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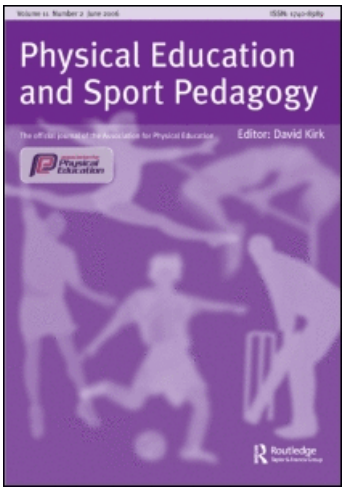

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Field dependence–independence and physical activity engagement among middle school students

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Background: Field dependence–independence (FDI) is a tendency to rely on external frames (given situations and authoritative people) or internal frames (oneself, including one's own body) for one's information processing and behavior. Literature has constantly reported that field-dependent (FD) individuals, who are less autonomous in decision-making processes and less effective in detecting and using body information (kinesthetic feedback and proprioceptive awareness), tend to demonstrate less desirable performance in sport, motor learning, and physical education settings compared with their field-independent (FI) counterparts. Little attempt, however, has been made to investigate whether FD individuals have less desirable physical activity (PA) levels than FI individuals. Lack of knowledge might pose a potential risk of health problems to FD individuals.
Purpose: This study was intended to investigate and compare PA levels as well as organized sports participation between FI and FD middles school students. It was hypothesized that FDI would be associated with higher PA levels and more participation in organized sports for FI students as opposed to FD students.
Participants and setting: One hundred and thirty eight middle school students (72 girls and 66 boys) in the USA participated in data collection of this study. Of these 138 participants, 46 FI participants (22 girls and 24 boys) and 46 FD participants (24 girls and 22 boys) were identified as final participants whose data were analyzed.
Research design: A cross-sectional design was utilized in this study. Participants were grouped based on their FDI status, gender, and cross-classification of FDI status and gender to compare PA variables and participation in organized sports. FDI status and gender were independent variables, and PA variables and participation in organized sports were dependent variables.
Data collection: The Rod-and-Frame Test was used to identify FI and FD participants, the Self-Administered Physical Activity Checklist was administered to determine participants' PA amounts, and a demographic inventory was employed to obtain information regarding participants' participation in organized sports.
Data analysis: A two-way (FDI × gender) MANOVA was used to detect differences in PA variables among groups, and a Chi-square analysis was employed to test independence of FDI from participation in organized sports. An alpha of .05 was set for significant levels.
Findings: This study revealed the contrasting PA levels and participation in organized sports between the FI and FD students. The FD students demonstrated much lower PA levels and were less engaged in organized sports than the FI students. Further, the FD students tended to choose activities that were less related to sports, resulting in shorter PA minutes and lower energy expenditure compared with the FI students.
Conclusions: FDI is related to PA levels in addition to being related to sport, motor learning, and physical education. Specifically, FD students have lower sports

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potential and are less physically active compared with FI students and this could put FD students at a higher risk level in terms of health problems now and in the future. Lifestyle PA and other non-competitive activities might be good choices for FD students to enhance their PA levels.

Keywords: field dependence–independence; physical activity; middle school students

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According to Witkin's field dependence–independence (FDI) theoretical perspective (Witkin et al. 1977), people can be divided into field-dependent (FD) and field-independent (FI) individuals based on their information-processing tendencies. FD individuals have a tendency to rely on, and are influenced by, external referents (environments, authorities, and significant others), and function less autonomously in decision-making and behaviors. In contrast, FI individuals tend to rely on internal referents (self) as the primary source for, and are more autonomous in, decision-making and behaviors, have a more articulated body concept, and are more sensitive to body information.

Because autonomy in decision-making and effective use of body information (kinesthetic feedback and proprioceptive awareness) are critical to sport-related settings, Meek and Skubic (1971) argued that individuals with higher athletic ability would be more FI. This assertion has repeatedly gained support when comparisons of FDI between athletes and non-athletes are made (Brady 1995; Golomer et al. 1999; Liu and Si 2001; Vuillerme, Teasdale, and Nougier 2001).

