PHYSICAL ACTIVITY AND LEARNING IN THE SWEDISH BUNKEFLO PROJECT
EVALUATION OF MOTOR SKILLS TRAINING IN COMPULSORY SCHOOL

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Abstract

The aim was to study relationships between physical activity and school performance in perspective of results found in the Swedish Bunkeflo project, also called the Pediatric Osteoporosis Prevention (POP) study. Another aim was to evaluate the model for motor skills training used in the project, the Motor skills as Ground for Learning (MUGI) model – (in Swedish: Motorisk Utveckling som Grund för Inlärning). The MUGI model for motor skills training was found to be useful as a pedagogic model for improving motor skills (balance/bilateral coordination and eye-hand coordination) in school pupils. Both boys and girls improved significantly in motor skills with extended physical education and extra motor training in school. The article proposes a theoretical model for understanding relationships between motor skills and school performance.

Key words: Academic achievements, Cognition, Motor skills development, MUGI, Physical Education and Health

I INTRODUCTION

Physical activity play is important for children’s social life, since friendships develop in conjunction with physical activity play during the first school years. Pellegrini (1995) found that exercise play (with gross motor movement) increase and peak during primary school years. According to Blatchford (1998) being able to participate in physical activities is important when it comes to acquiring friends, maintaining friends, and belonging in peer groups. Some children with impaired coordination may not become involved at all in social physical play and they are at risk of becoming isolated and solitary in the school playground. Research has shown that school-aged children with the diagnosis Developmental Coordination Disorder (DCD) spend less time in formal and informal team play (Smyth and Anderson, 2000). Fundamental motor skills may thus be an important factor in motivation for being physically active and being able to participate in social physical play.

The aim of this article is to discuss relationships between physical activity and school performance in perspective of results found in the Swedish Bunkeflo project, also called the Pediatric Osteoporosis Prevention (POP) study. Another aim is to evaluate the model for motor skills training used in the project, the Motor skills as Ground for Learning (MUGI) model – [in Swedish: Motorisk Utveckling som Grund för Inlärning] (Ericsson, 2003).

II PHYSICAL ACTIVITY AND ACADEMIC ACHIEVEMENTS

Many pupils leave compulsory school without being qualified to apply for a national upper secondary school programs. Despite efforts the number of unqualified pupils appears to increase. In spring 2009,
the proportion of qualified pupils were 88% in Sweden (National Agency for Education, 2009), which is the lowest percentage since 1998. This is a paradox since researchers (Ekman and Dolan, 2010) claim that 100% of Swedish pupils have the potential and capacity to reach the goals in all school subjects.

According to previous research the majority of Swedish pupils participate in the school subject Physical Education and Health (PEH) (Lundvall and Meckbach, 2008; Redelius, 2004). In a study of physical activity among IV- pupils (Ericsson and Cederberg; 2010) a comparatively smaller proportion, 61%, answered that they usually attended PEH-lessons school year 9. Nearly one half, 45% of the IV-pupils never became sweaty or breathless during school year 9 and 34% never exercised or did sports of any kind.

Pupils who have high grades in the school subject PEH often have high grades also in other subjects (Thedin Jakobsson et al., 2012). Åberg et al. (2009) found that cardiovascular fitness at age 18 years was positively associated with cognition and could predict educational achievement later in life. Findings by Middleton et al. (2010) showed that women who have been physically active at any point over the life course, especially as teenagers, had a lower likelihood of cognitive impairment in late life.

III THE BUNKEFLO PROJECT, A CONTROLLED INTERVENTION STUDY

All pupils (n=220) at two compulsory schools in a middle class area in Sweden were studied from school year 1 to 9. The control group had the school’s regular PEH two lessons (90 min) per week. An intervention group had PEH and physical activities on the schedule five lessons (225 min) per week and also, when needed, one extra hour of motor training per week. Motor skill observations with the MUGI observation checklist (Appendix A) were made at project start, school years 2, 3, and 9. The checklist consists of nine gross motor tasks measuring two components of motor skills: balance/bilateral coordination, e.g. hopping and balancing on one leg and hand-eye coordination with tasks like throwing, bouncing and catching a ball (Ericsson, 2008a). Pupils in the intervention group who needed extra motor training were offered this according to the MUGI model (Ericsson, 2008a).

