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Nilda Graciela Cosco

Motivation to Move:
Physical Activity Affordances in Preschool Play Areas

School of Landscape Architecture, Edinburgh College of Art Edinburgh, Scotland

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Author **Nilda Graciela Cosco**

Degree **Doctor of Philosophy**

Institution: **School of Landscape Architecture, Edinburgh College of Art**

Heriot Watt University

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Abstract

Motivation to Move: Physical Activity Affordances in Preschool Play Areas

The goal of this study is to investigate the association between different types of play area design and level of physical activity of 3-5 year old children.

Rationale

1. The majority of USA children are in some type of childcare provision.
2. The childcare centre is the highest predictor of preschool physical activity.
3. Being outdoors is the strongest correlate of physical activity.

Three childcare centres in North Carolina, USA, were selected to carry out the study (n=90). A variety of methods were used to establish sample comparability: Early Childhood Attention Deficit Disorder Scale EC-ADDES, body mass index (BMI), the Test of Gross Motor Development TGMD-2 and children demographic information. Accelerometry was used to measure children's activity. To link the amount of physical activity to play settings and environmental features two methods were used: 1. Behaviour mapping (processed with GIS), and 2. *Video tracking of selected children* (analysed using The Observer, Noldus). Setting diversity was measured using a 1-4 point scale developed by the researcher.

Findings

The study strongly suggests that:

- The amount of physical activity afforded by preschool play areas can be intentionally improved by design.
- Diverse play areas containing pathways and natural elements, and combining a range of setting sizes are expected to be the most active.
- The most effective setting for motivating physical activity in this study is predicted to be a wide, curvy, wheeled toy pathway.
- Compact play areas, where greater numbers of children play together, are likely to support more physical activity.
- Educational programs that foster outdoor learning are likely to secure greater amounts of sustained physical activity.

As a research contribution to the emerging field of design for active living, a key purpose of the study is to influence childcare policy and accreditation. Appropriate design and childcare licensing policies are viable vehicles to produce environmental and behaviour change in early childhood institutions.

Dedication

To Pachamama.

Acknowledgements

This study would have not been possible without the support of many individuals and institutions. I would like to thank Professor Catharine Ward Thompson, Primary Advisor, for accepting my proposal, guiding my inquiry, and supporting my efforts to the last minute. Thanks also to Professor Peter Aspinall, Secondary Advisor, whose enthusiasm helped me appreciate and enjoy statistical analyses.

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Chapter 1: Introduction

1.1 Prologue

Children are intrinsically motivated to be active. Young children, in particular, learn about the surrounding world by physically interacting with it. For them, life is movement and sensory stimulation [1]. Despite this natural tendency, the health of even the youngest children in many developed countries is under the threat of sedentary lifestyles. This, combined with poor nutrition, has a profoundly negative effect on children's physical health. More than 10% of USA children two to five years old are overweight (above the Body Mass Index BMI 95th percentile) and more than 20% of children of the same age are at risk of being overweight [2]. In Europe the situation is as serious. For example, in the UK nearly 27% of children aged 2-15 are overweight or obese [3]. As overweight children often become overweight adolescents, these figures imply potentially serious health problems for a large number of young people in the future [4]. This is especially grave for low-income children who have limited opportunities for active play, because of perceived neighbourhood dangers and the lack of opportunities for playing in parks and other outside community facilities [5-7].

Childhood overweight has been associated with significant effects on children's health, such as cardiovascular disease as well as with morbidity and mortality in adulthood. These facts suggest the need for urgent interventions and the creation of prevention strategies if children are to avoid a compromised quality of life at an early age [8, 9].

The goal of this study is to investigate the potential associations between outdoor play area design in childcare centres and physical activity of preschool children as the childcare centre has been shown to be the highest predictor of physical activity of children 3-5 years old [10, 11] and the outdoors the strongest correlate of physical activity [12, 13], Given that physical activity levels of preschoolers vary depending on the school they attend, it seems pertinent to identify potential factors that might influence the levels of activity if policies and practices are to be changed based on scientific evidence [11]. Because the focus of the study is preschool physical activity levels linked to environmental components, the many facets of early childhood play (expressed through physical activity) are mentioned but not fully described or analysed, thus comprising a limitation of the study.

This research is intended to inform childcare licensing policy and accreditation regulations so that the design of outdoor play areas includes characteristics that support daily activity of preschool children. The methodology used is cross-sectional and multi-method. The study is a research contribution to the emerging field of design for active living for young children.

1.2 Definition of the problem

The *US Surgeon General's Report on Physical Activity and Health* "brings together, for the first time, what has been learned about physical activity and health from decades of research" [14]. The publication includes vital information about a new view of physical activity and its benefits, a call for moderate exercise in daily life, precautions for a healthy start at different stages of life, and special messages and guidance for different population groups. Remarkably, children under 12 years of age are not mentioned in the report. More recently, public health experts have recognised that the problem should be confronted earlier in life. On April 23, 2003, in a speech to the National Head Start Health Institute, Washington, DC, the US Surgeon General Vice Admiral Richard H. Carmona called childhood obesity "the most serious health problem in America" [15]. Such open recognition of the issue makes the topic a national priority in the United States, high on the agenda of health professionals working with young children.

Like the US, many other countries have identified childhood obesity as a serious health threat. In the UK, many actions are already in place including a strategy for prevention and management of obesity that involves initiatives in the early years, at schools, and in families and communities [16].

In July 2004, the UK government released new information showing that nearly 27% of UK children aged 2-15 were overweight or obese [3]. In this report, overweight and obesity levels are defined using international cut off points for body mass index of 25kg/m2 and 30kg/m2 at age 18 as the gold standard, respectively. Sadly, young children in Scotland show even higher incidences of overweight and obesity than the rest of the UK as recently recorded for 3.5 years of age: 20.7% of children were overweight, 8.6% were obese, and 4.1 % were severely obese [17].

Overall, in the UK, the medical and public health sector agree with governmental initiatives about the type of concerted actions that should be taken to tackle the problem of the obesity crisis in childhood as expressed in a report released recently [18]. The report spells out conclusions of three groups of professionals from the Royal College of

Physicians, the Faculty of Public Health, and the Royal College of Paediatrics and Child Health, who promote a positive and constructive approach to the problem. The group recommends a holistic approach (environmental and social), “dropping the blame culture”, and encouraging groups to take action according to their own possibilities.

The severity of the problem has also encouraged regional initiatives in Europe. On March 15, 2005 the European Commission launched the EU Platform for Action on Diet, Physical Activity and Health [19]. A broad spectrum of government, industry, and community representatives are part of the initiative (consumer organizations, food industry, and health NGOs, among others). Special emphasis is given to programs for children since this group show the highest obesity rise in the region and it is proven that overweight children will become overweight or obese adults. Approximately 14 million European children are already overweight or obese. The average rate of child obesity in Europe is 25%, with highest percentages in Spain (30%) and Italy (36%) [19]. Collective strategies like the EU Platform for Action on Diet, Physical Activity and Health might bring more articulated, effective programs and the possibility of disseminating best practices to a broader audience.

1.2.1 Preschool environments for daily stimulation

What interventions are possible to counteract the sedentary lifestyle trends in young children? According to the National Survey of America’s Families (1999), almost three-quarters (73%) of US children under five with employed parents were in a childcare arrangement other than care by a parent [20, 21]. This percentage represents in the United States 8.7 million preschool children spending most of their waking hours in childcare centres where they learn basic skills such as crawling, walking, talking, interacting with peers and adults, and taking the first steps in reading and writing. In effect, in the last two decades, childcare centres have become the most crucial environment outside the home for young children and have begun to attract the attention of researchers.

These institutions could become the first in line by developing prevention strategies embracing active lifestyle programs and by creating supportive environments [21, 22].

1.2.2 The Impact of the Environment in Children’s Health

There are well-established and statistically significant associations between human health and the built environment in general [22] and, in particular, in relation to children

[23]. According to Cummings and Jackson, children have the right to a healthy environment. But it seems that this is not the case for many children in the developed world. “Outdoors deprivation” and its negative consequences of limited time and lack of access to developmentally appropriate, high quality outdoor environments has been used to describe the phenomenon [24]. Furthermore, a recent book [25] names the lack of contact with nature as “nature deficit disorder” converting it into a health syndrome only curable by engagement and exploration of the outdoor environment.

The relationship between outdoor diversity and physical activity is powerfully presented in the book Natural Learning [26]. Although the book focuses on school-aged children, it convincingly illustrates how a well-designed, naturally diverse environment can support sustained daily physical activity and enhanced learning. The converse is also demonstrated: how a bland outdoor environment fails to motivate either children’s or productive behaviours.

It follows from the above research that childcare centre play areas should be designed to fully motivate physical activity in young children. However, this objective is rarely considered in the design of centres. This lack of attention is reinforced by the results of the North Carolina Childcare Outdoor Play and Learning Spaces Baseline Survey by Moore & Cosco [27] which shows that licensed childcare centres, in general, offer minimum accommodations for active play beyond sand areas and climbing structures. Low environmental diversity reflected in the number of elements present (natural or manufactured) is the norm of most outdoor play areas. A high percentage of centres have a single piece of play equipment and hardly any natural elements. Trees, pergolas, and arbours with vines are rarely part of the landscape vocabulary although there is great concern about sun protection and summertime ozone alerts [28]. While most centres report a total of seven manufactured play elements (e.g. play equipment, sandbox, playhouse, etc.) in their play yards, the total number of natural elements present is just three (e.g. mainly grass, mulch, and trees), see Chapter 2.2. Lack of diversity is a major reason why outdoor play areas are not attractive. They are boring and uncomfortable for children as well as teachers.

A major finding of the survey was the significant association between the childcare license or accreditation type and the quality of the preschool outdoors. The number of manufactured and natural and elements checked in the survey was considered, for the purpose of the survey, as an indicator of quality. The more elements present indicated a more diverse and, therefore, richer environment. The survey provides sufficient evidence

to conclude that US centres accredited by the National Association for the Education of Young Children [29] show a higher number of elements present in their play areas ($p<0.0001$). It is therefore possible to conclude that NAEYC accreditation is a predictor of higher quality outdoor areas.

1.2.3 Physical Activity Play

For the young child, outdoor physical play is the motivating force that produces physical activity. This type of play has been shown to have a significantly higher caloric expenditure than other forms of active behaviour and games [30].

Outdoor play can, therefore, be considered a key preventive strategy in counteracting unhealthy sedentary lifestyles and is worthy of consideration [31]. The motivating factor is the pleasant, and sometimes intriguing physical, sensory, proprioceptive and vestibular stimulation afforded by the surrounding environment (plants, animals, objects and equipment), and by social interactions with other children and adults [26, 32, 33].

Motivation is most powerful when the dimensions of both physical environment and social interaction act together [34]. Children's traditional games offer many examples of this co-action that produces high levels of physical activity [35]. A commonplace example such as hide-and-go-seek requires objects to hide behind and to chase around to activate a group of playful children. Without these physical accoutrements, hide-and-seek will not be "afforded," the children's bodies will not move, and the game will not exist [26, 36].

It is no surprise that an expert panel (US Centre for Disease Control) identifying research needs on physical activity and sedentary behaviour in children, recommended to focus on features of childcare environments as potential elements that support greater amounts of physical activity [37]. Priorities set by the panel for improving the activity of children aged 2 to 5 consist of a broad spectrum of research activities including:

Validate studies including seasonality and geographic regions;

Identify effects of physical activity and health outcomes (the associations between children's activity and cognitive, physiologic and mental health outcomes);

Identify environmental factors that determine physical activity (outside play and frequency of play).

Characterize the relationship between motor development and physical activity.

1.2.4 Protective effect of sunlight

Important for the present study is the fact that vitamin D deficiency has also been linked to obesity [38] [39]. Research has recently shown that low amounts of vitamin D, a vitamin that is triggered by sunlight, is associated with lower leptin secretion, a hormone produced by fat cells and involved in weight regulation [40]. Although it is not clear how the hormone controls weight, it is thought that the hormone signals the brain when fat cells are “full”.

At any stage of life, exposure to sunlight has a significant impact on physiological and psychological functions such as fatigue, irritability, illness, insomnia, and depression [41]. Furthermore, ultraviolet (UV) rays from sunlight trigger vitamin D synthesis in the skin and support the necessary calcium absorption for normal growth and bone development. Without vitamin D, bones can become thin, brittle, soft, or deformed. Vitamin D also prevents rickets in children [41].

A study performed with adults [42] demonstrates the association between obesity and vitamin D insufficiency. This study assessed whether obesity alters the cutaneous production of vitamin D3 (cholecalciferol) by sunlight exposure and/or the intestinal absorption of vitamin D2 (ergocalciferol) by oral ingestion. Both assumptions were confirmed. The study mentions the need for greater amounts of safe sunlight exposure and vitamin D ingestion by obese subjects in order to stay healthy. Although adults composed the sample, it is possible to infer that overweight and obese children, who are not often exposed to safe sunlight, might be at higher risk since they need the compound not only for counteracting obesity but also for normal development. Daily outdoor activities might expand opportunities to get the necessary safe sunlight exposure for overweight and non-overweight children.

Even though sunlight is necessary for normal development and for achieving good health status, it is necessary to recognize the potential negative effects of sun exposure. Numerous research studies confirm that skin cancer is associated with the intensity of sunlight that a person receives over a lifetime [43]. Experts recommend limiting exposure to high intensity sunlight and the use of proper clothing and appropriate shading devices in all locations and especially in regions closer to the Equator.

Recent research highlights the fact that skin cancer is not only the result of the total amount of sun exposure since childhood but the outcome of complex outdoor exposure

histories that include among others factors place of birth, summer vacation history, and everyday life behaviour patterns [43].

A new study linking preschoolers' spontaneous physical activity outdoors and sun exposure underscores the effect of high quality environments on both variables [28]. These researchers demonstrated that most active outdoor play areas are those that provide a diverse environment containing trees, shrubbery, topographic variations and sufficient sun protection. They conclude that play areas not shielded from the sun might be obesogenic in essence because they are uncomfortable and do not tend to be used.

The North Carolina Baseline Survey of Environmental Conditions in Outdoor Play Areas [27] shows that childcare centres in the State of North Carolina, USA, use different types of sun protection strategies most of which are aligned with the National Cancer Institute recommendations (sunscreen, protective clothing, and shade on sunny days) (Figure 1.1). Of the centres surveyed (n=326), 48% considered trees for protection of their children from the sun; 26% used other types of devices (canvas, tents, etc.), 22% installed awnings, and five 5% used arbours.

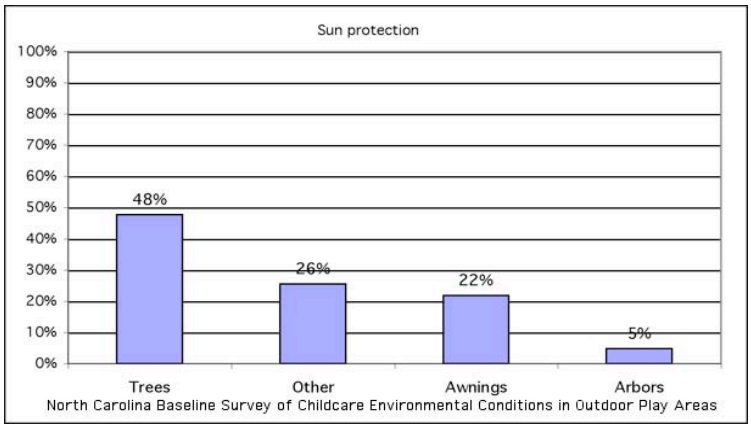

Figure 1.1. Baseline Survey of Environmental Conditions in Child Care Centres. NC State University. 2001.

The design of play and learning settings sheltered from harmful UV radiation is critical to ensure that children enjoy the outdoors and the benefits of sunlight exposure without its potentially negative health effects.

1.3 Study framework and rationale summary

Supporting research	Rationale
Almost three-quarters of US children with working parents are in some type of childcare provision [20, 44]	A childcare centre is a relevant research site for addressing the needs of enrolled children. Childcare is a policy-sensitive institution. Research results may inspire public debate and policy change.
The childcare centre is the highest predictor of physical activity of children 3-5 years old [10, 11]	Research may help retain and enhance childcare characteristics for supporting physical activity. To promote change, research findings must include associations of physical activity with specific spatial attributes of settings.
Being outdoors is the strongest correlate of physical activity of preschool children [13, 45]	Outdoors is a positive context for greater levels of physical activity. Research may help identify environmental components to support this existing trend.
Diverse natural environments support attention functioning, gross motor development, children's health, and richer play [46, 47].	The type of outdoor play area and the proportion of manufactured, mixed and natural elements it contains may have implications for children's health, development, and learning abilities.
Preschool physical activity tracks throughout childhood and has a protective effect against early adolescence adiposity [4]	Early childhood appears as a one-time opportunity for key preventive measures. Early acquisition of active lifestyles lays the ground for the following stages of development.
Exposure to sunlight has a significant impact on physiological and psychological functions such as fatigue, irritability, and synthesis of Vitamin D for calcium absorption, etc. [41]. It is also demonstrated in adults the association between obesity and vitamin D insufficiency [42]	Safe contact with sunlight is important for normal development. Most active outdoor play areas provide diverse environments containing trees, shrubbery, topographic variations, and sufficient sun protection.
Play areas not yielded from harmful sunlight might be obesogenic in essence because they are uncomfortable and do not tend to be used [28].	The design of high quality play areas should provide balanced exposure to safe sunlight
Overweight children may be at increased risk for further weight gains because of low levels of physical activity during the preschool day [48]	Overweight children are less active and less inclined to test their physical abilities. Therefore, identification of settings that afford moderate levels of physical activity for overweight children is a key preventive consideration.

In sum, the present study is based on the following key findings of existing research: the majority of children with working parents attend some type of child care arrangement on a daily basis, childcare is a predictor of physical activity, outdoors is a correlate of physical activity, and diverse environments support child development (physical, cognitive and social), safe exposure to sunlight enhances development and might prevent obesity.

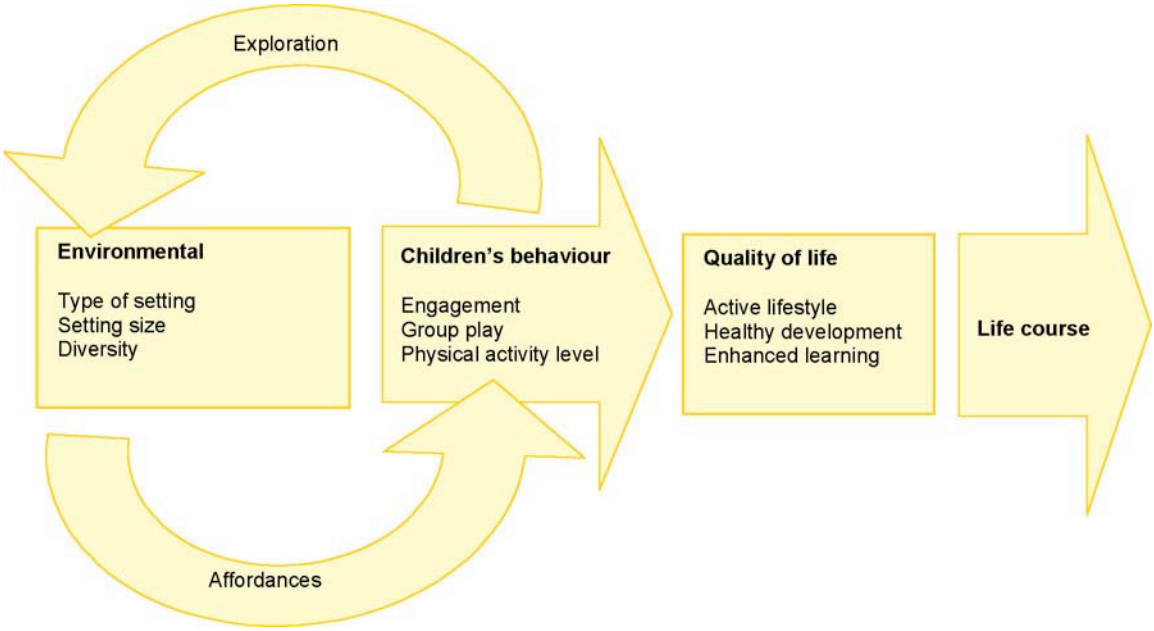

Figure 1.2. Hypothesized dynamics between children's behavior, the environment, and the impact on future quality of life.

1.4 Study findings summary

The study strongly suggests that the amount of physical activity afforded by preschool play areas can be intentionally improved by design. In this regard, diverse play areas containing pathways and natural elements, combining a range of setting sizes are predicted to be the most effective. The level of activity of a play area is due to the additive effect of the layout of the site and its attributes (objects and events) on children's activities.

The most effective setting for motivating physical activity in this study was a wide, curvy, wheeled toy pathway. Such a setting supports greater amounts of physical activity and numbers of children playing together.

Findings also explain that having a high quality outdoor environment is not sufficient to encourage preschool physical activity. The educational approach is critical in facilitating children's use of the outdoors. The creation of compact settings that support rich social interactions and educational programs that foster these interactions, are likely to be a positive way to secure sustained moderate and vigorous outdoor physical activity.

Appropriate space design and childcare licensing policies and accreditation regulations are viable vehicles to produce environmental change and, therefore, behavior modifications in the daily lives of millions of children.

Further research should be undertaken to confirm the findings of this study in a wider array of preschool institutions, climatic zones, topographic regions, and socioeconomic groups.

This study is intended as a research contribution to the emerging field of design for active living.

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Chapter 2: Literature Review

The causes of sedentary lifestyles in children appear complex. However, research is beginning to indicate that the interaction between the environment and type of preschool may support or hinder the level of physical activity in children [10, 11].

In response to the obesity crisis in early childhood, researchers are beginning to interweave knowledge from a wide spectrum of disciplines in the hope of creating new, successful methodologies and strategies to tackle the problem [49]. The study of the relationships between different types of childcare outdoor play areas, child development, and children's physical activity, lies at the intersection of *landscape design*, *child development,* and *public health*. As such, the new field of active living research is emerging as a blend of disciplines and research methods.

Traditionally the concept of the *environment* in early childhood literature has been described as the people surrounding children and their reciprocal interactions. Research on the design of play areas for preschoolers often refers to the layout of play equipment with little or no mention of other types of elements or of user needs [50]. In the field of public health, children's environments have been investigated at the macro level, mainly for describing problems and health threats such as air pollution [23]. Although these have been valuable contributions to the topic of environmental health and young children, they do not cover the multiple facets of the obesity crisis in early age.

Only recently has public health research turned its attention to the potential associations between environment and the physical activity of young children. There is now an effort to promote the development of efficient methodologies and instruments to better understand the problem, and to create strategies to counteract its rise [10, 11, 37, 51].

In general, studies point to the impact of the environment on children's behavior but they do not specify the physical characteristics associated with different levels of activity.

2.1 Theoretical Framework

The present study draws on a variety of theoretical sources. These include research by J. J. Gibson (1979) [52], Eleanor Gibson and Anne Pick (2002) [53] on perceptual learning and affordance; the concept of holding environment [54]; the work on motivation by Robert White (1959) [55] and Mark Lepper and Jennifer Henderlong (2000) [56]; studies on the response of young children to the environment by Leon Yarrow, Judith

Rubinstein, and Frank Pedersen (1975) [57]; and the concept of behavior setting, first developed by Roger Barker (1976) [58].

2.1.1 Concept of Affordance

The ecological approach to perception [52] opens a new door for looking at the relationship between the individual and the environment. It helps us to understand the impact of the physical environment on children and to identify environmental attributes that are associated with specific behavioural responses [53]. A child learns both about the functional properties of the environment and about herself by "picking up" information. Learned environmental affordances guide the child's future behavioural responses in a particular environment [53]. The concept can be used for analyzing and identifying similarities and differences among behavior settings (e.g. play equipment, sand play area, pathways, gardens). The concept is valuable for describing environments from a behavioural perspective (i.e. from the point of view of children's outdoor play in the case of this study). In this manner, an object in the play area will be considered *climb-able* if it is possible to climb on it, *slide-able* if it allows sliding, or *swing-able* if one can swing on it. The approach considers the individual and the environment as an interactive system that can be understood through three concepts: *affordance, information*, and *pickup of information*.

Affordance

Affordance is the functional property of the environment in relation to the individual [59]. Neither part of the environment, nor of the perceiver, the affordance exists at the intersection of the subject's behaviour in connection with the environment. Potential affordances exist even if the individual has not yet discovered them because the individual's action is what makes the affordance to be realised. Gibson (1979) explains this fact, saying: "The observer may or may not perceive or attend to the affordance according to his needs, but the affordance, being invariant, is always there to be perceived… The object offers what it does because it is what it is" (p. 139). Some affordances are easy to perceive and learn; others require exploration and practice.

Information

The environment provides *information* as ambient arrays of energy. The sources of information include physical elements (surfaces, objects, corners, etc.) and also events such as an expressive face or a celebration [53]. The possibility of perceiving the

environment depends on sufficient amounts of information to characterize it and a perceiver that can understand it. As the whole body is involved in the interaction with the environment, children perceive the environment and themselves simultaneously through the information provided by movement (via the joints) and their senses. Movements through space provide information about the layout of the site, volumes that exclude other views, about where one is, and where one goes. Information is gathered in active ways. Children run around objects and environmental components getting to know them (e.g. they peek over fences to see others, hide and spy on other children from vantage points in the play area, etc.). All these activities enable children to experience different views of the environment while supporting their active engagement.

Pickup of information

Active exploration supports children's need for getting acquainted with the environment and to recognize objects. Two basic kinds of information pickup have been defined: *exploratory* and *performatory* [53]. The first is characteristic of early childhood. Exploration allows children to learn about the surrounding world and about their own capabilities. The second is the result of previously learned affordances and corresponds to automated tasks learned through practice such as opening a faucet, digging, or riding a tricycle.

As children develop, they learn about the growing scale of their bodies and their emerging specialized skills by using the potential environmental affordances that appear in front of them. This progressive learning of affordances is supported by further exploration of the environment. Therefore, perception and action are intimately connected. The result of their co-activation is learning.

The need for diverse environments, full of novel information, should be considered as a developmental need that goes together with children's growth and the extension of their physical capacities [53].

From a developmental point a view, we should not consider play environments as a mere collection of play objects or physical components but the aggregation, as a whole, of space layouts, objects, and events. As stated by Heft (1988) [59] he concept of affordance reveals the importance of analysing play environments from a functional point of view and not from "form based" classifications (i.e. play equipment, shrub, lawn) "where labels are applied to environmental features independent of their relevance (other than a conventional, linguistic one) for an individual", p. 31 [59]. This approach is more

flexible and allows us to understand the ever-changing pattern of children's perceptions and use of play areas where settings can be used for a purpose at a given time (the *run-able* lawn) and for a totally different purpose the following day (as *rope jump-able* or *parachute play-able* lawn). These are described as the "multiple functional significances" of a physical feature or environment from a perceptual perspective, p. 87 [60].

Since affordances exist in relation to the individual, consideration of the scale and layout of outdoor settings in preschool areas is crucial. In order for the affordances to be "realised", children have to be able to access and use the surrounding environment to benefit from the opportunities for action they perceive.

Significant for this study is the notion that what is perceived is not the abstraction of colour, sound, or texture but the *layout* of the space, the *objects* in the layout, and the *events* that occur in that particular layout in relation to the existing objects [53].

The *layout* contains the surfaces to walk on, the walls or plants that surround the subject, the overhangs that wrap them up and communicate a sense that the body is a volume. The layout helps children to situate themselves in the place where they are. The layout, at the same time, contains *objects* (animate and inanimate) such as people, animals, plants, and objects to climb on, sit on, etc.

Perhaps the most extensive perceptual category is the one related to *events.* According to Gibson and Pick (2000) [53] *events* are:

> *"… the movement and actions that occur, some performed by ourselves and some external to us. They implicate objects and provide the dynamics of all scenes in the layout*" (p24).

Children learn about their surroundings by performing movements and actions (events), they learn how to orientate using fixed elements such as landmarks, and increase their territorial exploration with the confidence that they will not be lost. The process involves children's active engagement and supports the emergence of new actions that support expanding environmental experiences—and so on, day after day. For instance, preschool children have fascination for wheeled toys. They start by learning to use tricycles coordinating the movement of their legs, pressing hard on the pedals, and aiming at their destination with their arms and hands. Not long after the process starts, they master the movements and can perform other tasks as they drive their wheeled

toys. At this stage, they not only ride tricycles but also carry other children with them along with toys and play materials (see Chapter 6.5 Tracking and Behaviour Coding).

Gibson and Pick (2000) [53] identify four behaviour characteristics while using affordances: *agency, prospectivity, seeking and using order,* and *flexibility*.

Agency. This characteristic describes the subject in control of self and external events. Very early on infants learn when they are in control of the situation and understand when their actions make an impact in their surroundings (e.g. kicking a musical toy). Perception of one's own actions in the external world, in turn, provides information about oneself. This is how children enjoy being "agents" learning to repeat satisfactory actions, or creating conditions to be self-rewarded. Environmental settings that afford agency must contain objects that can be acted upon, to produce enjoyable events.

Prospectivity. According to Gibson and Pick (2000, p. 164) [53], *"The concept of affordance implies prospectivity of behaviour; to perceive an affordance means to perceive some potential environmental resource and a means of action that will lead to attainment of it*". This behaviour characteristic is related to that of *agency* because, after obtaining control, there is an expectation of what is going to happen next. Children often anticipate the outcome of their actions. This is what keeps children engaged. When actions are learned and they are carried out repeatedly, we are in front of performatory actions such as the use of tools. Children learn fast to execute this type of action and engage in progressively complex tasks such as those involving several steps to achieve a goal. They begin to plan ahead and to anticipate results using rational, age-appropriate strategies and by involving others.

Seeking and using order. The permanence of some aspects of the environment supports the need for regularity, order, and the recognition of patterns. Stability allows children to organize their perceptions, and become situated. Stability serves as a backdrop for the changing perception children obtain through their own movements. As children move through the site, their visual angles change and, consequently, objects appear and disappear in front of them

Flexibility. Perception and action are flexible and adapt to the changing conditions of the environment or the subject. This is most critical in children whose bodies and skills grow rapidly. Their perceptual systems are continually adapting to the demands of daily life facilitating the process of learning by doing. Static, sterile spaces do not support active exploration. In this type of space, children rapidly loose interest because their actions do

not produce changes. Conversely, naturally evolving environments offer children opportunities for acting upon emerging events in novel ways.

2.1.2 Motivation and response to environmental stimuli

Motivation and its implications for relationships with the environment has been a research topic for many years. In their review of twenty-five years of research on intrinsic versus extrinsic motivation Lepper and Henderlong [56] identify four types of intrinsic motivation (the four "C's"): *challenge, curiosity, control*, and *context*. The authors explain the relevance of each of the four types for children's behaviour in terms of providing a sense of autonomy, self-determination, achievement of meaningful goals, and transfer of learning to other contexts. This concept is analogous to that of "agency" described by Gibson and Pick (2002) to denote a type of behaviour performed by children while using or practicing affordances.

Most children interact profusely with the environment. Interactions are continually fed by exploration if the child's interest is sustained by environmental diversity, defined by White (1959) as "effectance motivation." Exchange with the environment produces, in turn, varied new behaviours. Exploratory behaviours in early childhood are not random but "directed, selective, and persistent" in order to satisfy the intrinsic need for being in contact with the environment and to experience a sense of mastery [55]. The consequence is "variability and novelty of behaviour." If the environment is undifferentiated or not dynamic, it becomes so familiar that behaviours may turn into reflex acts or automated tasks, at which point, development is impeded. The comparison of different types of outdoor play areas from this perspective will bring new knowledge about specific environmental attributes that feed and sustain the intrinsic motivation to move.

Kinaesthetic stimulation, produced by spatial attributes, can be a powerful source of motivation and is relevant to the present research. In the study by Yarrow, Rubinstein and Pedersen [57], exploration and attraction by novel stimuli were highly associated with characteristics of the objects within children's reach. The dimensions of the inanimate environment they describe—*variety, complexity*, and *responsiveness* of objects—are attributes that may help understand how environments entice children's physical activity. These attributes of the physical space might sustain interest and encourage diverse and novel physical activity. The scale developed by Yarrow et al. (1975) inspired the creation of the diversity score used in this study (see Chapter 5.4 Environment Behaviour Measures). Although the number of investigations on the topic of

preschool outdoor environments in relation with physical activity is growing [11, 33, 61], there is still a need to acquire more specific information on the design characteristics that might be associated with greater amounts of activity to influence the design disciplines and policy change.

2.1.3 Behaviour setting

The concept of *behaviour setting* is closely related to the concept of affordance [52, 53]. Behaviour settings are ecological units where the physical environment and the behaviour are indissolubly connected [58]. These eco-behavioural units were first described by Barker [58] through direct observation of children. Barker discovered that behaviour settings have a clear structure: they are located in time and space; they are composed of entities and events (people, objects, behaviour) and other processes (sound, shade, etc.); their boundaries are identifiable; their components are arranged in a functional way and are part of the whole; and their functions are independent of other adjacent eco-behavioural units. The concept is applied in design research for analyzing human spaces by disaggregating their functional parts. The identification of specific behaviour settings in childcare outdoor play areas (i.e. climbing area, sand play area, water play, tricycle path, vegetable garden, etc.) and their association with different levels of physical activity is essential for understanding the impact of design on children's behaviour.

Behaviour settings are part of a nested group of ecological units, as any biological system where a living organism is comprised of molecules, molecules of cells, cells of atoms and so on. Likewise, a play area contains settings (e.g. sand play area), sub-settings (digger in sand area, low table for moulding, etc) and even sub-sub-settings such as the space under the table where children enjoy hiding.

Behaviour settings are complex entities ruled both by the characteristics of the whole system they belong to and the limitations of the parts they contain. One of the attributes of the ecological environment is the "direction and purpose in the pre-perceptual environment" as stated by Barker (1972, p 16). This is important for understanding how much the designed environment might influence children's outdoor behaviour. The behaviour setting is "an objective, naturally occurring phenomenon with a specified time-space locus occurring outside the individual", p. 297 [62]. Participants are part of the behaviour setting as well as the events they produce. There is a strong interdependence between the environment and their resulting behaviour. This framework supports the crucial assumption of this study, that it is possible to design "active play settings" to

support the behaviour of preschool children who presumably would be more active in response to the offerings of the setting. Although Barker states the concept in a very deterministic way ("*Settings have plans for their inhabitants' behavior…"*, 1976, p 25) participants may or may not realize the setting potential according to their needs, desires, and capabilities. The educational programme may offer additional support by enticing inactive children to join the action.

2.2 Emerging data on conditions of childcare outdoor environments

The *Baseline Survey of Environmental Conditions of Outdoor Areas in North Carolina Childcare Centres* [27] provides a new source of detailed data on environmental conditions of childcare outdoor play areas. The study analyzed self-reported data from 326 centres (10% of the total number of childcare centres in North Carolina). Results indicate a low level of environmental diversity (measured by the number of manufactured and natural elements) in most centres.

Time outside per day was highest for 3-5 years olds but only in the 60-75 minute range as part of a 10-hour day. Many centres were below this range. These two findings, low environmental diversity and short time spent outdoors, present a picture of lost opportunity for improving the physical activity of preschool children. The study proposed here will give empirical force to these "baseline" findings.

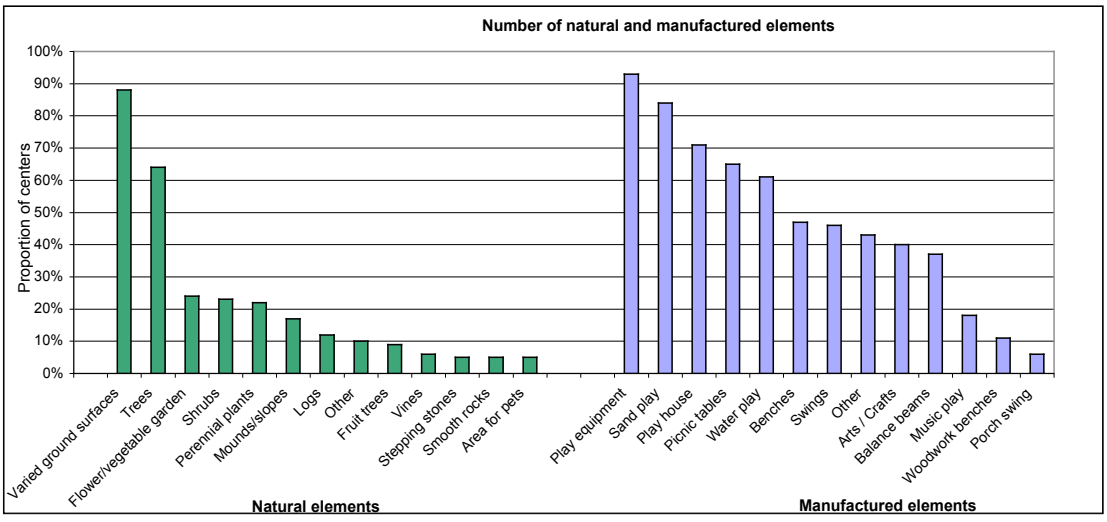


Figure 2.1. Natural and manufactured elements present in childcare centre play areas, North Carolina, USA

An unpublished analysis by the author of incident reports before and after renovation of a childcare centre outdoors supports the premise that environmental diversity provides safer play areas. A total of 530 incident records (minor injury reports prepared by

teachers) were processed. Analysis shows a statically significant reduction of incidents after renovation. In subsequent interviews, teachers explained that after renovation children were more engaged with the environment, there were more things to do, children named natural elements, played less with toys and more with natural objects. Teacher's patterns of supervision also changed. They walked around more and their attention was more focused on children's activities. As a result, they knew better where children were and what they did.

