

Landscape as Playscape: The Effects of Natural Environments on Children's Play and Motor Development

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Abstract

This study investigated the impacts of playing in a natural environment on motor development in children. Methods from landscape ecology were applied for landscape analysis and entered into a Geographic Information System (GIS). Localization of play habitats was done by use of Global Positioning Systems (GPS). A quasi-experimental study was conducted on five-, six-, and seven-year old children with an experimental group playing in a natural environment and a control group playing in a more traditional playground. When provided with a natural landscape in which to play, children showed a statistically significant increase in motor fitness. There were also significant differences between the two groups in balance and co-ordination in favor of the experimental group. The findings indicate that landscape features influence physical activity play and motor development in children.

Keywords: *children, natural environment, playscape, landscape ecology, physical activity play, motor development.*

Introduction

The natural environment has traditionally been a site for play and physical activity for many children, but modern societies seem to have neglected the value of such environments for the development of children and adolescents. A generation ago, children had access to wild lands and used them for exploring, challenging and exercising the skills needed to master a challenging landscape and unforeseen situations. Today, children's physical play environments and facilities for play are changing and the opportunities for free play in stimulating environments seem to be declining (Esbensen 1990, MMI 1997). There is a growing concern that children are becoming more sedentary in their adolescence, and scenarios predict enervated health later in life due to an inactive adolescence (Andersen et al. 1998, Heggebø 2003). Early studies by Hart (1979), Moore (1986), More and Wong (1997), Rivkin (1990; 1995), Titman (1994) and others describe the value of complex environments and wild lands for children, and how children perceive and experience wild lands as places of their own domain. Recently scholars have focused their attention on how the natural environment affords possibilities and challenges for children to explore their own abilities for exercise, playing and skill mastery. Focus has been directed on learning effects from the natural environment and its impact on children's development. For example, some Scandinavian studies have described and analyzed how natural environments affect learning qualities in children such as play behavior and motor skills (Fjortoft 2000a; Grahn et al. 1997). Lindholm (1995) found a relationship between the presence of natural environments in or around schoolyards and students' activities during their breaks. The students' activities were remarkably more creative with the presence of a natural environment. Baranowski et al. (1993) found a consistently higher activity level among three and four year-olds outdoors than indoors, and the environment seemed to be the strongest predictor of physical activity in pre-school children.

Traditionally, outdoor playgrounds are designed to facilitate children's play and are intended to enhance their physical, social, emotional and cognitive development (Hart 1993). Even though traditional playgrounds are anticipated to promote children's play, their design does not meet children's needs for exploring their environment. The traditional playground is typically flat, barren, covered with asphalt, and equipped with climbing bars, a swing, a sandpit, a seesaw, and a slide. Usually the equipment is made of metal (Frost 1992; Hartle and Johnson 1993). Such playgrounds have not been found to be very challenging and even very young children or those with motor behavior deficits do not explore their potential on these playgrounds (Frost 1992).

Natural environments represent different play opportunities for children. The rough surface provides movement challenges, and topography and vegetation provide a diversity of different designs for playing and moving. The present study documents and discusses the importance of natural environments in children's play, physical activity and motor development.

Outdoor Play Environments: Why Nature?

Play activities have proved to increase with the complexity of the environment and the opportunities for play (Frost and Strickland 1985, Wilkinson 1980). Children's play also is more vigorous outdoors than indoors (Henninger 1980), and play forms take different group and gender constellations outdoors than

indoors (Baranowsky et al. 1993; Kirkby 1984; Rivkin 1990). Options for choice, opportunities for play, and the possibility to construct and re-organize play settings are irreplaceable values in children's play environments (Lindholm 1995). Titman (1994) very clearly showed children's preferences for outdoor play environments. The environmental qualities most appreciated by children included: colors in nature, trees, woodlands, shifting topography, shaded areas, meadows, places for climbing and construction, and challenging places for exploring and experience. This indicates that children have a desire for more complex, challenging and exciting play environments than the traditional playgrounds usually offered them.

Rivkin (1990) mentioned some specific qualities of the outdoor room favored by children. For example, they prefer the "realness" of physical attributes over toys and sham. Furthermore, the symbolism and images that can make an environment magical during children's dramatic play demand a certain sense of "placeness." Similarly, she emphasized that open-ended spaces and the forms of landscapes and objects often have associative qualities and give meaning to children's play and imagination. Likewise, lines and shapes in the landscape give the children a conception of space and form. For example, children prefer multifaceted forms to plain ones and they relate better to softened edges and curves in the landscape. Layering the landscape with bushes and corners affords looking through and gives a sense of depth and diversity. Rivkin mentioned several other qualities of outdoor rooms which are intriguing to children, including: places that engage the senses through textures, sounds, fragrant smells from vegetation and natural elements; novelty and unpredictability; unusualness and incongruity; and surprise and discovery. Although Rivkin did not refer solely to natural landscapes, she emphasized complex and diverse environments for play.

Moore and Wong (1997) described the turning of a yard from an asphalt square into an environmental garden with naturalized settings. Children's perceptions of the yard after the re-formation included diversity, richness, a place to belong, caring for nature, and a friendlier atmosphere. Interviews with the children five and 20 years later revealed memories of fascination with the yard and the complexity of its plants and animals. They frequently recalled the landscape features that afforded play, such as the little clearings, the bridge over the stream, the stepping stones in the pond, all the bushes and the trees to climb. The children who spent time in the Environmental Yard expressed greater environmental awareness, attended natural events, were more innovative in their play, and increased their fantasy play using objects that were readily available from the environment. They also became more interactive with the natural environment outside school.

