Effects of the Coordination Exercise Program on School Children's Agility: Short-Time Program during School Recess

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Abstract

This study examined the impact of a short-time coordination program conducted during recess periods on improving agility in elementary school students. The subjects consisted of 60 third grade students, who were randomly assigned to an experimental group (n = 29) and a control group (n = 31). The experimental group completed a coordination program intended to improve agility during 20-minute recesses, two to three times a week for five weeks, whereas the control group participated in usual activities such as mini soccer games and tag games during the recess. Repetitive side steps, an indicator of agility, were measured for both groups at the beginning and end of the intervention period. While the test scores indicated no difference between the two groups in the pretest, the posttest indicated a significant difference in the test scores in favor of the experimental group, t (59) = 2.90 and $p < .005$. The results indicated that the short-time coordination program can be effective in improving agility in elementary school students.

Keywords: fitness, elementary school students

Physical fitness among children has continued to decline for more than 30 years. Despite the large body of research on physical fitness in children (Seki, 2009; Suzuki, 2008; Suzuki, Nishijima, & Suzuki, 2010) and improvement programs proposed (Azumane & Miyashita, 2004; Azumane, Otomo, Harada, Isaka, & Takeo, 2006; National Recreation Association in Japan [NRAJ], 2006), fitness is still seen as a problem today in Japan. A study in 2008 of physical fitness and ability showed that Japanese children's fitness today remained low compared to findings from 1985 (Ministry of Education, Culture, Sports, Science and Technology [MECSST], 2008). Hibino (2004) indicated that a lack of activity and an inappropriate lifestyle will lead to health issues such as obesity and lifestyle diseases, and have adverse psychological effects such as a lack of ambition and willpower. Although some improvement programs have been proposed, they are considered too lengthy and inappropriate for children who are not good at sports or have little interest in sports.

One concern is the deterioration in coordination and agility among children. The Lifelong Sports Division of the MECSST has reported deterioration in coordination and the ability to move quickly among children who are "unable to run in a straight line or evade a ball to avoid injury", stating that "even though the standards could not decrease any further, they are still at a dangerous level" (Yomiuri, 2007, p. 1). While there are studies reporting on the distribution of activities during recess (Senda, 2004) and observational studies on play activities (Choh, Senda, Ono, & Naka, 2004; Fukutomi & Abiru, 1968; Senda & Inoue, 2004), there have been no proposals or research addressing promoting coordination and agility of children in Japan.

Taking this situation into account, we based our research on the coordination theories of the Russian physiologist Bernstein (1996), and focused on agility, an aspect of coordination which comprises skill and quickness (Meinel, 1960, 1981). Agility is defined as the speed to change one's physical position and the direction of movement (Clarke, 1977) and react to a stimulus, start quickly and efficiently, move in the correct direction, and be ready to change direction or stop quickly to make a play in a fast, smooth, efficient, and repeatable manner (Verstegen & Marcello, 2001). Agility is known as a performance-related fitness component (Hatano, 2009), and it has been demonstrated to provide an impact on children's health. In Japan, accidents and injuries resulting from poor agility in children have frequently been reported, such as accidents caused by colliding with other students, being unable to dodge a ball or use their hands when falling (National Agency for the Advancement of Sports and Health [NAASH], 2010). Improvement in agility can prevent daily injuries and accidents in elementary school students and thus will lead to a safer, healthier everyday life.

Coordination is the integrative action of the nervous system as described by Sherrington, which is "when a movement is initiated by an individual, with a fixed intention and a fixed objective, that movement achieves its objective" (Yamamoto, Yabe, & Ikai, 1972, p. 41). The ability to perform voluntary movement comprises coordination, equilibrium, agility and flexibility (Hirohashi & Kanehara, 1977). Further, Hartmann and Minow (2008) describe coordination ability as the ability to move the body skillfully, a prerequisite for athletic performance. Coordination ability is related to rhythm skills, balance skills, transformation skills, reaction skills, consolidation skills, orientation skills and recognition skills. In this study, we focused on the agility aspect of coordination and aimed to examine the impact of a coordination exercise program during recess on improving the agility of elementary school students.