2.3 Environment and behaviour research

Although there is a growing interest in the impact of outdoor physical activity on healthy early childhood development, little empirical research has been generated to show the association of physical activity with different types of environments. Information is scattered and difficult to find. A review of empirical literature covering the developmental impact of the outdoors on children less than five years of age [63] identified 203 items on the topic and selected 43 for review. The authors Striniste & Moore (1989) re-affirmed the crucial role of diverse outdoor environments and active caregivers but also stressed the need for more in-depth research to provide empirical evidence for these assertions.

Almost fifteen years later, the present review found few additional items. Exhaustive database searches found mostly unrelated items dealing with the negative aspects of children's health and the environment such as lead poisoning and air pollution.

Selected studies show initial attempts to identify aspects of the physical environment (designed and natural) as predictors of child behaviour. However, the majority of these studies used small sample sizes (from 4 to 72 children) with ages ranging between four and seven years old [64]. Research studies concentrate on associations between contrasting play environments ("traditional" and "contemporary" or "play equipment based" and "naturalistic") and different aspects of child development such as creativity, cognitive abilities, gross motor development, and attention functioning [46, 65].

The most focused study addressing preschool children in childcare settings [46] is Swedish. The study compared two "good" nursery schools with different outdoor environments: a typical urban facility (located in Malmö) with play areas containing low plantings, play equipment, and surrounded by tall buildings and an "in-all-weather" nursery program (located in Klippan) with an overgrown play area with big rocks and trees where children stayed outdoors for long periods of time. Findings show that children attending the "in-all-weather" nursery were more fit according to the Eurofit test

(especially in balance, agility and strength of hands, arms and trunk), showed longer attention spans (as measured by the Attention Deficit Disorder Evaluation Scale, statistically significant results), had less sick days (8% in typical nursery; 2.4% in “all weather” nursery), and showed more diverse play activities (variety of games and play sequences). Further research of eleven additional Swedish nurseries using the same methods supports the earlier findings.

Norwegian researcher Fjørtoft [33]studied preschool children in an expanded outdoor play area—the forest adjacent to a nursery school. Fjørtoft investigated the impact of play in the natural forest environment on children’s physical development using the concept of affordances. She reached similar conclusions as Grahn and explained significant associations between motor development, play affordances and landscape diversity.

From the work mentioned above, we can infer that outdoor play, even in cold climates, supports positive health outcomes in young children. A five-year study of weather parameters and illness-associated absence in day care centres in South and Central Sweden supports this assumption. Research conducted by Sennerstam [66] confirms that outdoor activities reduce morbidity in children attending daycare and that caregivers should be encouraged to take children outside to play except under extreme weather conditions.

Not only does the outdoors have a positive effect on children’s general health but it also provides beneficial stimulation for specific areas of child development. The effect of green environments on aggression and attentional disorders has been well demonstrated by researchers working at the Human Environment Research Laboratory, University of Illinois at Urbana Champaign. Kuo and Sullivan [67] compared levels of aggression in 145 public housing residents living in buildings with varying levels of nearby nature (mainly trees and grass). Their attention functioning was assessed using an index of mental fatigue. Results show that residents living in buildings with barren surroundings reported more aggression than those living in greener environments. Equally important are the findings of the research conducted by Faber Taylor et al. (2001) [68] concerning the relationship between children’s exposure to nature during leisure time and their attentional functioning. Results show that children perform better than usual after playing in green settings and that the greener the play area is, the less severe their attention deficit symptoms are. Similar positive effects of greener environments were shown by Wells (2000) [47] in her study of relocated low-income

children. She found that children whose homes improved in terms of greenness (i.e. had a lawn and trees) also tended to have higher levels of cognitive functioning.

Other researchers have studied the influence of design on different aspects of child development. Researchers Brown and Burger [50] examined the relationship between social and motor behaviours, and language in young children (between three years six month and four years six month old) in “traditional” (individual, un-connected play equipment) and “contemporary” playgrounds (multifunctional, integrated play structures). Researchers used a 19 item rating scale to assess children’s behaviours. The items were divided in four areas: social/affective, cognitive, motor, and practical considerations. An analysis of variance indicated that there were no significant differences in the hypothesized variables but differences were found in the way the play areas were used (more diverse activities in “contemporary” playgrounds).

The study conducted by Susa and Benedict [65] also looked at the effect of “traditional” and “contemporary” playgrounds on creative behaviour of children between 4 to 11 years old (mean 7.3 years). A regression analysis revealed “contemporary” playground design as a predictor of creative behaviour.

Play equipment is important for gross motor activities and may help to protect children from sedentary lifestyle habits. But it is not proven that “equipment-based” play areas provide sufficient stimulation for all areas of child development and group play. A study performed by Herrington and Studtmann [64] in two childcare centres was implemented in two phases: “temporary interventions” (phase 1) and “permanent interventions” (phase 2). Findings show changes in the pattern of use of the yards, how the children used objects, and how they related to each other. Interestingly, the results suggest that the incorporation of plants and natural elements support more imaginative play and the interest of children considered “loners”. Unfortunately, the study is based on very small samples (phase 1, n=4 children; phase 2, n=16 children) and, therefore, its generalisability is compromised. However, the investigation supports the importance of creating rich, mixed environments for children’s enjoyment.

Similar playground studies mostly address older children and have major methodological weaknesses. Typically, the range of diversity of settings and affordances investigated are narrow that the results lack significant differences.

2.4 Public health research

In recent years, public health researchers have increased their efforts to identify early childhood factors associated with overweight, obesity, and physical activity. Twenty years ago, studies began to suggest associations between parental adiposity and daytime activity in four-to-eight-year old children. However, no specific findings were reported about the location of the physical activity [69]. Longitudinal studies have demonstrated that healthy diet and physical activity can decrease accelerated weight gains even in preschool children if they are engaged in leisure activities. Researchers have examined the effect of physical activities on children's body fatness between preschool and first grade and found that less active preschoolers gained more fat than more active children in the same period [70].The study used longitudinal data from the Framingham Children's Study launched in 1987, initially with the participation of 106 families and 97 healthy children were included in the analyses. A subsequent analysis of data collected over 8 years (children 4 to 11 years old) shows that higher levels of physical activity in early childhood may decrease the amount of fat gained in early adolescence [4]. Parents and children were evaluated once a year while children's physical activity was monitored twice a year using accelerometers for three-to-five consecutive days. This highly relevant longitudinal study links the level of physical activity in early childhood with the level of fat in early adolescence. These researchers comment, "…since physical activity has also been shown to track throughout childhood it is important to establish an active lifestyle beginning very early in childhood." They conclude, "thus, successful strategies for the prevention of obesity should be designed to increase total activity beginning in the preschool years" [70].This means that the preschool years could be a one-time opportunity for establishing active lifestyles.

Recent studies have linked the impact of the preschool environment to children's level of physical activity and therefore to the possible gain/decrease of fatness in young children [48]. In an effort to elucidate what factors may predict body mass index (BMI) among children three-to-seven years old, researchers identified diet, physical activity, sedentary behaviour and television viewing as potential predictors [71]. A tri-ethnic cohort of children (3 and 4 years old) was followed for three years to assess BMI, TV viewing time, diet, and sedentary behaviour. Results show that stronger predictors of BMI are physical activity (negatively associated) and TV viewing (positively associated) with a stronger association of these factors at six-seven years of age. This research suggests that focusing in reducing time TV watching and increasing physical activity appears as a constructive strategy to counteract weight gains at this age.

Research conducted by Finn and colleagues [10] identified the childcare centre as a strong determinant of physical activity in children three-to-five years old. A total of 214 children from ten childcare centres in South Dakota participated in the study. Variables investigated included age, gender, body mass index (BMI), history of preterm birth, season of the year, childcare centre, child's participation in organized activities, mother's and father's BMI, and parental education level. Children wore accelerometers for 48 hours while a subgroup of 40 children was also observed using the Children's Activity Rating Scale (CARS) to assess the validity of the accelerometer monitoring. In this study, childcare was the highest individual predictor of physical activity representing 45% to 64% of the total daily accelerometer counts 9:00am-5:00pm. The study underlines the potential of childcare centres to become sites of healthy intervention by offering time and space for adequate levels of physical activity.

The comparison of activity levels of overweight and non-overweight children *while attending preschool* suggests that low levels of physical activity during the preschool day may contribute to an increased in overweight children [48]. Two objective measures of physical activity (direct observation and accelerometry) were employed to obtain valid and reliable data. A total of 245, three-to five-year old children (127 girls, 118 boys) were sampled and observed for one hour on three different days. Participants with at least three days of accelerometer monitoring were included on the analysis.

According to the authors, this was the first study to evaluate the association of levels of physical activity during the preschool day and its impact on weight. They found that overweight boys were significantly less active than non-overweight boys and that parental obesity was strongly associated with child weight. No difference was observed in girls. No conclusive evidence was found related to other variables identified by the researchers such as modelling of physical activity, time watching TV, park visits, level of coordination, and amount of active toys and sporting equipment at home. The results of this research suggest that overweight children are at risk of gaining additional adiposity if they are not physically active during their stay at the childcare centre. These findings are important for the present proposal as a control for confounding variables because they clearly reinforce the impact of the preschool on children's physical activity level in contrast to other possible factors.

Because there is such a strong indication that the preschool or childcare environment is associated with children's physical activity [10, 72] research is now orientated to the identification of specific physical components and attributes. For that reason, preschool

quality is becoming a research topic in the search for potential indicators that might guide future strategies to counteract sedentary lifestyles. A recent study looked at the potential influence of policies, practices, and preschool quality on the level of preschool physical activity (three-to-five year olds) in nine preschools of Columbia, South Carolina, USA [73]. The physical activity of 266 children was assessed for one hour during three days using direct observation and recording the activity on a scale 1-5 (1=motionless; 5=fast movement). Preschool quality was evaluated using the Early Childhood Environment Rating Scale-Revised Edition-ECERS-R [74]. Results show that children that attend preschools with more resources, better-educated teachers, and policies that support frequent field trips show greater levels of moderate-vigorous physical activity. Similarly, preschools with higher scoring in ECERS-R (higher quality) were associated with greater levels of children's physical activity.

2.5 Outdoor play and academic performance

Diversity in the outdoor environment affords many opportunities for free play and many choices for exploration and learning [26, 75, 76]. The curriculum developed in these types of settings has the potential for influencing learning processes such as early mathematical skills, phonemic awareness, aural comprehension, and general knowledge.

It is well established that preschoolers that attend childcare programs that allow self-exploration and experimentation, are better prepared for academic success [77]. High quality outdoor environments provide opportunities for a large array of hands-on activities and self-guided explorations. Furthermore, those explorations are conducted performing a wide variety of whole body movements that support beneficial outcomes for children's physical, cognitive and social development [30]. Gross motor activities not only support energy expenditure and balance between calories in and out (the main concept for not gaining weight), but help build endurance and strength, develop a sense of mastery, and provide a playful break from demanding cognitive tasks [78]. This research review highlights the work of well-known developmental psychologists who have established that lower cognitive development could be the result of less active exploration [79]. Self-guided exploration, as a base for learning and active living, is even more critical for low-income children whose parents tend to enrol them in academically oriented preschools [80].

Chapter 3: Research Purpose

Following the lead from previous research, many questions appear unanswered, especially in the realm of the physical environment of young children. If there is to be a dramatic change in the environmental conditions of early childhood, as suggested by many researchers [8, 10, 48, 73], architects, landscape architects and designers of children's environments will need to be involved. These professionals will be required to interpret the need for active living of preschoolers and follow specific guidelines to create supporting environments for such a purpose. But evidence-based design guidelines for early childhood active living do not exist. Currently, the need for physical activity in early childhood is mainly addressed by the installation of play equipment in childcare centres and the introduction of curricular strategies such as structured physical activity sessions.

Due to the magnitude of the problem, the scientific community has reacted positively towards the importance of producing changes in the physical environment [2, 3, 17, 18, 37, 81]. The need for research in this area has been recognised [37] and several initiatives have been launched to debate the issue and to support research [81-84].

The request for applications for the research program *Obesity and the Built Environment*, issued by the National Institutes of Health in 2004 [82], solicited proposals focused on the significance of the built environment for overweight and obesity and stressed the fact that there is "insufficient research that delineates the influence of the built environment on nutritional factors and physical activity" (p.1).

The present study, supported by the Robert Wood Johnson Foundation, Active Living Research Program, is a contribution to the understanding of the outdoor built environment in relation to physical activity levels of preschool children in childcare centres. The findings are intended to guide design professionals to produce informed design decisions and to influence childcare policy.

Research is already indicating that high quality outdoor environmental conditions at preschools should be considered as a health preventive measure to increase physical activity and counteract sedentarism [48, 85, 86]. The present study is based on the assumption, stated in the introduction, that the childcare outdoors and its diverse settings are predictors of physical activity in preschool children.

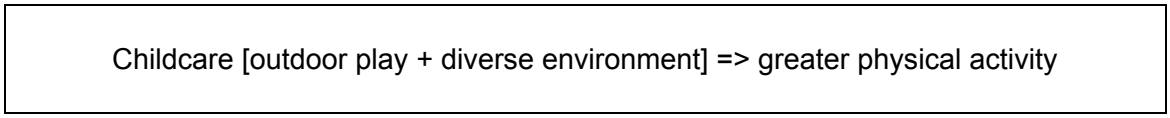


Figure 2.1 Study assumptions.

For identifying specific variables and defining analytical procedures, a detailed research framework was created, containing two primary aims, two secondary aims, and one exploratory aim.

Question 1

Is there an association between childcare outdoor play area design and the level, type, and duration of children's physical activity?

Primary Aim 1

To compare the effect of three different types of preschool play areas on children's physical activity level.

Hypothesis 1

Different types of preschool play areas afford different types and intensities of children's physical activities.

Exploratory Aim

To explore the possible association of environmental diversity of play settings within equipment-based, mixed, and natural preschool play areas and children's level of engagement with each other and the environment.

Question 2

What are the environmental attributes of play areas associated with greater physical activity?

Secondary Aim 1

To compare the effect of environmental variety of play areas (number of natural and manufactured elements present) on children's physical activity level as measured by accelerometers.

Hypothesis 1

The variability of children's physical activity will be explained by the environmental variety of each play area (number of natural and manufactured elements present)

Question 3

Is there a difference in the development of gross motor skills of children attending childcare centres with different types of outdoor play areas?

Primary Aim 2

To assess the effect of long term exposure (24 months or more) to three different preschool play areas on gross motor development of children.

Hypothesis 1

Long term exposure (24 months or more) to three different preschool play areas will result in different motor development levels in preschool children.

Chapter 4: Methodology

4.1 Methodological Approach

Deepening the understanding of sedentary lifestyles in young children, beyond traditional epidemiology (disease distribution and causes), is critical to promoting appropriate behavioural changes. The latest research has already established a link between greater amounts of physical activity and the childcare outdoor environment [10, 11, 13], as described in Chapter 2. At this point in time, it is appropriate to rise above the general notion that the childcare outdoors (as a whole) is a determinant of greater amounts of physical activity and look for more specific environmental attributes and components that may influence such behaviours. The design disciplines are critical to confront the problem since they are the driving force behind environmental change.

Sedentary lifestyle experts suggest that the use of a behavioural epidemiological framework is most appropriate to study the phenomenon of physical activity / inactivity since "…[it] is concerned with the distribution and aetiology of behaviours linked with disease" [9]. The use of this approach for researching preschool environments may help discover the reasons behind dissimilar levels of activity of children attending childcare centres with contrasting outdoor environments. However, for identifying specific environmental changes to modify habits, it is necessary to have a deep understanding of the dynamics between behaviour and the built environment. The concepts of behaviour setting [58] and affordances discussed in Chapter 2 [52, 53] offer a useful framework to approach this task. The indissoluble relationship between person and environment could be seen as an impediment for the design research field that, traditionally, has been concerned with the properties and attributes of physical space rather than the behaviours of its users. Without doubt, the topic of sedentary lifestyles justifies the use of a multi-method ecological research approach where intrapersonal, interpersonal, and institutional factors, as well as environmental variables are taken into account [87].

The field of design research is relatively young compared to public health. The design research field in the U.S was formally established in 1968 by the creation of the Environmental Design Research Association (EDRA) whose purpose is "the advancement and dissemination of environmental design research, thereby improving understanding of the interrelationships between people, their built and natural surroundings, and helping to create environments responsive to human needs" [88]. A broad range of studies and methodologies characterized the interest of the founding

group in the first years of the organization. Methodologies ranged from phenomenological, in depth studies with small sample sizes, to broad scale studies with large data sets and statistical analyses. The approach taken for this study reflects the "environment and behaviour" approach of much of the field in the last thirty-seven years.

Design researchers have shown a rapid response to the emergence of obesity as a new health issue connected to the built environment. Attention to the problem is reflected in the creation of new interest groups within the design research community and in the growing number of sessions and initiatives at national and international conferences. This trend also includes the development of new research methodologies and advances in technology (e.g. accelerometry [89], GPS [90], GIS [91], observational software via video or palm pilot coding, etc.) appropriate for design research applications that support quantitative studies with the purpose of meeting the scientific criteria of public health research.

The present study is an attempt to move in the above direction and to produce results that may influence both the design and health professions, particularly in applications in childcare outdoor environments. For this investigation, a methodology was devised for the first time combining the use of innovative software for behavioural research [92] with the characterization of preschool play areas using behaviour mapping coded with GIS software [91]. Although behaviour mapping has been previously used for investigating children's environments [26, 93], this is the first time it has been applied to preschool, childcare environments using GIS coding (gender, physical activity level, and use of wheeled toys). These codes were added to the location of subjects to achieve a deeper understanding of the relationship between children's behaviour and their surroundings. This methodological approach was driven by theoretical constructs (see Chapter 2 Literature Review) particularly the concepts of behaviour setting [58], motivation [55-57, 94], and affordance [52, 53] as a contribution to the emerging field of design for active living.

4.2 Research Questions

Three research questions guided the investigation.

Research question 1. Is there an association between childcare outdoor play area design and the level, type, and duration of children's physical activity?

This question explores the potential effect of preschool play area designs on children's physical activity. For this purpose, contrasting outdoor preschool areas were identified in three childcare centres serving comparable groups of 3-5 years old children (see Sample of Children 4.5). A sub-sample of these children wore accelerometers during two sessions of physical activity monitoring that lasted one day and one week respectively to assess physical activity variability between centres, Sub-Sample 4.5.1. To objectively measure children's physical activity, System for Observing Play and Recreation in Communities SOPARC [95] was utilized. Observation of activity was coded in behaviour maps (see 4.9.2 Physical Activity Coding on Behaviour Maps).

Research question 2. What are the environmental attributes of play areas associated with greater physical activity?

Based on previous research studies that looked at preschool areas by analysing their overall characteristics [28, 46, 96], the methodological approach used here aims at uncovering the effect of the environment by analysing its *components* (number and size of behaviour settings) along with their *qualities* (diversity, type of settings) linked to children's activity.

With the objective of seeing beyond total amounts of physical activity performed by children at a given time (research question 1), two research tools were used to answer question 2: a. *Behaviour mapping* of groups of children and b. *Video-tracking* of selected individual children.

a. Behaviour mapping was used to identify behaviour settings in each play area using observational data coded for level of physical activity, gender, and the use of wheeled toys.

b. Video-tracking was conducted to appreciate more closely children's activity in relation to environmental features (4.9.4 Video-Tracking and Behaviour Coding). The literature on motivation [56] and children's response to the environment [56] facilitated the selection of variables to score for environmental diversity and setting category. An analysis of individual children's play by video-tracking (location, social interactions, physical activity, and play) was used to illustrate the potential of environmental features and programmatic aspects that might motivate preschoolers to stay active while playing outdoors.

Observed environmental attributes and qualities associated with greater amounts of physical activity (identified by behaviour mapping and video tracking) are assumed to be physical activity affordance indicators.

Research question 3. Is there a difference in the development of gross motor skills of children attending childcare centres with different types of outdoor play areas?

Gross motor development skills develop by exercising and full body involvement with the environment [97]. This question explores the possibility that long-term exposure to certain types of play areas might have an impact on gross motor development. For this purpose, the Test of Gross Motor Development - TGMD-2 [98] was included in the study.

4.3 Research Methodology Summary

Figure 4.1 summarises the research methodology and the approach to analysis adopted in this study.

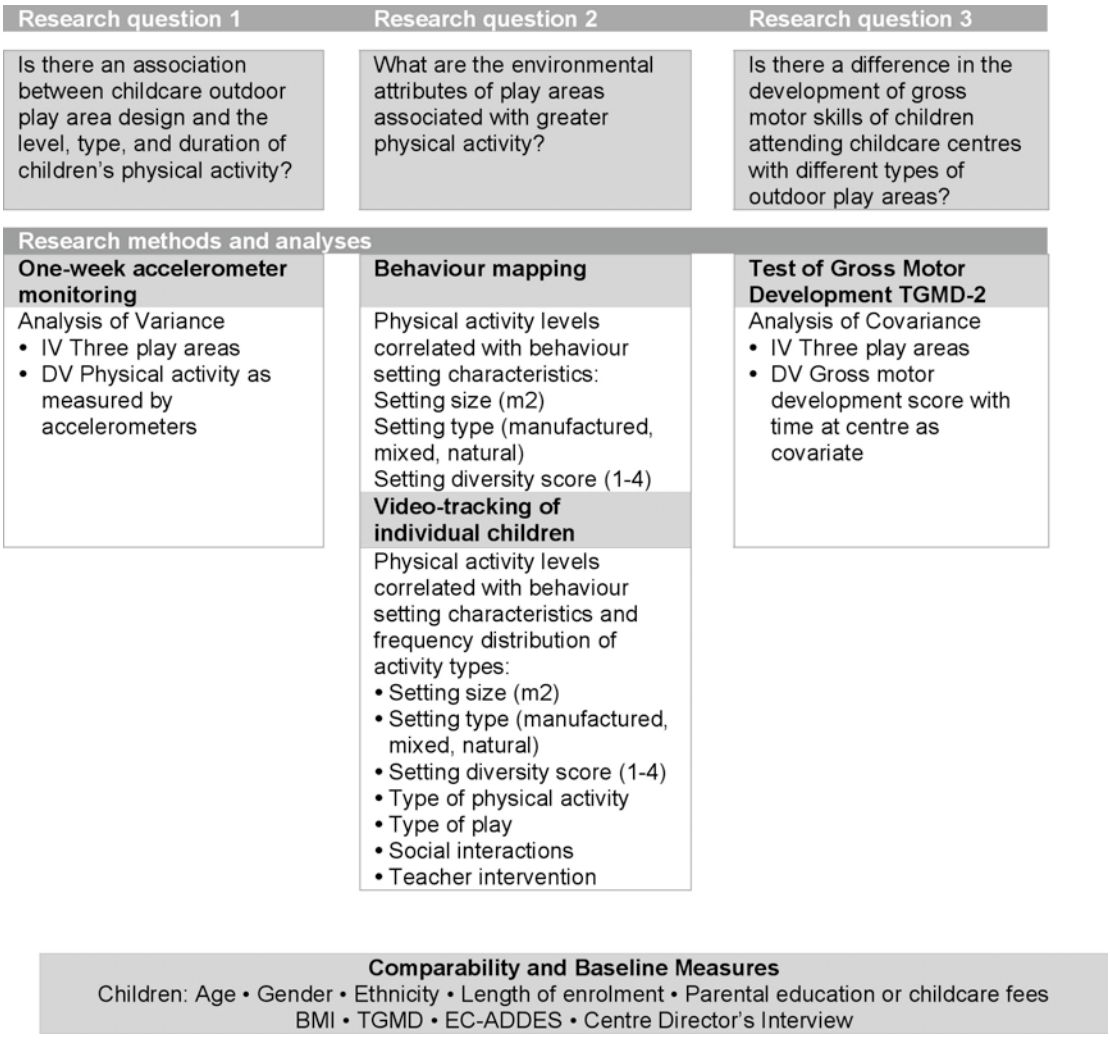


Figure 4.1. Research methodology and approach to analysis.

The methodological challenge was to link children's behaviour with environmental features in preschool play areas for the purpose of identifying potential physical design factors associated with greater amounts of physical activity.

4.4 Site selection

Three childcare centres willing to participate in the study were selected (Centres A, B, and C) containing play areas with different design characteristics (Figures 4.2, 4.3 and 4.4) and dissimilar proportions of manufactured and natural elements (Figure 4.5).

Figure 4.2. Centre A Manufactured setting example: play equipment.

Figure 4.3. Centre B. Mixed setting example: trellis and vines.

Figure 4.4. Centre C. Natural setting example: circle of rocks.

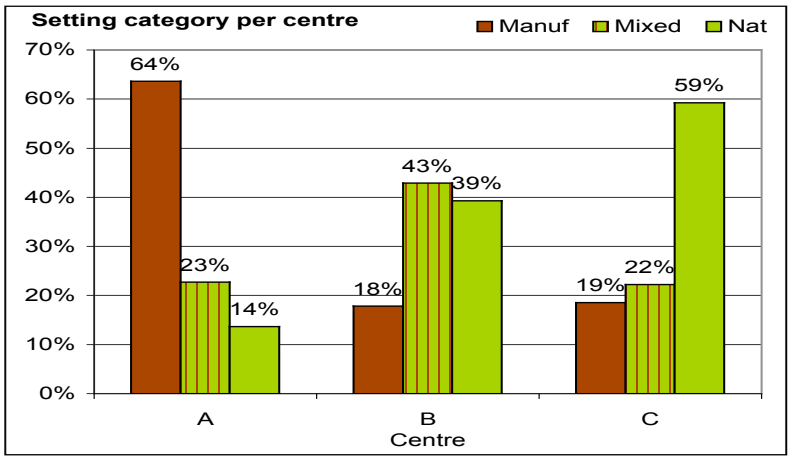


Figure 4.5 Proportion of manufactured, mixed, and natural settings in Centres A, B, and C.

4.5 Centre Profiles

Located in the Triangle Region of North Carolina, USA (Research Triangle Park, and Cary), the centres are part of *Bright Horizons Family Solutions* [99], one of the largest international childcare provider networks. Selecting these highly regulated centres provided an opportunity to control for confounding variables such as child screening

procedures, standards of excellence, licensing and accreditation requirements, staff selection, and facility infrastructure.

Each of the Centres A, B. and C received the highest licensing rate at North Carolina State level (i.e. Five Star Licenses, [100] and were accredited by the National Association for Education of Young Children [29].

Control for possible differences in teacher training and educational philosophy was achieved through data gathered from the Centre Director Interview (Figure 4.6). The interview, adapted from the *Centre, Children, and Teacher Profiles* developed by Gary Moore [101], offered insight concerning similarities and differences between each centre as well as specifics about how the play areas were scheduled and used.

Likert scale questionnaire 1-5 (1 = do not agree → 5= strongly agree).	**Centre A**	**Centre B**	**Centre C**
For the most part, this centre encourages children to follow their own interests rather than follow a curriculum.	5	4	5
Most teachers stress conformity to rules and group expectations.	3	3	1
Most classroom activities are focused on group rather than individual teaching.	3	3	1
I believe the children need strong role models from the staff.	5	5	5
I would characterize this centre as pursuing a "traditional" versus a progressive philosophy on education.	2	2	2
I would characterize the staff as actually practicing a "progressive" versus a "traditional" mode of teaching.	4	3	4
The centre's outdoors is as important as the indoors	3	5	5
Outdoor play schedule	flexible	flexible	flexible

Figure 4.6 Director questionnaire responses.

Using data from the Centre Director Interview, Figure 4.7 provides summary characteristics of each centre (A, B, and C) in terms of numbers and ages of children, centre capacity, numbers of teachers, play area size, and space/child ratio (m^2/number of children). The latter was calculated to provide a further measure of comparison between sites.

	Centre A	**Centre B**	**Centre C**
Min children age/weeks	6	6	6
Max children age-years	5	5	5
Total number of children	160	114	150
Centre capacity	168	134	162
Preschoolers	60	60	72
Number of teachers	36	42	25

Assistant teachers	0	0	0
Coordinators	2	2	5
Teachers & coordinators	38	44	30
Approx child/ratio per teacher	4	3	5
Approx. building m2	1,672	1,480	1,208
Preschool play area m2	1,194	1,341	1,863
Approx, m2 per child	20	22	26

Figure 4.7 Centre characteristics.

Centre A is located in the Research Triangle Park, NC. The building has 1,672m^2 and the preschool play area is 1,194m^2. Undeveloped land surrounds the centre creating a green backdrop. The play areas, situated in the back of the building, are fenced and divided by age (infants, toddlers and two years of age, and preschoolers) as required for licensing purposes. The centre welcomes children as young as 6 weeks old who can attend until they are five years. The capacity of the centre is 168 children and, at the time of the study, 160 children were enrolled. Personnel include 36 teachers and 2 coordinators. The child ratio per educational staff (teachers and coordinators combined) is four children/teacher. The number of enrolled preschoolers was 60. The approximate proportion of square meter per child in the play area is 20m^2/child.

Responses to the director questionnaire, Figure 4.6, show that this centre strongly encourages children to follow their own interests, that teachers balance conformity to rules and group expectations as well as individual and group activities. The director believes that children need strong role models and characterizes the centre as pursuing a moderately progressive philosophy. In her opinion, Centre A teachers conduct a satisfactory progressive mode of teaching. The director moderately agrees that the outdoors is as important as the indoors.

Figure 4.8 Centre A. Lawn with easels and play equipment.

Centre A has a flexible schedule that allows teachers to go outside between 10:00am-11:30am in the morning and after 4:00pm and until children leave in the afternoon.

Centre B is also located in the Research Triangle Park, NC. The building has 1,480m^2 and the preschool play area is 1,341m^2. Woodlands and a wetland surround the centre. The play areas are fenced, divided by age (infants, toddlers and two years of age, and preschoolers) as required for licensing purposes, and situated behind the building. Like Centre A, this centre receives children from six weeks to five years of age. The capacity of the centre is 134 children. At the time of the study, there were 114 children enrolled. The staff of this centre is composed of 42 teachers and 2 coordinators. The child ratio per educational staff (teachers and coordinators combined) is three children/teacher. The number of enrolled preschoolers was sixty. The approximate proportion of square meter per child in the play area is 22m^2/child.

Responses to the director's questionnaire (Figure 4.6), show that this centre encourages children to follow their interests although there is compliance with the curriculum, that teachers balance conformity to rules and group expectations, and they equally plan for individual and group activities. The Centre B director believes that children need strong role models and characterizes the centre as pursuing a moderately progressive philosophy. This centre recently embarked in a change of educational philosophy based on Reggio Emilia guiding principles (emergent curriculum, project work, teachers as researchers, and project documentation). In the director's opinion the teachers at this centre, have a mode of teaching that balances progressive and traditional strategies. The director strongly agrees with the statement that the outdoors is as important as the indoors.

Figure 4.9 Centre B. Train and wheeled toy curvy path.

Centre B has a flexible schedule that allows teachers to go outside between 10:00am-11:30am in the morning and 4:30pm-6:00pm in the afternoon. In this centre usually parents pick up their children in the play areas.

Centre C is located in Cary, NC, about 6 kilometres South of Centres A and B. The building has 1,208 m^2 and the preschool play area is 1,863m^2. This centre is located in a suburban area adjacent to a shopping area. A busy avenue defines one of its sides. The play areas are adjacent to the sidewalk and visible from the parking lot. They are fenced and divided by age (infants, toddlers and two years of age, and preschoolers) as required for licensing purposes. As the other two centres, Centre C receives children from six weeks to five years of age. The capacity of the centre is 162 children. At the time of the study, there were 150 children enrolled. There are 30 teachers and 5 coordinators. The child ratio per educational staff (teachers and coordinators combined) is five children/teacher. The number of enrolled preschoolers was 72. The approximate proportion of square meter per child in the play area is 26m^2/child.

Responses to the director's questionnaire (Figure 4.6) show that Centre C highly encourages children to follow their interests, that teachers stress individual children to adhere to rules (rather than to group expectations) and emphasizes individual teaching.

Centre C director believes that children need strong role models and characterizes the centre as pursuing a moderately progressive philosophy. In her opinion the teachers at this centre are inclined to carry out a progressive mode of teaching. The director strongly agrees with the statement that the outdoors is as important as the indoors.

Figure 4.10 Centre C. Bench by lawn and "music tree".

Centre C has a flexible schedule that allows teachers to go outside between 10:00am-11:30am in the morning and 4:30pm-6:00pm in the afternoon in periods of 30-40

minutes. Teachers take children out in subgroups of about 9-10 children at a time. At this centre, parents often pick up their children in the play areas at the end of the day.

4.5.1 Summary of research sites

The greatest difference between centres focuses on differences in individual or group activities and conformity to rules. Whereas Centres A and B equally favour these approaches, Centre C stresses individual over group teaching strategies. Equally important to note is that Centre A does not strongly agree that the outdoors is as important as the indoors—in contrast to Centres B and C that highly support the statement. Regarding the education approach, Centre B leaves more flexibility in the curriculum for children's own expectations to guide activities. This could be explained by the fact that this centre has embarked in a change of educational philosophy to embrace the Reggio Emilia approach.

4.6 Sample of Children

A total of 116 children three-to-five years old (Appendix A) were recruited from the three centres as follows:

Centre A	Centre B	**Centre C**	Total
39 children	33 children	44 children	116 children

Thirty children from each centre were retained as the final research sample (n=90). Twenty-six children were removed from the sample because of age range (being six years old soon after the study began), insufficient length of enrolment, leaving before the study was complete for family reasons (family relocation, change in parent employment or modified family routines because of newborn siblings, etc.) or refusal to complete the Test of Gross Motor Development.

Because this was a convenience sample, efforts were made to establish comparability between participating children (see 4.7 Baseline Measures).

4.6.1 Sub-Sample

A sub-sample (Appendix A) was drawn (equal proportion of boys and girls) from the larger sample after completion of the *Children's Profile Questionnaire*, *BMI* measurement, and *Test of Gross Motor Development* (TGMD). A total of thirty children

comprised the sub-sample (10 children per centre). The objective of working with a sub-sample was to conduct a one-week sequence of accelerometer monitoring.

A selected number of children from the sub-sample were further chosen for a session of video-tracking while wearing accelerometers.

4.7 Baseline Measures

Figure 4.11 summarises the baseline variables, instruments used and outcome measures. Baseline measures were collected with the objective of confirming sample comparability in variables important to the study including demographics (gender, age, ethnicity), Body Mass Index (BMI), gross motor development, and attention functioning.

Variables	Instrument	Outcome measures
Children		
Gross motor development	Test of Gross Motor Development TGMD	Gross motor development percentile score
Attention functioning, hyperactivity behaviours	Early Childhood Attention Deficit Disorder Evaluation Scale EC-ADDES	Attention / hyperactivity percentile score
Child general information	Children's profile questionnaire	Gender Age Ethnicity Stay in centre Approx socio economic level
Height and weight readings	Body mass index	BMI-for-Age
Centre		
Teacher profile	Director's semi-structured interview	Teacher education level / Approach to education
Centre philosophy	Director's semi-structured interview	Centre profile

Figure 4.11. Variables, instruments and outcome measures.

The *Test of Gross Motor Development* TGMD-2 [25] was included to respond to Research Question 3 and was administered simultaneously with the collection of height and weight of participating children (to calculate BMI).

The *Early Childhood Attention Deficit Disorder Evaluation Scale*, EC-ADDES [102], was completed by the teachers that had daily contact with children in the sample.

Baseline measures are fully described in the following sections.

4.7.1 Body Mass Index

Height and weight information was gathered from each participating child to calculate his or her Body Mass Index (BMI). Because overweight has an impact on children's movements, this measure was planned to control for confounding variables that could be a factor on children's physical activity performance [48].

BMI is a measure to assess if a child is underweight, overweight or at risk of being overweight. It is calculated by dividing the child's weight by the height squared (weight/height^2). Because children develop in bouts and height and weight changes are not linear, the U.S. Centres for Disease Control (CDC) suggest using the *BMI-for-age* for children and teens as a more accurate measure [103]. Weight and height of children are plotted on age-specific charts that reflect the pattern of growth for boys and girls between two to twenty years of age.

4.7.2 Gross Motor Development

Several gross motor development assessments were considered for use in the investigation guided by a thorough review of gross motor development scales created by experts in physical therapy [104]. With the purpose of guiding professionals working with children with motor coordination difficulties, the authors selected for review a group of tests based on their high frequency of use. They analysed the *Bruininks-Oseretsky Test of Motor Proficiency* (BOTMP), the *Movement Assessment Battery for Children* (MABC), the *Peabody Developmental Motor Scales* (PDMS), and the *Test of Gross Motor Development* (TGMD). The researchers compared administration procedures as well as the reliability and validity of the scales. In comparison to the other three tests, the TGMD appeared to be a more practical and reliable tool for screening children's development, particularly because it is designed to assess children 3 to 10 years of age. Furthermore, it requires materials readily available and easy to transport (masking tape, traffic cones, plastic balls, bat), is affordable, and does not require specialized training.

The TGMD Second Edition [98] is used to assess twelve gross motor skills that develop early in life. The items are appropriate for kindergarten to fourth grade children as proposed by the National Association for Sport and Physical Education (1995) and yield standard and percentile scores, as well as age equivalents.

The TGMD is organized in two subtests containing a number of gross motor skills:

1. *Locomotor subtest*: run, gallop, hop, leap, horizontal jump, slide.
2. *Object control subtest*: striking a stationary ball, stationary dribble, catch, kick, overhand throw, and underhand rolling.

Most children enjoy performing the gross motor skills tasks during the 15-to-20-minute duration of the test. As with all gross motor testing, special consideration must be given to ensuring appropriate space to administer the assessment. Ample space is needed for running for example and, to guarantee stable conditions, the space should be the same for testing groups of children in their childcare centres.