The Impact of the Environment on Development and Learning

The ecological approach to development stresses the interrelationships between the individual and the environment (Haywood 1993). One ecological perspective is dynamic systems theory, which emphasizes process rather than product or hierarchically structured plans. It places neural maturation on an equal plane with other structures and processes that interact to promote motor development (Thelen 1992). Cooperating systems include musculo-skeletal components, sensory systems, and central sensor-motor integrative mechanisms. This co-

operation of systems has a co-coordinative structure and the resulting movement emerges from self-organization of body systems, the nature of the performer's environment and the demands of the task (Haywood 1993; Vereijken, Whiting, and Beek 1992). In this theoretical approach, the internal components of the organism and the external context of the task jointly co-determine the outcome of behavior (Campbell 1994). Dynamic systems theory goes beyond the metaphoric level of behavioral development change and looks into the variables that cause change (Vereijken 1997).

A second branch of the ecological approach is the perception-action perspective introduced by Gibson (1979) as the Theory of Affordances. In this theory, Gibson proposed that a close interrelationship exists between the perceptual and motor systems. To be ecologically valid, i.e., applicable to the real world, perception cannot be studied independently of movement, and the individual has to be studied in relation to its surrounding environment. The term "affordances" describes the functions environmental objects can provide to an individual. For example, if a rock has a smooth and horizontal surface, it affords a person a place to sit. If a tree is properly branched, it affords a person the opportunity to climb it. This exemplifies an intertwined relationship between individuals and the environment and implies that people assess environmental properties in relation to themselves, not in relation to an objective standard (Konczak 1990).

Problem and Aims of the Study

The present paper focuses on two issues related to children's play and development, namely, the value of the natural environment as a playground for children, and the ability of such landscapes to afford challenging and stimulating play environments for children.

The domain of children's motor development has been addressed through numerous research projects (e.g., Thelen and Smith 1994; Ulrich 1997; Sigmundsson and Rostoft 2003), but just a few (Fjørtoft 2000, Grahn et al. 1997) have related motor fitness development to play activities in the natural environment. Thus, the main purpose of this study was to investigate the relationship between children's motor development and playing in a natural environment.

Definition of Concepts

Natural environments are here defined as environments not designed or cultivated by humans. The natural environment in this project is bounded as a small forest located close to a kindergarten. *Facilities for play* are defined here by structures in topography and vegetation that afford different types of play (i.e., trees for climbing, slopes for sliding, fields for running, etc.). *Play activities* are classified according to Piaget (1962) and Frost (1992) into categories of functional play, construction play and symbol play. These are play forms that enhance physical activity and gross motor movements. The definition of *motor fitness*, based on Gallahue (1987), is the abilities of coordination, speed, agility, power and balance. *Playscape* is defined by Frost (1992) as a landscape that affords children the ability to play.

Study Design and Analysis

The model in Figure 1 illustrates the logical framework for the study. The research has a quasi-experimental design which examines the effects of children's playing in a natural environment on their motor development. The dependent variable is motor development, measured as motor fitness in children. The independent variables are: 1) the landscape structures that afford physical activity play in children, and 2) how children use those structures for play.

Figure 1. Study Framework Model

Variables	Landscape Structures	<i>Afford</i> →	Physical Activity Play	<i>Affect</i> →	Motor Development
Operationalized As:	Topography		Functional Play		Motor Fitness
	Vegetation		Symbolic Play		
	Landscape Ecology		Construction Play		
Measured As:	Slope and Roughness		Observations		Intervention Study
	Mapping Vegetation		Classification		Fitness Tests
	Function, Habitat, Change				

Materials and Methods

Experimental and control groups were selected from voluntary kindergartens with the same original playground opportunities in the same geographic area. Both groups were selected as stratified samples, as randomization was not possible due to the available kindergartens and numbers of children in each age group. The experimental group was offered a natural playscape as playground, while the controls continued using the kindergarten playground. It was investigated whether the play of children in the experimental group in the natural playscape would have any effect on their motor development compared to the control group.

Methodology for Landscape Analysis

The area was described using methods from landscape ecology and geomorphology (Fjørtoft and Sageie 2000), based on two landscape elements: vegetation and topography. The vegetation was mapped by field inventory on aerial photos at the scale 1:6000 (Paine and Luba 1980; Ihse 1989; 1995). The vegetation was described according to the Norwegian classification system based

on Fremstad (1997), where each unit is classified by phytosociology and physiognomy. Phytosociology describes the vegetation based on the composition of the plant cover with the dominating and/or characteristic species as indicators. The physiognomy is the vegetation structure such as main growth forms and cover.

Analysis of topography was based on methods from geomorphometry by slope and roughness. Slope (in degrees) and roughness were derived from contour lines in the municipality base map at the scale 1:1000 with one meter equidistance. Roughness is often described as the second derivative function of the height of the surface (i.e., the slope of the slope) (Berry 1997), and describes the "diversity of topography." Analysis of slope and roughness was based on the Digital Elevation Model (DEM) (Burrough 1996).

The surface elevation was modeled and analyzed, as contour lines, profiles, altitude matrices, regular grids and Triangulated Irregular Network (TIN). Berry (1997) claims that one final surface configuration factor taken into consideration is profile. Consequently, two methods were used for profiling, including terrain measurements by use of geodetic methods and the deriving of profiles from DEM.

Profiling was applied to describe the differences in topography between the natural playscape of the experimental group and the outdoor playground of the comparison group.

Methods from landscape ecology and geomorphometry were used for the description of the study area and the analyses of landscape ecology metrics (Dramstad et al. 1996; Fjørtoft and Sageie 2000). Play habitats were mapped by use of differential Global Positioning Systems (GPS). Data from landscape ecology were entered in a Geographical Information System (GIS) for analysis and visualization. The landscape analyses and application of GIS and GPS are described in more detail by Fjørtoft and Sageie (2000).

Landscape Ecology

The theories of landscape ecology are based on the structure, function and change of landscapes (Forman 1995; Dramstad et al. 1996). A landscape's *structure* refers to the topography and physiognomy of its vegetation. *Function* is the interaction among the spatial elements in the ecosystem (Forman and Godron 1986; McGarigal and Marcs 1998). In the present context, function is referred to as the interaction between the structure and the complexity of the topography and vegetation. The physical patterns of habitat complexity or diversity include its structure, composition and function (Skånes 1997). Diversity in the landscape (i.e., diversity in topography and vegetation) was related to children's play behavior and its effect on their motor fitness.

