminton, tennis, paddleball	5.7	15030, 15675 (mean)
14. Ball playing: four square, dodge ball, kickball	5.0	15135
15. Active games: chase, tag, hopscotch	5.0	15135
16. Outdoor play: climbing trees, hide seek	5.0	15135
17. Water play: in swimming pool, ocean or lake	6.0	18310
18. Combatives: judo, karate, competitive wrestling	8.0	15430, 15730 (mean)
19. Dance	4.5	03025
20. Outdoor chores: mowing, raking, gardening	4.6	08095, 08160, 08245 (mean)
21. Indoor Chores: mopping, vacuuming, sweeping	3.5	05030
22. Mixed walking/running	6.0	12010
23. Walking	3.3	17190
24. Running	8.0	12030

Based on the SAPAC version 9/30/1993 (Sallis et al., 1996) and the Compendium of Physical Activities (Ainsworth et al., 2000)