4.7.3 Attention Functioning

Recent research demonstrates that the outdoors has an impact on attention functioning [46, 47, 67, 68]. A review of these studies showed that the Attention Deficit Disorder Evaluation Scale (ADDES) was the instrument most frequently used in research looking at the impact of nature on children's attention functioning [46, 47]. For this reason, EC-ADDES [102] was selected as the instrument in this investigation to assess attention functioning and hyperactivity of participating children.

This assessment was introduced with the objective of ruling out possible hyperactivity behaviours as a confounding variable in relation to physical activity levels. It was hypothesised that children suffering attention deficit disorders (ADD) and/or hyperactivity (ADHD) would be more active and restless than those without these symptoms [105].

This scale is standardized and designed to assess the frequency of behaviours associated with attention deficit and hyperactivity in children two to six years of age. EC-ADDES is used for screening purposes. Although it is not a diagnostic tool, it may contribute to the identification of attention deficit disorder / hyperactivity symptoms, and support the development of remedial activities in the school.

The instrument is composed of two sub-scales: 1. Inattentive (to assess poor sustained attention to tasks) and 2. Impulsive / hyperactive (to assess impaired impulse control and delay of gratification, and excessive activity and physical restlessness). EC-ADDES is composed of 56 items presented in the form of behaviour statements to be scored according to the frequency of the observed behaviour on a scale 0-4 (where "0" equals "does not engage in the behaviour" and "4", [the child engages] "one to several times per hour"). The scale includes items such as [the child] "Needs oral questions and directions

frequently repeated" (Section 1, Item 7.) or "Does not follow the rules of games" (Section 2, Item 43.).

The scale helps document the most common symptoms of children with attention deficits and hyperactivity disorders in a way that makes characteristics easy to identify and quantify by the caregiver or teacher. The procedure of counting the occurrence of certain behaviours (an hour, day, week, month, or never) is an objective way of estimating the incidence of children's attention functioning or hyperactivity. This mechanism is in agreement with the definition and frequency of observations of inattention and hyperactivity-impulsivity behaviours specified in the Diagnostic and Statistical Manual of Mental Disorders - DSM-IV [38].

Normative data for the EC-ADDES School Version was gathered from 2,887 children from 52 schools systems in 30 US states [30]. Test-retest reliability was implemented by assessing a sample of 65 children who were rated at an interval of 30 days from the first measure. Results ranged between 0.92-0.97. For the age relevant to this study (3-5 years), the test re-test reliability ranged between 0.94-0.97. Inter-rater reliability is reported at 0.64 and 0.66 for the Inattentive and Hyperactive/Impulsive sub-scales respectively ($p<0.5$). The instrument was validated using factorial analysis and the Diagnostic and Statistical Manual of Mental Disorders - DSM-IV categories [106].

The author recommends that caregivers and teachers have to be properly briefed and carefully read the instructions before starting to code behaviour. It should be noted that, in institutions where rules are stricter, children might get higher scores showing greater levels of inattention and hyperactivity / impulsivity.

4.8 Physical activity monitoring using accelerometry

To establish which group of preschoolers exhibited greater amounts of physical activity while playing outdoors, selection of an objective measurement of physical activity levels was a key consideration. An array of methods is available including self-report, doubly-labelled water, indirect calorimetry, heart rate monitors, pedometry, and accelerometry [107, 108]. Some of these methods are clearly not appropriate for young children (e.g. self-report). Others provide only a general estimate of activity but no insight into patterns of activity (e.g. double labelled water) or are impractical and costly (e.g. indirect calorimetry) for research projects such as the present study [109]. Because of the fast pace of children's activity, researchers agree that objective observational methods and the use of non-invasive devices such as pedometers and accelerometers are most

appropriate [107-109]. Pedometers are relatively inexpensive and readily available. However, each one must be calibrated to the step size of the child, which would be time consuming and imprecise. Also, they are easily tampered with by children. Accelerometers, on the other hand are enclosed units.

For the present study, accelerometers were selected because they give accurate recordings of children's activity bouts with a time stamp enabling comparisons such as start-end time of activity by day, week, indoor-outdoor activity, morning and afternoon. Accelerometers are small devices, similar in form to pedometers that register motion in two spatial plane dimensions while attached to the waist of the individual. The device is non-invasive and provides reliable and valid estimates of physical activity [110-113]. Research studies confirm that the use of accelerometers is well tolerated by young children [110, 113, 114], that they are practical tools to study and understand children's activity variability and that they yield objective data [48, 112, 114-119]. Recent research of preschool children suggest that accelerometers should be used for a minimum of seven days to provide reliable information and to account for probable activity differences within a given day [116].

Because of these recommendations and as a guard against possible confounding variables (i.e. daily weather conditions and seasonal climate), one-week accelerometer monitoring using CSA-7164 accelerometers was conducted in all centres simultaneously. CSA-7164 monitors have demonstrated good reliability and validity when tested against other accelerometers [120].

4.9 Behaviour-Environment Measures

Behaviour-environment measures were developed using behaviour setting and behaviour mapping data.

4.9.1 Behaviour mapping

Behaviour mapping has been used in several studies of children's environments in the past [93, 121-123]. The technique is an unobtrusive, objective observational method for measuring actual space use. Behaviour mapping is conducted by visually scanning a pre-defined space and noting the location of each user on a base plan mounted on a clipboard. Behaviour mapping, coded using GIS as implemented in the present study, yields a compiled behaviour map which can be employed to assess environmental attributes such as behaviour setting size, pattern of use, and loading of setting.

4.9.2 Physical activity coding in behaviour maps

Because the focus of this inquiry was the identification of play settings that afford greater amounts of physical activity, it was imperative to simultaneously code the location of subjects and their level of activity. For that purpose, a literature search was conducted to identify reliable and validated instruments that could be used to code physical activity while mapping the location of children.

Several physical activity observational instruments have been developed [124-127]. Nine of those instruments, including the Children's Physical Activity Form, Activity Patterns and Energy Expenditure, Children's Activity Rating Scale, System for Observing Play and Leisure in Youth SOPLAY, and System for Observing Fitness Instruction Time SOFIT, have been reviewed and compared by McKenzie [124-127] across eleven categories of analysis including instrument citation, observation strategy, activity categories, energy validation, summary variables, recording method, associated variables, training time, test site, subjects, and reliabilities.

The observational scoring scheme created by McKenzie and used in similar fashion in different tools (SOFIT, SOPLAY), is a reliable system repeatedly used in children's activity research. The System for Observing Fitness Instruction Time (SOFIT) [128] has been validated as an observational tool created to measure physical activity, lesson context, and teacher behaviour during physical education classes [129]. The System for Observing Play and Leisure Activity in Youth (SOPLAY) has been developed more recently for observing groups of children [130].

Using the same principles, the System for Observing Play and Recreation in Communities SOPARC [95] was designed and validated to measure physical activity in open spaces. The SOPARC coding structure was used in the present study to record the level of preschool physical activity on behaviour maps where 1=low activity, 2=walking, and 3=vigorous activity.

4.9.3 Behaviour Setting Category and Environmental Diversity

Most behaviour mapping studies use behaviour setting as a unit of analysis, as defined by the spatial distribution of the behaviour mapping data [58]. This approach was employed in the present study.

For this investigation, behaviour settings were categorised in one of three setting categories (manufactured, mixed, or natural) and assigned a level of diversity (where 1=low and 4=high diversity). These score assignments were based on the expert opinion of Professor Robin Moore[1] and the author. Setting categories were defined as follows:

Manufactured: settings containing mainly timber structures and fixed, built elements, such as play equipment and shade structures.

Mixed: settings containing a balanced proportion of manufactured and natural elements such as a pathway under a vegetated pergola.

Natural: settings containing mainly shrubs, trees, flowers and vegetables such as gardens and play spaces defined by plants.

The criteria for assessing setting diversity (Figure 4.12) includes items related to movement, colour, sound, textures, and topographical variations.

Item	**1**	**2**	**3**	**4**
Movement	Parts do not move	Parts move under deliberate action	Parts move noticeably by children's actions	Parts move freely and noticeably by children's actions and by other means (e.g. wind)
Colour	None or very little colour change over a year	Colour change over a year	Noticeable colour change between seasons	Colour, shades, and accents change over a year
Sound	No sound production	Subtle and occasional sound production	Distinctive sound production by children's action	Loud and frequent, changing sound by children's actions and other means
Texture	Smooth surface, subtle change in tactile patterns	Different types of material or tactile patterns	Four types of materials or tactile patterns	More than four perceptible array of materials and tactile patterns for exploration
Topographical variation	Site is flat	Slight topography and/or steps	Visible topographic variation	Topography is part of play setting

Figure 4.12. Diversity criteria for scoring

The criteria followed the principle that kinaesthetic stimulation can be stimulated by physical attributes of the behaviour setting [57]. In this context, variety, complexity, and responsiveness of objects surrounding children might sustain interest and encourage diverse physical activity and play episodes.

1 Professor of Landscape Architecture with more than forty years of experience researching children's outdoor environments. College of Design, NC State University, USA.

4.9.4 Video-Tracking and Behaviour Coding

For many years, researchers have tried to understand children's patterns of activity in different settings and how they afford specific behaviours by asking children to lead guided tours to their favourite destinations, producing exhaustive descriptions of their activities, and/or inconspicuously tracking their behaviour [131-133].These types of techniques allow in-depth examination of behaviours in relation to the context. For this study, video taped sequences of outdoor play activities performed by individual children were used to reveal links between different levels of children's physical activity and environmental components and qualities of the place where the activity was performed. The software, The Observer [92], was used to analyse individual behaviour sequences.

The Observer is a professional software package for the collection, analysis and presentation of observational data. Originally created to study animal behaviour, it can be used to study activities, postures, gestures, facial expressions, movements, and social interactions. Video episodes are imported into the computer and coded following a tailor made configuration. This sophisticated and costly software is a resource offered by to the PhD Program at the College of Design, NC State University. The present study benefited from the generosity of the College that made it available for coding video episodes. The use of The Observer has been suggested for coding children's activity using validated observational tools such as SOPLAY [130].

The configuration contains independent variables and a list of behavioural classes defined specifically for each research project.

Independent variables, as defined by The Observer [92], are variables that remain constant throughout the whole observation although they can be edited before or after the observation. The Observer coding structure contains *behavioural classes* and a listing of the *behaviours* within the classes (i.e. behavioural class: "physical activity type", behaviour: "crawling"). Behaviours can be defined as "events" when they only take an instant to occur (a shake, kick, scream, unrepeated jump) and / or in cases where it is important only to record their occurrence but not their duration. Behaviours are defined as "states" when the activity has a clear start / end and when it is important to identify duration (e.g. walking). These behaviours are mutually exclusive within their class. This means that only behaviour per class is active for coding at a given time. For example, activating "walking" will deactivate any other behaviour listed within the "physical activity type" behavioural class such as running, pulling, pushing, etc. It follows that, to score a number of simultaneous behaviours, it is necessary to create separate behavioural

classes. Data can be analysed using basic statistics or exported to a statistical package for further examination.

4.10 Pilot study

A pilot study was implemented to test the proposed research design and methods, and to identify issues related to the study organization and logistics.

The pilot project was conducted at the *Jordan Child and Family Enrichment Centre*, Raleigh, NC, during the months of May and June 2004. The parents of all four participating children (two boys and two girls) signed the consent form submitted to the North Carolina State University Internal Review Board) before pilot activities begun (see Appendix K). Teachers were briefed beforehand about the research objectives and the activities that would take place during outdoor play time. The date for accelerometer monitoring was agreed one week in advance with the assistant director and confirmed two days prior to the session.

Child ID. IDs for each child were generated using the first letter of his/her last/first name (capital), followed by gender (small letter), and age (years and months). For example, the ID for a hypothetical child named Mary Smith, 4 years 7 months old, would have been MS-g-4.7. Participating children were:

EM-g-4.3 LM-b-5.9 NX-g-5.1 WG-b-3.10

4.10.1 Children Assessments

The *Test of Gross Motor Development* (TGMD-2) was administered to selected children before the accelerometer monitoring and behaviour tracking session. Teachers completed the *Early Childhood Attention Deficit Disorder Evaluation Scale* (EC-ADDES) for all four children.

Children	*TGMD-2 Percentile*	*EC-ADDES Percentile*	**BMI / percentile**	**Comments**
EM-g-4.3	84	100	BMI 15.3	Healthy weight
LM-b-5.9	39	20	BMI 14.5	Healthy weight
NX-g-5.1	27	50	BMI 18.2	At risk of becoming overweight
WG-b-3.10	58	75	BMI 16.0	Healthy weight

Figure 4.13. Pilot study sample and results.

4.10.2 Compound Index of Diversity

Because diversity has appeared as a major contributor of children's engagement with the outdoors [26] a *Compound Index of Environmental Diversity* was developed and completed during the pilot project.

The index aimed at characterizing the environment on the assumption that settings that are more diverse motivate children to stay active. A second iteration of the index included a five level Likert scale instead of three levels in an effort to improve item discrimination. The proposed scoring structure for "responsiveness" and "complexity" items is shown in Figure 4.14.

The scoring task proved to be very complex due to the intricate nature of open play space environments. For instance, the sub-item "change in colour" within the attribute of "responsiveness" is observed over time (e.g. flowering trees) making it difficult to identify the item in a cross-sectional study. However, the item could be included in a teacher interview.

Several additional versions of the Compound Index of Diversity were tested but they did not help to discriminate environmental differences between the research sites. Although, the index might offer a useful way to analyse environmental diversity in play areas, further instrument testing and refinement are required.

Because of the challenge of making the instrument operational, the Compound Index of Environmental Diversity was not used in the present study. It was replaced by a diversity score on a 1-4 point scale established and validated by expert opinion[2] that proved to be operational and reflected the gross differences between the three sites (4.4 Site Selection, Figure 4.5). Development of a more elaborate tool to measure environmental diversity proved to be beyond the scope of this current study. However, based on the pilot results, development in the future appears to be a worthwhile contribution.

[2] In collaboration with Professor Robin Moore, Department of Landscape Architecture, College of Design, NC State University

Compound Index of Environmental Diversity					LIKERT Scale 1-5
Centre:	**Date ……** Time……		**Rater ……**	**Weather ……..**	
OVERALL		**Score**	PER SETTING		
# of SETTINGS	Count		RESPONSIVENESS		
VARIETY	Natural Elements		COMPLEXITY		
	Manuf. Elements				
Natural elements			**Manufactured elements**		
	Lawn			Play equipment	
	Woodchips			Swings	
	Sand			Play house	
	Flowers / vegetables			Water play	
	Fruit trees / shrubs			Arts & Crafts	
	Logs			Acoustic play	
	Grasses			Deck / stage	
	Perennial plants			Picnic table/s	
	Shrubs			Benches	
	Rocks			Shade structure	
	Trees			Storage	
	Vines			Arbour / pergola	
Setting # ---------			**Setting #---------**		
Responsiveness	Moving parts		**Responsiveness**	Moving parts	
	Change in colour			Change in colour	
	Sound production			Sound production	
Complexity	Colour		**Complexity**	Colour	
	Tactile patterns			Tactile patterns	
	Landform			Landform	

Figure 4.14. Proposed scoring structure for Compound Index of Diversity.

4.10.3 Accelerometer session

Accelerometers to conduct a one-day monitoring for the pilot project were provided by the School of Public Health, UNC-Chapel Hill. The devices were programmed at 15-second epochs to start recording motion at 9:00 am of the day scheduled for the monitoring session (June 25th, 2004).

At the time of the pilot project, a discussion was held with experts on exercise science and public health[3], about the sensitivity of accelerometers to record pedalling in young

[3] Dr. Dianne Ward, Director, Intervention and Policy Division, Department of Nutrition, UNC-Chapel Hill; Larry Johnston, Health Promotion and Disease Prevention, UNC-Chapel Hill

children if worn on the waist. Pedalling is a high intensity physical activity that accounts for greater percentages of children's physical activity in some of the research sites. A decision was made to ask one child to wear two accelerometers (waist and ankle) in order to analyze the variability of total output of each accelerometer.

A total of five CSA-7108 accelerometers were borrowed with their corresponding adjustable belts. For the ankle, a Velcro band was provided to keep the device tight to the child's leg. An attractive pair of socks was also given to the child to secure the device and to ease the child's burden of wearing two accelerometers at the same time.

Four children (two girls and two boys) wore accelerometers on June 25th, 2004 from 8:30 am to 3:20 pm except for one of the boys whose session ended at 12:00 pm when his mother picked him up unexpectedly.

Children wore accelerometers during all morning activities, lunch, naptime, and for the first activity in the afternoon on the pilot day. All children showed acceptance of the device. None of them played with it or asked for it to be removed.

In this centre, children usually enjoy a second daily outdoor play session scheduled at 3:00 pm. Unfortunately, two unexpected events compromised this schedule. At 2:30 pm all children were invited to the main lobby for a special presentation and, at 3:15 pm when children where preparing to go out, it started to rain. The pilot session was declared adjourned, accelerometers collected, and prepared for mailing them back to the lender.

After importing the data into an Excel spreadsheet, illustrative charts were created showing total activity performed by participating children during one-hour of outdoor play, including the output from the girl wearing two accelerometers.

Consultation meeting. On Friday July 2, 2004, a meeting was scheduled at the UNC-School of Public Health to discuss the results of the pilot activity and the pros and cons of using accelerometers on children's ankle or waist[4]. Dr. Trost is one of the few experts on physical activity who is currently working with children 3-5 years old in the United States. Discussion topics included cut-off points for moderate activity in children, different ways to monitor physical activity, validation methods, the relation between gross

[4] Dr. Stewart Trost, Department of Kinesiology & Community Health Institute, Kansas State University; Dr. Dianne Ward, Director, Intervention and Policy Division, Department of Nutrition, UNC-Chapel Hill; Larry Johnston, Health Promotion and Disease Prevention, UNC-Chapel Hill; Professor Robin Moore, Landscape Architecture, College of Design, North Carolina State University

motor development and physical activity intensity, and the importance of play as physical activity.

Waist and ankle output. The accelerometer used on the ankle showed more sensitivity to activities such as pedalling and running than the one worn on the waist (see Figure 4.15).

There is no consensus in the literature about the effectiveness of gathering data from accelerometers placed on the ankle because currently there are no studies showing valid calibration between the two locations in young children. Exercise science experts suggest the activity recorded on the waist is sufficient to determine the physical activity intensity of children's play [134].

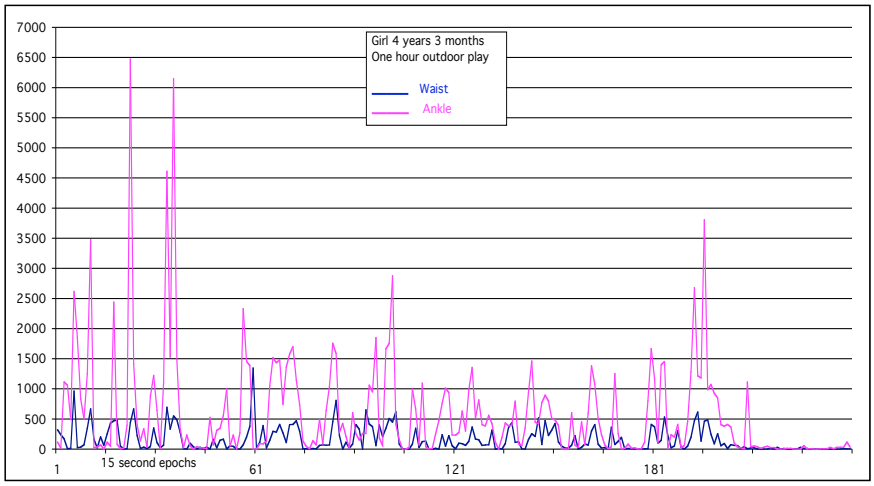


Figure 4.15. Waist and ankle accelerometer output.

Broken lines (— —) in Figure 4.16, show waist and ankle accelerometer output for girl EM-g-4.3. The highest intensity (mean 871/15 minute) represents her pedalling activity during the first 15 minutes at the playground, validated by direct observation (video recording of behaviour). Although there is a strong indication that pedalling is an important contributor of vigorous physical activity, rigorous validation studies need to be conducted to corroborate the need for different accelerometer placement. This task was beyond the scope of the present study.

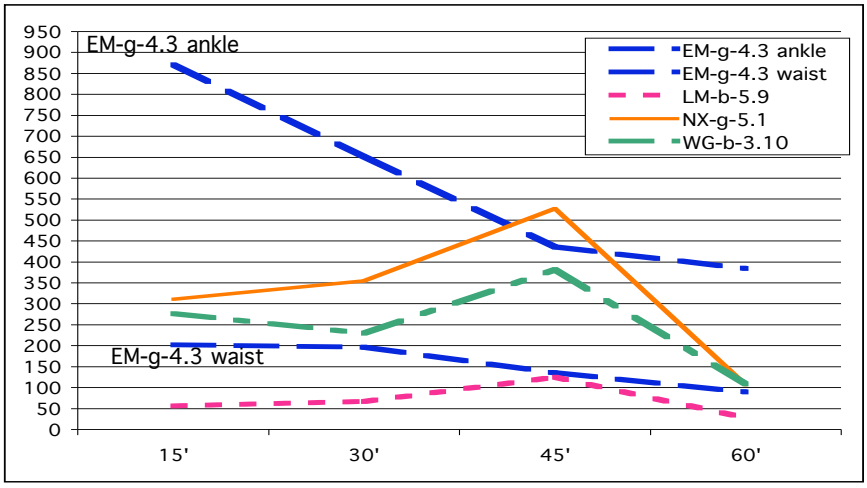


Figure 4.16. Fifteen minute mean output for all four children showing ankle and waist output for one girl.

4.10.4 Behaviour tracking and analysis using The Observer software

The Observer is a versatile software program for coding behaviour along with contextual variables. All steps necessary for preparing video materials to code behaviour were reviewed. Several draft configurations for The Observer were completed and tested during the pilot project. Analyses of video tracking episodes can be downloaded into a statistical package or presented in illustrative graphics (Figure 4.17). The time-event output charts permit graphic representation of simultaneous activities and events and provide a sense of the child's behaviour at a glance. In the example below, time-event output for a girl, we can see that low physical activity (first yellow line coded as "PAlevel") appears simultaneously with physical activity type "still" (second line coded as "PAtype"). In addition, we can see that when the girl is still and, consequently, her physical activity level is low there are also teacher interventions (coded as "interactions", pink bars).

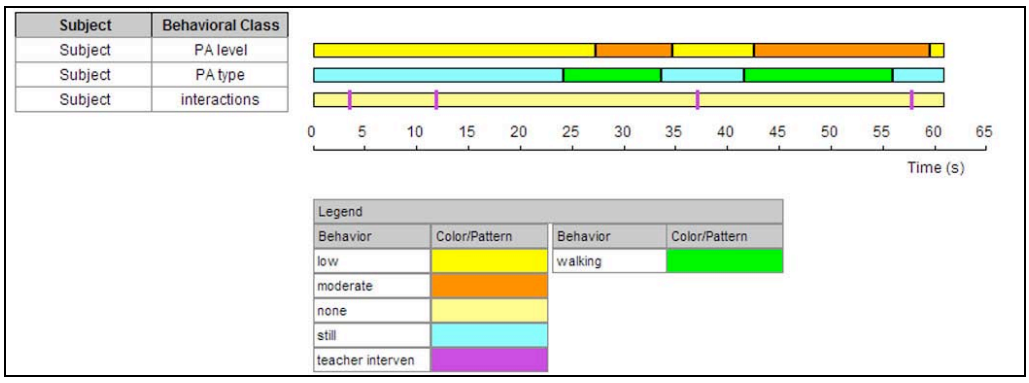


Figure 4.17. Time-event output for girl. Initial configuration for The Observer (Noldus).

Conversely, there are no teacher interventions when she is walking and her physical activity is moderate (coded green and yellow respectively). This example shows the child's pattern of activity and interactions over sixty seconds.

4.10.5 Conclusion from the Pilot Study

The implementation of the pilot project exposed the author to the complete sequence of proposed research activities. This helped to refine protocol details and confirm the sequence of research activities.

Behaviour mapping codes for physical activity levels were modified by replacing letters (l-low, w=walking, v-vigorous) with numbers (1=low, 2=walking, 3=vigorous).

Child ID was changed to include only the centre identification letter (A, B, or C) and the first three letters of the child's name.

The Observer coding. Familiarization with The Observer software was critical for the final coding and analysis of tracking episodes. The configuration was changed and tested twice. Coding requires a high level of concentration especially if working with multiple behavioural classes. For this reason, the behaviour class "physical activity level" for coding from the video was deleted and added later to the database created for performing statistical analyses.

Video-tracking. Producing good quality video material following a child at play is a difficult task. Children move fast, they like to hide in small spaces, and it is hard to predict their movements. A Sony 2100 video camera was used for the pilot project that proved to be too bulky. For the fieldwork, a Sony 1500 with a large view monitor was substituted for the fieldwork. This smaller camera proved to be more practical. The author used it at waist height watching children's activities through the viewer.

4.11 Potential Obstacles for Project Implementation

Parents. A meeting was conducted in each centre to offer information about the study to avoid parental refusal to include individual children in the study. Parents were very receptive and interested in the topic of sedentary lifestyles in early childhood. Except for some parents that requested their child not to be photographed, parents did not express reservations about the research activities. No obstacles were found.

Childcare staff. Several individual and group meetings were conducted with teachers, preschool coordinators, and centre directors to review all research procedures and fieldwork schedules. Although preparatory activities were conducted in similar fashion in the three research sites, response and follow-up varied between centres. During the fieldwork, one of the centres showed a high turnover of teachers and children. This required the inclusion of new children in the sample. In spite of this situation, teachers, coordinators, and directors in all centres expressed interest in the study. Further research should look at teacher knowledge and attitudes towards the importance of outdoor physical activity in early childhood.

Weather. Daily weather conditions highly regulate the amount of outdoor play in childcare centres. Children 24 months and older do not go out if the temperature is higher than 95F/35C or when it rains. The latter was corroborated during the accelerometer monitoring week when it rained on Wednesday and none of the groups went out even though it was only wet in the afternoon.

4.12 Ethical Issues

Parents of preschool children in Centres A, B, and C received a letter of invitation to authorize their children to be part of the study. Letters were sent via each centre director. Additionally, parent presentations were delivered prior to beginning the study to provide overall information about the planned research activities and to encourage parents to return the *Informed Consent Form* (Appendix L).

The Human Subjects Review Presentation was submitted to the North Carolina State University Institutional Review Board for the Protection of Human Subjects in Research (IRB) on August 27, 2003. The IRB mission is threefold: *"First, to protect the rights and welfare of human research subjects through project review. Second, to foster compliance with institutional policy and federal regulations by facilitating institutional personnel's efforts in utilizing living human subjects for research, education and other scholarly pursuits that are systematically designed and endeavoring to contribute to generalizable knowledge. Third, to provide education to institutional personnel on the ethical use of human subjects*" [135].

All questions contained in IRB forms (Submission for New Studies and Human Subjects Review Presentation, Appendix K) were completed as required including:

- Description of the research, its purposes, procedures and expected contribution in lay language.
- Information about eligibility criteria showing not exclusionary procedures.
- Submission of parental consent forms due to the fact that this study recruited minors considered as a vulnerable population.
- Explanation of all procedures in good detail.
- Affirmation that potential risks were not expected in the study because children performed daily, habitual activities while author observed their behaviours at a prudent distance.
- Declaration that no information that could embarrass the subjects would be collected nor any procedure used that could cause anxiety, stress or psychological harm.
- Clarification of the mechanism utilised to protect subjects' identity (ID code for each participant child).
- Statement that no compensations were offered.

The Parent Consent Form included separate authorisations for video and photographic documentation. All available mechanisms to protect children's privacy were used to formulate a study that complied with ethical regulations. The objective was to learn from children by observing their natural behaviours in a respectful and harmless way. Although cooperation by the classroom teachers was required, the research protocol did not interfere with normal, daily classroom activities.

Chapter 5. Data Gathering

5.1 Introduction and Research Phases

Preparation for the data gathering was initiated in the Summer of 2004 including contact with teachers and letters to parents. Baseline data (BMI, TGMD, and EC-ADDES) for 96 children was collected between the months of June-October, 2004. One-day accelerometer data collection and tracking behaviour was conducted in October 2004. Because of weather conditions, the scheduled one-week accelerometer monitoring was conducted in April 2005 along with additional video tracking behaviour. Behaviour maps were gathered between end of February 2005 and during one-week accelerometer monitoring sessions, April 2005.

Research Phases. The research activities were conducted following a logical sequence that ensured centre and sample comparability (Figure 5.1). First, the overall characteristics of each play area were examined.

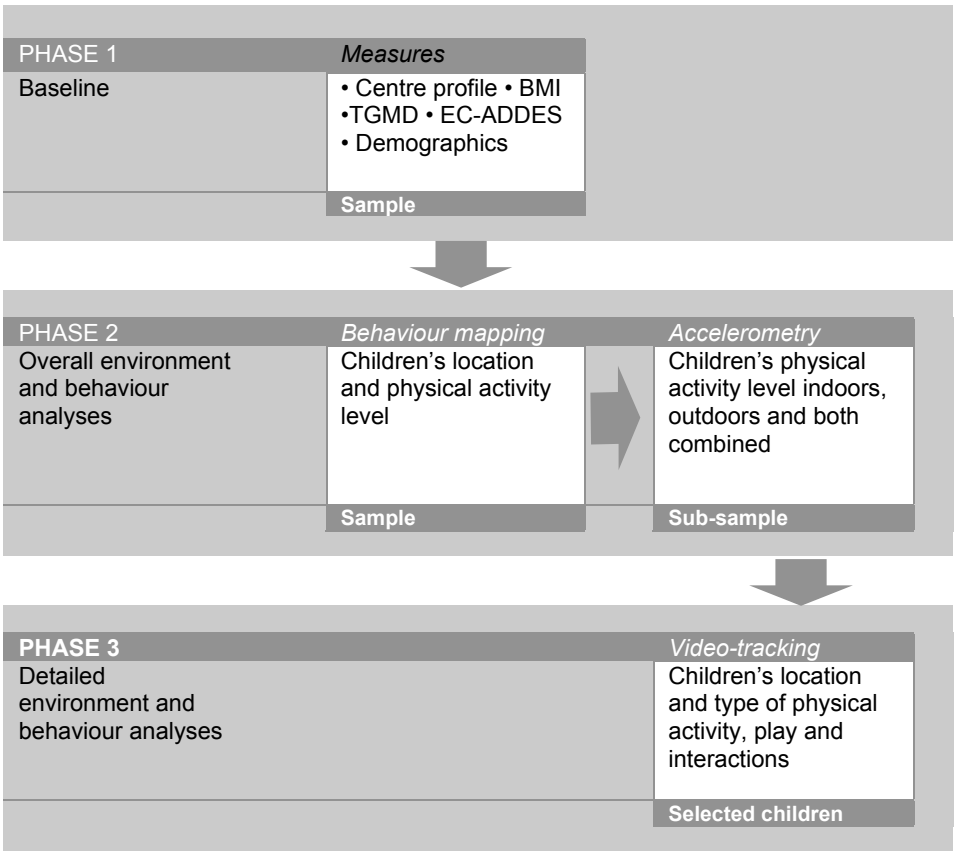


Figure 5.1. Research phases.

Subsequently, accelerometer sessions were conducted with a sub-sample of children. Detailed observations of environment and behaviour relationships were conducted and analysed through video tracking episodes of selected children.

5.2 Baseline Measures

Once parents had signed the *Informed Consent Form* (Appendix L), the collection of baseline measures began in coordination with the teachers. The Test of Gross Motor Development TGMD-2 [98] was administered simultaneously with the collection of height and weight of participating children.

5.2.1 Body Mass Index

Procedure. Groups of two or three children were weighed (without shoes, wearing light clothes) in grams using a digital scale (Health-o-Meter Model HDM575). Their height was measured to the closest centimetre using a portable stadiometer (Seca Model 214). Body mass index was calculated using the CDC *BMI-for-age* charts [103]. Figures 5.2, 5.3 and 5.4.

Figure 5.2. Stadiometer. (Seca illustration)

Figure 5.3. Assistant controlling weight reading.

Figures 5.4. Child looking at weight reading

5.2.2 Early Childhood Attention Deficit Disorder Evaluation Scale

The researcher provided training sessions for all teachers involved in the study during naptime at each centre. Additional individual training sessions were organized for those teachers unable to attend group sessions. The session included an overview on the topic of attention deficit disorder and hyperactivity and a thorough review of EC-ADDES [102] (background and procedures). Handouts and additional readings on the topic were

provided. Centres B and C considered the session part of their usual in-service monthly training.

Procedure. To complete the EC-ADDES protocol, teachers have to estimate how often the behaviours listed in the protocol are shown by the child on a scale 0-4 (where "0" equals "does not engage in the behaviour" and "4", "[the child engages] one to several times per hour"). The assessment can be completed in one session or as the result of several observation sessions of the child. The full assessment takes about fifteen minutes per child to complete (Appendix E, EC-ADDES protocol).

5.2.3 Children's Profile

The author completed the *Children's Profile Questionnaire* with information provided by centre directors. The objective of this task was to develop a children's profile that could be used to compare children among centres. The information solicited included gender, age (in years and months), ethnicity, enrolment date, and approximate socio-economic status.

5.2.4 Centre Profile

The baseline for each centre was established to control for possible differences in teacher training, educational approach, and facility structure using data gathered from the Centre Director interviews. The interview, adapted from the *Centre, Children, and Teacher Profiles* [101], offered additional insight concerning similarities and differences between each centre (number of children, teachers, teacher education, education philosophy) as well as specifics about how the play area was scheduled and used by teachers. (See Appendix F, Centre Profile Questionnaire).

The space/child ratio (m^2/number of observed children) for each outdoor play area was calculated to provide another measure for comparison.

5.3 Physical activity monitoring using accelerometry

Recent active lifestyle research of preschool children suggest that accelerometers have to be used for a minimum of seven days to provide reliable information and to account for probable activity differences within a given day [116].

Because of these recommendations and as a guard against possible confounding variables (i.e. daily weather conditions and seasonal climate) a second session of five-

week-day accelerometer monitoring was conducted in all centres simultaneously. Since the aim of this study is to compare the pattern of use of preschool play areas, it was not necessary to monitor children's activity during weekend days.

First accelerometer session	Second accelerometer session
- One day - 6 accelerometers - 12 children/centre - Different days	- One-week - 30 accelerometers - 10 children/centre - Same week all centres

The decision to monitor the full sample simultaneously in the same week created the challenge of obtaining ninety accelerometers. This proved unfeasible. However, thanks to the assistance of three groups of researchers in the area of active living[5] a total of thirty CSA-7164 accelerometers were obtained and used with a sub-sample of 30 children (n=10/centre) (Figure 5.5).

Accelerometers were initialized at 15-second epochs (240 data points/hour) in order to record the high variability of children's physical activity. In Centre A, two additional children were added to the sub-sample to replace those that for health reasons did not attend on target days. A total of 10 children were monitored every day for the five-day week session in each centre.

	Girls	**Boys**	**# children/day**
Centre A	7	5	10 (12 total)
Centre B	6	4	10
Centre C	5	5	10

Figure 5.5. Sub-sample composition by gender

Procedure. The author organized meetings for teachers and directors at each participating centre to provide information about the purpose and method of using accelerometers. A schedule for the monitoring week was presented. To avoid teacher overloading with additional obligations and to prevent mistakes, every morning the author and one assistant put accelerometers on the children's waists and removed them at the end of the day during the monitoring week, April 11-15, 2005. Since two of the research sites (Centres A and B) are located close to each other, the author was responsible for both of them, while the assistant took care of the same task at Centre C. Total accelerometer counts were calculated and compared among centres. Additionally

[5] Dr. John Reilly, Glasgow University, UK; Dr. Dianne Ward, UNC-Chapel Hill, and Dr. Nancy Wells, Cornell University.

and to extend the validity of the findings, Dr. Trost provided support to process the data using cut-off points by age (unpublished at the time) defined by his latest collaborative research [136]. Further information about the topic of accelerometry is discussed under Pilot Study, Section 4.10.3 Accelerometer Session and Findings, Section 6.2 Accelerometer monitoring.

5.4 Test of Gross Motor Development TGMD-2

The *Test of Gross Motor Development TGMD-2* was conducted in the same session when height and weight was measured. Most of the assessments were conducted with groups of two or three children of the same age to help shy children perform at their best without feeling threatened by the detailed observation of movements by the researcher. Each child carried out the required movements individually.

Procedure. Testing conditions were arranged prior the session. Assessments were conducted in the same space in all centres, except for one session at Centre A. A white tape was laid out on the floor to measure distances and cones placed to mark start and end positions as required. Testing arrangements, modelling, and instructions were kept uniform as much as possible.

Figure 5.6. Object control subtest. Skill 1: Striking a stationary ball

Figure 5.7. Object control subtest. Skill 2: Stationary dribble. Researcher observing first trial

Figure 5.8. Object control subtest. Skill 3: Catch.

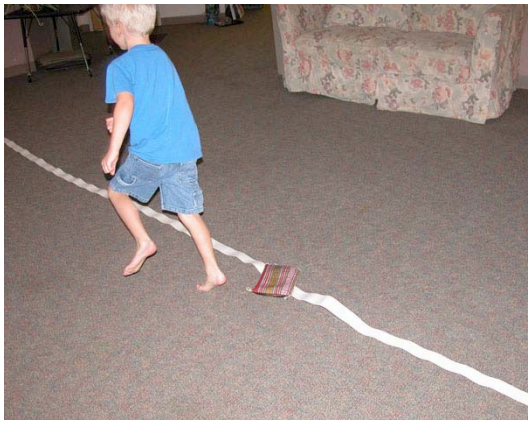


Figure 5.9. Locomotor subtest. Skill 1: Run

The author invited two or three children of similar age to participate in the assessment who performed the skills barefoot. An assistant modelled all skills and the children had the opportunity to try once before the author scored skills, figures 5.6 through 5.9. Most children enjoyed running and "playing" ball and only two refused to perform the required activities. Those children were not included in the sample.