Change in the landscape may be explained through the alteration of the structures and functions of the ecological mosaic over time (Skånes 1996). It is possible to interpret change in the landscape according to the seasons. This perspective was applied to explain how seasonal changes affected the children's play in the landscape.

Habitat is defined as the space or place used by one or more organisms co-existing with each other. The habitat often comprises different biotopes that can be used in different seasons or for different purposes (Heywood and Watson 1995, Ims 1992, Skånes1997). In this study the concept of play habitats refers to the places used by the children for different forms of play.

Physical Activity Play

Play behavior that constituted physical activity was observed and classified in three categories (Frost 1992):

1. Functional play (physical play activities: identified and categorized in subgroups such as running and tumbling, climbing rocks and sliding slopes, climbing trees, and playful skiing).
2. Constructive play (building huts and shelters and playing with loose parts, sticks, cones, pebbles, etc.).
3. Symbolic play (role-play, dramatic play and social play like play house, pirates, etc.).

Play activities were observed and logged by the kindergarten teacher, who wrote down the children's play behavior using their own phrasing. Later this information was systematized by the researcher and classified according to Piaget (1962) and Frost (1992). The actual habitats named and used by the children for specific play activities were recorded and referred to as reference areas or habitats for the different forms of play.

The Study

The study was carried out with five- to seven-year-old children in kindergartens in Telemark, Norway, using a quasi-experimental approach (Robson 1993; Thomas and Nelson 1985). The groups were selected from three kindergartens with comparable age groups. The experimental group of 46 children from one kindergarten was offered free play and versatile activities in the nearby forest. This group used the forest every day for one to two hours throughout the year. 29 children of the same age groups from two kindergartens in the neighboring district were chosen to be a comparison group. Using multiple regression analysis, with parents' educational and professional background as variables, the two groups' socio-economic living conditions were found to be comparable. The comparison group used the traditional outdoor playground for one to two hours a day and visited natural sites only occasionally. Both control groups had the same standard playground equipment, such as sandpit, a swing, a seesaw, a slide and a climbing house in their outdoor playground. The study started with a pre-test in September. The observation period lasted for nine months, and was terminated with a post-test in June the following year.

The experimental and control groups were both tested with the European Test of Physical Fitness (EUROFIT) Motor Fitness Test (Adam et al. 1988). The data were collected by the author and a trained assistant who was a kindergarten teacher. The test included the following items: flamingo balance test (standing on one foot) for testing of general balance; plate tapping (rapid tapping of two plates alternatively with preferred hand) measuring the speed of limb movement; sit and reach expressing flexibility in knee and thigh joints; standing

broad jump (jumping for distance from a standing start) measuring explosive strength; sit-ups (maximum numbers of sit-ups achievable in half a minute) measuring trunk strength; bent arm hang (maintaining a bent arm position while hanging from a bar) for testing of functional strength in arms and shoulders, and shuttle run (sprinting to a turn-around point and back) testing running speed and agility. Two additional tests were used: beam walking for testing dynamic balance, and Indian skip (clapping right knee with left hand and vice versa), for testing cross co-ordination (Fjørtoft 2000b).

Data analyses were performed with SPSS/PC+, the PC version of the Statistical Package for the Social Sciences (Norusis 1993; Frude 1993), including frequency distributions, means and the T-test for independent samples and paired samples, correlations, multiple regression analyses and factor analyses (Fjørtoft 2000a; 2000b; 2001).

Reliability and Validity

Landscape analyses followed strict methods for vegetation mapping and classification (Skånes 1997; Fjørtoft and Sageie 2000) and professionals performed the field inventory. Computerized data were analyzed with the help of software programs FRAGSTATS*ARC and Geographic Information Systems (GIS). Topography was measured instrumentally and by Global Positioning System (GPS) with an accuracy of five meters. Topographical data was implemented and analyzed in ARC/INFO.

Reliability of the motor fitness tests was checked by retesting all items after a one-week interval. Validity was established by correlations of results of field tests with laboratory monitoring of two test items.

Results

The Natural Playscape

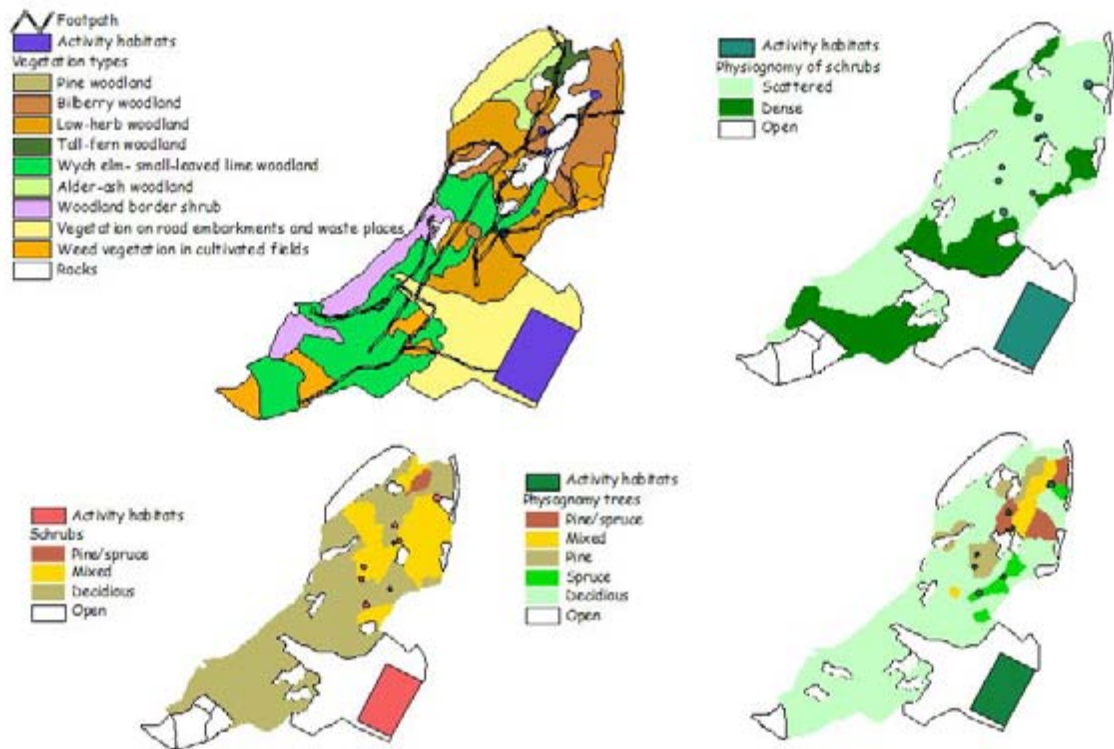
The study area, defined as the natural playscape, was the forest and fields next to the experimental kindergarten located in Bø, Telemark County, Norway. The forest was located outside the fence behind the kindergarten (Figure 2). The total area of the forest and the fields was 7.7 hectares (19 acres) and the area of the defined playscape was 6.8 hectares (16.8 acres). The landscape pattern showed a mosaic of patches of woodland interspersed with some open spaces of rocks, open fields and meadows. The topography, expressed as slope and roughness, was varied, including some steep cliffs, slopes and plains. Vegetation and topography jointly afforded a diversity of play habitats for the children. The experimental group used this area one to two hours each day accompanied by a kindergarten teacher.