III.1 Intervention with the MUGI model for motor skills training

The Motor skills as Ground for Learning (MUGI) model [in Swedish: Motorisk Utveckling som Grund för Inlämn] (Ericsson, 2008a) is an education program, which started in Lund in the early 1980s. The model was developed in collaboration with the school health service. It includes motor skills observations of all pupils at school start, information to teachers and parents, and offers of extra motor skills training. The aim is to identify children with any problems or difficulties in motor skills in order to give early support and stimulate their motor skills development, before motor deficits become a problem to the children. Children who need extra motor training are offered to come and practise gross motor skills with the PEH teacher in a smaller group one hour per week for as long as they need it. The training is a part of the school’s remedial teaching program for pupils with difficulties in motor skills, perception, and self-esteem.

Many children having motor skills problems have experienced a lot of failure when asked to do coordination or balance tasks in PEH lessons. The failures are probably perceived even worse by being visible and obvious to all class mates. Therefore the MUGI model for motor skills training is based on the principle of success, i.e. the children are never asked to do things they are not good at, but instead offered tasks with the aim of automatization of skills coming earlier in motor skills development. The MUGI model is influenced by the social cognitive theory, formulated by Bandura (1997). One of the most important goals in the training is that children feel motivated and enjoy taking part in physical
activities. It is important that the focus is on what each child wants to learn, that goals are achievable, and that the child takes pleasure in practising. Since children often are very good at finding skills they need to practice, the introduction to the training often includes questions like: “What do you think would be a good skill for you to know? “What would you like to learn?”

According to Bandura (1997) cognitive guidance is especially important in early phases of skill development, when a cognitive representation of the skill is formed. It is of importance that any feedback given is structured to build a sense of personal efficacy as well as a specific skill. Corrective feedback that highlights successes and directs attention to relevant aspects of sub skills aids the development of proficiency. Informative feedback improves the performance as well as facilitates observational learning for similar activities. The aim with continued practice is that skills become fully integrated and are executed with ease. Once a skill becomes routinized, it no longer requires higher cognitive control. The execution can then be regulated by lower sensory-motor systems in managing recurrent task demands.

After people develop adequate ways of managing situations that recur regularly, they act on their perceived efficacy without requiring continuing directive or reflective thought. (Bandura, 1997, p. 34)

This disengagement of thought from action performing has considerable functional value. Having to think about details in every skilled activity would consume most of the brain’s attentional and cognitive resources. The automation of complex skills involves several processes. Bandura (1997) outlines three major steps:

1. Mergerization, i.e. segments of the skill are merged into larger skills until it becomes a fully integrated routine that no longer requires cognitive organization or linkage.

2. Production of contextual linkages. Practiced actions repeatedly in the same situations are linked to recurrent contexts so that performers respond instantly without having to think about what to do.

3. Shift of attention from execution to result of the action.

The principles in MUGI motor training can thus be summarized as:

- Success instead of failure
- No training of skills the child cannot perform
- Automation of skills in earlier development

With better, i.e. automatized, motor skills the child will hopefully improve in self-efficacy (Bandura, 1997), social abilities, and eventually also in self-esteem. An early evaluation of the MUGI model showed that the motor training had positive effects on children’s motor control, perception and ability of remembering details (Ericsson and Lindström, 1987).

The results in the Bunkeflo project showed that motor skills improved from school year 1 to school year 9 in both groups, but more in the intervention than in the control group so that motor skills were superior in the intervention compared to the control group in school year 2, year 3, and year 9. Both boys and girls improved significantly in motor skills and the differences between them decreased with extended physical activity and extra motor training in school. In the control group, however, differences between boys’ and girls’ motor skills increased from school year 2 to school year 3. But in the intervention group there were no significant differences, neither in balance/bilateral coordination nor in eye-hand coordination between boys and girls in school year 3. At this point, 90% of the boys and 94% of the girls had good motor skills. The corresponding values in the control group were 46% and 83% respectively. School year 9 93% of boys and 92% of girls in the intervention group had good motor
skills. In the control group 42% of boys and 33% of girls had good motor skills (Ericsson and Karlsson, 2012). In the control group, which had the school’s ordinary PEH two lessons per week, there were no measurable differences between pre and post test for pupils with small or major deficits in motor skills. This indicates that motor skill deficits do not disappear by themselves, and that the school’s two lessons of PEH per week are not sufficient to stimulate improvements in motor skills for these pupils. These results are in line with other studies (Cratty, 1997; Cantell, 1998; Kadesjö and Gillberg, 1999; SEF, 2000), which confirm that without any remediation program many children with deficits in motor skills will keep these problems for many years.