5.5 Environment Behaviour Measures

5.5.1 Behaviour mapping

Behaviour mapping allows recording of the location of subjects on a map. Compilation of maps discloses the pattern of behaviour of a given setting. For the present study, additional codes were added with the objective of understanding better the relationship between children's physical activity and preschool play area settings (codes included: gender, physical activity level, and use of wheeled toys).

The System for Observing Play and Recreation in Communities (SOPARC) was chosen to measure physical activity [95]. The author received an intensive training course on the use and applications of SOPARC prior to the beginning of the fieldwork[6]. The objective of the workshop was to train researchers in the use of the instrument to collect reliable data and teach others how to use the instrument. The program included an overview on systematic observation procedures as well as live observation practice.

Procedure. For this investigation, each play area was systematically and consecutively scanned on a timed cycle. Location of individual children and adults was recorded on a

[6] *Assessing Physical Activity Through Direct Observation: An Intensive Training-of-the-Trainers Workshop* sponsored by Active Living Research, Robert Wood Johnson Foundation. Dr. Thom McKenzie & Dr. Hans van der Mars, June 2005.

plan and GIS-coded. Nine behaviour maps were compiled for each study site. Data points were collected following the same procedure for all centres. The author walked clockwise scanning play settings and recording on a paper base map the presence of subjects coded as follows: boy (b), girl (g), teacher (t). Additionally, the use of wheeled toys was coded (c=cart, t=tricycle, w=other type of wheeled toy such as wagons and scooters) along with the subject physical activity level. Physical activity level (SOPARC coding, 1=sedentary, 2=walking, 3=vigorous) is shown in gradient colours in the map after being entered in GIS. Figures 5.10 and 5.11.

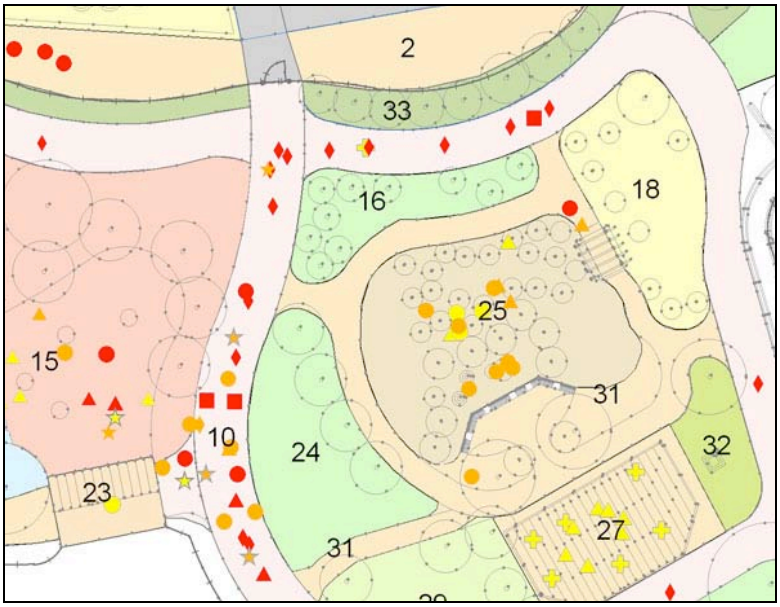


Figure 5.10. Centre C behaviour map section example.

Physical activity level	girl	boy	teacher	cart	wheeled toy	parent
1						
2						
3						

Figure 5.11. Behaviour map coding key.

Compiled behaviour maps measured the loading of use and the level of activity performed in each setting. Behaviour maps are objective measures of density of use over time.

The resulting GIS database was exported into SPSS software [137] and additional codes inserted for each data point (centre ID, setting ID number and name, ft2, m2, category, diversity), Figure 5.12. Further recoding of variables was performed to run statistical analyses. Size of settings is shown in square feet and square meters.

5.5.2 Behaviour Setting Assessment: Setting Category and Environmental Diversity

Analyses of the pattern of use in all sites show a series of well-defined behaviour settings [58] with clear boundaries and attributes that support distinct children's activities.

For the purpose of this study, behaviour settings were classified into one of three setting categories (manufactured, mixed, or natural) and assigned a level of diversity (scale 1-4, where 1=low and 4=high diversity), Figure 5.12.

gender	wheeltoy	palevel	sheet	centre	Sett#	ft2	m2	settid	settname	Sett categ	diversity	Three categ	ft2	centnum	genmun
boy	n	2	2	A	9	996	93	E9	playequip	manuf	2	nat	5	1	1
girl	n	3	5	B	4	1741	162	G4	natpath	path	4	mixed	9	2	0
girl	n	1	14	C	21	607	56	S21	secretgarden	nat	4	nat	4	3	0
Coded in the field				GIS database					Additional coding					SPSS coding for analyses	

Figure 5.12. Behaviour mapping data view in SPSS. Example.

Setting category definitions. Manufactured settings are those that contain mainly timber structures and fixed, built elements, for instance play equipment and shade structures (Figure 5.13). *Mixed* settings show equivalent proportion of manufactured and natural elements for example a pathway under a vegetated pergola (Figure 5.14). *Natural* settings are those that contain mainly shrubs, trees, flowers and vegetables such as gardens and play spaces defined by plants (e.g. circle of rocks surrounded by vegetation, Figure 5.15).

Figure 5.13. Centre A Manufactured setting example

Figure 5.14. Centre B. Mixed setting example

Figure 5.15. Centre C. Natural setting example. Circle of rocks.

5.5.3 Tracking and Behaviour Coding

Tracking behaviour allows in-depth understanding of how individual children respond to environmental affordances. For this reason, selected children were video-recorded while playing outdoors to identify their social and environmental interactions, as well as amount and type of physical activity.

Procedure. Target children were selected from the sub-sample (children wearing accelerometers) for in-depth observation. A total of 6 children were observed (a boy and girl in each centre). The target child was followed by the author at a discreet distance and her/his behaviour videotaped during the entire outside playtime. Later, behaviour episodes were imported into the computer, coded using the configuration created for this purpose, and processed with The Observer 5.0 software (Noldus Information Technology, 2001).

Coding configuration (see Appendix H). Tracking of selected children were coded using a continuous recording method. This method enables the observation of most instances of target child behaviour for a specified amount of time. For this study, the whole length of the tracking episode was coded. Episodes varied in duration between 20 and 60 minutes. One subject per observation was coded.

The following are the independent variables defined for the present study:

Independent Variable Name	**Type**	**Values**
Centre	Nominal	A B C (…Add while scoring)
Name	Nominal	[child ID} (…Add while scoring)
Gender	Nominal	boy girl (…Add while scoring)
Weather	Nominal	clear overcast partially cloudy cloudy rainy (…Add while scoring
Temperature	Numeric	32 to 100
Other	Nominal	(None) (…Add while scoring)

Table 5.16. Independent variables, The Observer configuration.

Ten mutually exclusive *behavioural classes* were created from an open coding list that was generated from video episode reviews. The objective of these behavioural classes

was to analyse the dynamic interactions of children with the environment (social, natural, and manufactured). All behavioural classes were defined to characterise, as close as possible, children's interactions with the environment (loose and fixed elements) and other subjects (children and adults) to realise affordances. Two undefined behaviours were added to selected behavioural classes to enable additions afterwards if necessary (see behaviours notated as "xxxx" and "yyyy" respectively). All codes were generated automatically by The Observer to avoid repetitions and configuration errors.

Following are the *behavioural classes* defined for this study:

1. Setting
2. Wheeled toy
3. Natural loose element (sand, leaves, etc.)

Physical activity type

4. Social interaction
5. Natural fixed element (trees, shrubs)
6. Type of play
7. Play equipment / fixed structure
8. Toy
9. Teacher intervention

Behavioural Class 1: Setting

Since the three research sites have a series of settings that differ from each other (e.g. pathways, grape arbour, vegetable garden, etc.), settings were assigned a number. The highest number of settings was recorded in Centre B (28), followed by Centre C (27), and Centre A (22). Two extra numbers were added to code for additional settings if necessary. Setting names were restored for analyses purposes.

Behavioural Class 2: Physical activity type

The list of behaviours within this class was created from the open coding generated from video reviews. The following list presents behaviour names, codes and type of coding included in this behavioural class:

Behaviour Name	*Code*	*Type*
bending	be	Event
climbing	cl	State
crawling	cr	State
digging	di	State
hanging	ha	State
jumping	ju	Event
kicking	ki	State
kneeling	kn	State
lying	ly	State
moving	mo	State
pedalling	pe	State
pulling	pu	State
pushing	aa	State
rolling	ro	State

running	ru	State
runPULL	af	State
runPUSH	av	State
sitting	si	State
sliding	sl	State
standing	nu	State
still	an	State
swinging	sw	State
walking	wa	State
walkPULL	aw	State
walkPUSH	ax	State
xxxx	xx	State
yyyy	yy	State

Behavioural Class 3: Social interactions

The influence of the physical environment on children's interactions is important for this study. Four behaviours were defined in this class with the objective of associating the level of preschoolers' physical activity and their social interaction.

Behaviour Name	Description
Nointer	target child is alone, there are children around but child does not interact or share play activities with others
1child	target child plays with one other child
2children	target child plays with two other children
group	target child plays with three or more children

Behavioural Class 4: Play

With the assumption that children's physical activity is influenced by the environment and shown as play in early childhood [31] ten behaviours that characterise play were established. Play activities were coded in a gradient scale from more detached ("disengaged") to more organised play sequences ("game with rules"). Social conversations and negative behaviour were also coded as part of this behavioural class. Play categories were adapted from the Preschool Outdoor Environment Measurement Scale (POEMS) validity and reliability process [138].

Behaviour Name	Description
disengaged	child is alone, appears to be doing nothing (e.g. staring off into space, wandering aimlessly)
onlooking	child is alone, in close proximity to peers, watching other's activity (but not joining)
transition	child is intentionally moving from one activity or place to another (not wandering)
functional	child engages in repetitive or active physical activity
constructive	player(s) create or constructs something
dramatic	player(s) perform fantasy actions and/or vocalizes fantasy

gamew/rules	player/s engage/s in activity with clear purpose and parameters
otherinter	child is engaged in interactive or non-interactive behaviours, not defined by the above categories (routine caregiving w/out verbal, non-verbal expression
social conversat	children engage in conversation that is not dramatic or game oriented (e.g. explain what they are doing)
negative beh	child is engaged in unorganized, antagonistic behaviour w/other or hostile talk.

Behavioural Class 5: toy

The behavioural class "toy" was created to code for loose, manufactured elements that children were seen using during outside play. They include pails, shovels, dolls, plastic blocks, costumes, etc. The objective here was to assess the potential association of the use of this type of object with different levels of physical activity. Three behaviours were defined that allowed recording of the presence or not of toys and whether the child played with one of more objects simultaneously during the tracking episode.

Behaviour Name	Description
noToy	target child does not play with toys or manufactured objects
toy1	target child plays with a toy or manufactured object (pail, scoop, puppets, plastic or wooden blocks, costumes, etc.)
toy2	target child plays with two toys simultaneously

Behavioural Class 6: wheel

The behavioural class "wheel" was created to code for target child's use of wheeled toys. The three elements of this class specify the type of wheeled toy used by the child. The objective of this behavioural class was to assess whether or not wheeled toy use is associated with increased levels of physical activity shown by children. Three behaviours were included in this behavioural class.

Behaviour Name	Description
Trike	tricycle
Cart	cart or scooter used by target child to propel her/himself or driven by other child
NoWheel	child does not use wheeled toy

Behavioural Class 7: NATloose

This behavioural class shows whether the target child interacts or not with loose, natural elements such as leaves, flowers, sand, dirt, water etc. Three behaviours were associated with this behavioural class.

Behaviour Name	Description
NoNATloose	target child is not in contact with natural loose materials
NATloo1	child plays with twigs, leaves, flowers, small rocks, sand, dirt, water, etc.
NATloo2	target child plays with two natural loose materials simultaneously

Behavioural Class 8: fixedNAT

This behavioural class allows coding for the child interactions with natural fixed elements such as shrubs, trees, large rocks, etc. Three behaviours were associated with this behavioural class.

Behaviour Name	Description
Nonatfx	child does not interact with natural fixed elements
natfx1	child interacts with fixed to ground natural elements such as trees, shrubs, stumps/rocks, flowers, plants, etc
natfx2	child interacts with two natural fixed elements

Behavioural Class 9: playeqFxstruct

This behavioural class specifies if the child interacted with a fixed play equipment structure (playeqFxstruct). Three behaviours were associated with this behavioural class.

Behaviour Name	Description
NOfxelem	child does not play or interact with fixed play equipment elements
fxelem1	manufactured play elements that the child cannot move: benches, play equip, trellis, acoustic shelter (e.g. child stamping on stage or platform, ringing bell)
fxelem2	child interacting with two fixed play elements simultaneously

Behavioural Class 10: teacherinterv

The teacher intervention behavioural class contains five behaviours that characterize teacher interactions with the target child. The code “none” implies the teacher was not interacting with the target child and was out of sight of the camera although she/he might have been present in the preschool play area. Five behaviours were associated with this behavioural class.

Behaviour Name	Description
none	teacher is present but does not interact with target child; teacher is not present
neutral	teacher interacts with target child, without revealing her feelings or her/his particular attitude towards the child's play
custodial	teacher looks after target child (does shoe laces, help child to blow nose, offers water, collects jackets, etc.)
positive	teacher encourages target child overtly, indicating agreement and support
negative	teacher stops target child actions in authoritative manner, rejects child's behaviour

Chapter 6. Findings

As stated in Chapter 5 the study design followed three research phases. The record of data gathered is shown below (Figure 6.1).

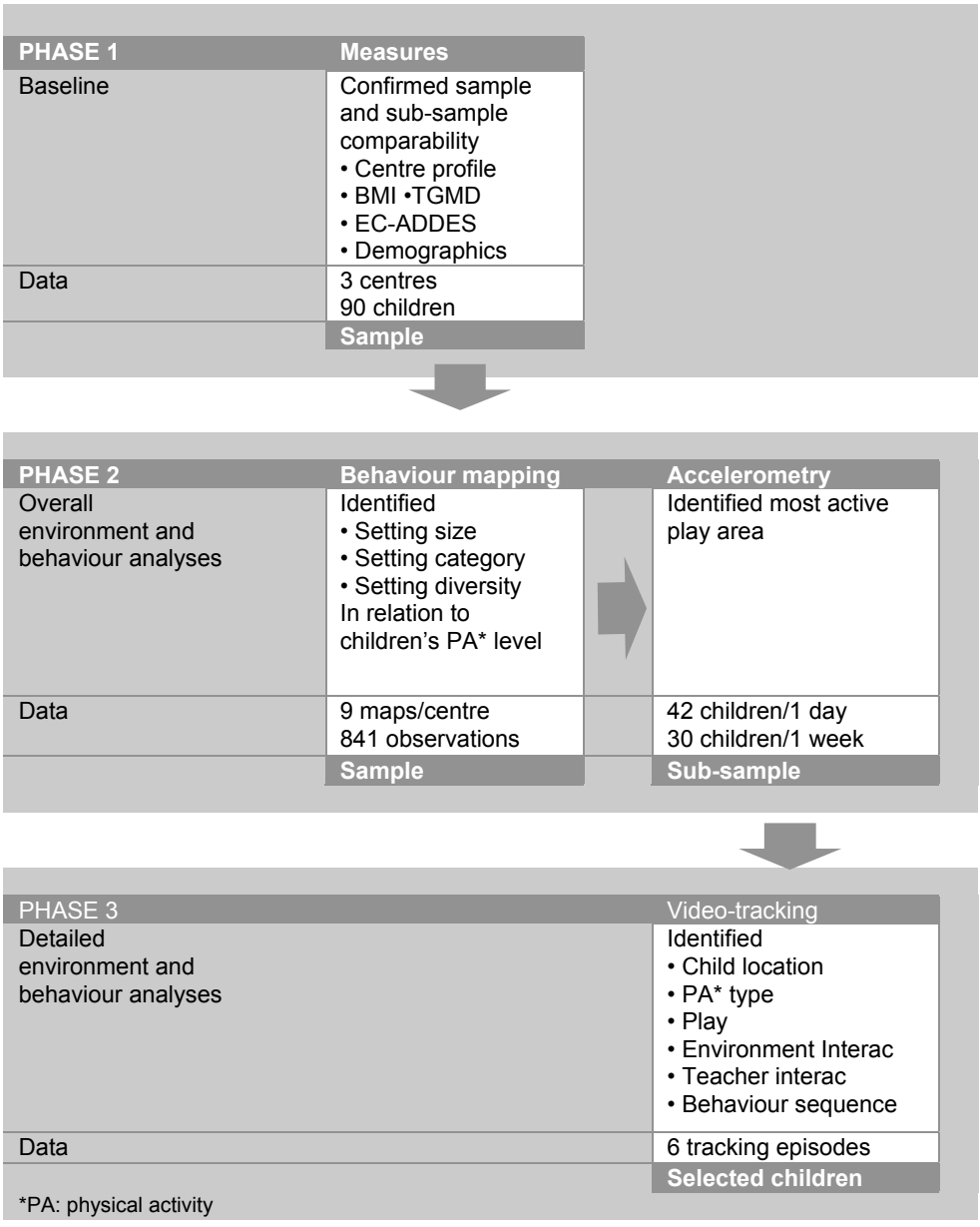


Figure 6.1 Research phases and findings overview.

The following sections show the analyses of the sample and primary data sets: accelerometer monitoring, behaviour mapping and related behaviour setting measures, and illustrative tracking behaviour episodes.

6. 1 Sample Analysis

Sample comparability was analysed using a variety of methods:

- Demographic measures: age, gender, ethnicity, and parent education or centre fee range used as proxies for socio-economic status[7];
- Body mass index (BMI) measured by the child's weight in kilograms divided by the child's height (in metres) squared;
- Gross motor development measured by the Test of Gross Motor Development (TGMD);
- Attention functioning, measured by the Early Childhood Attention Deficit Disorder Evaluation Scale (EC-ADDES).

Thirty children from each centre composed the research sample (n=90). As stated in Chapter 4, 26 children were removed from the sample because they fell out of age range (being six years old soon after the study began), leaving before the study was complete for family reasons (family relocation, change in parent employment or modified family routines because of newborn siblings, etc.) or refusal to complete the Test of Gross Motor Development.

6.1.1 Demographic Measures

Age. Children's age shows the following spread: minimum age in Centres A and B, three years, and for Centre C, three years one month; maximum age for Centre A, five years nine months, for Centre B, five years one month, and for Centre C five years six months (Figure 6.2).

There is no statistically significant difference among children's ages (p-value=0.077). (Appendix B).

Gender. Proportions of boys and girls in the sample are as follows: Centre A, 50% girls and 50% boys; Centre B, 47% girls, 53% boys; and Centre C, 53% girls, 47% boys (Figure 6.3; Appendix B).

The sample does not show statistically significant differences in gender (Pearson Chi-square. Asymp. Sig. (2-sided), p-value=0.875).

[7] Centre B was unable to supply parental education level data instead offered centre fee range data as a substitute.

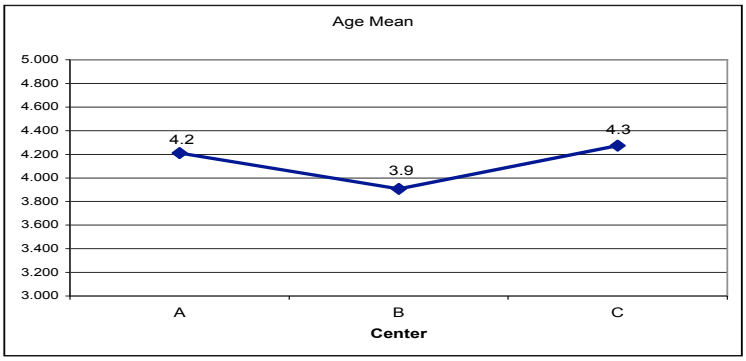


Figure 6.2. Mean age of sample.

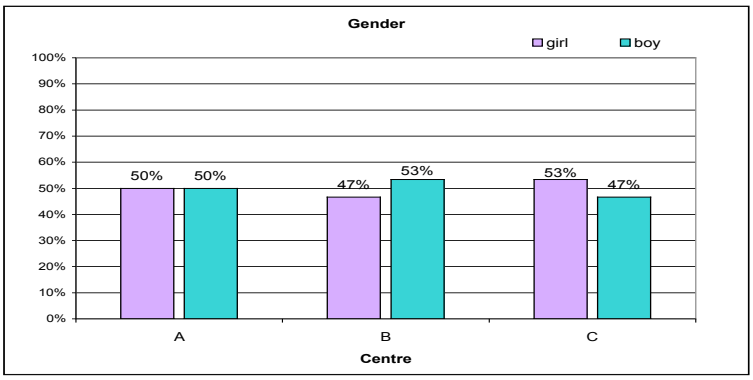


Figure 6.3. Gender distribution of sample.

Ethnicity. The proportion of children with different ethnicities in the sample is the following: Centre A, 83% white, 7% African American, 3% Hispanic, and 7% other; Centre B, 70% white, 10% African American, 10% Asian, and 10% other; Centre C, 87% white, 3% African American, 3% Asian, and 7% other (Figure 6.4; Appendix B). The sample does not show statistically significant differences in ethnicity between centres (p-value=0.497).

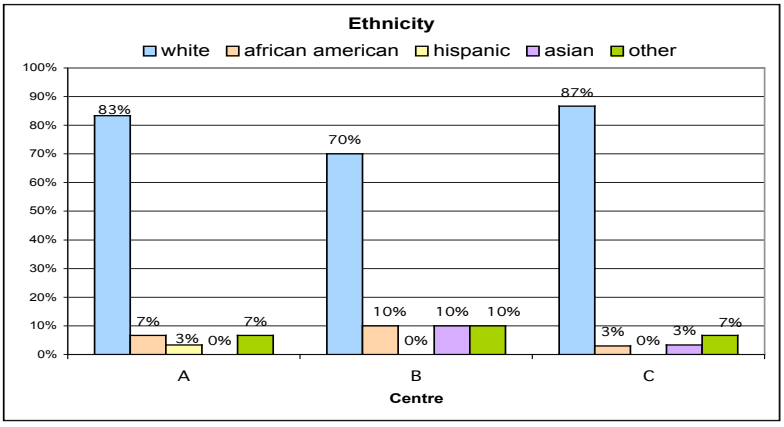


Figure 6.4. Ethnic composition of sample.

Approximate socioeconomic status. The study proposed to gather information about parental education as a proxy for socioeconomic status. In Centre B this was substituted by fee range because the information about parental education was not available. Centre B uses a fee scale based on parental salary range.

Most parents in Centres A and C have university degrees (Masters or PhD). The reported fee range for participating children in Centre B (most parents earning more than u$s60,000 / year) is approximate to salary ranges that require postgraduate studies. Although approximate, the socioeconomic status of the sample can be considered comparable. However, this is not a representative sample for the State of North Carolina because the socioeconomic status of these families is relatively higher. As a consequence, the generalisability of the findings of this study is limited.

Summary. Demographic measures indicate that the sample was composed of comparable groups of children with no statistically significant differences in age, gender, ethnicity, and approximate socioeconomic status.

6.1.2 Baseline Measures

Body Mass Index (BMI). Measurement of BMI comparability across the sample shows the following minimum and maximum results: Centre A, 14.45/18.96; Centre B, 12.97/18.68; Centre C, 13.60/32.87. Although there are two outliers in Centre C (girls with BMI=32.87 and 30.61 respectively), there is no statistically significant difference among children's BMI values (p-value=0.778) (Figure 6.5; Appendix B).

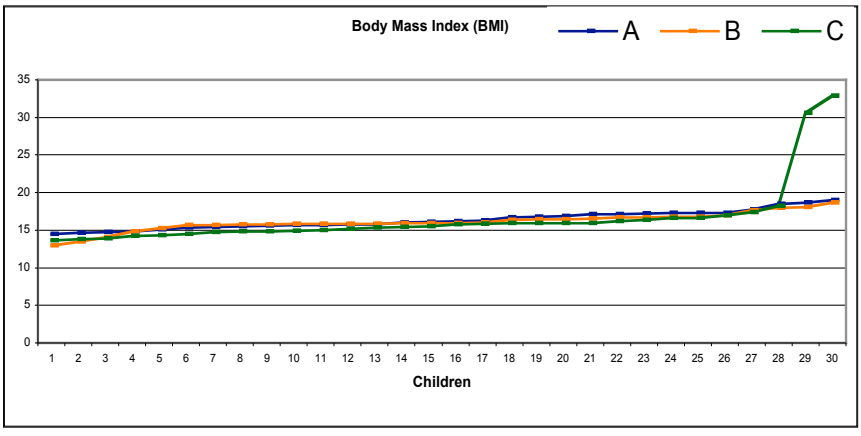


Figure 6.5. Body Mass Index (BMI) of sample.

Gross Motor Development. Gross motor development comparability across the sample was measured using the Test of Gross Motor Development (TGMD-2). Results show the following minimum and maximum percentile results: Centre A, 12/99; Centre B, 35/98; Centre C, 21/99. All centres show a wide spread of results. There are no statistically significant differences among children's TGMD results (p-value=0.185) (Figure 6.6; Appendix B).

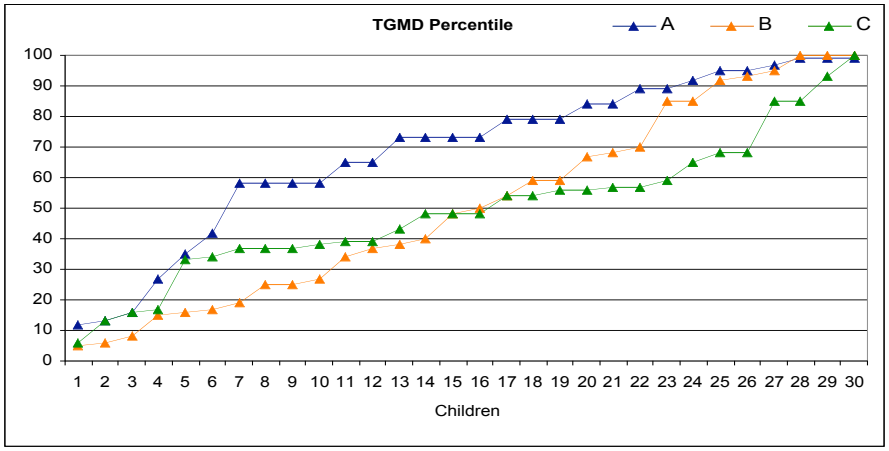


Figure 6.6. Gross motor development profile of sample.

Attention functioning. *Attention functioning comparability across the sample was measured using the* Early Childhood Attention Deficit Disorder Evaluation Scale *(EC-ADDES). Results show the following minimum and maximum percentile results: Centre A, 13/100; Centre B, 5/100; Centre C, 6/100*. All centres show a wide spread of values in the results. There are no statistically significant differences among children's EC-ADDES (p-value=0.375) (Figure 6.7; Appendix B).

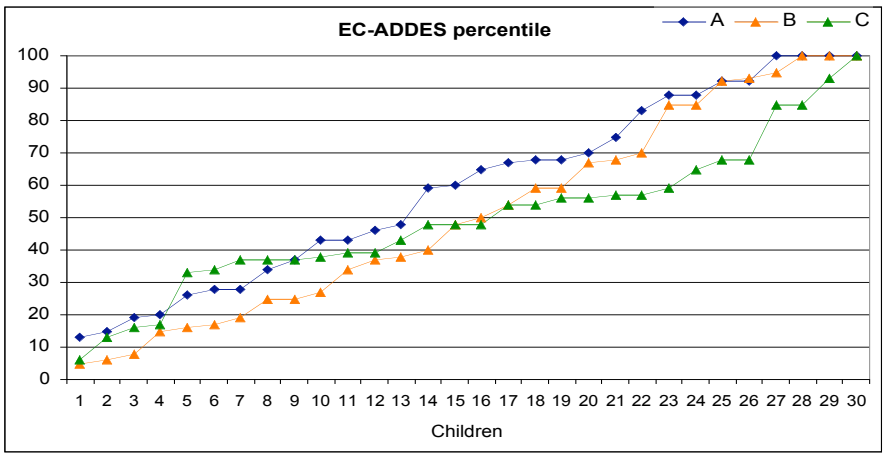


Figure 6.7. Attention functioning profile of the sample.

Summary. Baseline measures of the sample (BMI, gross motor development, and attention functioning) confirmed that the three groups of preschoolers were comparable.

6.1.3 Sub-sample Composition

A sub-sample (Appendix A) was drawn from the final sample after completion of the *Children's Profile Questionnaire*, *BMI* evaluation, *Test of Gross Motor Development* (TGMD), and *Early Childhood Attention Deficit Disorder Evaluation Scale* (EC-ADDES).

The sub-sample is composed of a total thirty-two children (Appendix A.). Analyses show no statistically significant differences in gender (p-value=0.88), ethnicity (Pearson Chi-Square=0.69), body mass index BMI (p-value=0.882), and Test of Gross Motor Development TGMG-2 (p-value=0.954). The sub-sample shows differences in attention functioning using EC-ADDES (p-value=0.01) attributable to the Centre A subgroup of children who scored significantly higher than the other two. This means that these children show more attention deficit and higher hyperactivity impulsivity behaviours than the other two groups. Despite the EC-ADDES result, this group did not show higher levels of physical activity (see 6.2 Accelerometer Monitoring).

6.2 Accelerometer Monitoring

6.2.1 One-day monitoring session

The first session of accelerometer monitoring was performed using seven accelerometers (CSA 7164) during one day. A total of 14 children wore accelerometers for one day in each centre. Because of malfunction data of one accelerometer in Centre A had to be discarded. The reading of 13 accelerometers was retained in Centre A for analyses. Morning outdoor play was analyzed for all children. During this monitoring session, children stayed outside in the morning an average of sixty minutes (60) in Centre A, 84 minutes in Centre B, and 43 minutes in Centre C (Figure 6.8). Time outdoors was markedly longer in this session than the time outdoors observed in the one-week monitoring session. This may have been because the teachers thought that this was going to be the only monitoring session conducted with individual children thus encouraging them to stay longer outside to support the research effort.

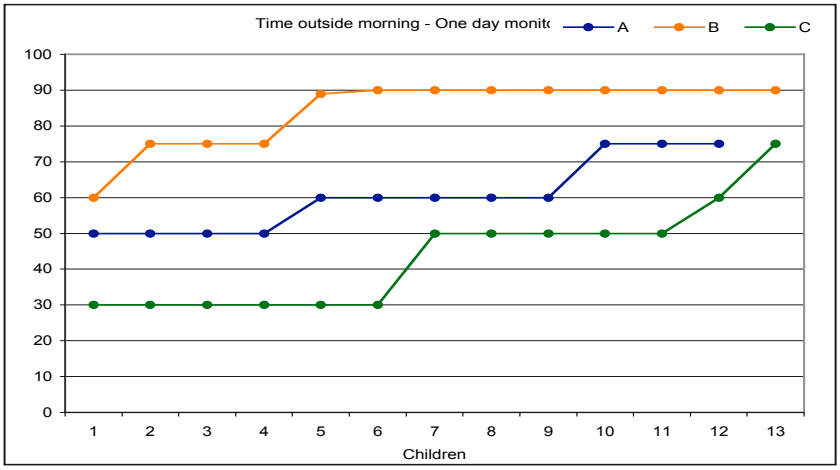


Figure 6.8. Time outdoors, one-day accelerometer monitoring.

This one-day monitoring session shows higher total counts of outdoor activity in Centre B (Figure 6.8). Although the difference is not statistically significant, it shows a trend that was later confirmed by the one-week accelerometer monitoring.

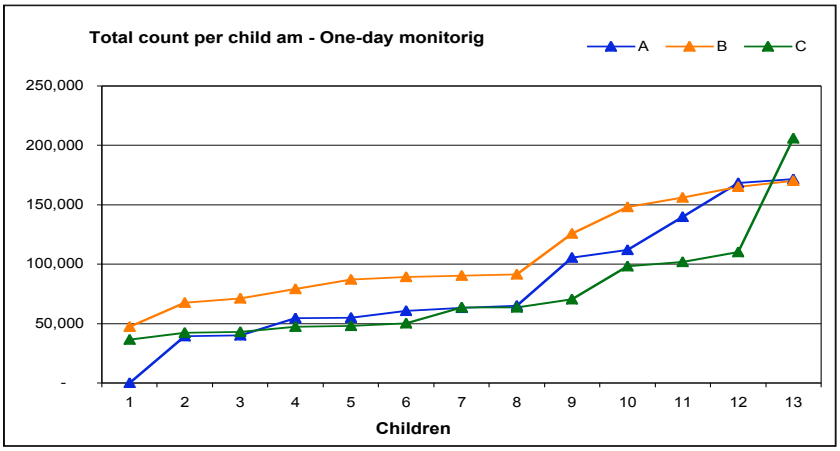


Figure 6.9. Total counts one-day accelerometer monitoring.

6.2.2 One-week monitoring session

The second session of accelerometer monitoring was performed using 30 accelerometers (CSA 7164) over five-week day period. A total of 10 children a day wore accelerometers in each centre. The second accelerometer session was used to compare the levels of children's physical activity among centres including indoor and outdoor (morning and afternoon). During the monitoring session, children stayed outside in the morning an average of 62 minutes in Centre A, 51 minutes in Centre B, and 39 minutes

in Centre C. In the afternoon, they were outside on average for 44 minutes in Centre A, 48 minutes in Centre B, and 29 minutes in Centre C (Figure 6.10).

The second session was used also to control for activity variability in a given week. It is advisable to take this type of precaution because different activities might be routinely conducted on a given day (e.g. weekly movement class) or variable weather could distort the results if only one-day monitoring is conducted.

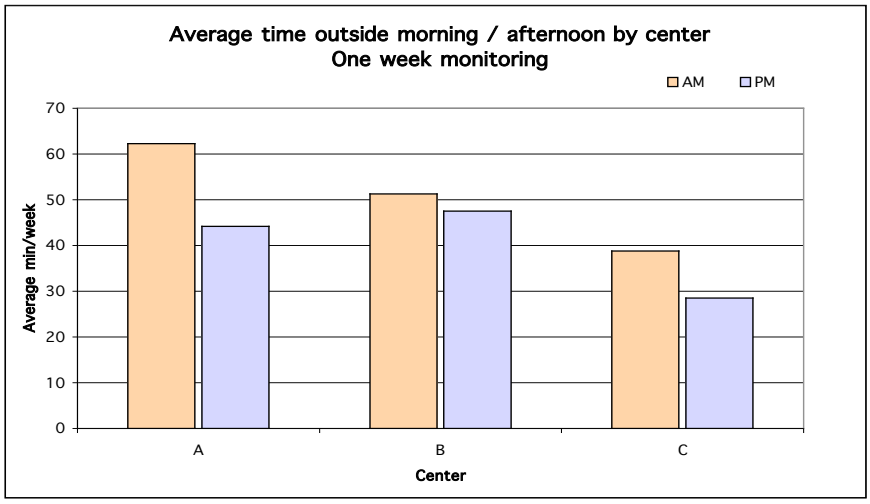


Figure 6.10. Average time outside in minutes, morning and afternoon (one week session).

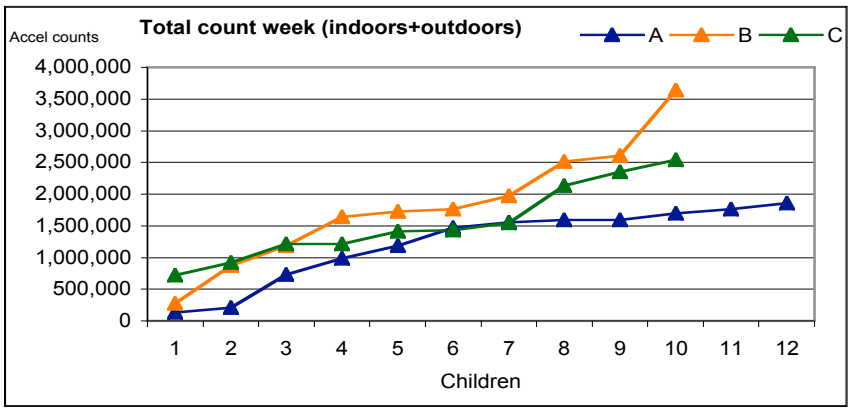


Figure 6.11. Total accelerometer counts indoors+outdoors during monitoring week.

Total accelerometer counts during the week (Figure 6.12) show no statistically significant difference among centres if indoor and outdoor activities are considered together (p-value= 0.1367). However if considered separately, the centre (i.e. the play area) has a significant effect on children's activity in the morning, afternoon or both combined (p-

values=0.0117, 0.0098, and 0.0104 respectively) at 0.05 confidence level (Appendix. B). Centre B shows the largest effect on physical activity levels in the morning and afternoon attributable to outdoor playtime.

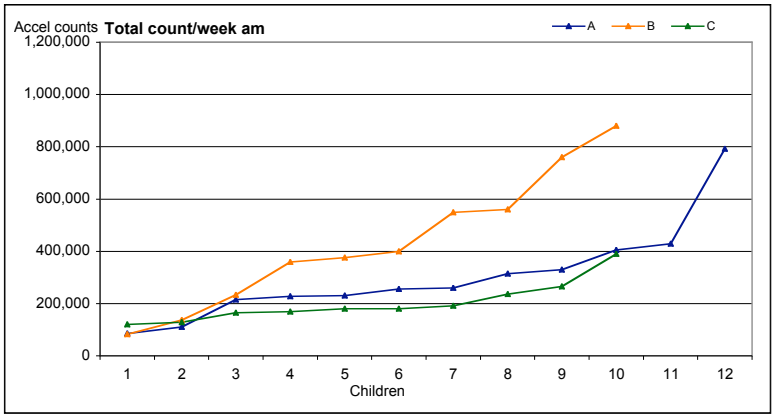


Figure 6.12. Total accelerometer counts in the morning outdoor play during monitoring week.