According to Meinel (1981, p. 247), "Children regularly play with objects and use sporting equipment, refining and correcting their hand-eye coordination and the coordination between peripheral stimuli and movements, making them particularly suitable subjects." Gallahue (1999) also describes the use of sporting equipment as a contributing factor in the development of athletic skills. In view of this, this study used equipment as part of a program held during recess in which students were required to move quickly. The hypothesis of the study was that the short-time coordination exercise program held during the recess would be effective in improving the agility level of elementary school students.

Method

Participants

The subjects of this study were 60 third-grade students aged 8-9

years from a public elementary school in Tokyo, Japan. The average height and weight of the participants were in line with the national average: 128.6 cm and 26.6 kg for females (national average 127.5 cm & 26.6 kg) and 130.1 cm and 28.5 kg for males (national average 128.2 cm & 27.3 kg). We held detailed discussions with the Board of Education and the principal of the school with regard to implementing this study, and prior to commencing our research, the principal gained the consent of the students' parents. The study was carried out with the approval of the ethics committee of the School of Health and Sports Science, Juntendo University.

Design of the Study

The study used a pretest and posttest with control group design. Of the 60 participants, nearly half of them (n = 29, 13 female and 16 male) were randomly assigned to an experiment group and the other half (15 female and 16 male) in the control group. A series of 20-minute recesses during the school day were used to implement the intervention and the study lasted for five weeks during a regular school semester. Immediately before and after the intervention, an agility test was administered to participants in both groups. The scores of the agility test was the dependent variable and compared between the two groups to determine the effectiveness of the intervention.

Intervention Procedure

There was a 20-minute recess period in each school day. Of the five recesses in a week, two to three recesses were used for the intervention, resulting in a total of 12 intervention recesses during the five weeks of the study. The coordination intervention was the *Droutability* coordination exercise program developed by Yasumitsu (2007). The *Droutability* program involved the use of cross plates (24 cm × 24 cm) and different colored disks 15 cm in diameter (see Figure 1). A total of 16 cross plates and six sets of disks were randomly placed on one half of the gymnasium floor (15 m × 15 m). Each set of disks contained nine different colored disks with painted numbers from 1 to 9, resulting in 54 disks in total (Figure 1).

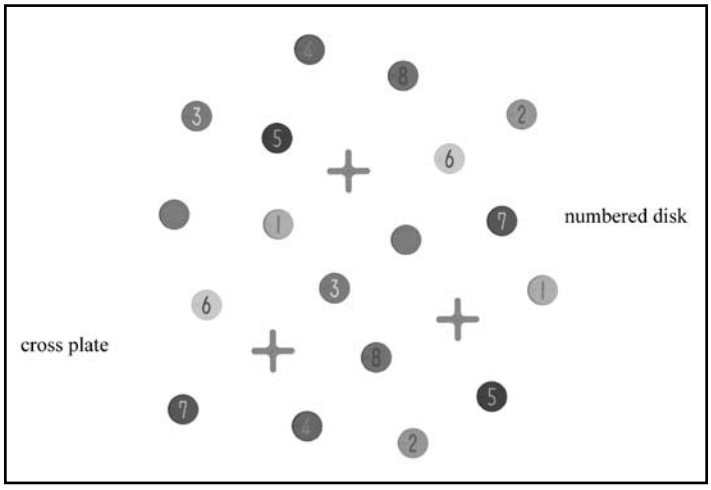

Figure 1. Configuration of cross plates and numbered disks. Sixteen cross plates and six sets of numbered and colored disks (54 disks in total) were randomly placed on half of the gymnasium floor (15 m × 15 m).

During the intervention recess, the intervention group was evenly divided into two subgroups. The two subgroups continuously took turns to participate in a 30-second intervention activity in an alternate manner. That is, while one subgroup participated in the intervention activity, the other subgroup observed and rested, then the two subgroups shifted activities, and so forth. When the intervention activity began, students ran to a cross plate of their choice and stepped backwards and forwards over the cross plate as quickly as possible without touching the plate. Then a command was given to ask students to reach a disk with a specific color or number. For example, if the command was "red", the student would move to the nearest red disk, touch it with a foot, and then quickly return to his/her original cross plate to resume stepping action over the cross plate.