The children used some favorite places in the forest more frequently than others. These play habitats were located close to the kindergarten and represented specific play habitats for summer and winter play activities. The play habitats used in the spring, summer and autumn time were all located immediately behind the kindergarten. The natural playscape included five different types of woodland, with the low-herb woodland being the dominant type of vegetation (Figure 3). The mixture of woodland types represented a high diversity in vegetation elements.

Figure 2. The Kindergarten and the Forest



Figure 3. Vegetation Maps of the Forest



The variety of woodland vegetation and the physiognomy of trees and shrubs in the area afforded multiple choices for play. The shrubs constituted a mixture of scattered species, which afforded shelter and hiding, as well as social play and construction play. Very special was the flexible juniper bush, which motivated functional play (getting in and out) and social play (playing house) as well. Some trees were suitable for climbing depending on the branching pattern, the stem diameter, and the flexibility of the tree. The young deciduous trees were easily accessible for climbing (Figure 4).

The spruces were more suitable for hiding than for climbing due to the dense branches. The more open areas in the pine and low-herb woodland afforded running, chase and catch, leapfrog, tag and other games. The shrubs afforded hide-and seek, building dens and shelters and role playing games like house-and-home or pirates, and fantasy and function play (Figure 5).

Figure 4. Tree Climbing



Figure 5. Hiding and Role-Play

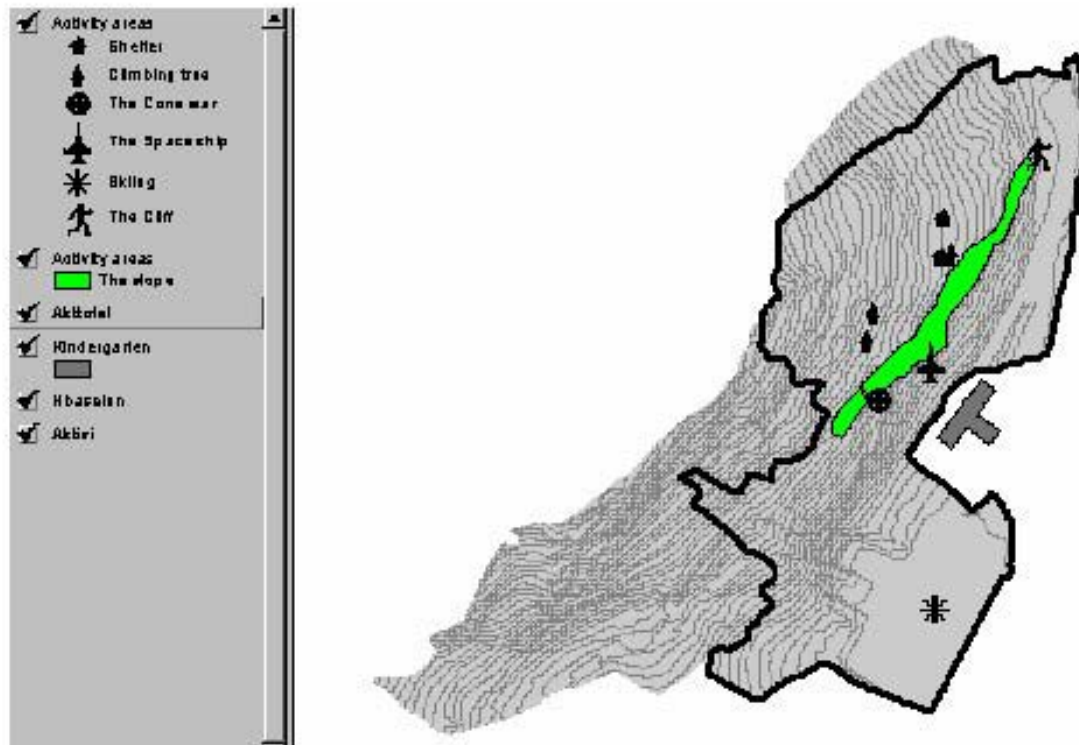


Figure 6. Climbing Rocks



The topography was undulating with terraces and slopes and a dominant cliff traversing the area, which afforded slopes for sliding and cliffs for climbing (Figure 6). Roughness showed changes in the topographical curvature and an equal amount of convex and concave changes in the terrain (Figure 7).