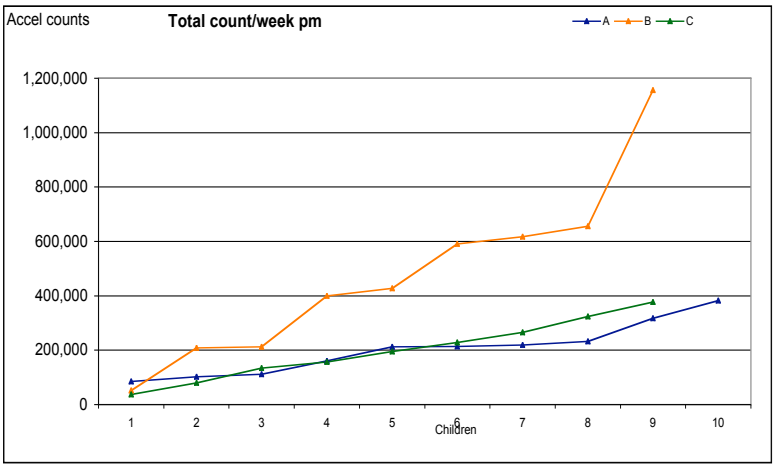


Figure 6.13. Total accelerometer counts in the afternoon outdoor play during monitoring week.

6.3 Behaviour Setting Analysis using Behaviour Mapping

Behaviour mapping was used to link the level of physical activity to the environmental features and components of behaviour settings. From the nine cycles of behaviour maps conducted at each centre, a total of 948 data points were entered including teacher location. Setting analyses were performed on 841 data points that correspond to children's location, gender, and physical activity level (see 4.3 Research Methodology Summary).

A database was created from behaviour mapping data (including different levels of physical activity coded with SOPARC, 1=low, 2=walking, 3=vigorous activity). Data points were used to generate a series of eight illustrative maps per centre and downloaded into the Statistical Package for the Social Sciences [137] to perform additional analyses. All calculations were made over the total number of observations (n=841). Distribution of observations per centre is as follows:

Centre	Number of observations
A	239
B	406
C	196
Total	841

The full set of maps is presented in Appendix J. Map descriptions follow:

Map 1. Site layout and behaviour settings with names. Shows behaviour settings of each play area and their boundaries.

Map 2. Total compiled data points map. This map shows child location, physical activity level (SOPARC coding 1-2-3) gender, and use of wheeled toys. See also Chapter 5. Data Gathering Section 5.5.1. Codes are shown below:

Physical activity level	girl	boy	teacher	cart	wheel toy	parent
1						
2						
3						

Figure 6.14. Behaviour mapping coding.

Map 3. Percent of use bar charts per setting. This map shows the distribution of children over the different behaviour settings in each play area. The percentage of use was obtained dividing the number of observations per setting over the total number of observation multiplied by 100. As an example see calculation for play equipment 2 at Centre A: 36 observations / 239 (total number of observations) x 100= 15%) (Figure 6.15). This means that fifteen percent of the observations were made in the play equipment 2 setting.

Map 4. Physical activity level (1-3) bar charts per setting. This map shows the distribution of different physical activity levels per setting. The percentage was obtained by dividing

the number of observations coded with SOPARC for each setting over the total number of observation coded with SOPARC multiplied by 100. As an example see calculation for the same setting mentioned above (Centre A, play equipment 2): the total number of observations coded at level one (sedentary) was 8 out of 66 observations. This equals 12% of total sedentary behaviour observed in this setting. The total number of observations coded at level two (walking) was 14 out of 131 observations. This equals 11% of total walking behaviour observed in this setting. Finally, the total number of observations coded at level three (vigorous) was 14 out of 42 observations. This equals 33% of total vigorous behaviour observed in this setting (Figure. 6.16).

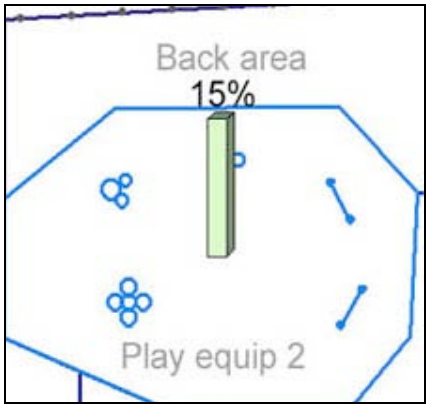
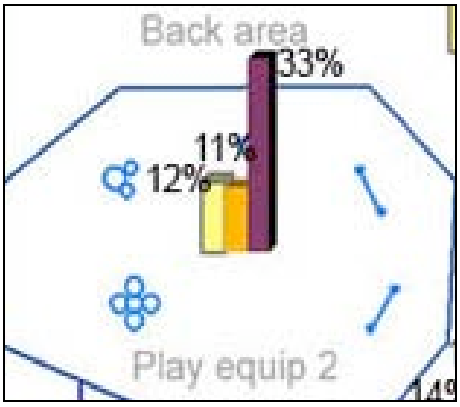


Figure 6.15. Centre A. Play equipment 2 percent of use.



6.16. Centre A. Play equipment 2 physical activity levels.

Map 5. User loading per setting (all children). This map shows the number of children per 25 m^2. Settings in darker colour show higher numbers of children per setting.

Map 6. User loading per setting (girls). This map shows the number of girls per 25 m^2. Settings in darker colour show higher numbers of girls per setting.

Map 7. User loading per setting (boys). This map shows the number of boys per 25 m^2. Settings in darker colour show higher numbers of boys per setting.

Map 8. User sub-areas. This map shows the different sub-areas used.

Analyses of the patterns of use for all sites show a series of well-defined behaviour settings [58] with clear boundaries and attributes that support distinct children's activities. Centres differ in the number of settings, their dimensions, category, and diversity.

6.3.1 Setting size

With the purpose of running statistical analyses and comparing setting size among centres, a categorical variable "setting size" measured in square metres was created at 25 m^2 intervals. The range was chosen based on the estimate of outdoor space required per child by the State of North Carolina, USA [100, 139] for licensing purposes. Licensing regulations require 75sqft (7 m^2 approx) of outdoor space per child. Taking this estimate as a precedent, an area of 25 m^2 would support about 4 children playing together. Setting m^2 ranges are:

Range	Square meter
1	1 - 24,99
2	25 - 49.99
3	50 - 74.99
4	75 - 99.99
5	100 - 124.99
6	125 - 149.99

Range	Square meter
7	150 - 174.55
8	175 - 199.99
9	200 - 224.99
10	225 - 249.99
11	250 - 274.99
12	275>

Centre A. The preschool play area at Centre A covers an area of 1,194.32 m^2 used as a whole without subdivisions. The preschool area contains 19 settings: 59% manufactured, 27% mixed, and 14% natural (Figure 6.17). The size of settings varies between 6.22 m^2 and 412.40 m^2 (mean 61.86 m^2). Behaviour mapping data show setting #9, play equipment-3 (77.48 m^2), as the most popular in this play area. Setting diversity is moderately low (mean 2.37) because this play area has little vegetation and most settings are play-equipment-based installed over a surface of wood chips.

Centre A	settname	diversity	3settcateg	m^2
1.	sandplay	2	nat	178.93
2.	backpath	4	mixed	63.45
3.	backarea combined	4	mixed	74.79
4.	flowergdn	4	nat	14.21
5.	trianglecorner	3	mixed	7.06
6.	basketbhoop	1	manuf	7.25
7.	playequip1	2	manuf	92.53
8.	playequip2	3	manuf	7.71
9.	playequip3	2	manuf	77.48
10.	shadestruct	2	manuf	23.78
11.	arbour	3	mixed	5.30
12.	easels	2	manuf	6.22
13.	bench	3	mixed	9.48

14.	porch1	2	manuf	24.34
15.	porch2	1	manuf	15.98
16.	Littletikes-kitchen	3	manuf	18.77
17.	porch3	1	manuf	32.24
18.	porch4	1	manuf	47.75
19.	grassyarea	2	nat	412.40
		Mean div 2.37		Mean m^2 61.86

Figure 6.17. Centre A settings, level of diversity, category, and size.

Centre B. The preschool play area at Centre B covers an area 1,341m^2 programmatically divided into two sub-areas[8] of 630 m^2 and 711 m^2 respectively. The preschool area contains 28 settings: 18% manufactured, 49% mixed, and 39% natural (Figure 6.18). The size of settings varies between 5.67 m^2 and 161.74 m^2 (mean 47.90 m^2). Behaviour mapping data show setting #4, natural pathway (161.74 m^2), as the most popular in this play area. Most settings score high in diversity (mean 3.36) either 3 or 4 on a scale 1-4. This preschool area has many fruit trees, shrubs, and vines interspersed with play equipment and other manufactured items such as a stage.

Centre B	settname	diversity	3settcateg	m^2
1.	pathbehindplayeuip	2	mixed	59.64
2.	rock bed	4	nat	4.55
3.	figheart	4	nat	18.49
4.	natpath	4	mixed	161.74
5.	planter	4	nat	13.10
6.	train -trees	4	mixed	85.41
7.	backcorner	4	nat	51.47
8.	playequip1	2	manuf	173.82
9.	bogandgrass	3	nat	20.84
10.	dirtandrocks	3	nat	41.43
11.	waterplay	4	mixed	29.45
12.	playequip	3	manuf	70.23
13.	beantepee	4	mixed	8.73
14.	trellis	4	mixed	5.67
15.	woodchipspath	2	mixed	78.78
16.	drinkingfount	4	mixed	9.20
17.	fruittreegrove	4	mixed	35.02
18.	grassyarea	4	nat	52.68
19.	swings	2	manuf	105.72
20.	plantings1	4	nat	13.80
21.	plantings2	4	nat	20.07
22.	shadestruct	3	mixed	41.90
23.	deck	3	manuf	10.87

[8] Centre director explained it was a natural division that allows several age groups to use the play area simultaneously.

24.	grassyarea	3	nat	149.57
25.	entrylawn	3	nat	22.02
26.	privacycorner	2	mixed	16.16
27.	picnictable	4	mixed	15.79
28.	entryporch	3	manuf	25.18
		Mean div 3.36		Mean size 47.90

Figure 6.18. Centre B settings, level of diversity, category and size.

Centre C. The preschool play area at Centre C covers a total area of 1,863m^2 divided into four sub-areas[9] of 270 m^2, 462 m^2, 515 m^2, and 616 m^2 respectively. The preschool area contains 25 settings: 18% manufactured, 22% mixed, and 56% natural. Size of settings varies between 14.68 m^2 and 240.43 m^2 (mean 68.98 m^2) (Figure 6.19). Behaviour mapping data show setting #4, play equipment 1 (154.5m^2), as the most popular in this play area. Most settings score high on diversity (mean 3.36) either 3 or 4 on a scale 1-4. This preschool area appears mainly as a garden with a play equipment area (616m^2) separated by a fence. The garden includes trees, shrubs, and vines on fences, a hill, a secret garden, a play stream, and a stage.

Centre C	settname	diversity	3settcateg	m^2
1.	vegetable garden		nat	22.39
2.	woodchipspath	2	mixed	76.18
3.	shadestruct	2	manuf	14.68
4.	playequip1	2	manuf	154.5
5.	path	2	manuf	98.94
6.	shadestruct	2	manuf	78.13
7.	grassyarea&shrubs	3	nat	201.71
8.	tricycle path	3	mixed	240.43
9.	hillshrubs	4	nat	125.23
10.	natpath	4	nat	61.59
11.	sandplay	4	nat	38.28
12.	waterplay	4	nat	87.05
13.	sandplay2	2	nat	2.23
14.	grassmaze	3	nat	27.96
15.	circleofrocks	4	nat	14.12
16.	acousticplay	4	mixed	37.81
17.	secretgarden	4	nat	56.39
18.	stream	4	nat	30.10
19.	bench	4	mixed	31.31
20.	plantingsbystorage	4	nat	30.66
21.	birdblind	4	nat	50.82
22.	entrylawn	4	nat	51.37

[9] Areas are subdivided for supervision purposes and to allow several age groups to use the play area simultaneously.

23.	lawn&stage	3	mixed	65.31
24.	stepped planter & lawn	4	mixed	71.53
25.	natpath	4	nat	55.74
		Mean div 3.36		Mean size 68.98

Figure 6.19. Centre C settings, level of diversity, category and size.

Summary. The three play areas show different setting areas, number of settings, setting categories, and levels of diversity. The table below (Figure 6.20) summarizes the main results:

	Centre A	Centre B	Centre C
Area	1,194.32 m^2	1,341m^2	1,863m^2
Sub-areas	N/A	Two	Four
Settings	19	28	25

Figure 6.20. Summary.

6. 4 Environmental Variables Associated with Level of Physical Activity: Setting Size, Setting Category, and Diversity Level

6.4.1 Non-parametric correlations

To investigate associations between environmental variables and physical activity, non-parametric correlations were calculated among setting size range (1-12), physical activity level (1-3), setting diversity (1-4), and setting category (manufactured / mixed / natural) (Appendix O).

Centre A. Maps A-1 and A-2 (Appendix J) show the distribution of behaviour settings and total behaviour mapping data points respectively for Centre A. Analyses show highly significant correlations (at the 0.01 level) for setting size with physical activity level and setting category. This means that in Centre A the larger the setting the greater the physical activity. Setting size shows also a highly significant negative correlation with the level of diversity (i.e. the larger the setting the lower its diversity). This result could be due to the lack of diversity of the large grassy area (setting #22, 412.40 m^2).

Although not significant, physical activity shows a negative correlation with diversity that might result from the large number of children actively playing in low diversity settings such as the grassy area and play equipment.

Setting category (manufactured / mixed / natural) shows a highly significant correlation, at the 0.01 level (2-tailed), with setting square metre range. This suggests that the larger the setting the more likely it is to be natural. Setting category is significantly associated with diversity (p-value=0.05 level, 2-tailed). Again, the large number of children playing in the grassy area (Setting 22) may explain these results.

Centre B. Maps B-1 and B-2 show the distribution of behaviour settings and total behaviour mapping data points respectively for Centre B. Analyses show a highly significant correlation (p-value=0.01) for setting square metre range with physical activity level (i.e. the larger the setting the greater children's physical activity) and diversity (p-value=0.05). In this centre, highly diverse settings appear to be larger. Diversity is also highly correlated with setting category (i.e. the more natural the more diverse are the settings).

Centre C. Maps C-1 and C-2 show the distribution of behaviour settings and total behaviour mapping data points respectively for Centre C. Analyses show only two highly significant correlations: an association of setting square metre range with physical activity (p-value=0.05) and level of diversity with setting category (p-value=0.01). As in the other two centres, this means that the larger the setting the greater children's physical activity and the more diverse the more natural.

6.4.2 Layout, Objects, and Events

The layout of the site, the presence of objects (animate and inanimate), and the events that occur in each setting are the principles selected to guide the investigation of potential environmental variables that might explain children's activity. Below, the principles are discussed in relation to the findings for each centre.

The *Centre A* preschool play area layout is a continuous, spacious grassy area where play equipment settings are the main attraction. An expanse of lawn surrounds and connects all settings. The circulation pattern is not physically defined and preschool children have direct access from their classrooms to the outdoors. Centre A play area is mostly open and visibility is not a problem. The few vertical elements include a trellis, a large piece of play equipment and a small tree with a bench located near the building. Two additional trees are located in the periphery of the area behind the largest piece of play equipment. Although these trees are large, they do not provide sufficient shade during the hot summer.

This play area does not have paths, therefore children cannot use wheeled toys there. To counteract this fact, teachers take preschoolers to the parking lot to ride their tricycles on a weekly basis. However, this is not a daily occurrence and the setting is an open expanse of unshaded asphalt, which clearly does not function like the Centre B pathway.

Even though the Centre A lawn setting is not highly diverse, children find ways to be in touch with nature by collecting leaves, twigs and dirt, and performing dramatic play. The motivation for this increased level of activity is a “play kitchen” adjacent to one of the porches, which serves as the catalyst for most of the observed dramatic play. The play kitchen affords social interaction. The lawn and scattered natural objects afford exploratory behaviour and physical activity as children run around searching for “cooking ingredients”. Because different groups share the space at a given time, peaks of activity can be seen in the play equipment and chasing games in the lawn area.

The *Centre B* preschool play area layout is organized along a path surrounded by vegetation and additional settings that spring off the path. Among others, settings include play equipment, water play, a deck, a picnic table and they are freely used by children either in the sub-areas named by the teachers as “train” and “woodchips”. There is a main entrance to the outdoors and a secondary door off a corridor. Most classes access the play area by the main entry.

The path organizes the site circulation and helps children to orientate via this activity spine. As observed, children play and circulate on it “in endless journeys.” This wide, sinuous, and diverse pathway supports linear activity such as running, chasing, walking, and the use of wheeled toys. The bordering vegetation, although profuse, does not block view lines for supervision because it is composed of small trees, a few shrubs and low plantings.

This play area supports a wide variety of interactions with plants and small animals. Additionally, different preschool groups share the space simultaneously. This fact promotes higher interaction among children and, therefore, more activity.

Because this site includes a high proportion of vegetation interspersed with other manufactured elements, children can often observe movement and environmental changes, and perceive the effects of wind, rain or seasonal change. Centre B programming is based on experiential learning which provides opportunities for additional events and outdoor activities. For instance, teachers were observed conducting special projects such as an investigation of fruit (shapes, textures and

colours of pears, grapes, figs, and apples) that can be harvested in the preschool play area.

The *Centre C* preschool play area layout is complex. The largest of the three sites contains four sub-areas. Several paths transverse the site creating well defined settings. This play area has three access points. Separated with a fence, one of the sub-areas contains three small play structures.

Wheeled toys are only allowed in one of the sub-areas (the bird blind area) and children are required to wear helmets even for a short ride. Tricycles and helmets are kept in the storage unit close to the path. Children ride wheeled toys in circular fashion around the paved path.

This preschool play area is garden-like containing a hill, a secret garden, a vegetable garden, trees, vines and abundant shrubs. In some areas, low vegetation may block teachers' lines of sight, which obliges them to keep continuously moving to supervise children's activities. Children play outside for shorter periods of time than in Centres A and B in the morning and the afternoon. They also go outside in smaller subgroups of approximately 9 or 10 children.

As in *Centre B*, the amount of vegetation offers opportunities for appreciating movements and environmental changes. Seasonal vegetable and flower gardens provides a chance for children to be in contact with plants and, potentially, to make connections with healthy eating and nutrition.

6.5 Behaviour Tracking Analysis

Six video tracking episodes are presented here featuring a girl and a boy from each centre while playing outdoors. The objective of this research task was to carry out in-depth analyses of children's physical activity behaviours associated with play, and social and environmental interactions. Given that the focus of this study is the level of physical activity afforded by preschool outdoor areas, play behaviours were only coded in descriptive categories and not fully examined or analysed. However, the value of play in connection with physical activity has been highlighted by recent research and is considered of critical importance for child development [30, 31]. Play implications associated with physical activity should be addressed in further research to disclose the role of different types of outdoor play in breaking sedentary patterns of behaviour.

Although tracking episodes were analysed using statistical tools, the results shown in this section should be considered only as illustrations of children's activities in different types of play areas that also show the empirical potential of this method. Although, tracking sessions bear evidence of how these play areas are used by specific children, it cannot be argued that the quantitative analyses of the episodes are sufficient to define causal relationships between behaviour and environment. However, the addition of more observations in the future could move the analyses in that direction.

Observed behaviours were coded using The Observer software [92] using the following behavioural classes (see Chapter 5, Data Gathering): setting, physical activity type, social interaction, type of play, toy, wheeled toy, natural loose element (sand, leaves, etc.), natural fixed element (trees, shrubs), play equipment / fixed structure, and teacher intervention. Children' play was recorded during the entire length of time that the child was outdoors on the video-tracking day. For the purpose of this report, children are identified by gender preceded by the letter of the corresponding centre (e.g. *A-boy*). Percent of time spent performing specific activities, using different materials, or interacting with teachers reveal the dynamics of each play area (Appendix I). Highest percentage scores are presented also in minute equivalents. Except for Centre A that contains only one area, episodes reported here were selected to illustrate the dynamics of mixed play areas in Centre B, and natural play areas in Centre C.

The three centres, even though comparable, conduct outdoor play time in different ways, which may have an impact on the overall results of this study. During observation sessions, children in Centre A spent longer times outside and shared the space with several classes. Children in Centre B were more active and also shared the space with other children in smaller settings, which increased density of use. Children in Centre C spent less time outside than the other groups and used sub-areas with smaller, individual groups.

6.5.1 Behaviour sequences

Children's tracking behaviour traced on the play area maps, offered another way of appreciating the use of the environment. Although only a small number of illustrative tracking episodes were conducted, they show clear patterns of children's use of the space in the form of foci, chains, and flow as defined by Moore, R. [140]. *Foci* activity is related to a well demarcated area (i.e. play equipment), *chain* is the type of activity that moves from different foci (i.e. child collecting leaves from different settings and going back to the sand pit to "cook") and *flow* is the type of activity that transverse settings (i.e.

chasing games). Moore also introduces the aspects of time and territory to these dimensions by looking at how *concentrated* (related to a component or feature), *contained* (within a specific setting), or *expansive* (including several settings) children's activities are.

All children participating in behaviour tracking sequences wore accelerometers. Charts showing accelerometer counts during tracking behaviour episodes include approximate cut-off points based on age [136] for sedentary, light, moderate and vigorous activity[10].

Centre A, girl. The selected girl is in sand play area 2 accompanied by two other boys. She appears to be on-looking, walking slowly and looking around. She runs towards the boundaries of the play equipment 2 to get a scoop and comes back to the sand play area. She starts digging and finds a worm that she shows to other children. While she is doing this, another child takes the scoop what creates a short altercation resolved after children negotiate. They run and pick a smaller scoop from the play equipment area 1. After the incursion in a third setting, she will remain in the sand play area and near the adjacent tree for the rest of the play episode. She resumes digging and finds another worm that she shows to the researcher who is observing her playing at a discreet distance.

A-girl takes a bowl and starts collecting items to mix with sand. She pulls down a branch from the adjacent tree and grabs some leaves for the mix. She is engaged in cutting the leaves into small pieces and adding some grass. The other two boys join in the activity but she seems to have a clear plan. *A-girl* gives instructions to them while kneeling and mixing the preparation for several minutes. She leans on the tree carrying the bowl and scoop in her hands. The trio remain "cooking" until the teacher calls them to go back indoors. See Figure 6.21 and *A-girl* behaviour sequence map.

A-girl tracking analysis. During the 20 minute-tracking session, *A-girl* played in the sand play area (27%, 5.4 minutes) and the adjacent grassy area (64%, 12.8 minutes). She briefly passed by one of the porches (3.36%), play equipment setting 2 (1%), and play

[10] Based on Sirard et al., 2005

Intensity category	Sedentary		Light		Moderate		Vigorous	
Age	3	4	3	4	3	4	3	4
Counts/ 15s	0-363	0-398	811	890	1234	1254	1235=>	1255=>
Counts/min	0-1452	0-1592	3244	3560	4936	5016	4940=>	5020=>

equipment setting 1 (0.45%). The results show her digging, kneeling, standing, and walking in relatively similar proportions of time (Figure 6.23). The accelerometer chart for this girl shows low activity with some outbursts corresponding with walking or running short distances to get a pail.

Figure 6.21. Centre A girl playing with two boys in the sand play and adjacent tree areas.

A-girl played mostly as part of a group of children. She mainly used two toys (pail and bucket) and her play was mostly dramatic (i.e. “cooking” with sand and leaves). During most of this observation, the teacher was not involved and her interventions were positive or custodial when she interacted with the girl.

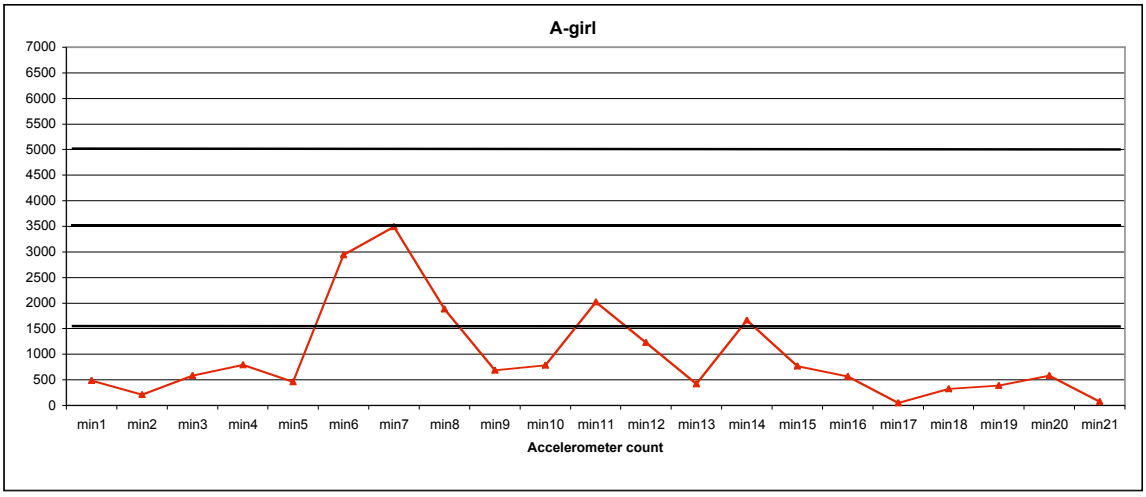


Figure 6.22. A-girl accelerometer chart. Thicker lines show approximate cut-off points for sedentary, light, moderate and vigorous activity [7].

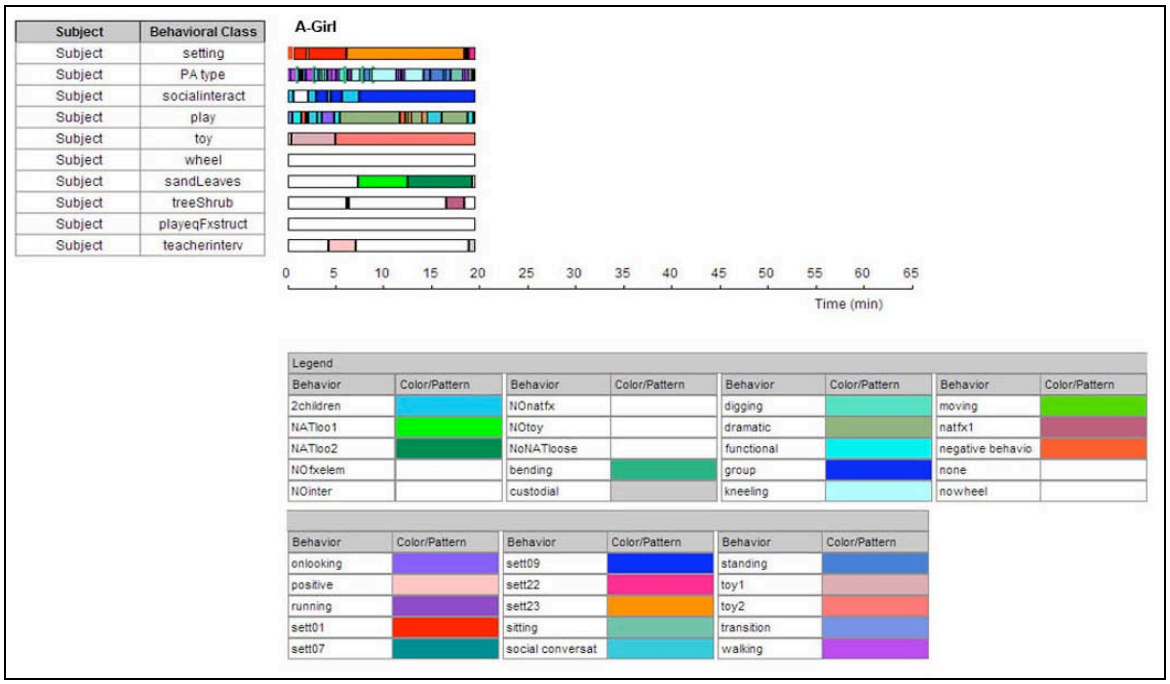


Figure 6.23. Time-event plot generated by The Observer showing all behavioural classes coded for A-girl.

Centre A, boy. When the tracking starts, the boy is alone running in the play equipment back area towards the weeping willow tree. He kneels by the tree, finds a metal plate and starts to collect dry leaves on it. He walks towards the lawn with the leaves and plate and finds a yellow pail that he will carry with him for most of the tracking episode. He also finds a plastic pan to collect additional leaves and other loose parts. He interacts with other children while “cooking” in the play kitchen area and play equipment area 2. He walks almost continuously between the play kitchen and the play equipment back area engaged in dramatic play with girl. They are playing family and preparing dinner. The action is expanded by three boys and a girl who join the action. The target boy uses the plastic stoves and pretends to cook.

The wind is blowing and leaves drop from the tree so he decides to keep his pail, with arms extended, to catch the dropping leaves. But this is not successful and he abandons the pail and runs to the swings (setting play equipment 2). He interacts with the teacher and swings pumping himself with strength. He alternates the use of the swing with a boy and girl. There are some moments of transition until the target child, two girls and one boy start playing with dirt on a small plastic structure located in the play equipment area. They go back and forth to the play equipment back area for more dirt. They collect flowers and other natural parts as ingredients until a teacher sits close to them and lets them know that it is better not to mix the woodchips (from the play equipment area) with the dirt from the back area. By then, the action looses interest and the target child runs

successively to the swings and big play equipment area with another boy. *A-boy* uses the tube slide repeatedly. Several children join. The action transforms into a chasing game that involves sliding down, running to climb to slide again. They also crawl on the bridge and jump with the help of a teacher from the big tyre installed at one end.

The target boy extends this activity choosing the bench under the tree (by the play kitchen) as a platform for touching a branch of the tree and to continue jumping. Two other children imitate. They jump without interruption for several minutes until a teacher advices not to continue and invites them to jump on the grass. They briefly do this as "rabbits" until the three children start collecting leaves again and return to the play kitchen.

Figure 6.24. Centre A boy collecting leaves, in the play kitchen, swinging and jumping.

A-boy tracking analysis. During a 60-minute tracking session, *A-boy* divided his time playing in several settings: play equipment 2 (26%, 15.6 minutes), play kitchen area (15.07%, 9 minutes), play equipment 3 (14.04%, 8.4 minutes), and grassy area (11%, 6.6 minutes). He spent 51% of outdoor time walking and standing while collecting leaves. He also performed a variety of other physical activities such as climbing, crawling, digging, jumping, moving, running, sitting, sliding, walking and pushing (Figure 6.26).

Jumping was the most vigorous activity performed by A-boy clearly reflected in the accelerometer chart (Figure 6.25).

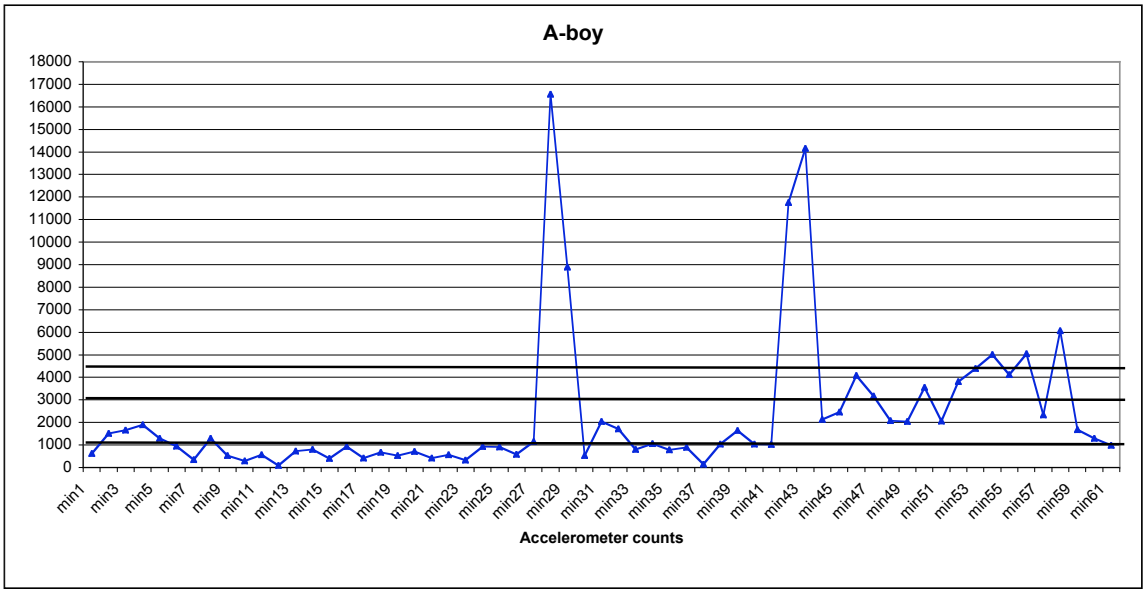


Figure. 6.25. A-boy accelerometer chart. Thicker lines show approximate cut-off points for sedentary, light, moderate and vigorous activity [7].

A-boy played mostly with a group and two other children. He was engaged in functional play (i.e. collecting leaves), dramatic play (i.e. cooking with leaves and dirt) using two toys (pan and pail). The teacher only interacted with *A-boy* briefly and in a positive or custodial way.

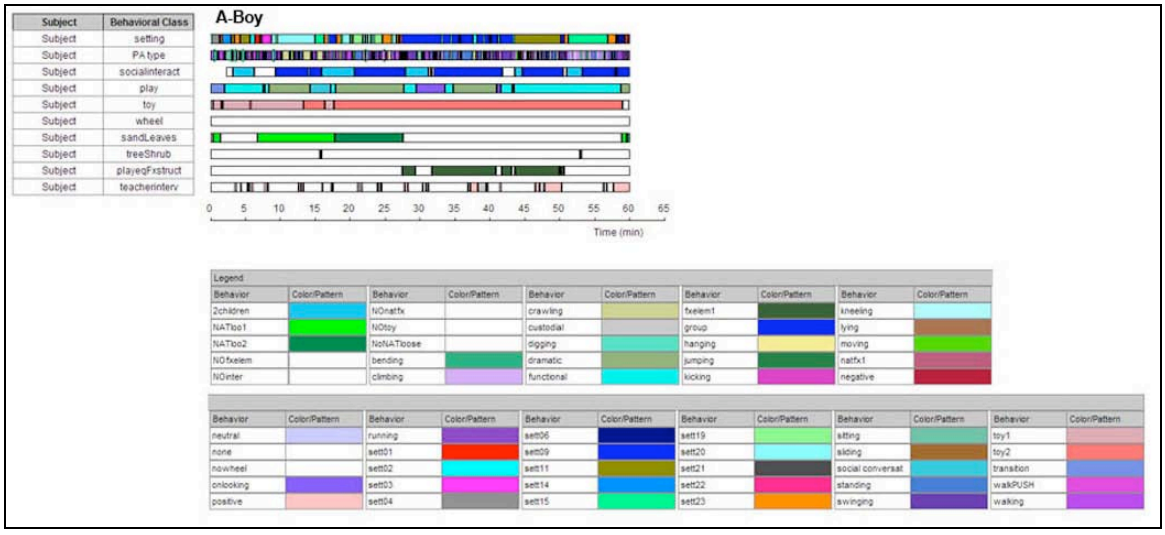


Figure 6.26. Time-event plot generated by The Observer showing all behavioural classes coded for A-boy.

Summary. These two tracking episodes show the prevalence of dramatic play in this play area (target boy and girl were both joined by a number of other children).

A-girl followed a contained pattern of activity focused in one behaviour setting (sand play area and adjacent tree). Although her physical activity was low, she was engaged and alternated functional and dramatic play with social conversations.

A-boy, in contrast, showed an expanded chain of activity (he visited several settings to perform specific activities). Although he was also engaged in dramatic play for many minutes, he was more active than *A-girl*.

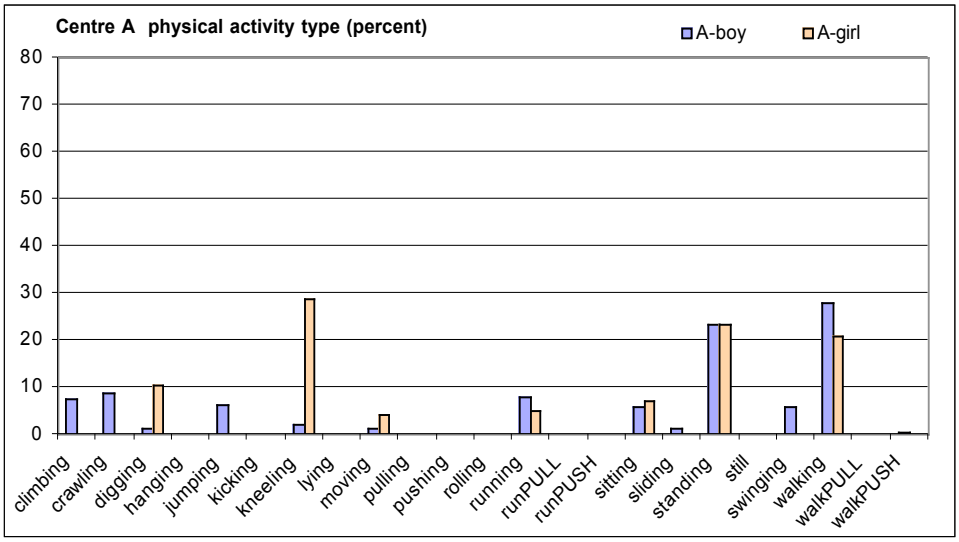


Figure 6.27. Centre A individual tracking physical activity type (percent).