FI learners, compared with FD learners, are also found to learn novel motor skills faster due to their stronger autonomous decision-making processes and more effective use of body information. Specifically, studies have shown that FI learners are more effective in learning Alaskan Yo-Yo (Jorgensen 1972), ball catching (MacGillivary 1979), gymnastics (Swinnen 1983; Swinnen, Vandenberghe, and Van Assche 1986), trampoline (Swinnen 1984), and ice hockey (Goulet et al. 1988). Because of the similar characteristics on the part of FI learners, Ennis and her colleagues (Ennis, Chen, and Fernandez-Balboa 1991; Ennis and Chepyator-Thomson 1990) have found that FI children, compared with FD children, tend to have fewer learning problems in physical education classes. Liu and Si (2001) have also reported similar observations in favor of FI students in physical education classes.

While the relationship between FDI and sports ability, motor learning, and physical education has become increasingly clear, little attempt has been made to understand the association of FDI with physical activity (PA) participation. As with other sport-related settings, PA also involves use of body information. In addition, sport involvement is one of major forms of PA in the present day (Corbin, Pangrazi, and Frank 2000) for school students, and their PA levels are closely related to sports participation (Liu and Chepyator-Thomson 2004). Given the literature discussed above, which suggests that FD individuals consistently demonstrate less desirable performance in sport, motor learning, and physical education settings, it is reasonable to expand this research by investigating a possible association between FDI and school students' PA levels.

PA is considered the number one leading health indicator (US Department of Health and Human Service [USDHHS] 2000), and many leaders in the physical education profession in the USA agree that preparing students for a lifetime of PA is a major goal of school physical education programs (Rink 2006; Siedentop 2004). Unfortunately, the prevalence of physical inactivity remains high across most age groups, and PA level declines to 50% during the school years (Sallis 2000; USDHHS 1996). In order to increase the PA level

of school students, however, a thorough understanding of the various factors associated to their PA participation is needed (Sallis 2000).

Therefore, this study intended to investigate a possible association between FDI and PA levels as well as organized sports participation of middle school students. Specifically, middle school students were categorized by FDI status and gender, and PA level and participation in organized sports were compared among groups. It was hypothesized that FDI would be associated with higher PA levels and more participation in organized sports for FI students as opposed to FD students.

Methods

Participants

A middle school in the South-east region of the USA was chosen for this study due to its diverse student population that reflected the public school condition in the USA. Informed consent forms were distributed to parents of all students ($n = 345$) who took physical education classes in the semester in which the data were collected. One hundred and forty six informed consent forms were returned, giving a return rate 42.3%. All these 146 students participated voluntarily in data collection; however, eight of them were eliminated because they did not show up on all three PA assessment days, resulting in a total of 138 participants. Of these 138 participants, there were 72 girls and 66 boys; 41 sixth graders, 48 seventh graders, and 49 eighth graders; 59 whites, 51 blacks, and 28 of other ethnic backgrounds.

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Instrumentation

Self-administered physical activity checklist (SAPAC)

The SAPAC is a previous-day recall checklist of physical activities. A test–retest reliability of .65 and validity of .60 against heart rate monitors were reported by SAPAC developers (Sallis et al. 1996). The SAPAC involves recall of PA on a single day (the previous day) only and cognitive requirement of its administration is reduced considerably. It consists of 24 sports and activities plus space of listing up to three other activities, and has been used frequently for public school students (Chen and Kennedy 2005; David 2004; Prochaska et al. 2002; Sallis et al. 1996).

Rod-and-Frame Test

Witkin and his colleagues (Witkin et al. 1954) originally used the Rod-and-Frame Test to operationally define FD and FI individuals. The Rod-and-Frame Test involves use of vestibular and proprioceptive information to perceive the body's spatial orientation and is considered suitable in use for sport- and PA-related participants (Brady 1995; Liu 2003; Raviv and Nabel 1990). In fact, the Rod-and-Frame Test has been used in many studies involving sport- and PA-related participants (Apitzsch and Liu 1997; Brady 1995; Liu 1991, 2003, 2005; Wu 1991).