Figure 7. Topography of the Playscape and Core Activity Areas



The Affordance for Play

The children's favorite places were named "The Cone War," located at a patch of pine forest affording cones to throw at each other; "The Space Ship," located at a big rock affording different forms of fantasy play; and "The Cliff," located at a steep rocky wall affording jumping off, sliding and climbing (see notations in Figure 7). It is clear from the place names that different play activities corresponded with different landscape features, relating to the affordances of the vegetation and the topography. Sliding slopes and climbing rocks were naturally found in areas with a slope of 15 – 30 degrees. Table 1 shows different slope values in areas for climbing and sliding (22.5 degrees, $SD=7.8$) than in areas for construction play (10.3, $SD=3.4$). The same effects were found in the values of roughness which were higher and more dramatic in areas for climbing and sliding (-0.8, $SD=4.8$) than for construction play areas (-0.1, $SD=1.5$) where the surface is smoother. Characteristically, areas for symbol play and constructive play also differ in vegetation physiognomy from areas for running, sliding and skiing (Table 1).

Table 1. Play Activities Related to Landscape Characteristics

Landscape Characteristics	Play Activities									
	Class	Climbing Rocks %	Climbing Trees %	Running %	Sliding %	Skiing %	Symbol Play %	Construction Play %		
Physiognomy-Trees¹	Deciduous	-	28	-	-	-	35	40		
	Spruce	-	-	-	-	-	18	-		
	Pine	-	34	-	-	-	20	-		
	Mixed	-	7	-	-	-	6	14		
	Pine/Spruce	-	20	-	-	-	11	38		
Physiognomy-Shrubs¹	Deciduous	-	-	-	-	-	46	48		
	Mixed	-	-	-	-	-	48	53		
	Pine/Spruce	-	-	-	-	-	-	-		
Density of Shrubs	Open	13	-	-	12	98	7	-		
	Scattered	79	-	100	79	-	86	96		
	Dense	9	-	-	9	-	8	4		
Topography-Slope²	Mean	22.5	-	11.6	22.3	7.0	17.2	10.3		
	Degree	(7.8)	-	(4.1)	(7.7)	(8.3)	(7.7)	(3.4)		
Topography-Roughness³	Mean	-0.8	-	-0.2	-0.8	0.2	0.2	-0.1		
	Value	(4.8)	-	(2.4)	(4.8)	(2.3)	(4.0)	(1.5)		

¹Physiognomy of vegetation reported in percentage of playscape area, topography reported as mean

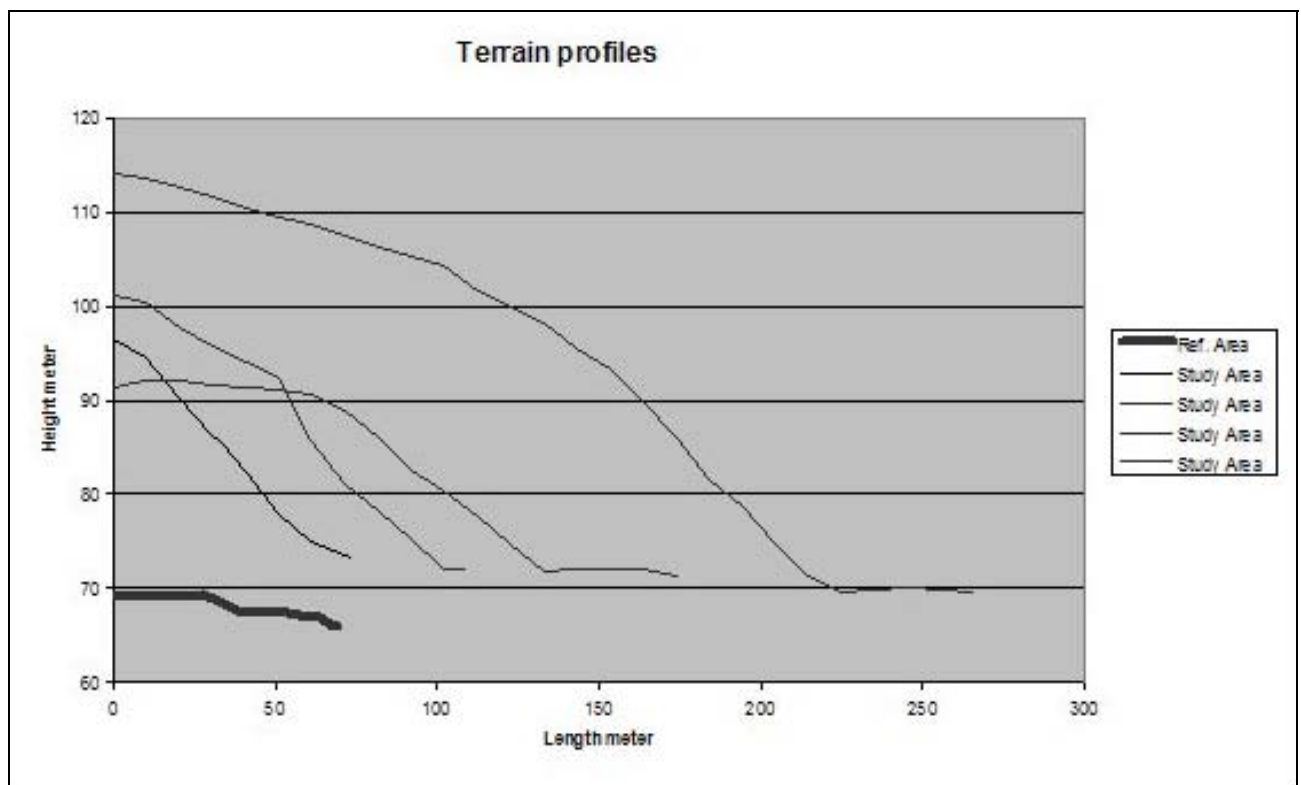
²Topography reported as mean values and degrees of slope

³Roughness is a derivative of height

The play habitats around the kindergarten were also used during the wintertime, but they were used differently. The cliff turned into sliding slopes, and a dense snow layer made the trees more accessible for climbing (see Figure 4). The deep snow provided affordances for tumbling, rolling and other acrobatics. The meadow located next to the kindergarten comprised a soccer field and the lower parts of a ski jump arena. In the winter it was used by the kindergarten almost solely as a skiing arena. The more gentle slopes of the ski-jump arena (7.0 degrees, SD=8.3, roughness=0.2, SD=2.3) were used for different skiing disciplines (see Table 1 and Figure 7).

