Interrelationship among selected measures of motor skills

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Accepted for publication 14 April 2007

Abstract
Background This study set out to explore the interrelationship among selected measures of motor skills.

Methods Ninety-one 4-year-old children from 10 nursery schools were tested using eight motor tasks from the Movement Assessment Battery for Children test.

Results The most striking finding was that there were very low correlations between the motor tasks.

Conclusions In relation to these findings, it is possible to argue that learning of particular motor skills is specific to that task. This is discussed in relation to the principle of task specificity of learning.

Introduction
Maturation theories (Shirley 1931; McGraw 1935; Gesell 1954; Bayley 1969) dominated the field of developmental psychology until 1970; at that time it was challenged by researchers within the field (Connolly 1970, 1986). In this period the current view within embryology changed, and environmental factors were assigned a larger role in individual development. In 1970 Gottlieb presented his theory of probabilistic epigenesis (Gottlieb 1970, 1976); the theory focuses on the bidirectional nature of genetic, neural, behavioural and environmental influences on individual development. In the last decade the approach of dynamical systems has been used to explain motor development and learning (Thelen & Smith 1994). This dynamical view has provided a unifying perspective on how to explain both the global similarities and individual differences (variations) in motor development and is in accordance with the perspective on development as a probabilistic epigenetic process (Vereijken 2005).

The role of practice (learning) for individual development has received increased attention and with it the role of nurture and environmental conditioning (Connolly 1970, 1986; Edelman 1987, 1992; Gottlieb 1998). The concept of development has become closely linked to the concept of learning (practice or experience leading to changes in the ability to perform tasks) (Sigmundsson 2005). This leads us to question the relative roles of nature and nurture in acquiring different skills. Edelman’s theory (Edelman 1987, 1992) on ‘neural Darwinism’ argues that the process of learning can be explained as a process of selection that takes place inside the neural system. The theory emphasizes how stimuli and practice increase connections within specific areas of the brain. Practice of a task strengthens the neural networks that are used for that particular task. Sigmundsson and Rostoft (2003) and Sigmundsson (2005) pointed out that it is possible to argue that Edelman’s theory supports the perspectives of ‘task specificity’ of learning. By saying that training is specific, we mean that every particular skill is specific and should be trained specifically (Larkin &
In relation to motor skill learning it might be argued that by training specific tasks the neuro-motor and perceptual-motor subsystems involved in that specific task may be tuned in (Sporns & Edelman 1993). However, how much training an individual need will vary depending on a variety of factors acting as constraints on the skill-learning process, e.g. the person’s organismic constraints (see for overview Newell 1986). Fleishman (1966) attempted to distinguish between abilities and skills. He provided the following definitions of the two terms: ‘...ability refers to a more general trait of the individual which has been inferred from certain response consistencies (e.g. correlations) on certain kinds of task’ (p. 147/148). ‘The term skill refers to the level of proficiency on a specific task or limited group of tasks’ (p. 148). To distinguish between ability and skill, Fleishman argued as follows: ‘the assumption is that the skills involved in complex activities can be described in terms of the more basic abilities. For example, the level of performance a man can attain...may depend on his basic abilities of manual dexterity and motor coordination’ (p. 148). If Fleishman’s assumption is correct we should expect to find high intercorrelations among different tasks of various skill types, if the tasks belong to the same ability, e.g. manual dexterity. If, on the other hand, skills are task-specific, the same intercorrelations should be low, perhaps even regardless of the tasks belonging clearly to the same category or, in Fleishman’s (1966, p. 148) terms, the same basic ability. The present study set out to evaluate this hypothesis focusing on motor skills e.g. between eight different motor tasks of the Movement Assessment Battery for Children (ABC) test.

**Method**

**Subjects**

A total of 91 nursery school children aged 4–5 years participated in the study, 46 boys and 45 girls. They were selected from 10 nursery schools in an urban area in Norway.

The sample included children from a wide range of socio-economic backgrounds and reflected the population of children attending nursery schools in this area. The mean chronological age for the boys group was 4.4 years (SD 0.30), and for the girls 4.4 years (SD 0.29), the overall range being 3.9–5.0 years.

**Apparatus: Movement ABC**

The Movement ABC was designed to identify children with motor co-ordination problems. The test was developed by Henderson and Sugden (1992), and is an extended version of Test of Motor Impairment. It is a formal, standardized test and provides both a quantitative and a qualitative evaluation of the child’s motor competence in daily life across a wide range of motor skills. Norms are provided for children aged 4–12 years. On the basis of these norms it is possible to establish whether a child has normal motor performance (compared with 85% of children of the same age), borderline performance (85%–95%) or, belongs to the 5% with a deviant performance (95%–100%). In the age group 4–5, an ABC score of 10.5 would place the child at the 15th centile and a score greater than 17.0 at the 5th centile.

The Movement ABC consists of three subtests, with a total of eight items, the content of which differs depending on the age range for which the test is used. In this study the items that were constructed for children aged 4, 5 and 6 were used. The subtests and items are: (i) manual dexterity, with the items posting coins (PC); threading beads (TB) and bicycle trail (BT); (ii) ball skills, with the items catching bean bag (CBB) and rolling ball into goal (RBG); and (iii) balance, with the items one-leg balance (OB); jumping over cord (JC) and walking heels raised (WHR).

On each item a score between 0 and 5 can be given, a higher score indicating worse performance. Item scores are summed to obtain scores on subtests. Scores on manual dexterity and balance range from 0 to 15, while scores on ball skills range from 0 to 10. Summation over the subtests results in a total score, which ranges from 0 to 40.

**Procedure**

The administration and scoring were carried out according to the instructions given in the test manual. The children were tested at their nursery school in a quiet room where they were alone with the experimenter. Two trained experimenters carried out the testing.