During the 30-second intervention activity period, the students continuously moved around in all directions in search of the disk with designated colors or numbers and repeated the activity described above in response to the command. Also, the students were asked to move as swiftly as possible and to avoid collision with their classmates. The students in the experiment group participated in four sets of 30-second intervention activity in each intervention recess. The control group took part in usual recess activities such as mini soccer games and tag games during the recess. The students of the experimental group also participated in usual recess activities three to two days/week during recesses without receiving intervention in addition to participating in the intervention activities two to three days/week during recesses.

Measurement of the Agility

On the first and final days of the study, all participants took part in a physical test battery of *repetitive side steps* as a measure of agility. The physical battery of repetitive side steps was adopted by the MECSST (aimed at 6-11 year olds) - a Japanese version of the side step test in the California Physical Performance Test. Before the start of the repetitive side steps test, students stood over a center line facing the same direction. When the command "start" was given, they began to take side steps (not a jump) to touch or cross over the line on the right, then return to the center line and side step to touch or cross the line on the left (see Figure 2). This motion was repeated for 20 seconds and one point was given for each line they passed (e.g., right center left center would make four points). This test was conducted twice at the pretest and twice at the posttest; the better score was recorded for each.

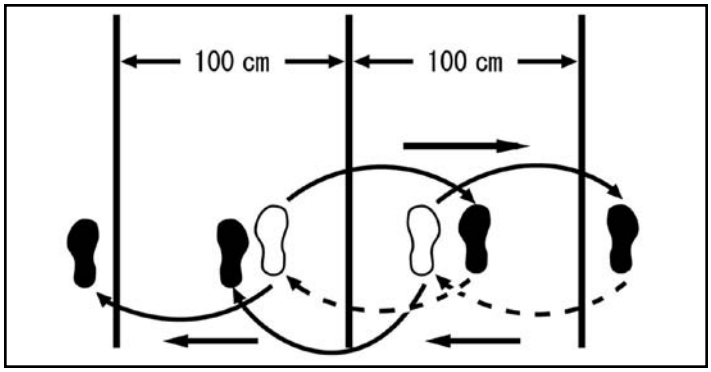

Figure 2. Movement Direction and Pattern of the Repetitive Side Steps.

We had the students form two lines to complete the repetitive side steps and each line had seven to eight students, enabling us to take measurements for a total of 14-16 students simultaneously at a time. To accurately record the score, we used the same method as described in the MECSST guideline that the students were put into pairs, counted the number of steps their partner passed, and recorded the score in the result sheet.

The repetitive side steps test used in the study was one of the new physical test batteries (2008) currently used by the MECSST, and it is an accepted way to measure the agility aspect of coordination (Hirohashi & Kanehara, 1977; Seki, 2009; Suzuki et al., 2010). The coordination field tests (Kuroki & Mizuta, 1997) of the Sports Science Center in Japan established by a coordination specialist committee also included the repetitive side steps as a test of agility. In view of this, the repetitive side steps test can be seen as an effective measuring test.

Data Analysis

A *t*-test was used to compare the results of the repetitive side steps between the two groups at the pretest and the posttest. SPSS version 18 was employed for the data analysis and the level of significance was set at 5%.

Results

The means (with standard deviations in parentheses) for the repetitive side steps scores at the pretest were 31.62 (6.04) for the experimental group and 32.87 (4.08) for the control group, with the control group's score a little bit better than that in the experimental group. The t test results indicated no differences between the two groups, with t (58) = 0.95, $p > .10$. After the intervention, the scores of the repetitive side steps were 35.69 (7.24) for the experimental group and 32.87 (5.73) for the control group. The differences between the two groups were statistically significant in favor of the experiment group, with t (59) = 2.90, $p < .005$.