The topography showed a variety of slopes in the study area. Total altitude was approximately 50 meters, with the cliff measuring 20-30 meters with slopes varying from 15 to 30 degrees. The playground of the comparison group showed only a 2 meter variation in altitude and an almost flat slope (Figure 8).

Figure 8. Terrain Profiles in Study Area and Comparison Areas



Motor Fitness

There were no significant differences in age between the groups, and there was a mean age of 6.1 years. The six-year-olds dominated both groups. There was a predominance of boys in the experimental group (27 boys, 19 girls), whereas in the comparison group there were more girls (18 girls and 11 boys). There were no significant differences in test results between the sexes. Body mass and height did not differ significantly between the groups or between the sexes. Multiple regression analyses correlating test results with background variables, such as parents' education and profession, showed that these variables had no significant influence on the test results.

During the intervention period a gradual improvement in motor ability was observed in the experimental group. The children became strikingly better at mastering a rugged and unstructured landscape. The impact of the environment on the children's motor ability was documented in the motor fitness tests. Table 2 and Figure 9 show the main test results of motor development in both groups.

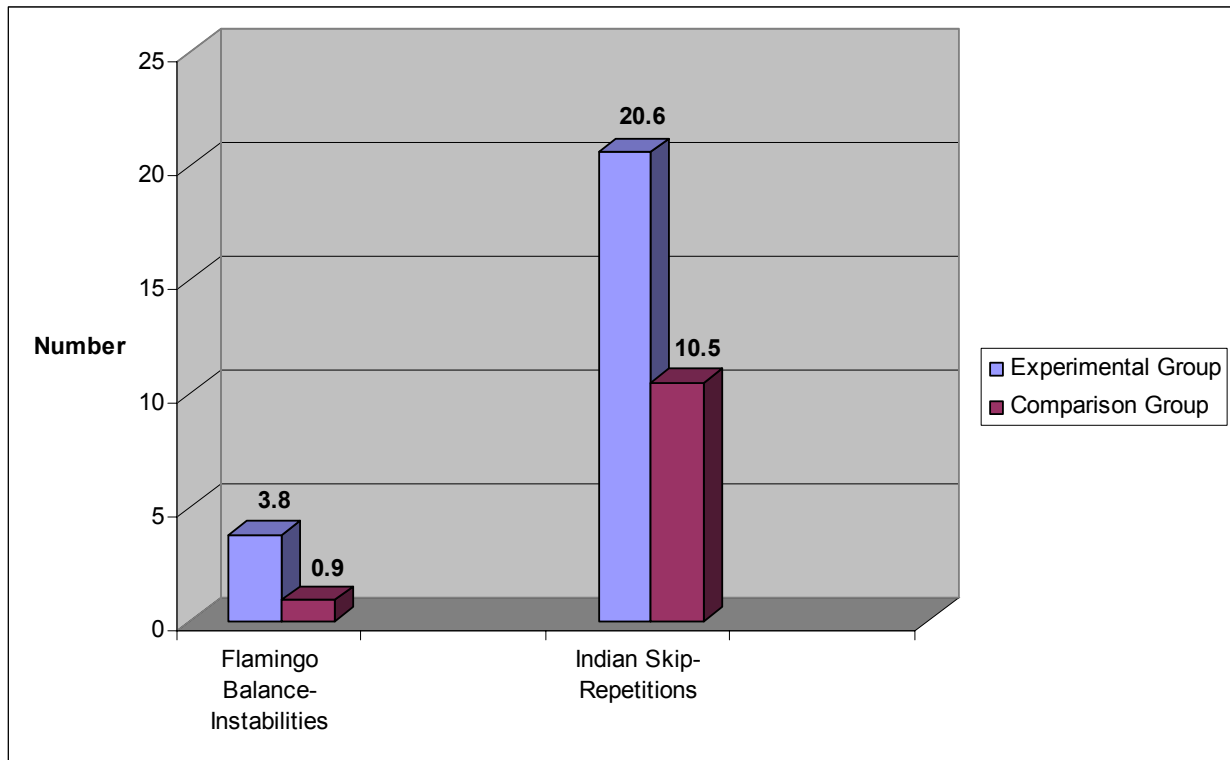
At the motor fitness pre-test, the comparison group scored better than the experimental group (Table 2). At the post-test the experimental group had caught up with the comparison group and exhibited significant improvement between the pre- and post-test in all the test items except for flexibility (sit and reach). The improvement within the comparison group was not as striking (Table 2). Specifically, the experimental group showed significant intervention effects in the flamingo balance test ($p < .001$) and the Indian skip co-ordination test ($p < .01$) (Figure 9).