**Data analysis**

The scoring instructions from the manual for the Movement ABC test were followed. Raw scores for each task were converted to scaled scores according to norms presented in the manual. In the present study, the focus was on children’s scaled scores dealing exclusively with the scores for the eight different tasks.

**Results**

Correlations (Pearson, two tailed) between the eight subtasks of the Movement ABC are presented in Table 1.
It is interesting to note the relatively low correlation between the tasks within the Movement ABC battery. The highest correlation was found between the tasks RBG and WHR (0.614) and the lowest correlation was found between the tasks TB and RBG (−0.005). It is also very interesting to see the low correlation within each of the subgroups. Within the subgroup manual dexterity the correlation was 0.155 (PC – TB), −0.031 (PC – BT) and 0.203 (TB – BT). Within the subgroup ball skills the correlation was 0.155 (CBB – RBG) and within the subgroup balance the correlation between the tasks was 0.270 (OB – JC); 0.177 (OB – WHR) and −0.034 (JC – WHR).

### Discussion

In this paper, data are presented about the performance of 4-year-old Norwegian children on eight different motor tasks from the Movement ABC test. This study was carried out to explore the interrelationship between the selected measures of motor skills.

The most striking findings were the low correlation found between the eight different motor tasks of the Movement ABC test. These results support the hypothesis that skills are task-specific. Furthermore, the present results lend support to and extend the findings of Drowatsky and Zuccato (1967) showing the correlation among six different tests of static and dynamic balance to be very low. The highest correlation found in their study was 0.31, most of the correlation varies between 0.12 and 0.19.

In relation to these findings it is possible to argue that the process of skill learning is specific. This is in line with Sporns and Edelman (1993) who argue that training a specific task will strengthen the neural connections (synapses) involved in that particular task thus making this behaviour more probable to be executed next time. On the basis of this it might be argued that task-specific training is necessary because the neuro-motor and perceptual-motor subsystems involved in that specific task needs to be tuned in.

This view is later supported by Vereijken (2005), who argues that learning effects can be both context-specific and task-specific.

Another problem to discuss is the way different skills are classified under some subcategories involving as e.g. manual dexterity. Handwriting is often viewed as a signature of fine motor control although this skill probably must be seen as a specific motor skill. If a child has problems with writing, one could not say it has a general problem with fine motor co-ordination as handwriting is only one skill out of many skills categorized under fine motor control. The child might, despite this, be an excellent builder with Lego bricks that also depends heavily on fine motor control. However, the findings of this study support the ‘task specificity’ of learning (Sigmundsson et al. 1998; Larkin & Parker 2002; Sigmundsson & Rostoft 2003; Rostoft & Sigmundsson 2004; Sigmundsson 2005) and therefore supporting Edelman’s theory ‘on neural Darwinism’ (Edelman 1987, 1992; Sporns & Edelman 1993). This view of specificity in learning of motor skills is earlier supported by Revie and Larkin (1993), whose study found that clumsy children made specific improvements to the task actually taught. Karlsdottir and Stefansson (2003) support these notions but within other skills. The authors were looking at reading competence and found as for the motor skill that there was low correlation between each subtask within reading.

The results from this study could be seen as important for the ‘practical’ field. It would be possible to argue that each skill should be treated as specific. Therefore, we must decide what skills are necessary and important for children to learn. Then it is important to find out the level of each individual children in that particularly task. By doing that it is possible to give the children the right challenge in relation to their performance in the task (Sigmundsson et al. 1998).

There is clearly a need of further research about specificity in learning both in the field of motor skills and in cognitive skills like mathematics and reading.

### References


Connolly, K. J. (1986) A perspective on motor development. In: 
Motor Development in Children: Aspects of Coordination and 
Martinus-Nijhoff, Dordrecht, the Netherlands.

Drowatsky, J. N. & Zuccato, F. G. (1967) Interrelationships between 
selected measures of static and dynamic balance. Research 
Quarterly, 38, 509–510.

NY, USA.

Mind. Basic Books, New York, NY, USA.

In: Acquisition of Skill (ed. E. A. Bilodeau), pp. 147–167. Academic 
Press, New York, NY, USA.

New York, NY, USA.

Development and Evaluation of Behaviour: Essays in Memory of T C 
Schneirla (eds L. R. Aronson, E. Tobach, D. S. Lehrman & J. S. 
Rosenblatt), pp. 111–137. W.H. Freeman, San Francisco, CA, USA.


influences on gene activity: from central dogma to probabilistic 

Battery for Children The Psychological Corporation, Kent, UK.

primary school subjects. Perceptual and Motor Skills, 97, 
1058–1060.

with developmental coordination disorder: a systems view. In: 
Developmental Coordination Disorder (eds S. A. Cermak & D. 


Newell, K. M. (1986) Constraints on the development of 
coordination. In: Motor Development in Children: Aspects of 
Coordination and Control (eds M. G. Wade & H. T. A. Whiting), 

reduces movement problems. Adapted Physical Activity Quarterly, 
10, 29–41.

co-ordination disorder: different perspectives on the 
understanding of motor control and co-ordination. Advances in 
Physiotherapy, 6, 11–19.

Shirley, M. M. (1931) The First Two Years: A Study of Twenty-five 
Babies, Vol. 1. Postural and Locomotor Development. University of 
Minnesota Press, Minneapolis, MN, USA.


exploring the motor competence in 4 year-old children. 

Thelen, E. & Smith, L. B. (1994) A Dynamic Systems Approach to the 
Development of Cognition and Action. MIT Press, Cambridge, MA, 
USA.

Encyclopedia of Child Development (eds B. Hopkins, R. G. Barr, 
Press, New York, NY, USA.