These episodes are examples of the different forms that dramatic and functional play may take. Dramatic play, combined with exploration, can turn into an energetic activity involving fantasy and a "variable amount of body energy" as expressed by Moore, R., p 123 [6].

Centre B, girl. The target girl is roaming among the fruit trees (adjacent to the entry area), the trellis and the train setting. Other children surround her. She brings leaves and a ball to contribute to a pile of pails that other children have built by the trees. She is clearly following the actions of the group. She goes to the deck with the teacher and two other children to get a parachute. The three of them transport it to the adjacent lawn where, with the help of five other children, unfold it. The leader is another girl who organizes the group and guides the action (hereinafter, *B-girl*2). The target child appears to enjoy the role of follower. The group plays with the parachute hiding beneath it, resting

on top and carrying it to the train setting (still with some children under it). This proves complicated especially when they try to pull it through the trellis in their way to the train setting. *B-girl* leaves the group and walks around the train picking some leaves from the fence vine until she hears *B-girl*2 crying and joins her near the bean tepee. The target girl seems to dislike the situation and walks alone towards the grove of trees, she is on-looking. She picks up different materials, and toys. She discovers the teacher is opening the storage room and distributing carts.

From now on *B-girl* will play with *B-girl*2 for most of the remaining outdoor playtime. She pulls the cart (walking and running) with *B-girl*2 on top. They pick the parachute that was left near the bean tepee and carry it around in different ways (folded on top of the cart passenger, hauling it behind the cart). They go around the pathway many times, taking time for additional activities in the way (helping other cart users, re-arranging the parachute and other materials on top of the cart, rescuing a frog under the water play table, and negotiating the pathway with a full load).

After the group finds the frog, the target girl looks for food under the rock by the pathway. *B-girl*2 calls her loudly to continue the journey while the target child is engaged looking for food for the frog in the rock area. *B-girl* joins again the play with the cart until the teacher calls them to go inside.

B-girl tracking analysis. During a 58-minute tracking session, *B-girl* played most of the time (51%, 30 minutes) in the natural path. The rest of the time she played in a variety of settings: the deck (12.03%, 7 minutes), the rock bed (10.36%, 6 minutes), the train (8.37%, 4.8 minutes) and passed briefly by the water play area, the bean tepee, tree grove, the lawn, the shade structure, and entry lawns (Figure 6.30).

B-girl spent most of her time walking on the natural path, standing, moving, walking-and-pulling and walking-and-pushing a cart. The accelerometer chart shows the amount of sustained activity over one hour of outdoor play. She played in a group for more than 50% of the time.

B-girl did not use toys (60%, 34 minutes) and divided her time between a variety of activities: on-looking (observing other children catching a frog), playing games with rules (parachute play), functional play (pulling and pushing a cart), and in social conversations with other children.

Figure 6.28. Centre B-girl *playing with parachute, pulling carts, and being pulled by other girl.*

B-girl used a cart for 22 minutes (38%). The teacher interacted briefly with the girl in a positive and/or custodial fashion.

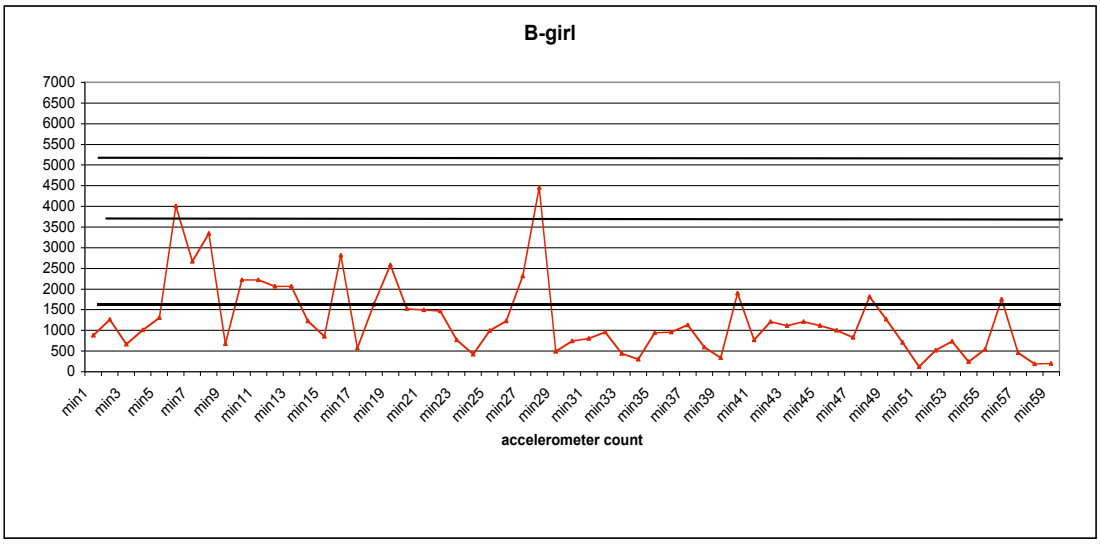


Figure. 6.29 B-girl accelerometer chart. Thicker lines show approximate cut-off points for sedentary, light, moderate and vigorous activity [7].

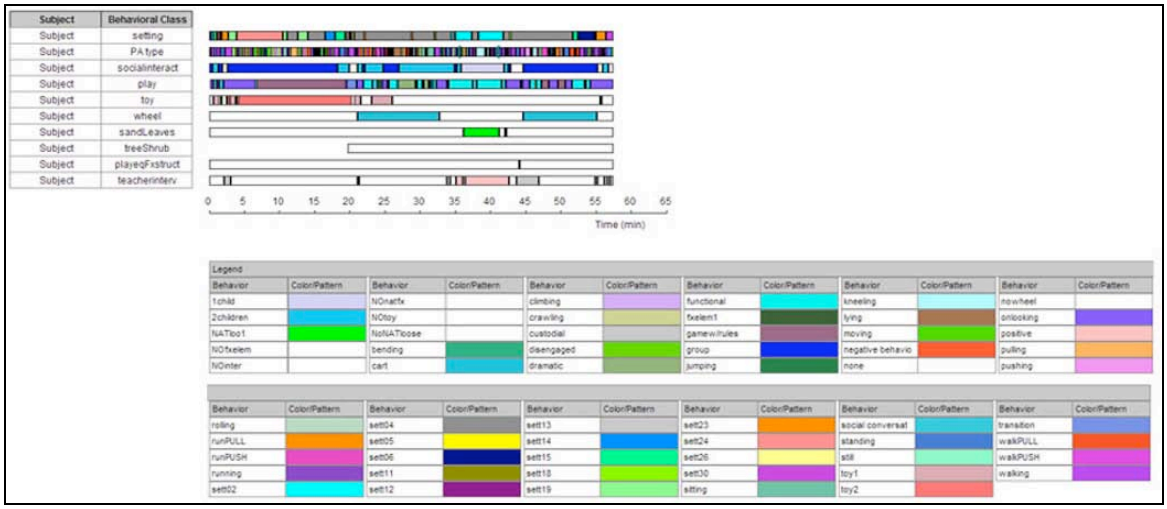


Figure 6.30. Time-event plot generated by The Observer showing all behavioural classes coded for B-girl.

Centre B, boy. The tracking episode starts in the natural path near the fruit tree grove. *B-boy* is running across settings. He briefly interacts with other children in the trellis, takes a play spade and walks around. He seems to be exploring as he walks between settings (the deck, the entry area). He kicks a ball that he finds by the entry lawn but does not engage with the group of boys that are playing there. He continues to the path and grove of fruit trees. He wanders around until he goes back to the lawn and plays with two other boys pretending to fall down, stepping on a cube, and jumping. The target child kicks the ball but one of the children does not like it and there is an altercation. *B-boy* is crying now, he goes to the picnic table in the entry setting, and sits. Some moments later, he hides under the table and watches the boys play ball. He sees other children with a cart, emerges from his hiding spot and joins them. Another boy offers a plastic spade that *B-boy* accepts and visits briefly the deck. He goes back to the entry area and pulls the cart with a boy sitting on it. He pulls the cart, running by the path towards the drinking fountain, turns and tries to pull the cart over the dirt and rocks. He is not successful and abandons the cart.

The teacher is close by and he interacts with him briefly. The target child heads towards the play equipment area where he grabs a shovel and starts digging with two other boys. The teacher remains close to the group. He digs for a while and other children join.

Figure 6.31. Centre B boy running by the pathway, crawling out under the table, balancing on block and digging.

Suddenly, *B-boy* runs to the deck with his shovel and pretends to play the guitar with it. The teacher asks children to gather the toys and play materials. *B-boy* runs back to the tepee to pick up a ball and returns it to the deck area. The target child runs to the train setting now to pick up two additional toys, which he brings to the storage box in the deck before sitting by the entry door with the rest of the group.

B-boy tracking analysis. During a 16-minute tracking session, *B-boy* spent most of his outdoor play time in various settings: the shade structure that was set up for group play (20.47%, 3.2 minutes), the adjacent deck where toys and play materials are stored (17.85%, 2.85 minutes), and play equipment 2 (15.57%, 2.49 minutes). He briefly played in the lawn, the natural path and train, passed by the water play area, trellis, and tree grove. *B-boy* spent most of the time walking and running (both activities combined 60%, 9.6 minutes). The accelerometer chart shows that this boy sustained light activity for about 19 minutes.

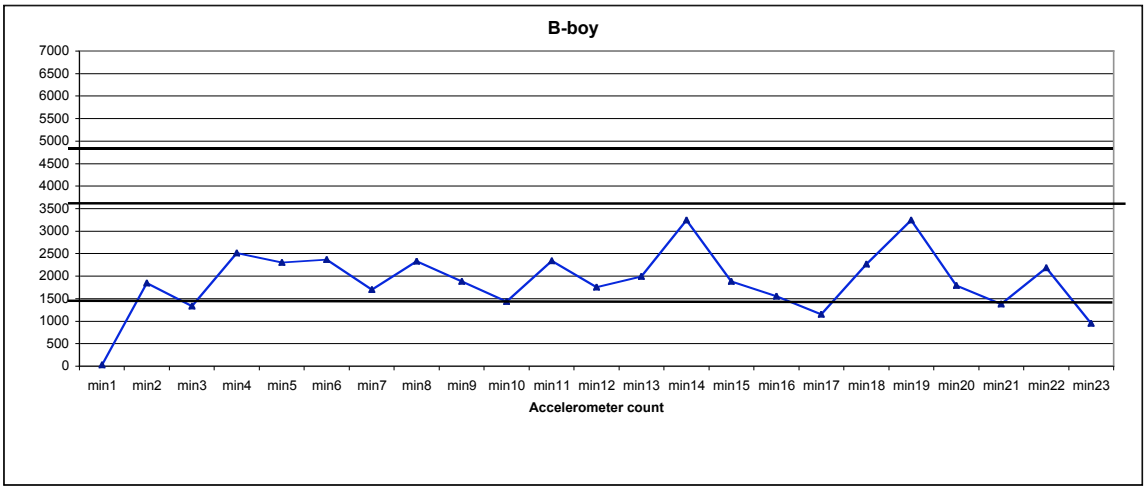


Figure 6.32. B-boy accelerometer chart total count/minute. Thicker lines show approximate cut-off points for sedentary, light, moderate and vigorous activity [7].

He interacted mainly with a group of boys, using one toy (a ball), and playing ball or simply running. He also held social conversations with other children and was part of an altercation. The teacher interacted with *B-boy* several times mostly in a custodial manner.

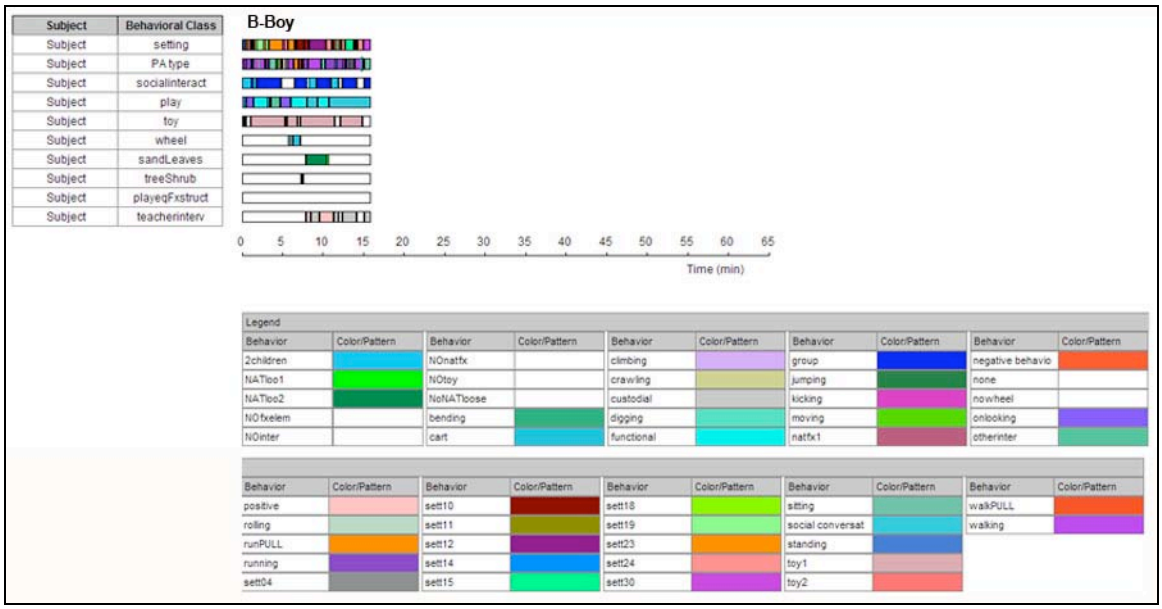


Figure 6.33. Time-event plot generated by The Observer showing all behavioural classes coded for B-boy.

Summary. These two tracking episodes show diverse behaviour patterns in similar settings. *B-girl* alternated concentrated focus activities (i.e. rock area) with expanded chains of activity in a long sequence of functional play (i.e. cart journey over the pathway). Even though she was following *B-girl*2 most of the time, she was engaged and

had opportunities for exploration and for getting involved in the events that occurred in her proximity (e.g. “feeding” the frog, pulling other carts).

B-boy sequentially followed an expanded chain and flow pattern of activity. He appeared to wander, running from one setting to the other (flow) while he engages in actions with others for short periods of time (chain). See Appendix J for tracking sequence map.

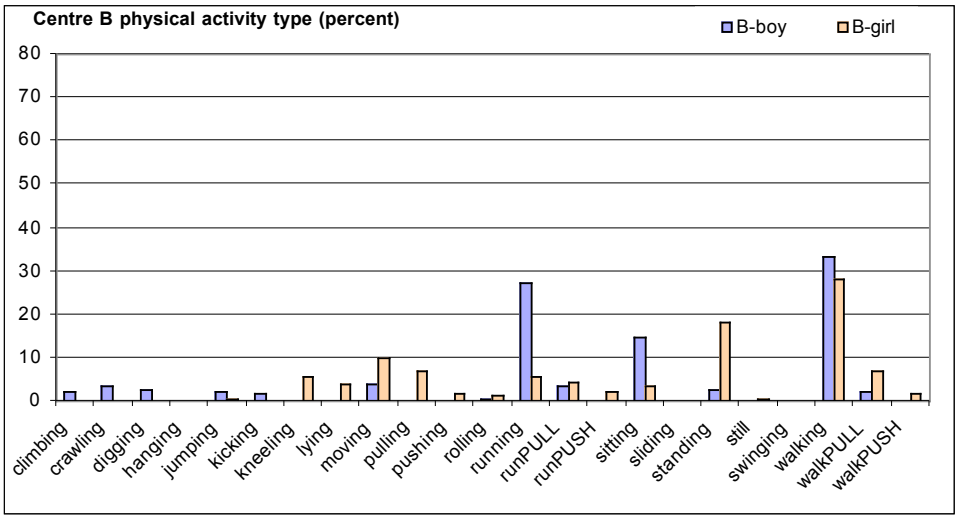


Figure 6.34. Centre B individual tracking physical activity type (percent).

Centre C, girl. The target girl gets paper and markers from a bag that the teacher brought outdoors and proceeds to the sand play area. She sits on a stump and quietly writes on paper. While she does so, she observes other children around her. One boy joins her and stays with her playing “teacher” for the rest of their outdoor time. They talk to each other. Both move to the bench at the entry lawn. From there, they take short trips to observe plants and other environmental features and “write” their observations. *C-girl* and her companion move to the top of the hill. They sit and write on big plastic blocks they bring for that purpose. Again they repeat the action of running to different spots to observe, run back to the hill, and “write.” *C-girl* goes for water and brings a cup with her. They remain on the top of the hill until they are called by the teacher to go inside.

C-girl tracking analysis. During this 19-minute tracking session, *C-girl* spent 60% of her outdoor playtime in two settings: sitting on the stumps at the sand play area (31%, 5.8 minutes) and sitting in the bench at the entry lawn (30%, 5.6 minutes). She also played on the hill, the natural path, and the lawn. *C-girl* was mainly sitting (71%, 13 minutes) and walking (14%, 2.6 minutes). The accelerometer chart shows C-girl performing mainly sedentary activities. She played either alone or with a boy. They were engaged in

dramatic play, pretending to be teachers, writing and drawing. The teacher intervened briefly in positive and custodial ways. It is worth noting that although both children show low levels of activity, they were highly focused and engaged. The garden-like play area facilitated their observations and fed their imagination.

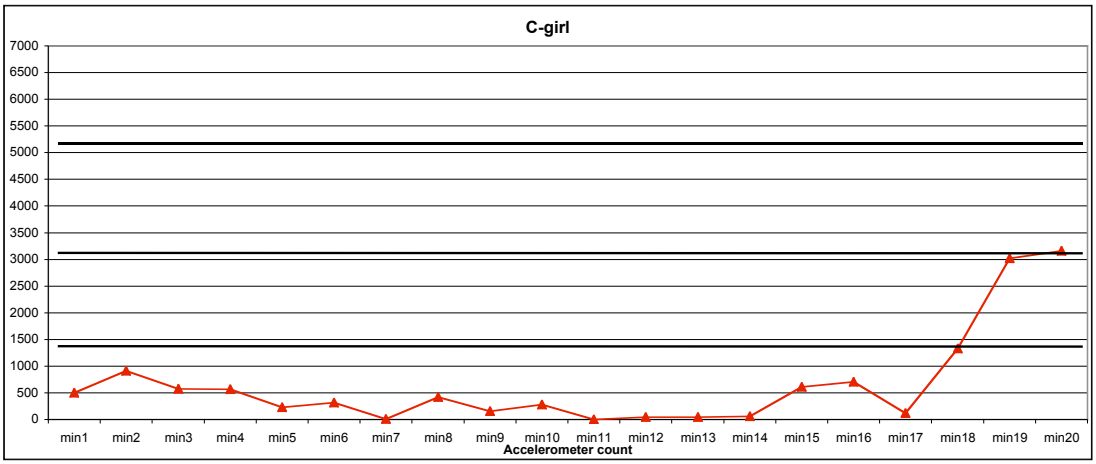


Figure 6.35. C-girl accelerometer chart total count/minute. Thicker lines show approximate cut-off points for sedentary, light, moderate and vigorous activity [7].

Figure 6.36. C-girl *getting paper and markers and "writing" by the sand play area, entry bench and top of hill.*

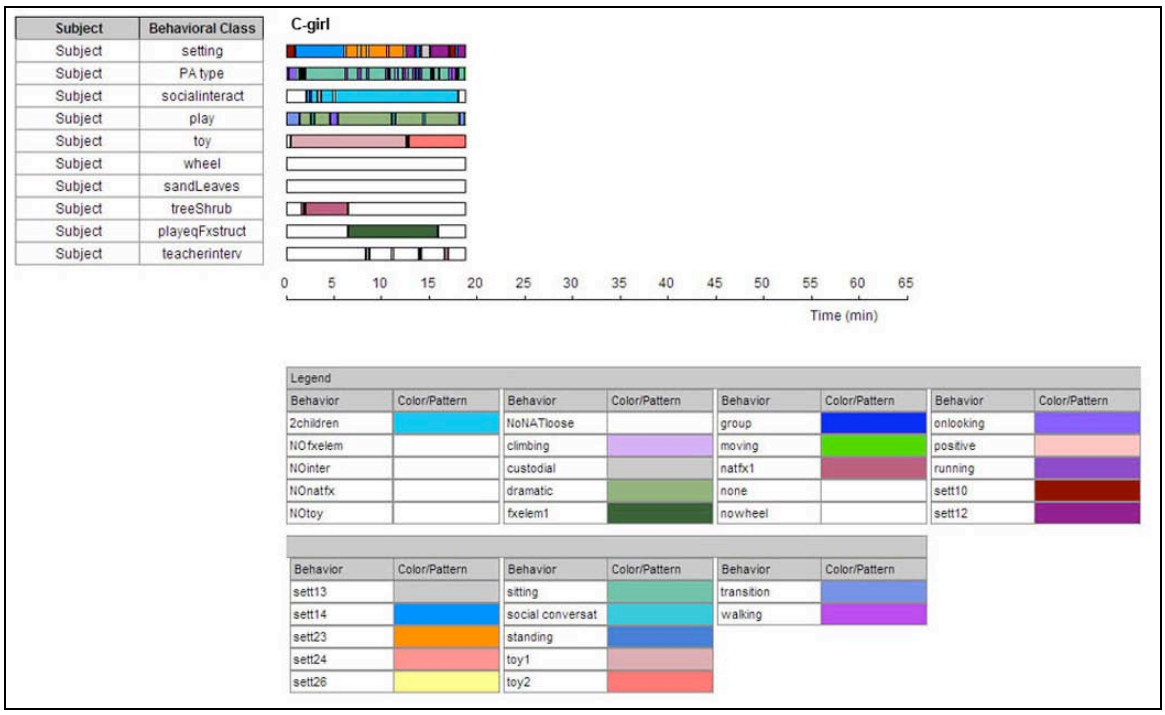


Figure 6.37. Time-event plot generated by The Observer showing all behavioural classes coded for C-girl.

Centre C, boy. The teacher carries a container with small toy animals to the wooden stage in the bird blind area. The target child takes some toy animals from the container and kneels on the stage playing with another boy. They are engaged in dramatic play, mimicking animal sounds and moving the figures on the wooden surface. They pretend being animals mimicking sounds. With the arrival of an additional group, He expands his dramatic play to adjacent settings with the toy animals chasing other children and pretending to be an animal with whole body movements. They also play hide and seek. He runs around the path and transverses the bird blind area and grass maze several times running after other children. At this point, his physical activity is vigorous and the teacher suggests he takes his jacket off and leaves it in the stage which he does. He remains walking and exploring the grass maze area until the group gathers by the stage and goes back indoors.

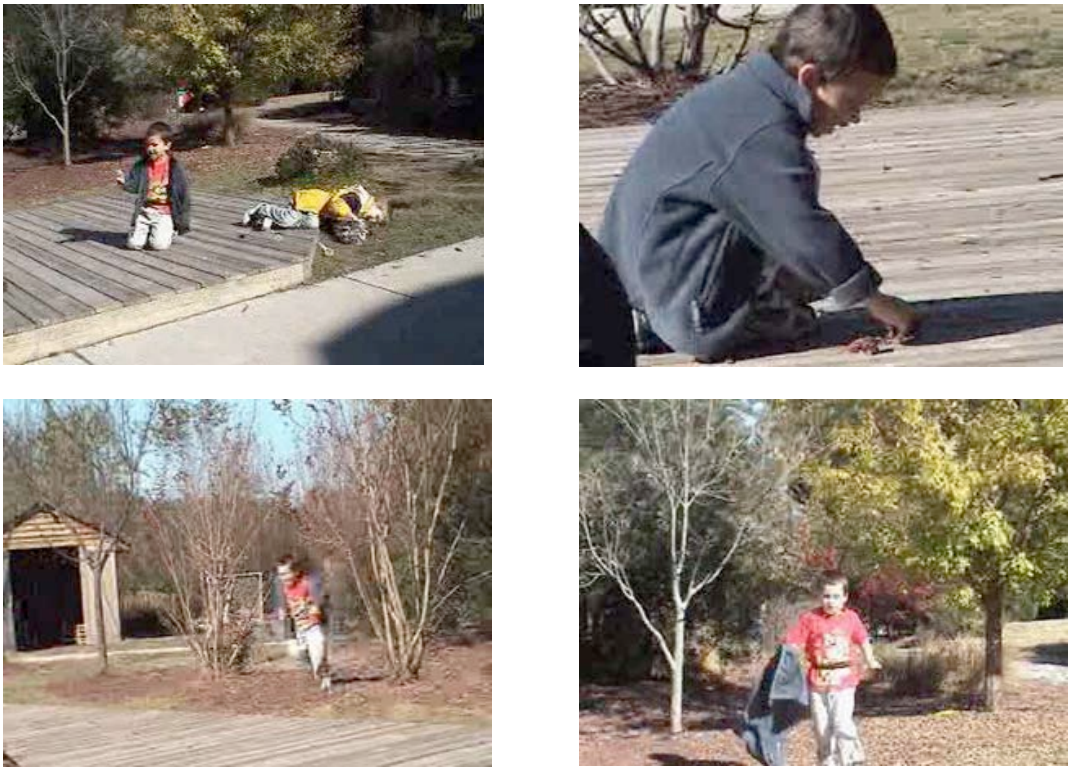


Figure 6.38. C-boy *playing with toy animals on the stage, running through settings and leaving jacket.*

C-boy tracking analysis. During this 20-minute tracking session, *C-boy* played on both the stage area and surrounding lawn (39%, 7.8 minutes), in the bird blind area (30%, 6 minutes), and on the path (20%, 4 minutes). He also used the grass maze, the planter area and the natural path.

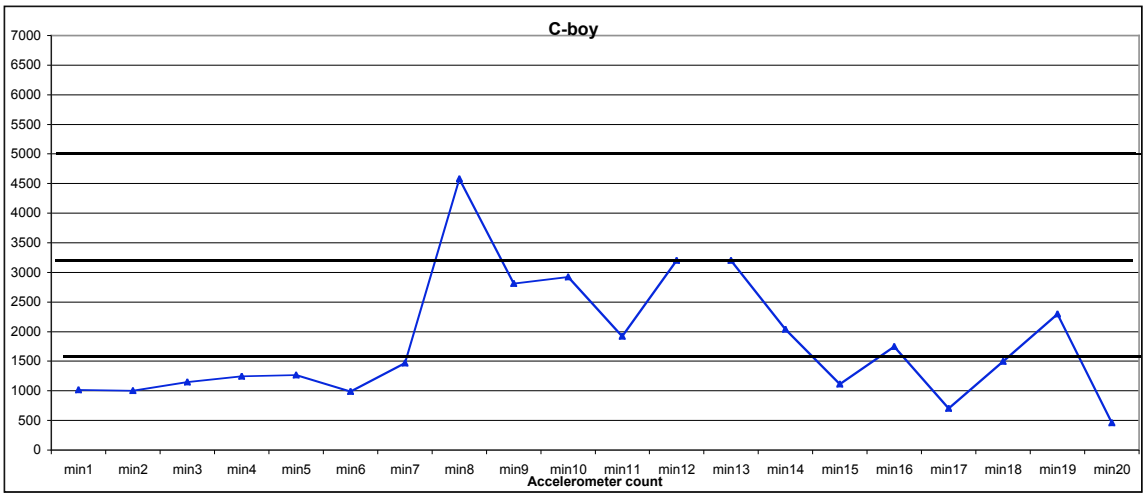


Figure 6.39. C-girl accelerometer chart total count/minute. Thicker lines show approximate cut-off points for sedentary, light, moderate and vigorous activity [7].

C-boy was mainly walking, running and kneeling (playing with animal toys and hiding from other boys). As can be seen from the accelerometer chart, B-boy was sedentary at the beginning of this play episode (while playing on the deck) and exhibited light and moderate intensity activity around 7 minutes later. He played in a group and with another boy. His play was mainly dramatic (scaring and running after other children). He used for a short period of time one toy (i.e. sword), and performed games with rules invented on the spot. The only teacher intervention was custodial.

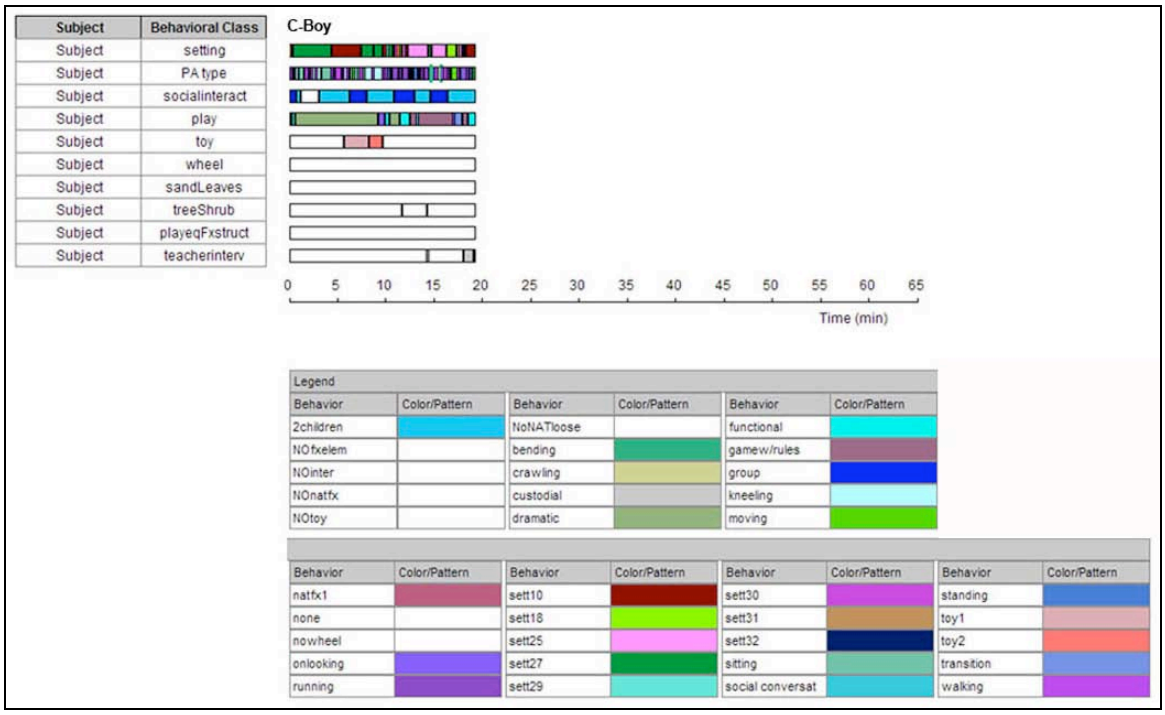


Figure 6.40. Time-event plot generated by The Observer showing all behavioural classes coded for C-boy.

Summary. C-girl exhibited a chain pattern of activity. She migrated to three different behaviour settings performing the same activity (playing teacher with a boy). Although her activity was mostly sedentary during this episode, she visited several settings and seemed to be fully engaged and learning about the environment through dramatic play.

C-boy started playing on the stage and his play was focused (i.e. on the toy animals) and contained (i.e. by the stage). But his pattern of activity changed and became an expansive flow. *C-boy*'s activity spread out by transferring the dramatic play with the toy animals into a whole body chasing game roaming over the bird blind, grass maze and pathways. *C-boy* exhibited a rich pattern of behaviour. See Appendix J for tracking sequence map.

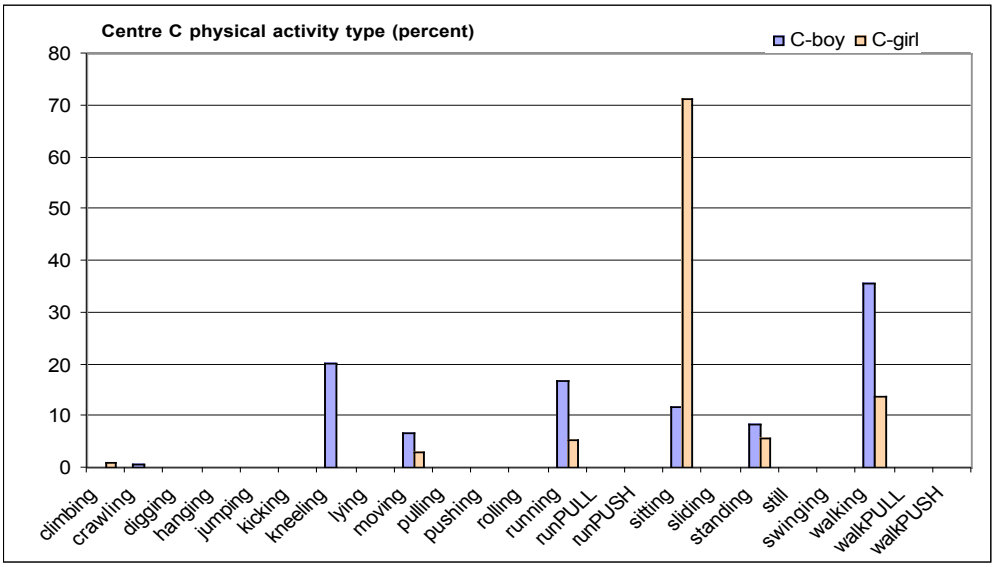


Figure 6.41. Centre B individual tracking physical activity type (percent).

6.5.2 Children's activities and interactions

For easy comparison of children's activities and interactions, a series of charts are included below.

Interactions

Different pattern of interactions characterize the observations in the three play areas. Target children in Centre A were observed playing mostly in groups. Children observed in Centre B showed more varied social interactions. They alternated playing alone, with one other child, two or a larger group. Children were seen going in and out of play episodes without conflicts. In Centre C, target children were seen mainly playing with one child, which might be a consequence of the small size of outdoor groups.

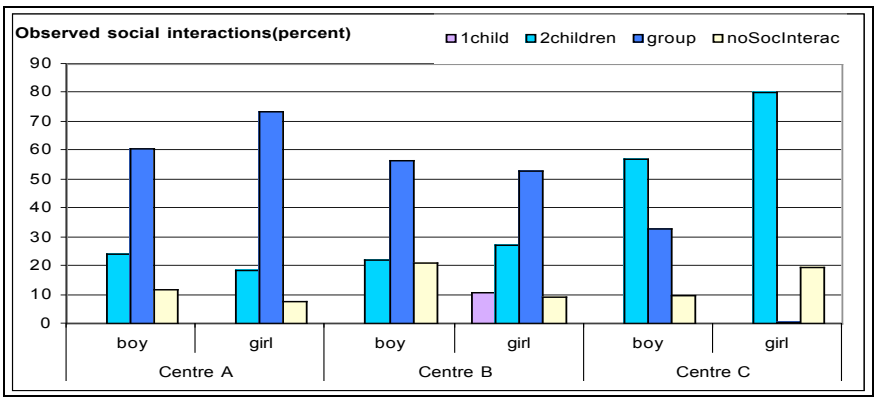


Figure 6.42 Social interaction comparisons. Percent of behaviour observed during tracking session.

Play

Play activities also show slight differences among target children. Between 7 and 10 play activities were observed. The difference is small. However, this could be a trend (also shown in behavioural classes social interactions and physical activity) supported by the physical and social environment that could be worthwhile to research in-depth in the future.

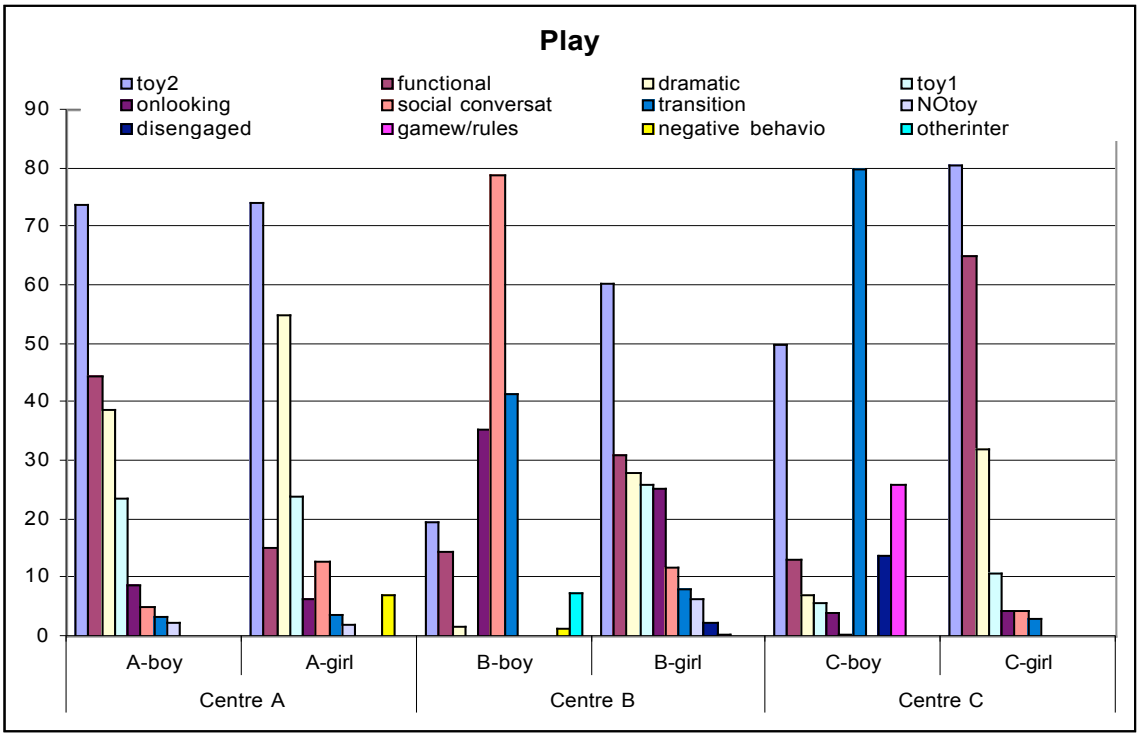


Figure 6.43 Play. Percent of behaviour observed during tracking session.