Table 2. Mean Pre- and Post-Test Results within the Groups (SPSS T-test for paired samples)

Tests	Experimental Group		Comparison Group	
	Pre-Test	Post-Test	Pre-Test	Post-Test
Flamingo (# of instabilities in 30 seconds)	4.7 (0.8)	1.5 (0.3) ***	4.0 (0.6)	3.3 (0.7)
Plate Tapping (time in seconds for 50 taps)	35.0 (1.9)	28.1 (1.2) ***	29.9 (1.1)	27.4 (2.6)
Sit and Reach (cm)	24.9 (0.8)	24.4 (0.8)	25.3 (1.0)	25.5 (0.9)
Standing Broad Jump (cm)	102.8 (2.9)	113.1 (3.6) ***	103.1 (4.3)	111.3 (3.8) **
Sit-Ups (# in 30 seconds)	5.3 (0.6)	6.5 (0.6) **	5.9 (0.8)	7.0 (1.1)
Bent Arm Hang (seconds)	2.6 (0.4)	7.0 (1.0) ***	2.6 (0.6)	5.4 (1.1) ***
Beam Walking (seconds)	11.4 (1.4)	7.5 (0.7) **	7.7 (0.8)	7.2 (1.1)
Indian Skip (# in 30 seconds)	21.8 (2.2)	43.6 (1.9) ***	27.8 (2.4)	37.2 (1.8) ***
Shuttle Run (seconds)	31.9 (0.7)	29.7 (0.5) **	30.7 (0.8)	30.3 (0.7)

** = $p < .01$

*** = $p < .001$

Figure 9. Group Differences in Physical Activity Test Results

Discussion

Methods

Learning from nature is a complex topic that demands a multi-dimensional approach. It has social, anthropological, biological, ecological, pedagogical and psychological aspects, and jointly, studies of these varied aspects would explain a great deal of the natural environment's influence on children's play behavior, learning and development. The present study took two main approaches. First, a natural environment as a playground for children was analyzed and described, applying traditional methods from landscape ecology and geomorphology. This study applies these methods to a new field, i.e., natural playscapes for children. Methodological innovation in non-traditional settings may incur the risk of low validity and reliability, but this may be the cost of exploring new fields.

This study was a field experimental design. Field research may involve several threats to internal and external validity (Thomas and Nelson 1996). Internal validity was considered the most crucial threat to the present study. The first issue was the selection bias that caused a non-randomized design. Second, there was a danger of uncontrolled variables impacting the intervention. A third potential challenge was the influence of maturation, but this was considered to be an equal factor in both the experimental group and control group, as both groups tended to be equal in mean age, body weight and height, although not in gender composition. Finally, another potential bias to the study design was the socio-economic background of the two groups. However, in rural Norway social class does not segregate children's leisure time activities, and regression

analyses did not reveal any significant influences of socio-economic class on the motor test results (Fjørtoft 2000).

Playing in Nature

Nature, whether a forest, seashore, creek, or mountain area, represents a dynamic environment and a stimulating and challenging playground for children. In this study, the natural environment of a forest was considered to be a potential playscape for children. The interpretation of landscape ecology metrics and topography as playscapes for children focused on Gibson's theory of affordances (1979, 127), explained as:

the affordances of the environment are what it offers the animal (or the child), what it provides or furnishes, either for good or for evil.

Heft (1988) further elaborated this concept by explaining how children perceive the functions of the environment and utilize them for play: If a tree is climbable it affords climbing; if a stone fits the hand it is grasp-able or throw-able and thus affords grasping and throwing. If a slope is smooth and steep enough it is slide-able and thus affords sliding. The forest in this study was a play with landscape characteristics that afforded structures for different play activities.

Functional play was predominant when the children in the study played in nature. Functional play comprises gross-motor activities and basic skills like running, jumping, throwing, climbing, crawling, rolling, swinging, sliding, etc. These activities, which Pelligrini and Smith (1998) called physical activity play, were linked in this study to games like play tag, chase and catch, leapfrog, hide and seek, making angels in the snow, and other games involving basic movements. These activities were also linked to special places and structures in the landscape (Fjørtoft and Sageie 2000). More skill-related activities like skiing were also included in this category of functional play.

Construction play is the type of play afforded by loose parts. It includes building shelters, dens and other constructions with loose parts such as cones and sticks. According to Leotjev's learning theories, construction play may be characterized as process learning (Jerlang and Ringsted 1988). An example of such process-oriented play in this study would be the construction of a shelter of spruce branches. Building dens in the forest is motivated by the excitement of the building process, rather than the finished product. Often, when the construction of a shelter is finished, it no longer holds interest for the children and a new construction project commences. Construction play affords various forms of learning: planning is needed for the concept of construction, choice of materials, and getting hold of the materials needed. Constructions need framework, covering and ropes for binding. All this requires cognitive processes as well as gross and fine motor skills. This process is also consistent with Vygotskij's learning theories, where play is the leading activity in child development: play includes imagination and leads to perception and action. This study also illustrated Nicholson's Theory of Loose Parts (1971) through the children's building projects and their playing with cones in the habitat known as "The Cone War." In wintertime, children substituted snow for loose parts (e.g., snow balls).

Symbol play involves playing together and can be described as role play or fantasy play, including such activities as playing house, pirates, or farmer with cones and sticks. In this study, there were some gender differences in symbol play. The boys preferred pirates or Indians and cowboys, while girls seemed to prefer playing house. The latter took place in different settings: between bushes, below low-branched spruces, or in the snow where the house was nicely organized in different rooms.

Surprisingly, a prickly juniper bush was a popular site for play in this study. It afforded possibilities to hide without being locked out from the activities going on outside. Several forms of play took place there, such as playing house, red Indians and cowboys, pirates, Star Wars, and other fantasy- and story-related play forms. A widely branched juniper bush became a house with several rooms and its dynamic "walls" would embrace the whole group of 12 children. Traditional play patterns changed in these outdoor play settings as boys and girls played more together and were less age-segregated. Kirkby (1989) made similar observations regarding juniper bushes, noting that children prefer small enclosures with a view.

These examples of how the children's use of the natural environment resulted in a multitude of play forms illustrate the theories of Bronfenbrenner (1979) and Gibson (1979). The children's play in the context of daily interaction with the local environment in terms of activities, roles and relations, refers to what is going on in the microsystem. Furthermore, according to Gibson, it is the features in the natural environment that afford and facilitate such play forms, roles and interactions.

Natural Environments as Determinants for Play and Learning

As explained by Heft (1988), a functional approach to the environment corresponds well to the ways children relate to it: children intuitively use their environment for physical challenges and play. Gibson (1979) notes that children perceive the functions of the environment and use them for play. In the context of the present study, *function* refers to the structure and complexity of the environment. The complexity of the environment was defined as the variety in landscape forms and structure, and variety in vegetation such as phytosociology and physiognomy (Figure 3). These functions afforded a range of uses as exemplified through different play forms (Table 1).