Significantly higher grades in PEH were found in the intervention than in the control group and there were no pupil without a grade in the subject, whereas almost 4% of the pupils in the control group did not receive a grade in PEH. Additionally, for pupils in the intervention group who had motor skills deficits at project start, the positive effects remained from school year 2 and 3 through school year 9. These pupils received significantly higher grades in PEH compared to pupils in the control group with corresponding deficits in motor skills at project start (Ericsson, 2011).

Results from the Bunkeflo project also showed that the amount of physical activity and pupils’ motor skills had an impact on school achievements in Swedish (reading and writing) and Mathematics (room conception/spatial ability and number conception/thinking proficiency). Pupils with small and large deficits in motor skills at project start, who had extended physical activity and extra motor training in school, performed significantly better in all parts of the national tests of Mathematics and in three of four measured parts of the national tests of Swedish than pupils in the control group with similar deficits, but who had only the school’s ordinary PEH (Ericsson, 2008a; 2008a).

There was a larger proportion of pupils in the intervention than in the control group (96% versus 89%) that reached qualification to upper secondary school. The sum of grades was also higher in pupils with no motor skills deficit than among pupils with motor skills deficits as was the proportion of pupils who reached qualification to upper secondary school (97% versus 82%). In addition, there were in school year 9, significant correlations between motor skills and sum of grades in evaluated subjects. Significant correlations were also found between motor skills and the proportion of pupils that reached qualification to upper secondary school (Ericsson and Karlsson, 2012).

IV MOTOR SKILLS AND SELF-ESTEEM

Physical self-concept is known to be an important part of self-definition in childhood (Harter, 2003). Raudsepp, Neissaar and Kull (2013) found reciprocal relationship between physical self-worth and physical activity in early adolescences. In the Bunkeflo project significant correlations were found between motor skills and self-esteem overall and two components of self-esteem: friendship/sports efficacy and attention/learning efficacy (Ericsson and Karlsson, 2011). Other studies have shown that some children do not participate in sport or exercise because they have not established early coordination skills while at school. A national evaluation of the Swedish school subject PEH revealed that 10% of the pupils felt bad and clumsy during the PEH lessons and that 7% of the girls did not reach the subject’s goals (Eriksson et al., 2003). The lack of development of fundamental motor skills in early years can lead to a disinterest in physical activities, lack of fitness, low self-esteem and health problems as they grow older (Brown, Walkley and Holland, 2004). Children whose fitness is poor and whose motor skills are insufficiently developed often develop a negative self-image (Strauss, 2000) and end up in a downhill spiral leading to less and less physical activity. They are physically passive during their leisure time, and do not participate in any sports activities. They are caught in a cycle in which, children who are in
need of motor skills training the most get the least practice. Because they don't participate in physical activity they have poor motor skills, and because they have poor motor skills they don’t participate in sport and other physical activities so that their motor skills further decline. This sees them trapped in a spiral of declining motor skills, fitness and motivation to take part in physical activity. School physical education is one logical and practical point for intervening in this damaging cycle. Researchers who found low motor skill levels across Australia claim that more children and young people would play sport and take part in other physical activities if they had better motor skills (Brown et al., 2004).

Levels of self-esteem, of which physical self-esteem is an important part, can be predicting factors for motivation and behavior (Kerni et al., 1993). Favourable perceptions of one’s physical capacity contribute to an increase of participation in physical activity. Regular physical activity seems to promote self-esteem (Steptoe and Butler, 1996) and perceived physical self-esteem can be increased by activity programs (Fox, 2000; Lindwall, 2004). Furthermore, increased physical self-esteem has been found to be a strong predictor to be highly physically active and maintain a normal BMI as adolescent (Raustorp, 2005). A conclusion is that exercise could be a valuable tool for increasing and maintaining physical self-worth. This indicates that, when planning intervention programs to increase physical self-esteem through physical activity, early interventions to improve fundamental motor skills may be successful starting points.

IV.1 Self-efficacy and learning

Theories of the self differ not only in concepts but also in comprehensiveness. Social cognitive theory adopts an ecological perspective on the contribution of efficacy beliefs to cognitive and social development. The self-efficacy theory, formulated by Bandura (1997), addresses sub processes at both an individual and a collective level. Efficacy beliefs play a crucial role in the self-regulation of motivation. The self is socially constituted, but individuals are contributors to what they become and do. Personal standards are constructed to be used to guide, motivate, and regulate the behaviour. Self-esteem, or self-worthiness, has many sources and it can stem from self-evaluations of personal competence. Competence or competent functioning requires appropriate learning experiences; it does not emerge spontaneously. Striving for competence is motivated by benefits of competent actions. This means that self-devaluation rooted in incompetence requires practice of skills that bring self-satisfaction.