Demographic inventory and rating sheet

A researcher-generated demographic inventory was used to collect participants' information of gender, grade, race, current involvement in organized sports, and school

attendance on the previous day. Also, a researcher-generated five-point Likert scale rating each participant's general sports ability was used, with 1 indicating *very poor* and 5 indicating *very strong* in sports ability at participants' developmental levels. The rating sheet was completed by participants' physical education teachers, who evaluated students' general sports ability based on their performances in physical education classes. The completed rating sheet was used to examine validity of the Rod-and-Frame Test. In addition, the physical education teachers also reported participant's involvement of organized sports on the rating sheet.

Procedures

Data collection: SAPAC and demographic inventory

During a two-week period the SAPAC was administrated to participants three times on three different weekdays except Monday to make sure the previous day was a school day. A classroom for administrations was arranged beforehand and about 20 students were administered in one period of physical education class, until all 138 participants were administrated three times. The time for each administration was approximately 25 minutes. PA and time estimation of PA were explained to participants first to lead them to recall and report the minutes they spent in each activity during three time periods (before, during, and after school) of the previous day. Participants were instructed to report the time they were 'actually' active and not to include the time they were resting or waiting to play, and only to recall the activities that lasted for at least five minutes. Participants were also required to recall and report their perceived exertion for every activity engaged in (whether out of breath 'none', 'some', or 'most' of the time). The administration protocol was followed strictly, and an overhead projector was used to show examples, clarify terms, and lead participants to navigate through the SAPAC step-by-step during administrations. The demographic inventory was filled out immediately before the administration of the SAPAC.

Data collection: Rod-and-Frame Test

The Rod-and-Frame Test was administered individually in previously scheduled physical education classes. At the beginning of each physical education class, eight to ten participants were called out and sat in a room for the test. One participant came to the testing table at a time. Testing time for each individual was roughly 3–4 minutes. The apparatus was a table-top-size rectangular box. One side of the box was open for the participant to look into. On the other side there was a tilted square frame with a tilted rod in the middle of it. The participant was asked to sit upright on a chair, putting his/her eyes against the opening of the apparatus and looking into it. The only things the participant could see were a *tilted* rod and a *tilted* square frame surrounding the rod. The participant was told to adjust the tilted rod to the vertical position *without the correct reference to verticality* (Figure 1). Eight trials were given to each participant, with frame and rod tilted to 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).

Usually, those who rely more on internal frames for information processing tend to use their body information (in this case, the sense of verticality from the body) more effectively and are able to adjust the tilted rod to a relatively vertical position, hence classified as FI

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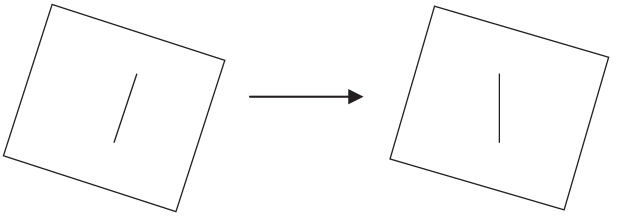

Figure 1. During the administration of Rod-and-Frame Test, the participant is asked to adjust the tilted rod to the vertical position overcoming the misguidance of the tilted square frame.

individuals. Those who rely more on external references for information processing tend to be influenced, or misguided, by the tilted square frame so it is more difficult for them to adjust the tilted rod to a relatively vertical position, hence classified as FD individuals.

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Data treatment

SAPAC

The following six PA variables were derived from the SAPAC after data reduction: (1) minutes of PA; (2) minutes of moderate to vigorous PA (MVPA); (3) PA MET score (minutes of PA ÷ 60 × MET value of PA); (4) MVPA MET score (minutes of MVPA ÷ 60 × MET value of MVPA); (5) weighted PA MET score (minutes of PA ÷ 60 × MET value of PA × weighted intensity rating); and (6) weighted MVPA MET score (minutes of MVPA ÷ 60 × MET value of MVPA × weighted intensity rating). The value for each of the six PA variables was the mean out of the three SAPAC administrations, representing daily PA level in school days.