In this study *play habitat* comprised the different landscape elements and vegetation types and structures that afforded children's play. The topography expressed by the slope and roughness of the playscape produced different habitats defined by the affordance of various activities, including: slopes for sliding, cliffs for climbing, and snowy hills for skiing. Moreover, the vegetation represented a variety of structures and functions (Fjørtoft and Sageie 2000). Trees were available in the climbing habitats, shrubs in the hiding, construction and role-play habitats; open fields formed the running/ catch and seek habitats (Table 1). These habitats corresponded to the children's intuitive perception of the landscape elements, and thus became determinants for the children's play behavior.

Change in the playscape was described as changes in climate and seasons and the corresponding changes in the structure and functions of the landscape. Such changes may be perceived through the changing structures of deciduous trees with changing seasons. As they changed, those trees gave a different expression and afforded different functions with small, green leaves in springtime, with a rich leafiness in summer, a leafy splendor in autumn, and some leafless "skeletons" in winter. These seasonal changes in structure provided different play habitats with different affordances. In winter, a dense snow layer changed the play habitats and consequently so did the affordances. The high-stemmed trees became easily accessible for climbing, the steep slopes became slide-able, and the meadows turned into marvelous arenas for skiing. Thus, changes in the landscape influenced children's play behavior.

From a landscape ecological aspect, change in the playscape can also be related to how the children's use of the landscape affects the landscape itself, i.e., wear and tear of vegetation elements. Wear resistance of a landscape varies with the tolerance and resilience of different vegetation types (Bjønnes 1977, INA 1986). The frequency of use and the carrying capacity of the environment are important factors in landscape and playscape planning. There is little knowledge of the carrying capacity of wild lands concerning children's use (Hart 1982). This perspective ought to be assessed when selecting and planning for natural playscapes.

The Impact of the Environment on Children's Motor Development

The intervention effect from playing in a complex environment was seen as improvement in motor fitness in the experimental group more than in the comparison group. Our research found significant differences between the experimental group and comparison group were found in balance and coordination abilities (Table 2, Figure 9). These abilities are components of all basic movements and will be improved with diverse movement patterns. This study's findings suggest that playing in a complex physical environment, where the landscape structures afforded diverse functions for play, caused this intervention effect.

Neither group improved their flexibility in the sit and reach test. In fact, flexibility decreased from pre- to post-test in for the six- and seven-year olds in both groups (Fjørtoft 2000). This tendency is also found in other studies (Brodie and Royce 1998), which have shown a decreasing level of flexibility (sit and reach) in boys and girls from age six to ten years. This development pattern could be explained by growth in body height which is a common feature in this age group, followed by decreasing flexibility in knee and thigh joints (Gallhue and Ozmun 1998). The present study showed a weak negative correlation with height in the flexibility test (Fjørtoft 2000b).

The reliability of the EUROFIT Motor Fitness Test was found acceptable, but factor analyses showed low correlations between the test items, which is in line with past research. In terms of validity, the field measures of balance and strength, tested by force platform tests for power and stability, showed low correlations indicating that field tests are testing a complex movement performance, while the instrumental tests are measuring more isolated abilities.

Dynamic systems theory emphasizes the importance of the environment in learning processes (Thelen 1992, Vereijken 1997). The results from this study confirm this theory. The interactive nature of motor learning was demonstrated by the interaction of the self-organization of body systems, the tasks performed and the environmental structures that afforded such performance (Vereijken et al. 1992).

Conclusion

In this study, the natural environment of a woodland area proved to be a suitable playground for children. Landscape ecology analysis confirmed a high diversity of topography and vegetation in the area. The complexity of the landscape afforded a variety of play activities. Particular forms of play were linked to special landscape elements.

Play activities were categorized as functional play, symbol play and construction play. Functional play, also defined as gross motor play, typically took place in landscapes with mixed vegetation and a varied topography. Characterized by low herb woodland with scattered shrub vegetation and smooth topography, these areas afforded running and tumbling, climbing trees, and a variety of games involving physical activity. Skiing was also categorized as functional play, as it is a typical physical activity for Norwegian children in the wintertime. The habitat typical for skiing was an open meadow with a varied topography, moderate in slope and with low values of roughness.

Symbol play and construction play typically took place in habitats dominated by scattered, mixed-bush vegetation that included trees as well as dense shrubs with open patches. The topography was more broken in these habitats than in the habitats for running activities. Climbing rocks and sliding were typical activities on steeper slopes. The activity of climbing trees was dependent on the available trees and whether they were properly branched for climbing and accessible from the ground. Such trees were found in the habitats for symbol and construction play.

Physical activity play in a natural environment improved all the motor abilities tested, except for flexibility. When compared to the comparison group, there were also significant differences in balance and coordination abilities as measured by the flamingo balance test and the Indian skip coordination test. These tests might have been too demanding for the children, as their coefficients of variation were high. However, the literature shows that demanding movement tasks stimulate learning more than stereotypic movements, and engage more varied ability patterns. The conclusion was, therefore, that play in a natural playscape had caused these effects and that more demanding tasks were learned. Although not fully explored, this study points to the natural playscape as an influential factor in children's motor development.

Directions for Further Research

The value of the natural environment as a playground and learning arena for children requires more research. First, more behavioral studies are needed, both to expand upon the present study of motor development, as well as to

determine whether there are specific skills or abilities that are learned better in a natural environment than in other environments. Secondly, learning from nature should also be further examined in other fields, such as science and cognitive learning, other health and fitness related aspects, and social relations. How natural environments influence play behavior, gender relationships, self-esteem and mastery of skills are some of many fields in child development research that need further study. The natural environment is a valuable source for diverse learning and diverse play habitats for children. Methods from landscape ecology need to be further explored as a tool for physical planning and for selecting and securing natural playscapes for children.

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