The initial efficacy experiences are acquired in the family, but peers have an increasingly important role in development of self-knowledge of capabilities. In peer interactions social comparison processes come into play. Children are especially sensitive to their relative standing among peers in activities that determine prestige and popularity. In a path analysis of influence patterns (Bandura, 1997) it has been shown that strong prosocial connectedness and peer popularity promote academic achievement directly.

Environments that are responsive to infants’ actions promote the development of causal agency. Infants who experience success in controlling environmental events by their actions become more attentive to their own behaviour and more competent learners than infants for whom the same environmental events occur regardless of how the behave. (a.a., p. 164)

Preschool programs that provide rich mastery experiences raise the intellectual level and academic attainments of children. The most disadvantaged benefit the most and the earlier and more intensive enablement programs, the greater the lasting intellectual benefits (Bandura, 1997).

Perceived self-efficacy is an important component in social cognitive theory. Efficacy beliefs are involved in regulating all types of performances, until they become routinized into habitual patterns. In fact, perceived efficacy beliefs contribute independently to intellectual performance rather than simply reflecting cognitive skills. Studies have shown that efficacy beliefs predicted interest in, and positive
attitudes toward, mathematics, whereas actual mathematical ability did not. The more self-efficacious children managed their work time better and were more persistent in solving problems.

Regardless of whether children were of superior or average cognitive ability, those with a high sense of efficacy were more successful in solving conceptual problems than were children of equal ability but lower perceived efficacy. (Bandura, 1997, p. 215)

Perceived self-efficacy may thus be regarded as a better predictor of intellectual performance than skills alone. Furthermore, efficacy beliefs can predict enduring changes in lifestyle activity patterns. Belief in one’s physical efficacy has been found to be a better predictor of long-term engagement in everyday physical and social activity than physiological capacity, age, or perceived exertion (Bandura, 1997). Results from the Bunkeflo project (Ericsson and Karlsson, 2011) suggest that perceived self-efficacy as well as physical self-esteem is associated with success in school work and that they both might be positively affected by success in motor skills and physical activities.

V DISCUSSION

The MUGI model for motor skills training was found to be useful as a pedagogic model for improving motor skills (balance/bilateral coordination and eye-hand coordination) in school pupils. The conclusion and implications of the present findings are that the school has good potentials in stimulating all pupils’ development of motor skills, but two lessons of PEH per week are not enough as shown in the Bunkeflo project. The European Parliament (2007) calls upon all Member States to guarantee at least three PE lessons per week under supervision of specialised PE instructors for all pupils. Physical activity and motor training every day showed positive effects in this study.

How could one understand the relationships between motor skills and cognition and explain possible effects from motor training on learning? It is hard to find any good theories or models for total explanations. However, there are different attempts of explanations which can be divided into three different perspectives: a sensory-motor perspective, a neurophysiologic and a psychological perspective. The sensory-motor perspective focuses on the importance of the child’s early motor experiences for the sensory and the perceptual development and also for cognitive processes. Deficits in motor skills might have a negative effect on self-esteem, skills to play, attention and other cognitive functions (Cratty, 1997; Gjesing, 1997).The hypothesis in a neurophysiologic perspective is that motor training might affect the nerve system in a positive way. Studies have shown that the same part of the brain (the pre frontal cortex) is active in motor learning as in problem solving and cognitive learning (Jensen, 1998; Shephard, 1997). Physical activity also increases the blood flow and the metabolism in the brain, which could result in a higher grade of arousal and attention (Shephard, 1997). In a psychological perspective the explanations are focusing indirect relationships between motor skills and cognition. Changes in psychological functions as a result from physical activity, such as motivation, communication, social competence, self-esteem and general life quality, might lead to better learning skills with higher quality and fewer disturbances (Kiphard, 1979; Bandura, 1997).

Based on earlier research, concepts in the social cognitive theory, and practise of the MUGI model presented in this article, some theoretical assumptions regarding the relationships between physical activity and school performance can be outlined as: Improvements and automatization of fundamental motor skills lead to increased physical self-esteem, which give better prerequisites for attention and comfort in school, which lead to increased motivation to learn and to attend classes. An illustration of this positive spiral is shown in figure 1.
Figure 1. Model for understanding relationships between motor skills and school performance: Improvements and automatization of fundamental motor skills may lead to increased physical self-esteem, which give better prerequisites for attention and comfort in school, which may lead to increased motivation to learn and to attend classes.