Wheeled toy use

Wheeled toy use was only observed in Centre B. *B-girl* used wheeled toys for almost 40% of the time while *B-boy* used them for a short period of time. In Centre B, children have access to different types of wheeled toys including tricycles, carts and wagons. Groups of children in Centre B pulled and pushed them around the paths and also over rough terrain.

Centre A does not contain pathways and, therefore, wheeled toys cannot be used in these play settings. Centre C has a paved pathway and wheeled toys are accessible but target children did not use them.

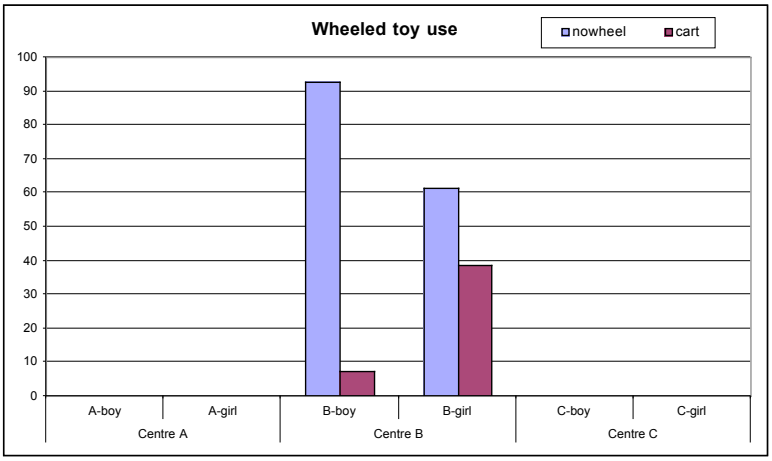


Figure 6.44 Wheeled toy use. Percent of behaviour observed during tracking session.

Interactions with natural loose and fixed elements

Target children in Centres A and B were observed using one or two natural loose materials for playing such as sand, leaves and rocks. They mainly used these materials for moulding and "cooking."

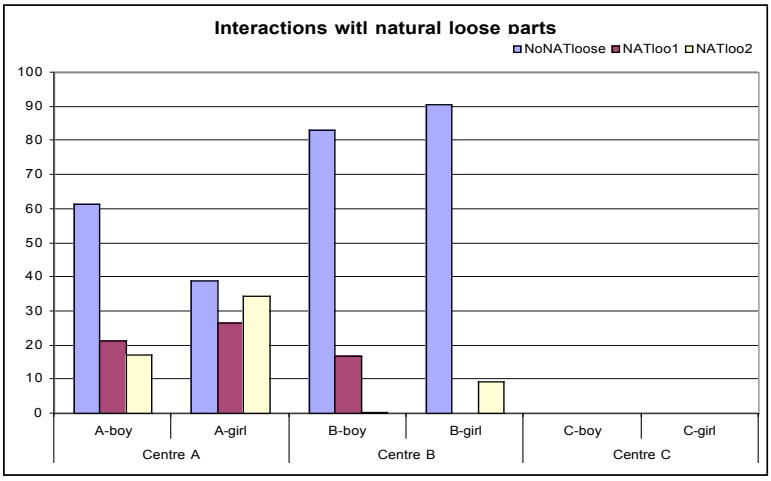


Figure 6.45 Interaction with natural loose materials. Percent of behaviour observed during tracking session.

Only two children interacted with fixed natural elements during tracking sessions. *A-boy* was in touch with a tree and *C-girl* with the sand play area peripheral stumps that she used for sitting.

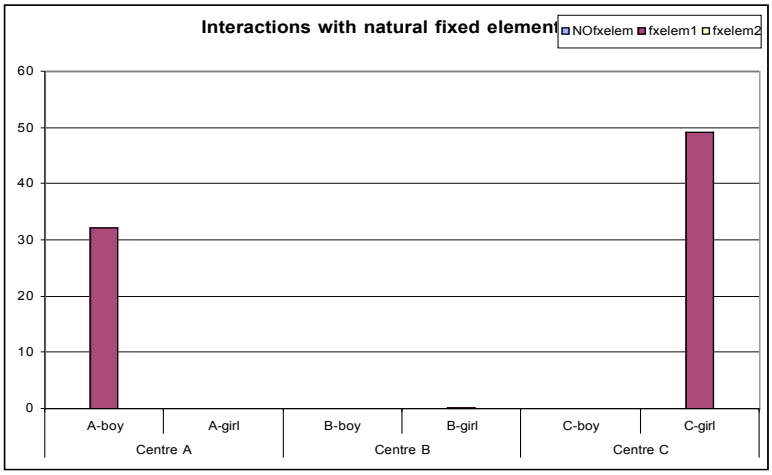


Figure 6.46 Interaction with natural fixed elements. Percent of behaviour observed during tracking session.

Teacher interactions

Teachers were observed interacting with children in positive ways with only one intervention that could be considered negative. In general, teachers remain at a discreet distance without interfering with children's play.

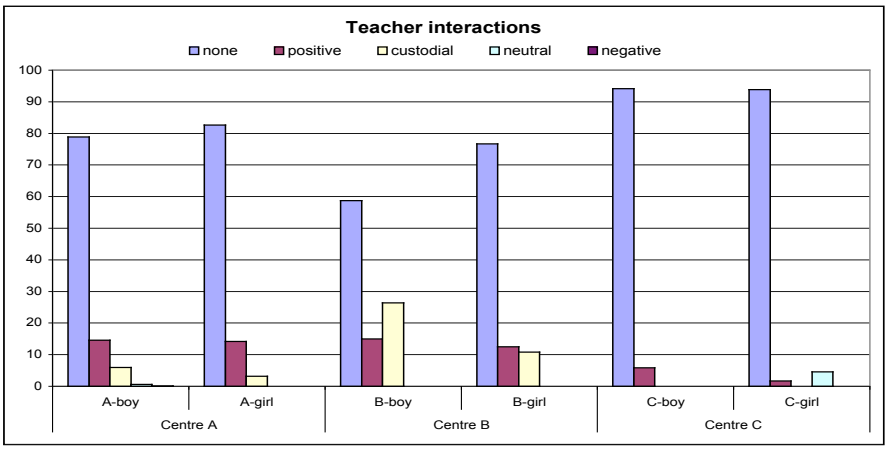


Figure 6.47 Teacher interactions with target child. Percent of behaviour observed during tracking session.

As can be seen from these six illustrative tracking episodes, children's activities vary among centres and suggest that there could be a pattern of behaviour that characterizes each of them.

6.6 Logistic Regression and AnswerTree analyses

Logistic regression. Using behaviour map data, a logistic regression was conducted to assess which variables best predicted the levels of physical activity in the preschool play

areas. Taking into account the importance of identifying environments that afford moderate and vigorous activity, the dependent variable “physical activity” was dichotomized for the logistic regression as follows: physical activity 1 (SOPARC coding “sedentary”), physical activity level 2 (SOPARC coding “walking” and “vigorous”). The independent variables included in the model are setting diversity, size of setting (“square meter range”), centre, centre(1), centre(2), centre(3), and gender.

The Kruskal-Wallis test based on groupings of physical activity levels was used as a screening test prior to the logistic regression analysis. Factors reaching significance at $p<0.01$ were included in the analysis. The procedure used was Backward Stepwise Logistic Regression (©SPSS, Inc.) and the cut value set at .75.

The two-step model shows a successful classification rate of 70%. See Figure 6.48 for observed and predicted variables in the logistic regression equation. The model predicted physical activity level 2 (walking and vigorous intensity) more accurately (step 1, 74.6% correct; step 2, 77.7% correct) than physical activity level 1, probably due to the effect of the larger number of observations in the former category. A diagnostic for potential collinearity effects was conducted that showed tolerance and variance inflation factor results of greater than 0.1 and less than 10 respectively, confirming the absence of collinearity between variables.

In step 1, the size of setting appears highly significant ($p<.001$) while other significant variables are centre and gender (both $p<.05$). In step 2, size of setting and centre are highly significant ($p<.001$) and centre(1) and gender appear significant again $p<.005$. Full analysis output is included in Appendix N.

Classification Table(a)

Observed			Predicted		
			pa2level		Percentage Correct
			1	2	
Step 1	pa2level	1	90	78	53.6
		2	171	502	74.6
	Overall Percentage				70.4
Step 2	pa2level	1	66	102	39.3
		2	150	523	77.7
	Overall Percentage				70.0

a The cut value is .750

Figure 6.48. Logistic regression classification table (SPSS output).

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1(a)	diversity	.144	.117	1.524	1	.217	1.155
	m2range	.155	.035	20.173	1	.000	1.168
	centre			6.963	2	.031	.000
	centre(1)	-.438	.244	3.221	1	.073	.645
	centre(2)	.181	.237	.581	1	.446	1.198
	genum	.394	.178	4.900	1	.027	1.483
	Constant	.154	.403	.147	1	.702	1.167
Step 2(a)	m2range	.152	.034	19.776	1	.000	1.164
	centre			14.824	2	.001	.000
	centre(1)	-.522	.235	4.924	1	.026	.593
	centre(2)	.255	.229	1.248	1	.264	1.291
	genum	.400	.178	5.058	1	.025	1.492
	Constant	.558	.239	5.434	1	.020	1.747

a Variable(s) entered on step 1: diversity, m2range, centre, genum.

Figure 6.49 Logistic regression (SPSS output).

AnswerTree. Using the same data an "AnswerTree" (©SPSS, Inc.) analysis was generated using the Statistical Package for the Social Sciences [137] (Figure 6.50). The AnswerTree analysis illustrates how data best predict the dependent variable at different levels in a hierarchical "tree". It shows the significant predictors of the dependent variable (dichotomised data for physical activity) and the best sequence in which to use the predictors (the independent variables) in order to categorise their effect. This is an additional way for interpreting the potential effect of the designed environment on children's physical activity intensity. In this analysis the classification and regression tree method were used.

Of all the variables included in the analysis, setting size appears again as the best predictor of physical activity. Furthermore, settings that are larger than $50m^2$ (range level 2 for this variable) predict physical activity level 2 (walking and vigorous) at 84% rate. After size, setting diversity appears in this model as the best predictor of physical activity levels.

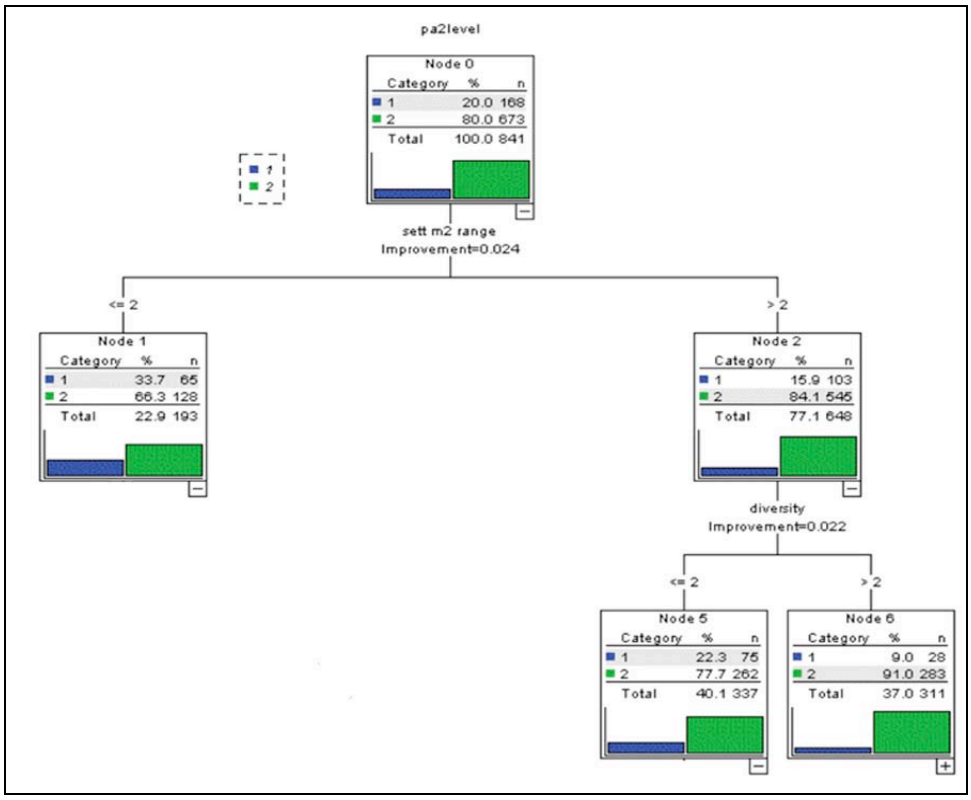


Figure 6.50. AnswerTree (©SPSS) output.

Summary. Together these analyses confirm the impact of setting size, centre, gender and diversity as predictors of preschool outdoor physical activity. Although diversity does not appear as a significant variable in the logistic regression it is interesting to see that the AnswerTree method demonstrates its effect. In summary, environmental variables relating to size of setting, diversity of setting and overall characteristics of the different centres have been shown to be important factors predicting levels of physical activity in preschool children.

6.7 Findings Summary

1. Demographic measures indicate that the sample was composed of comparable groups of children in age, gender, ethnicity, and socioeconomic status.
2. Baseline measures confirmed that the three groups of preschoolers were comparable in BMI, gross motor development, and attention functioning.
3. Children that composed the sub-sample were comparable in gender, ethnicity, BMI and gross motor development. The sub-sample showed differences in attention functioning.
4. Accelerometer Monitoring

a. One-day monitoring session showed higher total counts of outdoor activity in Centre B.

b. One-week monitoring session. Centre B shows higher total counts in the morning, afternoon and both combined.

5. Behaviour Setting Analysis

Centres differ in the number of settings, their dimensions, category, and diversity.

	Centre A	Centre B	Centre C
Area	1,194.32 m^2	1,341m^2	1,863m^2
Sub-areas	N/A	Two	Four
Settings	19	28	25

a. All centres show that the larger the setting the greater the physical activity and the larger the setting the more likely it is to be natural.

b. In Centre A the larger the setting the lower its diversity.

c. In Centres B and C, the more natural the more diverse are the settings.

d. In Centre B only, the higher the diversity, the greater the physical activity.

6. Tracking Analysis

a. Centre A. Groups shared the space, larger numbers of children were outside. High proportions of functional and dramatic play. Target children were observed playing mostly in groups. Children used natural loose materials and were in contact with trees.

b. Centre B. Slightly greater number physical activities and social interactions. Groups shared the space, larger number of children outside. Games with rules, dramatic, social conversation. Wheeled toy use. In Centre B, a higher number of settings were visited. Children used natural loose materials.

c. Centre C. functional, play with rules. Children mostly played with one other child. Children did not use natural materials but were in contact with fixed natural elements such as stumps and shrubs.

7. Teacher interactions

In general, all teachers remained at a discreet distance without interfering with children's play and their interactions are mainly positive and custodial.

8. Logistic regression and AnswerTree (©SPSS) analyses. These analyses confirm that environmental variables relating to size of setting, diversity of setting and overall characteristics of the different centres are significant factors predicting levels of physical activity in preschool children.

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Chapter 7. Discussion

The multi-method approach used to study the three preschool play areas yielded information not only about environmental variables linked with greater amounts of physical activity but also revealed the potential implications for physical activity of social interactions and programming of preschool outdoor play.

The study started by proposing the theory of affordance [52, 53] that considers the individual and the environment as an interactive system, to guide the interpretation of findings. During the course of the investigation, this theoretical concept illuminated the findings and helped to elucidate how preschool physical activity is linked to environmental variables in a way that can be applied to design.

This chapter discusses the theoretical framework, the research questions, important findings about the influence of social interactions on physical activity, and design, policy and curricular implications. The chapter ends with the limitations of the study and conclusions.

7.1 Theoretical framework

Children gather environmental information through active exploration and, if understood and used, the affordance is realized [52, 53]. The realization of an affordance depends on the dialectic relationship between the child and the environment in a “continuous perception-action” cycle as characterized by Gibson [52, 53]. In short, the affordance and the child’s capabilities should be in consonance [52, 53]. Children learn early in life about their own capacities and how to quickly adapt their growing bodies and skills to new opportunities. But if the environment does not offer developmentally appropriate affordances, the perception-action continuum is interrupted and the opportunity for learning about the environment and self is lost. Conversely, diverse and child appropriate environments offer multiple affordances supporting children’s movements through the space and the possibility of novel interactions between people, animals and objects.

The high correlations found in the most active play area (Centre B) between preschool physical activity and setting diversity confirm this relationship. The more diverse the setting the more actively engaged children are. This is critical for breaking the pattern of sedentary lifestyles but, perhaps, even more important is the recognition that movement co-acts with, stimulates and is stimulated by developmental areas such as the social,

affective and cognitive [34, 79, 97] supporting the totality of children's physical health and wellbeing [31].

How do children notice and respond to diversity? Children perceive environmental information through the *layout* of the space, the *objects* (animate and inanimate), and the *events* that occur around them [52, 53]. The layout of the site is important because it helps children situate themselves spatially as individuals and in relation to others. The objects in the space—people, animals, or plants—complete the space, offer rich information, and support children's activity. The events occurring in the space are probably the most interesting category for supporting children's activity. These are the movements and actions triggered by the child and/or external causes (i.e. variations in weather such as wind and precipitation, celebrations, special activities, etc.).

One could argue that the three play areas studied offer different physical activity affordances because they differ in their layouts, the objects they contain and the presence of events. These theoretical constructs are tightly linked to the main focus of research question 1: the potential effect of play area design on children's level of activity. Design, the arrangement of space to support a need or a specific experience, can be considered as a whole composed of the layout, the objects and the events.

7. 2 Discussion of Research questions

Findings related the three research questions are discussed here.

7.2.1 Play area design as a determinant factor of preschool physical activity level

The association between childcare outdoor play area design and the level of physical activity was confirmed by one-week accelerometry.

The analysis of behaviour maps confirms this result and demonstrates that children show greater amounts of physical activity in mixed settings (containing play equipment, vegetation, pathways, and areas for wheeled toy use). If mixed settings are not present, paths and play equipment support more vigorous activity than other settings.

These findings confirm most of the hypothesis established for the study: natural play areas produce greater amounts of children's moderate physical activity than play equipment-based or mixed environments; mixed environments produce greater amounts of combined moderate and vigorous children's physical activity than play equipment-

based or natural environments; and children's physical activity in mixed environments shows greater variability.

This study demonstrates that preschool play areas are composed of a number of behaviour settings that support different types and levels of activities. The level of activity of a play area is due to the additive effect of the layout of the site and its attributes (objects and events) on children's activities. As a result, it can be claimed that design is a critical factor for facilitating higher levels of moderate to vigorous activity in preschool play areas (7.4 Design Implications).

In this study, the play equipment-based area in Centre A did not help children to sustain greater amounts of vigorous activity as hypothesised. The existence of several pieces of play equipment (as in Centre A) might raise the level of physical activity in the setting where the equipment is installed but the amount of activity may not be enough to make the whole play area more active. However, in Centre A many children were engaged in collecting leaves, twigs and dirt, and performing dramatic play (mainly "cooking") in the "play kitchen" adjacent to one of the porches. This activity spilt out on to the grassy area and other settings affording lively social interactions. This suggests that a high incidence of moderately active dramatic play can increase the level of social interaction and provide children with critical experiences for healthy development and movement.

Centre B contained a circulation system of variable width pathways connecting to a choice of settings with different sizes and categories (natural, mixed and manufactured) readily available to the children. The observed pockets of activity created a dynamic that enticed and sustained children's activity. This suggests that the combination of a wide, sinuous wheeled toy pathway and a diversity of adjacent settings can be designed to increase physical activity.

The outdoor play areas in Centre C were not as active as expected even though they were profusely vegetated, highly diverse, and contained a pathway and play equipment (see 7.9. Conclusions). The fact that the play equipment was fenced off from other settings and children could not choose to use it unless with the whole group, might have had an impact on the results. Additionally, the program in Centre C called for smaller groups playing outside and for shorter periods of time. This meant that the children's level of physical activity was not able to benefit from the possible effects of increased social interaction.

As stated, although the three centres provide high quality childcare services, children's use of the outdoors in each of them was different. It was observed that the duration of outdoor play was conditioned by the programming and, presumably, by the attitude of teachers towards the outdoors in each centre. For instance, children in Centre A during accelerometer monitoring (one-day and one-week sessions) spent more time outside, followed by Centre B and Centre C, respectively. This was a surprising result because Centre A does not appear to support outdoor play as much as the other two. The high turnover of teachers in this centre at the time of accelerometer monitoring might have had an impact on the daily activity schedule. Furthermore, new teachers may have favoured staying outside longer to support the research activities.

7.2.2 Behaviour setting characteristics and preschool physical activity

A second intention of the study was to investigate further the relationship between environment and behaviour by looking at the environmental characteristics of the behaviour settings in each play area (size, category and level of diversity) associated with greater physical activity.

The perception of setting characteristics by children (via the site layout, objects and events) reveals the physical activity affordances of preschool play areas and, therefore, characterizes each of them [53]. This was easily observed in the most active play area (Centre B) where the combined effect of a diverse setting (natural path), wheeled toys, and parachute enticed activity as illustrated through behaviour tracking.

Behaviour map analyses yielded additional information on the effect of environmental characteristics related to preschoolers' physical activity levels. Significant correlations were found in all centres between *physical activity level* and *setting size* (i.e. the larger the size the more activity it supports). This is an obvious association because large-scale movements need more space.

Across all centres, there was a strong association between *natural settings* and *higher levels of diversity*. This is not surprising because green environments offer colours, textures, movement, and shadow patterns that enliven the settings and increase physical activity affordances. Thus, the presence of natural elements may provide a further extension to diversity associated with physical activity.

Only Centre B shows a significant and positive correlation *between diversity* and *setting size*. In Centre A this relationship is significant but negative (the bigger the setting, the

lower its diversity), which may be explained by the large lawn and relative lack of other natural elements. In Centre B, the natural path is the largest setting and contains a profuse mix of vegetation, moveable stones and other natural objects, and textured paving. In Centre C, the association is positive and weak, which may be explained because, with the exception of a large lawn, most of the natural settings are relatively small. Figure 7.1 offers a summary of the associated variables found in the most active play area (Centre B).

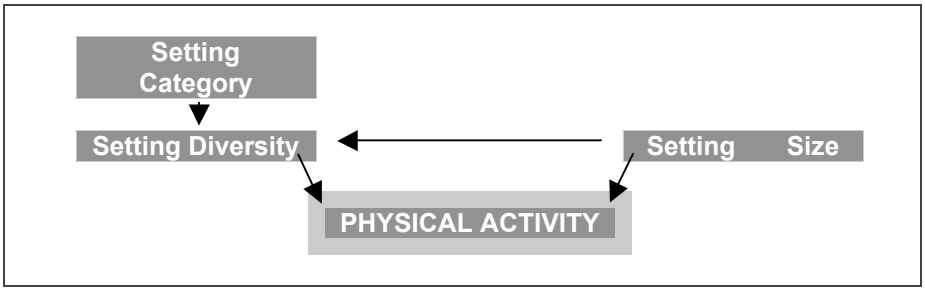

Figure 7.1 Summary of associated variables in most active play area (Centre B)

Centre B also shows a positive correlation between *physical activity level and diversity*. This interesting result may reflect the impact of the natural path where greater amounts of activity were observed. This unique association differentiates the Centre B preschool play area (most active as measured by accelerometry) and backs the assumption that a large (161m^2, 74 linear metres), diverse, and linear setting support children's sustained physical activity while outdoors. This finding extends the association between physical activity and setting size to include diversity as an associated factor. Illustrative tracking episodes support the result showing how children realize the natural path affordances performing moderate and vigorous activities.

7.2.3 The exercise of basic movements and physical activity implications

Another intention of this study was to explore the possible influence of play area design on the exercise of movement and, as an extension, on the potential enhancement of gross motor skills. According to Ayres, the more movement variations the child performs every day, the more complex and mature her/his body percept will be [97]. This is important because basic movements are linked to moderate to vigorous physical activities [141] and children need daily motor activities to establish a healthy body scheme and to develop mature patterns of fundamental movements [97, 141, 142].

Although no difference was found in children's gross motor skills among participating centres, as measured by the Test of Gross Motor Development – TGMD-2 [98],

additional activities such as dance, sports, and movement classes need to be assessed in future research as potential contributors to children's motor development. Because low-income children usually lack access to physical activity programs, they depend on childcare activities more than middle-class children that often have other physical activity opportunities as the children involved in this research might have had.

Collecting information about additional physical activity to rule out potential confounders was a limitation of the study. Nevertheless, the importance of outdoor play and its influence on motor development should not be overlooked.

7.3 The Influence of Social Interactions

As observed, contact with other children appeared to influence physical activity levels [32, 143]. Behaviour maps show the loading of use of each setting by aggregating observation data points on the illustrative map (Appendix J). In Centre B, loading increased because preschool classes shared the sub-areas with others converting the pathway into the most popular and, simultaneously, the most active setting.

It becomes apparent that dense, populated settings are more stimulating and offer a greater number of play affordances. Children fuel each other's activity. Even children that might be considered shy or followers become engaged in long play sequences. They perceive others and join in the action. Again, the continuous perception-action aids the realization of affordances [53]. The illustrative video-tracking for B-girl shows that, even though she is following another girl (the leader), she alternates varied physical activity play, games, and exploration with on-looking behaviour.

High setting loading results in *setting compactness* (higher number of children sharing multiple activities surrounded by plants and wheeled toys) and stimulates higher levels of social activity and associated physical activity. Setting *compactness* might be advantageous by providing close proximity to diverse activities where players exchange messages, invitations, and challenges, negotiate space, plan strategies, and therefore, stay active. It was observed that, in compact settings (Centre B), children went in and out of play episodes without conflict. There were always available a large enough number of players and play materials to sustain the action. Negative behaviour was sporadic and dealt without major complications between children or by facilitating teacher interventions.

The consideration of creating compact settings that support rich social interactions might be a way to secure sustained moderate and vigorous physical activity.

7.4 Design Implications

Design is becoming recognized as a key discipline for creating active living environments. The non-profit organization Active Living by Design, a national programme of the Robert Wood Johnson Foundation, USA, is one of the leaders in the field gathering and disseminating information to the design professions and the general public [144]. Unfortunately, research on the built environment and physical activity to guide evidence-based design is scarce in general and hardly exists in the area of children's environments. For instance, the most recent text on childcare design by Anita Olds covers the topic of outdoor areas in a single chapter out of 21 chapters [145].

However, public health researchers recognize the impact of the environment on sedentary lifestyles and new initiatives have been launched on this topic. For instance, in 2004, the U.S. National Institute of Environmental Health Sciences (NIEHS) [83] sponsored a national conference on "Obesity and the Built Environment" and launched a new research initiative devoted to the same topic. The objective of the Request for Proposals (RFP) was to support projects that delineate the significance and impact of the built environment on overweight and obesity by enhancing the understanding played by professionals in city and regional planning, housing, transportation, and media [82, 146]. Access to healthy foods and availability of public, green spaces (such as playgrounds, walking paths, etc.) were emphasised as determinants of physical activity and nutritious dietary practices. This RFP underlines the need for knowledge to guide future design.

The present study, although in a limited manner, underlines the significance of creating integrated, mixed environments. To support physical activity, preschool spaces need a variety of elements and levels of diversity, a wide range of choices, and physical elements that afford social interactions. The size of settings deserves consideration since environments with higher loading appear to be more active and adjacent smaller settings appear to sustain children's actions.

But the creation of high quality outdoor environments for preschoolers is highly regulated. It is not easy for childcare providers to comply with licensing requirements and safety regulations and, simultaneously, create attractive spaces for daily exploration (see 7.2 Policy Implications). How to confront these two apparently contradictory needs is a current dilemma. The opinions of educators, parents, owners, and designers are divided.

Some have chosen to comply with all regulations in the name of safety and have created play areas that appear static and “equipment based”. Others have decided to bypass the safety guidelines and have created “garden-like” play areas with minimum or no equipment. Still others have decided to leave selected pieces of equipment and to add trees, shrubs and naturalistic play settings. Surprisingly, this decision-making process does not seem to follow systematic steps and it is often driven by external reasons (budgetary, licensing, or space constraints) rather than by evidence-based design solutions.

The inclusion of teachers and landscape designers in the process of creation high quality environments is crucial. The use of interactive techniques has been devised in the past to support the effective participation of landscape professionals with people from different ages, abilities, and backgrounds [146-148].

7.4.1 Diversity and engagement

An exploratory aim of this study was to explore the possible association of environmental diversity on children’s level of engagement with each other and the environment as a factor influencing levels of physical activity. The aim was tested by tracking children’s behaviour during outdoor playtime. A greater variety of social interactions was documented for B-girl, for example, in Centre B where she was observed playing alone, with another child, two children, and in a group during a single tracking episode.

The video tracking analysis also showed differences in the number of physical activities performed by children in each play area. Comparisons among the six video tracking episodes showed B-girl performing a greater number of physical activities (18 types of physical activity such as walking, running, pulling, pushing, etc.) than girls in Centre A (7 physical activity types) and Centre C (5 physical activity types). Furthermore, children in Centre B showed higher physical activity variability than in Centres A or C (as objectively measured by accelerometers).

The study findings strongly suggest that the amount and level of physical activity afforded by preschool play areas can be intentionally affected by design. In this regard, diverse play areas containing pathways and natural elements, combining a range of setting sizes are predicted to be the most effective.

Setting diversity, as measured by a 4 point Likert scale (1-low, 4=high), shows that Centre A scores moderately low (mean 2.37) and Centres B and C score high (mean for

both centres 3.36). But it seems that the overall diversity of the play area does not influence behaviour as much as the particular level of diversity of each setting. Indeed, the analysis performed using AnswerTree (©SPSS) confirmed that diversity is a factor that predicts physical activity (6.5 Findings).

In Centre A, although most of the activity was observed in settings with lower diversity, children were often seen playing in the most diverse settings (back area of the play equipment by the trees and grasses). However, these areas are only large enough for small groups of children exploring or conducting dramatic play.

In Centre B, containing high number of mixed settings, diversity is high. It appears that vegetation lends diversity to the manufactured elements (such as play equipment, deck, picnic table) turning these settings into more dynamic and interesting places to play. Children's use of the play area in Centre B was spread among settings. One could speculate that environments offering balanced proportions of diversity encourage children to evenly and fully use most settings, realising their affordances. Clearly, centre educational programs have the potential to support these behaviours accordingly. In this regard, results in Centre B might be magnified by the strong support of experiential learning activities in the outdoors (Reggio Emilia approach). The Italian approach to early childhood education regards the environment as the "third teacher" providing a variety of sensory stimulation [149]. Exploration and discovery of materials is considered a way of establishing contact with the world.

In Centre C, setting diversity is also high. However, behaviour mapping shows children playing in some settings with relatively lower diversity. This might be caused by the fact that the play equipment area is divided with a fence and children could not choose to use the natural areas if they wished. In addition, the high proportion of plantings in Centre C may have appeared to the children as a mere backdrop without physical activity implications. The concept of agency is relevant here. Agency characterises children's actions to achieve control of the environment, act upon it, and therefore, realise affordances [52]. Settings perceived by children as not offering hands-on experiences might not be as attractive. The need for direct contact with the environment drives children's exploration and provides a sense of mastery [55]. Interactive environments foster novel behaviours, support motivation [56], and interactions with objects, animals and people.

7.4.2 Setting category

An additional dimension to take into account regarding children's physical activity is the analysis of each play area by setting category (manufactured, mixed, and natural). It becomes apparent that children use mixed environments because there are a variety of activities to choose from and their components can be manipulated. This allows children to exercise control over environmental features and become motivated by their colours, textures, and responsiveness and the high variety of activities that all of this affords [53, 56, [57]. Integrated, mixed settings sustain attention and motivation by providing a rich array of ever-changing natural and manufactured materials that expand affordances offering "things to do" with increasing levels of challenge. These settings extend children's motivation by offering diverse degrees of challenge, enticing curiosity and providing opportunities to transfer newly acquired knowledge about objects and environments. Mixed settings seem to multiply their attractiveness because they contain both the qualities of the manufactured and natural settings that support the type of intrinsic motivation described by Lepper and Henderlong as challenge, curiosity, control, and context [56].

7.4.3 Setting size

As demonstrated by the results of correlations between setting size and physical activity intensity, larger settings support greater physical activity. The most active setting was a linear path with pockets of activity surrounding it (Centre B) that, because its layout did not feel oversize. On the contrary, because it is a linear setting, it fits children's scale, allows for ample movements and high intensity activity, and supports social interactions. The latter is an important consideration because higher setting loadings seem to have a positive effect on children's activity level.

But establishing optimal setting dimensions is not an obvious task. As a possible baseline parameter, the Star Rated License of the State of North Carolina [100] requires the equivalent of 75 square feet (approximately 7 m^2) of outdoor space per child.

Centre A settings were an average of 61.86 m^2. Considering preschool groups have about 18 children enrolled, the proportion per child would be 3.43 m^2/child. In Centre B, that contains a larger number of settings, the proportion would be 2.66 m^2, and in Centre C 3.83 m^2/child. In this latter case, smaller groups were observed playing outside, sometimes only eight or nine together. If a small number of children is considered, the proportion would be 7.66 m^2/child.

The significant results obtained from the logistic regression and AnswerTree (©SPSS) analyses revealed that size of setting is the factor that best predicts walking and vigorous activities (6.5 Findings) in preschool play areas.

The optimal play setting area cannot be deduced from the findings of this study. However, it is possible to speculate that the coexistence of smaller, more intimate and diverse settings with larger linear settings offer a mix of diverse relationships more likely to result in more active preschool behaviour.

Early childhood experts agree that size matters and those young children need spaces scaled down to their body dimensions [150]. Additional research needs to be conducted to establish an objective measure of recommended outdoor area per child to accommodate that need.

7.4.4 Design research methodology

Additionally, by identifying physical activity affordances, this study developed a viable methodology for researching design aspects with behavioural implications. The development of research tools is critical for in-depth research of environments that might be conducive for active living. The combination of instruments and technical aids used in this study yielded objective information about the environment linked to children's behaviours. For instance, the configuration developed for coding tracking episodes contained a menu of physical activity types that, in future research, could be refined to include more specific physical movements or activities with the objective of understanding better how children use different behaviour settings. In addition, the incidence of the educational program could be investigated analysing in depth outdoor learning activities that, in essence, will be more active than the ones organized indoors.

Behaviour mapping with for physical activity intensity information and behaviour tracking coding using appropriate software, yield objective measures of children behaviours and their relation with the environment. The methods used in this study proved to be practical and effective tools to investigate children's physical activity in context.

It is foreseen that the methodology utilized in this study could be applied to different environments (e.g. parks or schools), populations (e.g. elderly, intergenerational groups) and to answer additional research questions related to physical activity issues (e.g., inclusiveness).

7.5 Policy Implications

A key purpose of this study is also to influence childcare licensing policy and accreditation regulations with objective information about the impact of preschool play area design on children's physical activity. Provision of outdoor active living environments at childcare centres is critical because this institution is the highest predictor of preschool physical activity [10, 11] and the outdoors is the strongest correlate of physical activity [12, 13].

The identification of specific design characteristics seems to be the first step towards establishing clear regulations for the development of healthy and active environments. It has been demonstrated that existing policies and established practices influence the level of preschool physical activity [73].

Childcare is a highly regulated, policy sensitive institution. For example in the State of North Carolina, where the present study was conducted, childcare centres are licensed using newly developed regulations: the "Star Rated License" issued by the North Carolina Division of Child Development [100]. Although, the star rated license is a voluntary system, parents use the ratings to choose high quality childcare. The response from providers to comply has been positive and more than 4,000 centres are already licensed. This shows the beneficial impact that policy may have.

Indeed, as shown in Chapter 2.2, the accreditation provided by the National Association for the Education of Young Children [29] is a predictor of outdoor play area quality (as measured by the baseline conditions of play areas in the State of North Carolina [27].

The search for evidence-based, site-specific recommendations is currently pursued by governmental health organizations in an effort to counteract the sedentary lifestyle trend and to support the work of planners and designers [139]. The places where children spend time daily are a highlighted priority.

In sum, studies that bring knowledge concerning the dynamics of active children's environments will support the creation of new standards of practice. The evaluation of outdoor play areas from the perspective of children's daily physical activity will follow as a natural spin off and necessary complement to the new standards. Currently, in the State of North Carolina childcare centres are mostly evaluated with instruments that superficially assess outdoor environments [74].

For that reason, specific instruments should be developed to measure preschool activity and play area characteristics using research findings such as those originated in this study. The author is already working with that objective as part of a research team that is testing variables (such as level of setting diversity and setting size) as discriminatory items to be included in such a tool [82].

The Preschool Outdoor Environments Measurement Scale POEMS [138] is an example of a scale intended to measure the overall outdoor quality of preschool play areas and might be precursor to instruments focussed on active lifestyles outdoors.

There is no doubt that childcare centres are potential agents of change that could be achieved by designing spaces and programmes that support healthy development. Appropriate space design and childcare licensing policies and accreditation regulations can be seen as viable instruments to produce environmental change and, therefore, behaviour modifications in the daily lives of millions of children [31].

7.5.1 Safety regulation implications

The safety guidelines implemented in the United States are a significant factor influencing the characteristics of childcare play areas and have adversely affected environmental diversity. In the last twenty years, playgrounds in general and childcare play areas in particular, have turned into unchallenging spaces that no longer support children's daily requirements for engaging physical activity, and therefore, healthy development.