The last four PA variables reflected energy expenditure in MET. MET is metabolic equivalent to express energy expenditure and PA intensity. One MET refers to metabolic energy expenditure when sitting quietly (resting metabolic rate), which equals one kilocalorie (kcal) per kilogram of body weight per hour, technically expressed as 1 kcal · kg body weifht^{-1} · h^{-1}. Energy expenditure in any given sport or activity can be expressed as multiples of the resting 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). MET values for different sports and activities are listed in published compendium of PA (Ainsworth et al. 2000). Activities with 4.4 METs and less are classified as light in intensity, 4.5–5.9 METs as moderate, and 6.0 METs and above as vigorous (Sallis et al. 1996).

Weighted intensity ratings were determined by participants' reported exertion (whether out of breath 'none', 'some', or 'most' of the time) for activities engaged in. Use of weighted intensity ratings was intended to take into account the actual intensity of participating in activities (Sallis et al. 1996), and resulted in weighted PA MET scores. For a light or moderate activity, the corresponding MET value was multiplied by 1.1 (a weighted intensity rating) if a reported exertion was out of breath 'some' of the time, and by 1.25 if a reported exertion was out of breath 'most' of the time. For a vigorous activity, the corresponding MET value was multiplied by 1.25 when a reported exertion was out of breath 'most' of the time; however, when a 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).

Rod-and-Frame Test

The participant's score was the mean of absolute deviations in degrees from verticality over eight trials. Large scores reflected relatively FD performance, and small scores relatively FI performance. Of the 138 participants in this study, the top one-third of scorers ($n = 46$, 22 males and 24 females) on the Rod-and-Frame Test were classified as FD participants, and bottom one-third ($n = 46$, 24 males and 22 females) as FI participants. These 92 students (46 males and 46 females) were the *final participants* whose data were analyzed. Remaining participants falling into a neutral group in terms of FDI were excluded from data analysis.

Grouping and statistical analyses

A cross-sectional design was utilized in this study. Participants were grouped based on their FDI (i.e., scores on the Rod-and-Frame Test), gender, and cross-classification of FDI and gender to compare PA variables and participation in organized sports. In any comparison, FDI and gender were independent variables, and PA variables and participation in organized sports were dependent variables. A two-way (FDI × gender) MANOVA was used to detect differences in PA variables among groups, and Bonferroni method was used for the control of family-wise Type 1 error with MANOVA. Chi-square analysis was employed to test independence of FDI from participation in organized sports. An alpha of .05 was set for significant levels.

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Results

Demographic characteristics of the 92 final participants in grouping, gender, grade, and ethnicity are summarized in Table 1 with male and female being equally represented and black

Table 1. Demographic characteristics of participants.

	Final Participants ($n = 92$)		FI Participants ($n = 46$)		FD Participants ($n = 46$)	
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

and white participants having almost equal representation. The age range of participants was 10–15 years ($M = 12.66$ and $SD = 1.07$). Mean scores of the Rod-and-Frame Test for the FI group and the FD group were 1.25 with *SD* of .30, and 4.72 with *SD* of 2.93, respectively.

Differences in six PA variables between FI and FD groups

A 2 × 2 MANOVA was conducted to determine the effects of gender and FDI on the PA variables and the interactions between gender and FDI. The omnibus test yielded no interactions between FDI and gender ($p < .05$) and no significant main effects of gender on the PA variables ($p < .05$). The main effects of FDI, however, were significant for the PA variables (Wilks $\Lambda = .817$, $F_{(6,\ 83)} = 3.10$, $p < .01$, and $\eta^2 = .18$), indicating a large effect size. Univariate analyses were conducted on each PA variable as follow-up tests to the MANOVA. Significant differences were found between the FI and FD group on each of the six PA variables with all *p* values smaller than .001 and five of the six η^2 values larger than .14 (large effect size), as indicated in Table 2.