To combat declining physical activity levels there is a need for more knowledge about motor development in children and school pupils. The link between motor competence, physical and psychological health needs to be examined further. Early discovery gives opportunity for early interventions, which could be of importance when it comes to avoiding discouraging pupils whose fitness is poor. Teachers might need education in observing and stimulating children’s motor development and how to influence pupils to have a healthy life long lasting appreciation of physical activity. Teachers and school staff also need to know more about interventions and motor training that can stimulate and improve motor functioning, for all children and for those with disabilities. Motor training can preferably be conducted by PE teachers in the school’s regular PE programs. However, children with motor skills deficits often need special education in a smaller group, where extra motor training with focus on balance and coordination has proven to be successful. The MUGI observation checklist (Ericsson, 2008a; 2011b; Appendix 1) give an indication of which children may need extra gross motor skills stimulation. The purpose of motor skill observations, by the time children start school, is to make possible early identification of deficits in motor control, so that pedagogical remedial programs can start before motor deficits become a problem to the children.

Schools have an essential role in promoting health through adoption of physically active lifestyles. Many of the activities in physical education, however, are devoted to ball games and team sports rather than to development of motor skills and recreational activities that can serve lifelong fitness (Carli, 2004; Eriksson et al., 2003). Forms and content of the school subject PEH may thus be questioned and call for a reorienting towards motor skills and physical fitness activities that can be practised regardless of time.
and place and which are transferable to adulthood. Coeducational PEH classes, at all times, may be questioned, in line with Carli (2004) and Moreno, Gimeno, Lacárcel and Pérez (2007), since it makes physical development and knowledge in motor skills salient to everybody, which could contribute to an uncomfortable situation for many pupils. Teaching approaches that are directive and focus on the execution of skills may be questioned, since they can discourage the less skilled from participation by highlighting what they cannot do in front of all their peers (Light and Fawns, 2003). Research indicates that, when planning intervention programs to increase motivation and physical self-esteem through physical activity, school interventions should focus on improvements in fundamental motor skills. When focus in grading is more on quality evaluations of motor skills rather than measurements of sports performances, pupils are more likely to compare results to their own previous results rather than judging themselves compared to others (Larsson, 2009). This may in its turn have a positive impact on motivation to participate in PE, which most likely would result in an increase in pupils’ kinesthetic knowledge as well as their grades in the subject.

ACKNOWLEDGEMENTS

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REFERENCES


Appendix 1. MUGI OBSERVATION CHECKLIST

The checklist is intended for the use of school nurses, PE teachers, trained sports coaches/teachers, and special needs teachers, under the supervision of a trained PE teacher.

**Introduction and warm-up:** Individual play with a large ball

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<table>
<thead>
<tr>
<th></th>
<th>MUGI task</th>
<th>Minor difficulty, insecurity, uncertainty</th>
<th>Major difficulty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Throw and catch a large ball</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5 consecutive times</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Bounce large ball</td>
<td>right</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5 consecutive times</td>
<td>left</td>
<td></td>
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<tr>
<td>3</td>
<td>Skip in diagonal pattern forward</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>15 m</td>
<td></td>
<td></td>
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<tr>
<td>4</td>
<td>Hop in one leg</td>
<td>right</td>
<td></td>
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<tr>
<td></td>
<td>2x7 m</td>
<td>left</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Stand on one leg</td>
<td>right</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10 sec.</td>
<td>left</td>
<td></td>
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<tr>
<td>6</td>
<td>Walk with toes pointing out</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2x7 m</td>
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<tr>
<td></td>
<td>Without big involuntary movements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Alternating “ski hop”</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rhythmically, 15 times</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Imitate body movements and positions game: “Simon says do this; do that!”</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a “Warm your knees”</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>In diagonal pattern</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>b Opposite arm and leg lifted to the side</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>c Right hand on left ear and left hand on left hip</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Obstacle course</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a Jump with hula hoop, moving forward with running steps</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>b “Broad jump over a ditch”</td>
<td>1 m</td>
<td></td>
</tr>
<tr>
<td></td>
<td>“High jump over a magic rope”</td>
<td>40 cm</td>
<td></td>
</tr>
</tbody>
</table>

Motorisk Utveckling som Grund för Inlärning MUGI [www.mugi.se](http://www.mugi.se)