Discussion

This study examined whether a short-time coordination exercise program held during recess would improve the agility of elementary school students. The experimental group participated in a coordination exercise program for a total of 12, 20-minute recesses in a five week period, whereas the control group did usual recess activities such as soccer and tag during the recess. The results support the hypothesis that a short-time coordination exercise program held during recess can be effective in improving the agility level of elementary school students.

Participating in the *Droutability* coordination exercise program might improve participants' ability to quickly change directions in response to conditions or commands. For example, when the children were performing the coordination exercise and on the verge of colliding, they had to make quick decisions and movements to avoid each other. Also, it is likely an improvement occurred in the ability to identify one's position and where to move, a so-called orientation ability and conversion ability, as indicated by Hartmann and Senf (2008). It turns out that all this improvement in coordination contributed to the improved agility reflected by the repetitive side steps test.

In Japan, accidents and injuries resulting from low agility in children — accidents caused by colliding with other students and being unable to dodge a ball or use their hands when falling — has been reported frequently (NAASH, 2010). Improvement in agility can help prevent everyday injuries and accidents in elementary school students, thus leading to safer, healthier everyday life.

Some similar studies have indicated that interventions can improve children's coordination and agility. Coordination research in Leipzig, Germany (Hartmann & Minow, 2008; Hartmann & Senf, 2008; Schnabel, Harre, & Krug, 2008) involved a program lasting 35-40 minutes per session. The coordination ability was measured before and after the program, and it was discovered that a coordination exercise program improved reaction skills. Other research projects on coordination in children (Azumane & Miyashita, 2004; Azumane et al., 2006; Rothlisberger, 2009) involved three weeks of 10-20 minute activities during regular physical education classes, and they reported positive changes in coordination and/or agility after the program. In addition, Azumane and Miyashita (2004) conducted a coordination exercise program on fourth grade elementary school students. The class average for repetitive side steps before the program was 32.2, while three weeks later it increased to 35.9. The results of this current study supported their findings.

In terms of the duration of programs, previous research does not differ from our research. However, most of the relevant studies discussed above were conducted in regular physical education classes without using a control group, whereas this study involved a control group and was conducted during recess rather than regular physical education classes. The implication is that effective use of the recess time also enables intervention to be carried out without disrupting regular physical education classes and produces significant results. The home room teacher and school principal commented that the program made effective use of time.

In our own as well as previous research studies, increased fitness scores suggest the effectiveness of the coordination exercise program. But in terms of the content of programs, it is not clear which method or activity could produce the most effective intervention. What is needed for further consideration is a comparative validation and analysis of each type of coordination exercise program and an investigation into creating the most efficient program.

In conclusion, this study confirms that a short-time coordination exercise program held during the school recess is effective in improving the agility of elementary school students. This suggests that by effectively using the recess period, physical fitness improvements can be made during the recess period. In addition, given the fact that the *Droutability* coordination exercise program just needs a short time to practice, it is convenient to practice it in elementary schools with limited time. Programs with a high element of gaming without losers like the *Droutability* allow all children to enjoy the activity and participate actively, including those children who do not like sports, hence improving children's physical fitness.

References

Azumane, A., & Miyashita, K. (2004). *More and more magical ways to get fit*. Tokyo, Japan: Shufu to Seikatsusha.

Azumane, A., Otomo, T., Harada, N., Isaka, M., & Takeo, Y. (2006). *Various sports coordination exercises* (2nd ed.). Nagoya, Japan:

Zenkoku Shoseki Shuppan.
Bernstein, N. A. (1996). *On the dexterity and its development.* In M. L. Latash & M. T. Turvey (Eds.), *Dexterity and its development* (pp. 9-244). Hillsdale, NJ: Lawrence Erlbaum Associates.
Choh, J. H., Senda, M., Ono, R., & Naka, A. (2004). Equipment seen from the playing activities in the kindergarten yard: Research into plans for public squares. *Landscape Research 67* (5), 429-432.
Clarke, H. H. (1977). *Application of measurement to health and physical education*. Tokyo, Japan: Baseball Magazine-Sha.
Fukutomi, H., & Abiru, T. (1968). Research into plans for landscape gardens in schools (1). *Chiba University Faculty of Horticulture Academic Report, 16*, 43-52.
Gallahue, D. L., & Sugihara, T. (1999). *Physical education for infants: A developmental approach.* Tokyo, Japan: Taishukan.
Hartmann, C., & Minow, H., J. (2008). *Sport verstehen — sport erleben teil 2: Trainingsmethodische grundlagen*. Leipzig, German: Freistaat Sachsen.
Hartmann, C., & Senf, G. (2008). *Sport verstehen — sport erleben teil 1: Sportmotorische grundlagen*. Leipzig, German: Freistaat Sachsen.
Hatano, Y. (2009). A brief historical review on the test and measurement studies in the United States during the period between 1861-1964 and its reflection to the Japan's counter-part on the selected topics. *Human Performance Measurement, 9*, 1-11.
Hibino, M. (2004). National initiatives towards physical development in children. *Children's Physical Growth and Development, 2*(5), 308-314.
Hirohashi, Y., & Kanehara, O. (1977). Fundamental research related to the development of coordination. *Research on Physical Education Studies, 22*(1), 27-36.
Kuroki, Y., & Mizuta, K. (1997). Research related to development of "coordination" in children and the young [Abstract]. *Japan Society of Physical Education, Health and Sports Sciences, 48*, 377.
Meinel, K. (1960). *Bewegungslehre*. Berlin, German: Volk und Wissen Vokseigener Verlag.
Meinel, K. (1981). *Meinel's sports studies*. Tokyo, Japan: Taishukan.
Ministry of Education, Culture, Sports, Science and Technology (2008). *2008 report on sports and fitness*. Tokyo, Japan: Japanese Government Printing Office.
National Agency for the Advancement of Sports and Health (2010). *Accidents which take place at school* (22). Tokyo, Japan: Author.
National Recreation Association in Japan (2006). *Aida aida*. Tokyo, Japan: NHK Educational.
Rothlisberger, M. M. E. (2009). Development and evaluation of a motor coordination training for children in special-needs classes. *Prax Kinderpsychol Kinderpsychiatr, 58*(3), 215-230.
Schnabel, Harre, & Krug, (2008). *Trainingslehre — trainingswissenschaft*. German: Meyer & Meyer Verlag, 300-307.
Seki, N. (2009). National initiatives on the decline of physical fitness in children: Initiatives on physical development and the changes in children. *Children's Physical Growth and Development, 7*(3), 171-175.
Senda, T. (2004). Research on improvements in the schoolyard based on a distribution diagram of recess activities at Sakata elementary school. *Landscape Research, 68*(5), 837-842.
Senda, T., & Inoue, S. (2004). Role of improvements in the schoolyard in the activities of the local and school community — example of plans for Sakata elementary school. *Landscape Research, 68*(1), 24-27.
Suzuki, H., Nishijima, N., & Suzuki, K. (2010). Improvements in basic lifestyle related to improvements in children's physical fitness: Investigation based on a three year tracking survey. *Growth and Development Research, 46*, 27-36.
Suzuki, K. (2008). Three year physical development plan for children and its effects. *Growth and Development Research, 37*, 68-76.
Verstegen, M., & Marcello, B. (2001). Agility and coordination. In B. Foran (Ed.), *High performance sports conditioning* (pp. 140-141). Champaign, IL: HumanKinetics.
Yamamoto, K., Yabe, K., & Ikai, T. (1972). Central coordination mechanism-1-voluntary movement and brain waves (Coordination [Special Edition]). *Physical Education Studies, 22*(1), 41-45.
Yasumitsu, T. (2007). *Stabilization official book*. Tokyo, Japan: PCY, Ltd.
Yasumitsu, T., & Nogawa, H. (2010). Effectiveness of a coordination exercise program during school recess of elementary school - Focusing on agility. *Research Society of Sports Performance, 2, 233-245.*
Yomiuri, S (2007). *Children's physical fitness - critical level*. Tokyo, Japan: Tokyo Head Office. ■