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Differences in PA choices between FI and FD groups

Because activities in which students participated during school hours were determined by physical education course content and did not reflect participants' choice, investigation into participants' PA choice was made from data of before- and after-school periods only. Table 3 summarizes the rank order of two groups' PA choices for the three previous school days. In before-school periods, energy expenditure rates (Ainsworth et al. 2000) related to the top four activities were higher in the FI group ($3.3 + 8.0 + 6.0 + 4.5 = 21.8$ METs) than those in the FD group ($3.3 + 3.5 + 6.0 + 5.0 = 17.8$ METs). In addition, incidents of PA participation were 40% higher in the FI group than those in the FD group.

In after-school periods, indoor chores went up to the first place in the FD group as opposed to basketball in the FI group. The contrast of energy expenditure rates of the top four activities between the two groups became more noticeable. That is, 25.3 METs ($6.0 + 3.3 + 8.0 + 8.0$) versus 17.3 METs ($3.5 + 3.3 + 6.0 + 4.5$) with a difference of 8

Table 2. Means, standard deviations, *F* values, *p* values, and η^2 values on six PA variables for FD ($n = 46$) and FI ($n = 46$) groups.

PA variables	Group	*M*	*SD*	*F*	*p*	η^2
Min of PA	FI	125.30	110.56	12.25	.001	.122
	FD	63.17	48.43			
Min of MVPA	FI	96.98	96.04	14.74	.000	.143
	FD	37.83	37.22			
PA MET Score	FI	11.69	10.85	15.02	.000	.146
	FD	5.00	4.03			
MVPA MET Score	FI	10.07	10.16	16.42	.000	.157
	FD	3.54	3.54			
Weighted PA MET	FI	12.38	11.48	15.03	.000	.146
	FD	5.28	4.30			
Weighted MVPA MET	FI	10.63	10.79	16.37	.000	.157
	FD	3.70	3.79			

Table 3. PA choices before and after school by number of participation and rank.

	FI ($n = 46$)		FD ($n = 46$)	
Rank	PA (MET)	Incidents	PA (MET)	Incidents
Before School				
1	Walking (3.3)	28	Walking (3.3)	24
2	Running (8.0)	15	Indoor chores (3.5)	10
3	Walk/running (6.0)	11	Walk/running (6.0)	8
4	Weight lifting (4.5)	10	Games (chase, tag, etc.) (5.0)	5
	All others	27	All others	18
	Total	91	Total	65
After School				
1	Basketball (6.0)	45	Indoor chores (3.5)	40
2	Walking (3.3)	34	Walking (3.3)	35
3	Running (8.0)	32	Walk/running (6.0)	16
4	Exercise (sit-up, etc.) (8.0)	27	Dance (4.5)	9
	All others	97	All others	51
	Total	235	Total	151

Note: Some participants participated in more than one activity in one or more before- and/or after-school periods.

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METs (25.3 – 17.3) in favor of the FI group. Further, incidents of PA participation were 55% higher in the FI group than in the FD group.

Differences in organized sports participation between FI and FD groups

Information regarding organized sports participation was obtained from both participants and their physical education teachers. Participants whose organized sports participation was reported by both participants themselves and the physical education teachers were considered *organized sports participants*. In addition, participants whose organized sports participation was reported by themselves only were confirmed by examining their PA reports on the SAPAC, and only those who reported a consistent organized sport PA and reported organized sports participation in at least two of the three SAPAC administrations were considered organized sports participants. There were no participants whose organized sports participation was reported by the physical education teachers only. In the FI group 20 organized sports participants were identified, and 10 were identified in the FD group. Chi-square analysis indicated that the numbers involved in organized sport for the two groups were significantly different ($\chi^2_{(1,\ n=92)} = 4.95$, $p = .026$, and Cramér's $V = .23$).

Reliability and validity

Reliability of the Rod-and-Frame Test was checked by split-half method and a strong correlation coefficient of $r = .73$ was obtained ($p < .001$). Validity of the Rod-and-Frame Test was checked with Spearman correlation against the ratings of sports ability for participants by the physical education teachers and a more-than moderate correlation coefficient of $r = -.41$ was obtained ($p < .001$).

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Discussion

The results of this study support the hypothesis that FDI was associated with higher PA levels and more participation in organized sport for FI students as opposed to FD students. This corroborates the findings from other studies regarding the relationship between FDI and performance in sport-related settings (Brady 1995; Golomer et al. 1999; Liu 2005; Liu and Si 2001; Vuillerme Teasdale and Nougier 2001), and is consistent with FDI theory in terms of FD and FI individuals' characteristics (Witkin and Goodenough 1977, 1981).

The Rod-and-Frame Test measures the extent to which people can effectively use their body information (sense of verticality, vestibular and proprioceptive awareness, etc.) in relation to potentially being involved in sport and PA (Brady 1995; Raviv and Nabel 1990). FI individuals have a stronger tendency to use body information, thus having enhanced competence and confidence in sport and PA skills. This may make them experience more enjoyment and satisfaction from sport and PA participation. This enjoyment and satisfaction, then, enhances their inclination to participate in sport and PA. This is the relationship among competence in skills, enjoyment of PA, and involvement in PA expressed by Graham, Holt/Hale and Parker (2001), 'Fitness comes from being physically active. Being physically active comes from enjoyment of activity, competence in skills, and confidence in self' (49). This relationship may explain the findings in this study that many more FI participants ($n = 20$) than FD participants ($n = 10$) were involved in organized sports, and that FI participants reported much higher PA levels than did FD participants.

Sport involvement is one of the major forms of PA in the present day for school students (Corbin, Pangrazi, and Frank 2000). Some research indicates that, with little transportation PA and vocation PA, school students' PA is largely determined by participation in sports (Liu and Chepyator-Thomson 2004). This is consistent with the finding of this study that the FI students' higher level of participation in organized sport contributed to their significantly higher PA levels compared with the FD students.

Another contrasting difference found in this study was that of PA choices between the FI and FD groups. By examining Table 3 carefully, it can be seen that the FI participants tended to choose activities that were more related to sports (basketball, weight-lifting, running, and fitness exercise). By contrast, the FD participants' top activities had less association with sports (indoor chores and walking, for example). Sport-related activities usually involve higher energy expenditure rates than non-sport-related activities (Ainsworth et al. 2000). As a result, the FI group had higher energy expenditure rates than did the FD group, as reported previously. It appears that the FI students' higher sports potential was associated with more involvement in sport-related activities, which contributed to their enhanced minutes in PA and energy expenditure.

One critical issue of FDI is its development and stability. According to Witkin and his colleagues (Witkin et al. 1954; Witkin, Goodenough, and Karp 1967), the developmental direction of an individual's FDI is from a relatively FD to a relatively FI mode of functioning, and a relatively stable position on the FDI continuum is set at 8–10 years old. As a result, Witkin and colleagues treated FDI as a trait (Witkin et al. 1954). As with other traits, FDI remains relatively stable after it is set at an early age and influences individuals' behaviors constantly and consistently across multiple domains (Witkin et al. 1954; Witkin, Goodenough, and Karp 1967). Consequently, related to their lower levels in sports potential, FD school students' lower PA levels may put them at a higher risk of health problems now and in future. PA interventions for FD school students are needed.

Given FD students' lower sports ability, corresponding strategies could be considered for PA interventions for FD students. Instead of pushing them to participate in competitive sports, daily lifestyle PA could be encouraged for them such as walking to school, taking stairs, and doing chores. Also, many non-competitive sports and activities could be introduced to them in PE curriculum. Those activities include jogging, swimming, camping, hiking, backpacking, and strength and flexibility activities. Further, more organized PA (not sport) programs in extra curriculum, such as jogging club, fitness club, and 100-lap run campaign (Siedentop and Tannehill 2000), may be provided to enhance FD students' PA levels. In addition, the Rod-and-Frame Test could be used as an early intervention assessment to identify FD school students for PA interventions.

In summary, this study revealed the contrasting PA levels and participation in organized sports between the FI and FD school students. The FI students demonstrated much higher PA levels and were more engaged in organized sports than the FD students. Further, the FI students tended to choose activities that were more related to sports, which contributed to their longer minutes of PA and higher energy expenditure compared with the FD students. These differences may be related to difference in sports potential between the two groups.

Although it is generally documented that boys are more physically active than girls, this study did not find this tendency. It was noticed during the SAPAC administrations that the boys tended to complete SAPAC faster than girls, suggesting that girls might recall PA more carefully than boys and that boys might have failed to recall some PA. It is desirable to use objective PA assessment tools (heart rate monitors, pedometers, etc.) for future studies.

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References

Ainsworth, B., W. Haskell, M. Whitt, M. Irwin, A. Swartz, S. Strath, W.L. O'Brien et al. 2000. Compendium of physical activities: An update of activity codes and MET intensities. *Medicine & Science in Sports & Exercise* 32, Suppl. no. 9: S498–S516.

Apitzsch, E., and W. Liu. 1997. Correlation between field dependence–independence and handball shooting by Swedish national male handball players. *Perceptual and Motor Skills* 84: 1395–8.

Brady, F. 1995. Sports skill classification, gender, and perceptual style. *Perceptual and Motor Skills* 81: 611–20.

Chen, J., and C. Kennedy. 2005. Factors associated with obesity in Chinese-American children. *Pediatric Nursing* 31: 110–5.

Corbin, C., R. Pangrazi, and B. Frank. 2000. Definitions: Health, fitness, and physical activity. *The President's Council on Physical Fitness and Sports Research Digest*, March, Series 3, no. 9. http://www.fitness.gov/pcpfs_research_digs.htm (accessed October 3, 2005).

David, K. 2004. Relationships among religiosity, physical activity, and sedentary behavior in Jewish adolescents. *Pediatric Exercise Science* 16: 54–63.

Ennis, C., A. Chen, and J. Fernandez-Balboa. 1991. Cognitive style differences within an analytical curriculum: Examples of success and nonsuccess. *Early Child Development and Care* 74: 123–34.

Ennis, C., and J. Chepyator-Thomson. 1990. Learning characteristics of field-dependent children within an analytical concept-based curriculum. *Journal of Teaching in Physical Education* 10: 170–87.

Golomer, E., J. Cremieux, P. Dupuis, B. Isableu, and T. Ohlmann. 1999. Visual contribution to self-induced body-sway frequencies and visual perception of male professional dancers. *Neuroscience Letters* 276: 189–92.

Goulet, C., S. Talbot, D. Drouin, and P. Trudel. 1988. Effect of structured ice hockey training on scores on field dependence–independence. *Perceptual and Motor Skill* 66: 175–81.

Graham, G., S. Holt/Hale, and M. Parker. 2001. *Children moving: A reflective approach to teaching physical education.* 5th ed. Mountain View, CA: Mayfield Publishing.

Jorgensen, J. 1972. *The relationship between perceptual style and rate of learning a novel movement task.* Master's diss., University of Wisconsin.
Liu, W. 1991. A preliminary study of nerve types and field dependence–independence of Chinese male high jump masters of sports. *Acta Psychologica Sinica* 23: 62–8.
Liu, W. 2003. Field dependence–independence and sports with a preponderance of closed or open skill. *Journal of Sport Behavior* 26: 285–97.
Liu, W. 2005. Black and white adolescents: Their differences in field dependence–independence and physical activity involvement [Abstract]. *Research Quarterly for Exercise and Sport* 76, Suppl.: A-106.
Liu, W., and G. Si. 2001. Field-dependent students in physical education: Their limitations and the solution thereof. In *2000 International conference for physical educators proceedings: Innovation and application of physical education and sports science in the new millennium – an Asia-Pacific perspective*, ed. M.K. Chin, L.D. Hensley, and Y.K. Liu, 237–47. Hong Kong: The Hong Kong Institute of Education.
Liu, W., and J. Chepyator-Thomson. 2004. Contribution of organized sports to physical activity level: A middle school as a case [Abstract]. *Research Quarterly for Exercise and Sport* 75, Suppl.: A-72.
MacGillivary, W. 1979. Perceptual style and ball skill acquisition. *Research Quarterly* 50: 222–9.
Meek, F., and V. Skubic. 1971. Spatial perception of highly skilled and poorly skilled Females. *Perceptual and Motor Skills* 33: 1309–10.
Montoye, H., H. Kemper, W. Saris, and R. Washburn. 1996. *Measuring physical activity and energy expenditure*. Champaign, IL: Human Kinetics.
Prochaska, J., J. Sallis, B. Griffith, and J. Douglas. 2002. Physical activity levels of Barbadian youth and comparison to a US sample. *International Journal of Behavioral Medicine* 9: 360–72.
Raviv, S., and N. Nabel. 1990. Relationship between two different measurements of field Dependence and athletic performance of adolescents. *Perceptual and Motor Skills* 70: 75–81.
Rink, J. 2006. *Teaching physical education for learning.* 5th ed. New York: McGraw-Hill.
Sallis, J. 2000. Influences on physical activity of children, adolescents, and adults. *The President's Council on Physical Fitness and Sports Research Digest*, August, Series 1, no. 7. http://www.fitness.gov/pcpfs_research_digs.htm (accessed October 3, 2005).
Sallis, J., P. Strikmiller, D. Harsha, H. Feldman, S. Ehlinger, E. Stone, J. Williston, and S. Woods. 1996. Validation of interviewer- and self-administered physical activity checklists for fifth grade students. *Medicine & Science in Sports & Exercise* 28: 840–51.
Siedentop, D. 2004. *Introduction to physical education, fitness, and sport.* 5th ed. New York: McGraw-Hill.
Siedentop, D., and D. Tannehill. 2000. *Developing teaching skills in physical education.* 4th ed. Mountain View, CA: Mayfield Publishing.
Swinnen, S. 1983. Role of field dependence in perception of movement. *Perceptual and Motor Skills* 57: 319–25.
Swinnen, S. 1984. Field dependence–independence as a factor in learning complex motor skills and underlying sex differences. *International Journal of Sport Psychology* 15: 236–49.
Swinnen, S., J. Vandenberghe, and E Van Assche. 1986. Role of cognitive style constructs field dependence–independence and reflection-impulsivity in skill acquisition. *Journal of Sport Psychology* 8: 51–69.
US Department of Health and Human Services. 1996. *Physical activity and health: A report of the surgeon general*. Atlanta, GA: USDHHS Centers of Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, International Medical Publishing.
US Department of Health and Human Services. 2000. *Healthy People 2010: Understanding and improving health.* 2nd ed. Washington, DC: US Government Printing Office.
Vuillerme, N., N. Teasdale, and V. Nougier. 2001. The effect of expertise in gymnastics on proprioceptive sensory integration in human subjects. *Neuroscience Letter* 311: 73–6.
Witkin, H., and D. Goodenough. 1977. Field dependence and interpersonal behavior. *Psychological Bulletin* 84: 661–89.
Witkin, H., and D. Goodenough. 1981. *Cognitive styles: Essence and origins.* New York: International Universities Press, Inc.

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Witkin, H., D. Goodenough, and S. Karp. 1967. Stability of cognitive style from childhood to young adulthood. *Journal of Personality and Social Psychology* 7: 291–300.

Witkin, H., H. Lewis, M. Hertzman, K. Machover, P. Meissner, and S. Wapner. 1954. *Personality through perception*. New York, Harper and Brothers.

Witkin, H., C. Moore, P. Oltman, D. Goodenough, F. Friedman, D. Owen, and E. Raskin. 1977. Role of the field-dependent and field-independent cognitive styles in academic evolution: A longitudinal study. *Journal of Educational Psychology* 69: 197–211.

Wu, D. 1991. A preliminary study of field dependence–independence in Chinese elite gymnasts. *Anhui Sports Science* 11: 18–20.

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