Childcare providers who returned the North Carolina Childcare Outdoor Play and Learning Spaces Baseline Survey [27] also showed concern about the impact of new health and safety regulations on the quality of the children's outdoor experience.

The Public Playground Safety guidelines, US Consumer Product Safety Commission CPSC [151]. had the purpose of reducing the risk of accidents in public playgrounds. The document was created as a set of guidelines rather than mandatory regulations in order to accommodate the needs of the many different types of existing playgrounds. In the "Introduction" to the Public Playground Safety Guidelines Handbook, the CPSC expects the guidelines to "promote greater safety awareness among those who purchase, install, and maintain public playground equipment." Great consideration was given to fall zones and safety surfacing under play equipment because 25 years ago falls and head injuries were the most frequent types of serious injury in public playgrounds.

Clearly, this praiseworthy effort was an essential step towards creating safe public playgrounds for children. However, some would say that they were never intended to be applied to the supervised, “private” spaces of childcare centres [152]. As currently implemented, the CPSC Guidelines have become an obstacle for creating environments that support healthy physical development in childcare centres and should be addressed in future research.

7.6 Curriculum implications

To solve the crisis of sedentary lifestyles and overweight children, strategies on many fronts are required. Educational programming approaches are a fruitful direction as they are likely to have an impact on children’s level of activity since outdoor play is an integral part of curricular activities and scheduling. Findings suggest that having a high quality outdoor environment is not sufficient to encourage preschool activity. For instance, the fact that Centre C favoured curricular activities with small groups of individuals resulted in small groups of preschoolers playing outside, producing lower setting loadings and social interactions. The duration of outdoor play can also be a consequence directly influenced by the educational approach.

Because outdoor play is the main physical activity of young children, programmes and environments should be created for children’s daily enjoyment [21, 31, 34]. The importance of outdoor free play should be also emphasized. Even though the behaviour coding conducted in this study only addressed play in a descriptive manner, it suggests that diverse environments support a greater repertoire of play behaviours (see Behaviour Tracking, B-girl). Play implications associated with physical activity should be addressed in further research to reveal the role of outdoor play in breaking sedentary patterns of behaviour.

A rich outdoor preschool curriculum not only will address the need for physical activity but also will influence children’s motivation to explore and discover [26], support multisensory stimulation and motor planning behaviours [97], and foster active learning [150].

The potential effect of teacher/child ratio is an additional point to consider. In this study, the centre with the most active outdoors (Centre B) shows a general teacher/child ratio of 3. This ratio is lower than the other two research sites where the teacher/child ratio was calculated at 4 for Centre A and 5 for Centre C. It is hypothesised that, if a larger number of teachers is available for outdoor play, there will be more opportunities for

them to support play and even interact with children. In turn, teacher facilitation may support and entice additional outdoor activities. The findings of this study do not offer sufficient evidence to establish the optimum outdoor teacher/child ratio; however, it is possible to assume that the smaller ratio might have had some influence on the higher level of activity observed in Centre B. Future research should look into this important issue, including an estimation of the relative greater cost of additional staff compared to its potential health benefits.

Additionally, the creation of rich outdoor play spaces brings to the forefront the need for teacher training and the creation of an innovative outdoor curriculum. There are hopeful signs that teacher awareness is raising. Childcare providers who returned the *North Carolina Childcare Outdoor Play and Learning Spaces Baseline Surve*y [34] expressed a strong need for training and professional help to improve and manage their outdoor play areas. Early childhood educators are ideal agents for promoting change in young children's routines [21].

7. 7 Limitations of the study

Several limitations to the study have been identified. The first limitation arises because, compared to the baseline survey of childcare centres in North Carolina [27], all three sites studied here (Centres A, B, and C) would be considered "high quality" due to their levels of diversity and overall quality design. This means that findings are only related to aspects regarding play area design rather than play area overall quality.

The second limitation is related to the climatic and geographical location of the centres. All centres are located in the Triangle area of North Carolina, USA, South of the frost line and the research activities were performed during the mild temperature season. Because climatic conditions affect the use of the outdoors (e.g. high ozone radiation in the Summer, wintry temperatures) different results might have been found if the study would have been conducted in a different season.

The lower number of children observed in Centre C should be addressed in future research. Although this brought insight about the effect of programming on children's levels of activity, remedial actions could be taken in the future such as devoting additional observation days to capture the pattern of outdoor activity.

Additionally, all centres are located in the Piedmont region (i.e. region of rolling hills and pine woods). Findings cannot be extended to other geographical or climatic regions.

The study was strictly focused on physical activity levels leaving without consideration other important early childhood behaviours such as play, verbal expression, and hands-on learning.

The last limitation relates to the sample that was composed of middle class children with educated parents. This may have produced biased results since few of these children were African-American or Hispanic populations that are considered at-risk for becoming overweight and obese [153].

7.8 Future Research Direction

Two aspects seem to have a strong impact on preschool physical activity. First, the layout of the site containing a diverse, natural path with connected pockets of smaller setting. Second, setting compactness (i.e. greater number of children playing at the same time) as a result of programming and the design of smaller settings. To test these findings, a quasi-experimental study would be advisable. Each of the conditions could be investigated separately proposing an environmental change in Centre A (the addition of a natural path with pockets of activity) and a programmatic change in Centre C (the use of sub-areas by greater number of children simultaneously). Data from the present study would constitute the baseline for such a study.

7.9 Conclusion

The study strongly suggests that the amount of physical activity afforded by preschool play areas can be intentionally improved by design. In this regard, diverse play areas containing pathways and natural elements, combining a range of setting sizes are predicted to be the most effective. The level of activity of a play area is due to the additive effect of the layout of the site and its attributes (objects and events) on children's activities.

Furthermore, the study indicates that childcare centres with mixed play areas (containing manufactured and natural settings) and diverse site layouts may have an impact on children's activity. In this research, the most effective setting for motivating physical activity was a wide, curvy, wheeled toy pathway in Centre B. The analyses of Centre B behaviour maps (Appendix J) show that such a setting supports greater amounts of physical activity and numbers of children playing together. Pathway settings organize the site circulation and help children to orientate themselves. The wheeled toy pathways in Centres B and C afford preschool physical activity in different ways. Both these settings

are sizable (161m^2 and 240 m^2 respectively) and comparable in linear dimensions (Centre B, 74m; Centre C, 73m). The site layout in Centre B appears to have a positive effect on children's level of activity by providing pockets of activity along the way. The use of these smaller settings located off the wide pathway can create a synergy in the play area that translates into sustained activity. Bordering vegetation adds interest, provides play materials, and functions as a screen from other children playing in different segments of the same setting. The soft screening of views supports the impression that the setting is larger and, consequently, "journeys" feel longer. In Centre B, effective supervision by teachers was ensured by low shrubbery.

Additionally, findings suggest that having a high quality outdoor environment is not sufficient to encourage preschool physical activity. The educational approach is critical in facilitating children's use of the outdoors. Diverse and ample settings are critical for breaking the pattern of sedentary lifestyles but even more important is the recognition that movement co-acts with, stimulates and is stimulated by developmental areas such as the social, affective and cognitive supporting the totality of children's physical health and wellbeing.

The creation of compact settings that support rich social interactions and educational programs that foster these interactions, are likely to be a positive way to secure sustained moderate and vigorous outdoor physical activity. Settings perceived by children as not offering hands-on experiences are unlikely to be as attractive. The need for direct contact with the environment drives children's exploration and provides a sense of mastery. Interactive environments foster novel behaviours, support motivation, and interactions with objects, animals and people.

Optimal setting size cannot be deduced from the findings of this study. However, it is possible to speculate that the coexistence of larger, linear settings in combination with smaller, more intimate and diverse settings offer a mix more likely to support active preschool activities. Additional research is needed to establish an objective measure of recommended outdoor area per child.

The identification of specific design characteristics is the first step towards establishing clear policy regulations for the development of healthy, active daily environments. Appropriate space design and childcare licensing policies and accreditation regulations are viable vehicles to produce environmental change and, therefore, behaviour modifications in the daily lives of millions of children.

Further research should be undertaken to confirm the findings of this study in a wider array of preschool institutions, climatic zones, topographic regions, and socioeconomic groups.

This study is intended as a research contribution to the emerging field of design for active living. Early childhood appears as a one-time opportunity for key preventive measures.

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Appendix A. Sample and sub-sample

Centre A

CENTER A – Sample

ID#	Girl	Boy	DoB	Assessment Date	Age in months	Age years/months	White	African Am	Hispan	Asian	Other	BMI	TGMD-2	EC-ADDES	Starting date	Total time at center	Accel DAY	Accel WEEK
1		1	9/1/01	9/27/04	37	3.0	1					17.7	73	92	3/11/02	31		
2	1		9/8/00	9/27/04	49	4.1	1					15.4	35	37	1/8/02	33	1	
3	1		2/19/00	6/22/05	64	5.3	1					16.1	92	88	3/15/04	15		1
4		1	8/5/99	6/22/05	71	5.9	1					17.3	42	60	3/1/04	7		1
5	1		5/22/00	8/24/04	51	4.3	1					15.7	79	68	7/2/01	38	1	1
6	1		6/16/00	8/24/04	50	4.2	1					15.6	58	100	1/2/01	44	1	1
7	1		9/7/01	9/27/04	37	3.1	1					18.5	16	67	1/2/02	33		
8	1		11/10/99	8/24/04	58	4.8	1					17.1	73	100	2/8/00	55	1	
9		1	4/3/01	8/24/04	47	3.9	1					16.3	58	65	6/25/01	38	1	
10		1	2/18/01	8/24/04	47	3.9	1					14.6	13	48	7/2/01	38		
11		1	8/14/01	9/27/04	37	3.1	1					16.0	79	43	11/15/01	34		
12		1	4/21/00	9/27/04	53	4.4	1					14.4	58	59	9/9/02	25	1	
13	1		2/23/00	8/24/04	54	4.5		1				17.1	95	88	8/15/01	36	1	1
14		1	7/6/01	10/18/04	39	3.3	1					16.7	84	70	2/23/04	8	1	
15	1		9/26/00	8/24/04	47	3.9	1					16.1	99	28	2/8/04	7		
16	1		2/18/99	8/24/04	66	5.5			1			17.2	27	20	2/19/01	42		
17		1	2/5/00	6/22/05	65	5.4		1				17.3	89	34	4/19/04	14		
18		1	11/23/98	8/24/04	69	5.8	1					17.3	97	26	11/5/03	10		
19	1		9/16/01	6/22/05	45	3.8	1					14.8	84	13	11/19/01	27		
20		1	5/26/01	9/27/04	40	3.3					1	15.6	95	92	4/7/03	18	1	1
21	1		12/7/00	9/27/04	46	3.8	1					19.0	73	43	3/5/01	43		1
22	1		6/27/01	8/24/04	38	3.2	1					15.7	89	75	4/19/04	4	1	1
23	1		12/4/00	9/27/04	46	3.8	1					15.5	73	68	7/6/04	3		
24	1		9/20/00	8/24/04	47	3.9	1					16.9	65	15	1/29/04	7	1	1
25		1	11/2/99	8/24/04	58	4.8	1					15.1	58	100	7/6/04	2	1	1
26		1	7/21/99	8/24/04	61	5.1	1					18.7	65	28	11/20/01	33		
27	1		1/6/01	8/24/04	44	3.6	1					15.7	99	19	8/20/02	24		
28		1	11/20/99	8/24/04	57	4.8	1					15.3	99	46	7/2/01	38		
29		1	9/18/00	8/24/04	47	3.9					1	16.8	12	83	4/7/03	17	1	1
30		1	10/22/00	8/24/04	46	3.8	1					14.7	79	100	10/14/03	10		
	15	15				4.21	25	2	1	0	2					24	13	11

Centre B

CENTRE B - Sample

ID#	Girl	Boy	DoB	Assessemnt Date	Age in months	Age years/months	White	African Am	Hispan	Asian	Other	BMI	TGMD	EC-ADDES	Starting date	Total time at center	Accel DAY	Accel WEEK
1		1	11/30/99	9/17/04	58	4.90	1					14.85	73	93	11/27/00	46	1	
2		1	7/12/00	8/23/04	49	4.10	1					15.70	98	59	10/16/00	46		
3		1	5/15/01	8/30/05	52	4.30	1					15.90	35	25	8/14/01	49		
4	1		10/2/00	8/23/04	47	3.10	1					16.39	84	37	3/4/02	30	1	
5	1		10/19/99	9/17/04	59	4.10	1					16.94	92	67	10/23/00	47	1	1
6	1		11/13/00	8/30/04	46	3.90	1					15.81	73	17	2/1/01	43		
7	1		12/6/00	9/10/04	45	3.90	1					15.76	65	68	8/29/02	24	1	1
8		1	12/16/00	8/23/04	44	3.80	1					16.72	97	34	2/26/01	42	1	1
9		1	12/11/01	12/13/04	36	3.01	1					15.73	42	92	4/3/01	44		
10	1		9/4/99	8/23/04	60	4.11		1				15.27	95	85	7/8/01	38		
11		1	2/2/00	9/17/04	56	4.70	1					18.02	42	100	9/22/00	48		1
12	1		10/19/98	8/23/04	70	5.10				1		14.0	95	50	7/8/01	38		
13		1	8/10/00	8/30/04	49	4.00	1					15.84	50	19	10/1/01	35		
14		1	4/21/01	8/4/04	39	3.40	1					18.7	65	27	7/23/01	36	1	
15		1	1/13/00	8/23/04	55	4.70	1					16.50	50	54	7/10/00	49	1	1
16		1	11/11/00	8/30/04	46	3.90	1					18.0	50	16	9/13/02	24		
17		1	2/18/01	8/23/04	42	3.60				1		17.60	79	70	8/16/01	36		1
18	1		10/31/00	9/10/04	46	3.10		1				15.90	79	48	1/9/01	44		1
19		1	6/20/00	9/17/04	51	4.20	1					16.47	89	100	9/12/00	48		1
20	1		9/19/00	8/30/04	47	3.11	1					15.87	95	6	2/1/01	43		
21	1		2/28/01	8/23/04	42	3.50	1					12.97	97	8	8/8/01	37		
22	1		7/13/01	9/17/04	38	3.20	1					16.78	92	100	12/3/01	34	1	1
23	1		1/13/00	8/23/04	55	4.70					1	16.72	35	15	2/2/04	7	1	1
24		1	12/10/00	9/14/04	45	3.90		1				16.0	98	59	3/5/01	42	1	
25	1		12/2/99	8/30/04	57	4.80	1					16.8	79	95	1/15/00	56	1	
26		1	10/3/00	9/14/04	47	3.11	1					16.4	84	38	2/5/01	43	1	
27	1		3/17/01	9/14/04	42	3.50	1					15.8	98	85	6/19/01	39		
28		1	3/25/01	9/10/04	42	3.50					1	15.98	98	25	5/14/01	40	1	
29	1		3/25/01	8/23/04	41	3.40					1	15.69	42	5	9/4/01	36	1	
30		1	2/14/00	8/30/04	55	4.60				1		13.47	79	40	10/13/03	11		
	14	16				3.91	21	3	0	3	3			51.233		38.4	14	10

Centre C

CENTRE C- Sample																		
ID#	Girl	Boy	DoB	Assessemnt Date	Age in months	Age years/months	White	African Am	Hispan	Asian	Other	BMI	TGMD-2	EC ADDES	Starting date	Total time at center	Accel DAY	Accel WEEK
1		1	12/25/99	8/18/04	56	4.70	1					14.91	79	57	4/1/02	29	1	1
2		1	11/22/99	9/8/04	58	4.9	1					17.39	92	39	1/3/00	56		
3	1		3/14/00	8/8/04	53	4.5	1					15.93	73	100	6/6/00	50	1	1
4		1	12/26/99	8/10/04	56	4.7	1					16.64	50	38	12/17/01	32	1	1
5		1	8/31/00	8/10/04	47	4.11	1					15.19	95	43	12/10/01	32	1	
6		1	3/15/00	8/10/04	53	4.4	1					14.85	89	16	2/15/01	42		
7	1		9/21/00	9/8/04	48	3.11	1					15.50	73	56	9/3/02	24		
8	1		3/27/00	8/10/04	53	4.4	1					14.98	89	37	9/3/02	23		1
9		1	9/8/00	8/18/04	47	3.11				1		18.23	65	68	10/16/02	22		
10	1		5/17/00	8/8/04	51	4.3	1					16.33	89	54	7/17/00	49	1	
11		1	8/2/00	9/8/04	49	4.10	1					16.98	84	54	10/12/00	47	1	
12		1	6/25/00	9/8/04	50	4.2	1					15.35	79	59	8/26/02	24		1
13		1	5/13/99	8/10/04	63	5.2	1					13.78	<99	57	4/17/00	52		
14		1	2/18/00	8/18/04	54	4.6	1					14.30	79	17	9/2/03	12		
15	1		11/14/00	36755.0	45	3.8					1	14.24	89	85	12/3/01	33	1	
16	1		7/25/00	8/25/04	49	4.10					1	30.61	27	85	9/17/01	35	1	
17	1		6/24/00	8/25/04	50	4.2	1					32.87	65	48	11/13/00	45	1	1
18	1		7/18/00	8/25/04	49	4.10	1					14.71	84	48	10/30/00	46		1
19		1	1/7/00	8/18/04	55	4.7		1				15.90	21	34	4/10/00	52	1	1
20	1		8/11/00	9/17/04	49	4.10	1					13.60	79	6	12/4/00	45		
21	1		5/30/00	8/8/04	50	4.3	1					14.51	92	48	9/18/00	47	1	
22	1		5/30/00	8/8/04	50	4.3	1					15.93	79	37	9/18/00	47		
23	1		9/9/00	9/15/04	48	4.00	1					15.96	95	13	9/16/02	24	1	
24	1		3/2/00	8/25/04	54	4.5	1					15.37	89	68	9/30/02	23		
25		1	6/28/00	9/22/04	51	4.2	1					15.74	65	39	8/19/03	13	1	1
26	1		2/24/99	9/8/04	67	5.6	1					15.86	92	93	7/26/99	62		
27	1		1/28/01	8/22/04	-43	3.7	1					14.85	95	33	4/2/01	41		1
28		1	7/23/00	8/8/04	49	4.10	1					16.58	95	37	10/16/00	46	1	
29	1		8/6/00	9/8/04	49	4.10	1					16.20	95	56	9/16/03	12		
30		1	8/6/00	9/8/04	49	4.10	1					13.84	84	65	9/16/03	12		
	16	14				4.27	26	1	0	1	2			49.7		35.8	14	10

Appendix B. Sample and sub-sample analyses

Sample

Centre A	Centre B	Centre C	Total
30 children	30 children	30 children	116 children

Children's Age

Age

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
A	30	4.2	0.8217	0.1500	3.9	4.5	3.0	5.9
B	30	3.9	0.6140	0.1121	3.7	4.1	3.0	5.1
C	30	4.3	0.5048	0.0922	4.1	4.5	3.1	5.6
Total	90	4.1	0.6720	0.0708	4.0	4.3	3.0	5.9

ANOVA
years,months

			Sum of Squares	df	Mean Square	F	Sig.
Between Groups	(Combined)		2.295	2	1.148	2.634	0.077
	Linear Term	Contrast	0.063	1	0.063	0.145	0.704
		Deviation	2.232	1	2.232	5.124	0.026
Within Groups			37.899	87	0.436		
Total			40.194	89			

Gender

Gender * Centre numeric Crosstab

			Centre numeric			Total
			A	B	C	
Gender	girl	Count	15	14	16	45
		% within Centre numeric	50%	47%	53%	50.0%
	boy	Count	15	16	14	45
		% within Centre numeric	50%	53%	47%	50.0%
Total		Count	30	30	30	90
		% within Centre numeric	100%	100%	100%	100%

Gender

Gender		Chi-Square Tests	
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	0.267	2	0.875
Likelihood Ratio	0.267	2	0.875
Linear-by-Linear Association	0.066	1	0.797
N of Valid Cases	90		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 15.00.

Ethnicity

Ethnicity numeric * Centre numeric Crosstab						
			Centre numeric			Total
			A	B	C	
Ethnicity numeric	white	Count	25	21	26	72
		% within Centre numeric	83%	70%	87%	80%
	African American	Count	2	3	1	6
		% within Centre numeric	7%	10%	3%	7%
	Hispanic	Count	1	0	0	1
		% within Centre numeric	3%	0%	0%	1%
	Asian	Count	0	3	1	4
		% within Centre numeric	0%	10%	3%	4%
	other	Count	2	3	2	7
		% within Centre numeric	7%	10%	7%	8%
Total		Count	30	30	30	90
		% within Centre numeric	100.0%	100.0%	100.0%	100.0%

Ethnicity		Chi-Square Tests	
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.369	8	0.497
Likelihood Ratio	8.404	8	0.395
Linear-by-Linear Association	0.000	1	1.000
N of Valid Cases	90		

a. 12 cells (80.0%) have expected count less than 5. The minimum expected count is .33.

Body Mass Index (BMI)

Means Plots
Descriptives
Body Mass Index

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
A	30	16.3437	1.20803	0.22055	15.8927	16.7948	14.45	18.96
B	30	16.0841	1.22142	0.22300	15.6280	16.5402	12.97	18.68
C	30	16.5709	4.27148	0.77986	14.9759	18.1659	13.60	32.87
Total	90	16.3329	2.63568	0.27782	15.7809	16.8849	12.97	32.87

ANOVA
Body Mass Index

			Sum of Squares	df	Mean Square	F	Sig.
Between Groups	(Combined)		3.560	2	1.780	0.252	0.778
	Linear Term	Contrast	0.774	1	0.774	0.110	0.741
		Deviation	2.786	1	2.786	0.394	0.532
Within Groups			614.705	87	7.066		
Total			618.265	89			

Multiple Comparisons
Dependent Variable: Body Mass Index
Bonferroni

(I) Centre numeric	(J) Centre numeric	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
A	B	0.25966	0.68632	1.000	-1.4158	1.9351
	C	-0.22715	0.68632	1.000	-1.9026	1.4483
G	A	-0.25966	0.68632	1.000	-1.9351	1.4158
	C	-0.48681	0.68632	1.000	-2.1622	1.1886
S	A	0.22715	0.68632	1.000	-1.4483	1.9026
	B	0.48681	0.68632	1.000	-1.1886	2.1622

Centre	Mean
A	16.3437
B	16.0841
C	16.5709

Test of Gross Motor Development (TGMD-2)

Means Plots
Descriptives

Test of Gross Motor Development-Percentile

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
A	30	68.60	26.479	4.834	58.71	78.49	12	99
B	30	75.00	21.841	3.988	66.84	83.16	35	98
C	30	79.37	18.871	3.445	72.32	86.41	21	99
Total	90	74.32	22.797	2.403	69.55	79.10	12	99

ANOVA

Test of Gross Motor Development-Percentile

			Sum of Squares	df	Mean Square	F	Sig.
Between Groups	(Combined)		1,759.489	2	879.744	1.720	0.185
	Linear Term	Contrast	1,738.817	1	1,738.817	3.400	0.069
		Deviation	20.672	1	20.672	0.040	0.841
Within Groups			44,494.167	87	511.427		
Total			46,253.656	89			

Post Hoc Tests
Multiple Comparisons

Dependent Variable: Test of Gross Motor Development-Percentile
Bonferroni

(I) Centre numeric	(J) Centre numeric	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
A	B	-6.400	5.839	0.828	-20.65	7.85
	C	-10.767	5.839	0.206	-25.02	3.49
B	A	6.400	5.839	0.828	-7.85	20.65
	C	-4.367	5.839	1.000	-18.62	9.89
C	A	10.767	5.839	0.206	-3.49	25.02
	B	4.367	5.839	1.000	-9.89	18.62

Early Childhood Attention Deficit Disorder Evaluation Scale (EC-ADDES)

Means Plots
Descriptives

Early Childhood Attention Deficit Disorder Evaluation Scale-Percentile

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
A	30	59.167	28.704	5.241	48.45	69.89	13	100
B	30	51.233	31.808	5.807	39.36	63.11	5	100
C	30	49.667	22.743	4.152	41.17	58.16	6	100
Total	90	53.356	28.003	2.952	47.49	59.22	5	100

ANOVA

Early Childhood Attention Deficit Disorder Evaluation Scale-Percentile

			Sum of Squares	df	Mean Square	F	Sig.
Between Groups	(Combined)		1556.422	2.000	778.21	0.99	0.375
	Linear Term	Contrast	1353.750	1.000	1353.75	1.73	0.192
		Deviation	202.672	1.000	202.67	0.26	0.613
Within Groups			68236.200	87.000	784.32		
Total			69792.622	89.000			

Multiple Comparisons

Dependent Variable: Early Childhood Attention Deficit Disorder Evaluation Scale-Percentile

Bonferroni

(I) Centre numeric	(J) Centre numeric	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
A	B	7.933	7.231	0.827	-9.72	25.59
	C	9.500	7.231	0.577	-8.15	27.15
B	A	-7.933	7.231	0.827	-25.59	9.72
	C	1.567	7.231	1.000	-16.09	19.22
C	A	-9.500	7.231	0.577	-27.15	8.15
	B	-1.567	7.231	1.000	-19.22	16.09

Sub-sample Composition

Sub-sample Gender

Crosstab

Count

		sex		
		0	1	Total
centre numeric	1	7	5	12
	2	6	4	10
	3	5	5	10
Total		18	14	32

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	0.237	2	0.888
Likelihood Ratio	0.236	2	0.889
Linear-by-Linear Association	0.138	1	0.711
N of Valid Cases	32		

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 4.38.

Sub-sample Ethnicity

Crosstab
Count

		ethnicity				Total
		White	AfricanAm	Asian	Other	
centre numeric	1	8	2	1	1	12
	2	8	0	1	1	10
	3	9	1	0	0	10
Total		25	3	2	2	32

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.876	6	0.694
Likelihood Ratio	5.850	6	0.440
Linear-by-Linear Association	1.551	1	0.213
N of Valid Cases	32		

a. 9 cells (75.0%) have expected count less than 5. The minimum expected count is .63.

Sub-sample BMI, TGMD-2, EC-ADDESS

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
BMI	1	12	16.508	1.1016	0.3180	15.808	17.208	15.1	19.0
	2	10	16.741	0.6845	0.2165	16.251	17.231	15.8	18.0
	3	10	17.188	5.5439	1.7531	13.222	21.154	14.7	32.9
	Total	32	16.793	3.0939	0.5469	15.678	17.909	14.7	32.9
TGMD-2	1	12	69.00	24.346	7.028	53.53	84.47	12	95
	2	10	72.00	22.642	7.160	55.80	88.20	35	97
	3	10	70.00	21.613	6.835	54.54	85.46	21	95
	Total	32	70.25	22.280	3.939	62.22	78.28	12	97
ECADDES	1	12	70.83	27.686	7.992	53.24	88.42	15	100
	2	10	41.30	13.905	4.397	31.35	51.25	15	70
	3	10	49.30	20.034	6.335	34.97	63.63	33	100
	Total	32	54.88	24.753	4.376	45.95	63.80	15	100

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
BMI	Between Groups	2.560	2	1.280	0.126	0.882
	Within Groups	294.179	29	10.144		
	Total	296.739	31			
TGMD	Between Groups	50.000	2	25.000	0.047	0.954
	Within Groups	15,338.000	29	528.897		
	Total	15,388.000	31			
ECADDES	Between Groups	5,209.633	2	2,604.817	5.480	0.010
	Within Groups	13,783.867	29	475.306		
	Total	18,993.500	31			

Appendix C. Test of Gross Motor Development TGMD-2 Illustrated short Version

Dale Ulrich, 1985

The short-form of the TGMD includes only four Locomotor Skill items and four Object Control (ball-skills) items

Object Control (ball skills)	Locomotor Skills
Bounce	Run
Kick	Slide
Catch	Hop
Throw	Jump

OBJECT CONTROL (BALL SKILLS)

Bounce

Equipment/Conditions: A 25 cm playground ball and a flat hard surface

Directions: Bounce the ball three times using one hand. Repeat 3 trials

Criteria:

1. Contact ball with one hand at about hip height.

2. Pushes ball with a finger (not slap)

3. Ball contacts floor in front of (or to the outside of) foot on the side of the hand being used.

Catch

Equipment/Conditions: A 20 cm sponge, 5 m of clear space, marking.

Directions: Mark 2 lines 5 m apart. Student stands on 1 line and the tosser on the other. Toss the ball underhand directly to student with a slight arc saying: “catch it with your hands”. Only count tosses between student’s shoulders and waist.

Criteria

1. Preparation phase where elbows are flexed and hands are in front of the body.

2. Arms extend in preparation for ball contact.

3. Ball is caught and controlled by hands only.

4. Elbows bend to absorb force.

Reliability

Throw

Criteria

1. A backward arc of the throwing arm initiates the windup.

2. Rotation of hip and shoulder to a point where the non-dominant side faces an imaginary target.

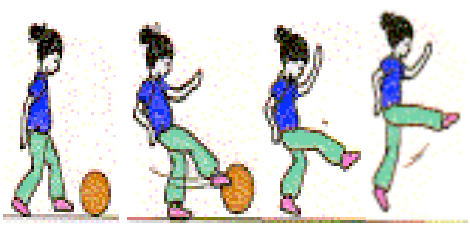
3. Weight is transferred by stepping with the foot opposite the throwing hand.

4. Follow-through beyond ball release diagonally across body toward side opposite throwing arm.

Equipment/Conditions: A tennis ball, a soft wall (e.g., covered with a curtain) and 8 m space.

Directions: Tell the student to throw the ball “hard” to the wall.

Kick



Criteria

1. Rapid continuous approach to the ball.

2. The trunk is inclined backward during ball contact.

3. Forward swing of the arm opposite kicking leg.

4. Follow-through by hopping on non-kicking leg.

Equipment/Conditions: A 20 cm plastic or lightly deflated playground ball, 10 m of clear space, marking.

Directions: Mark 1 line 10 m away from a wall and 1 that is 13 m away from it. Place the ball on the line nearest to the wall and tell the student to stand on the other line. Tell the student to kick the ball “hard” toward the wall.

LOCOMOTOR SKILLS

Run

Equipment/Conditions: A 15 m clear space and marking devices.

Directions: Mark off 2 lines 15 m apart. Instruct the student to “run fast” from 1 line to the other.

Criteria

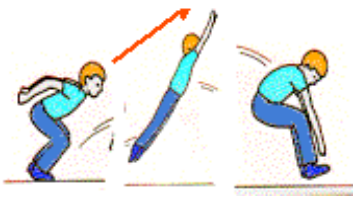
1. Brief period where both feet are off the ground.

2. Arms move in opposition to legs, elbows bent.

3. Foot placement near or on a line and not flat footed.

4. Non-support leg bent approximately 90 degrees (close to buttocks).

Jump



Criteria

1. Preparatory movement includes flexion of both knees with arms extended behind the body

2. Arms extend forcefully forward and upward, reaching full extension above head.

3. Take off and land on both feet simultaneously.

4. Arms are brought downward during landing.

Equipment/Conditions: A 3 m free space and marking devices.

Directions: Mark off starting line on the floor, mat or carpet. Have the student start behind the line. Tell the student to jump far.

Hop

Equipment/Conditions: A 5 m clear space.

Directions: Ask the student to hop 3 times, first on 1 foot and then on the other.

Criteria

1. Foot of non-support leg is bent and carried in back of the body.

2. Non-support leg swings in pendular fashion to produce force.

3. Arms bent at elbows and swing forward on take off.

4. Able to hop on the right and left foot.

Slide

Criteria

1. Body turned sideways to desired direction of travel.

2. A step sideways followed by a slide of the trailing foot to a point next to the lead foot.

3. A short period where both feet are off the floor.

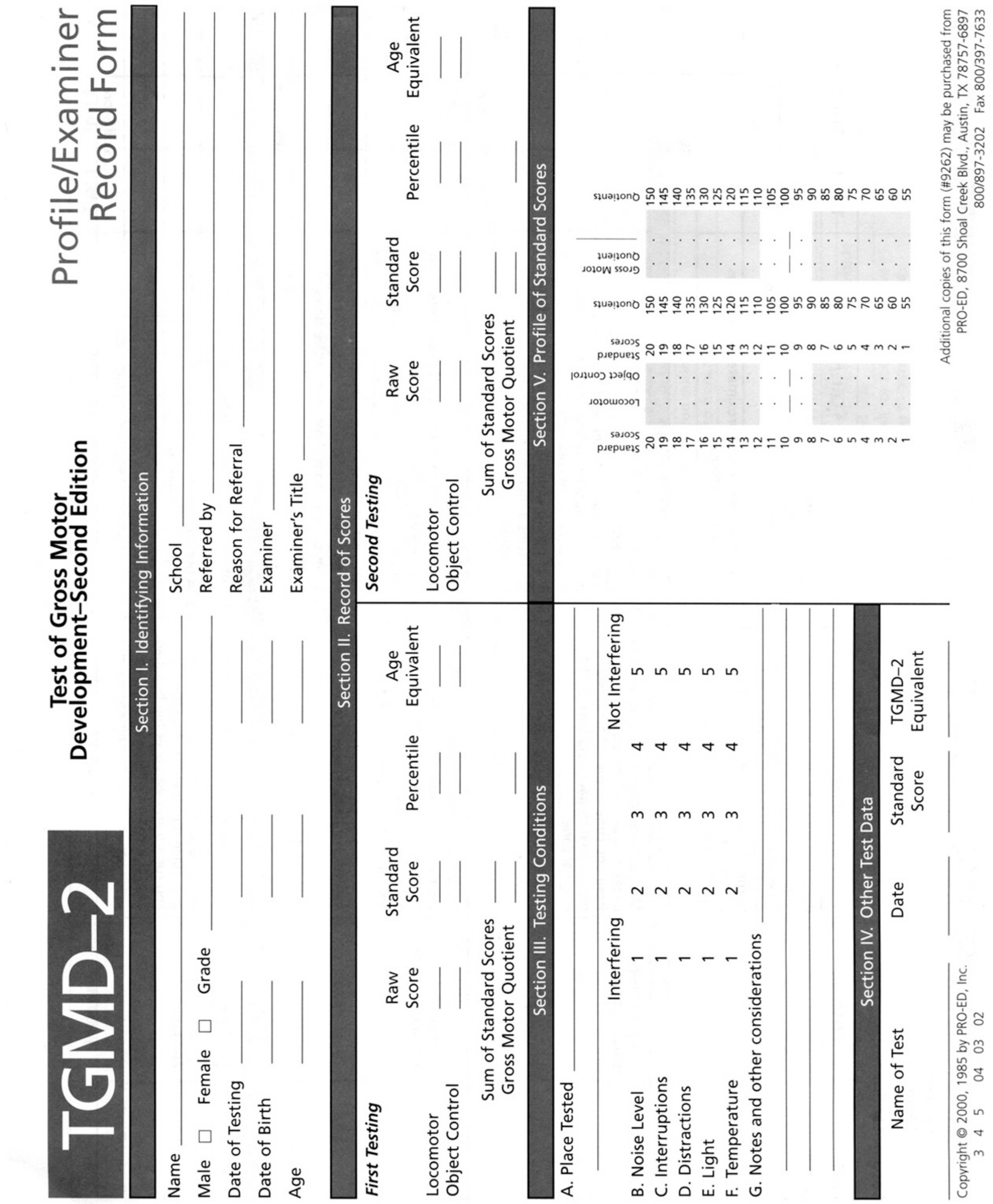
4. Able to slide to the right and the left side.

Equipment/Conditions: A 10 m clear space and marking devices.

Directions: Mark off 2 lines 10 m apart. Instruct the student to slide from 1 line to the other 3 times facing the same direction.

Text adapted from presentation by Dr. Shayke Hutzler (C) http://mofet.macam98.ac.il/~shayke

Appendix D. Test of Gross Motor Development TGMD-2 Record Form



TGMD–2

Test of Gross Motor Development–Second Edition

Profile/Examiner Record Form

Section I. Identifying Information

Name ____ School ____

Male ☐ Female ☐ Grade ____ Referred by ____

Date of Testing ____ ____ ____ Reason for Referral ____

Date of Birth ____ ____ ____ Examiner ____

Age ____ ____ ____ Examiner's Title ____

Section II. Record of Scores

First Testing

	Raw Score	Standard Score	Percentile	Age Equivalent
Locomotor	____	____	____	____
Object Control	____	____	____	____
Sum of Standard Scores		____		
Gross Motor Quotient		____	____	

Second Testing

	Raw Score	Standard Score	Percentile	Age Equivalent
Locomotor	____	____	____	____
Object Control	____	____	____	____
Sum of Standard Scores		____		
Gross Motor Quotient		____	____	

Section III. Testing Conditions

A. Place Tested ____

	Interfering				Not Interfering
B. Noise Level	1	2	3	4	5
C. Interruptions	1	2	3	4	5
D. Distractions	1	2	3	4	5
E. Light	1	2	3	4	5
F. Temperature	1	2	3	4	5

G. Notes and other considerations ____

Section IV. Other Test Data

Name of Test	Date	Standard Score	TGMD–2 Equivalent
____	____	____	____

Section V. Profile of Standard Scores

Standard Scores	Locomotor	Object Control	Standard Scores	Quotients	Gross Motor Quotient	Quotients
20			20	150		150
19			19	145		145
18			18	140		140
17			17	135		135
16			16	130		130
15			15	125		125
14			14	120		120
13			13	115		115
12			12	110		110
11			11	105		105
10			10	100		100
9			9	95		95
8			8	90		90
7			7	85		85
6			6	80		80
5			5	75		75
4			4	70		70
3			3	65		65
2			2	60		60
1			1	55		55

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3 4 5 04 03 02

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Section VI. Subtest Performance Record

Preferred Hand: Right ☐ Left ☐ Not Established ☐
Preferred Foot: Right ☐ Left ☐ Not Established ☐

Locomotor Subtest

Skill	Materials	Directions	Performance Criteria	Trial 1	Trial 2	Score
1. Run	60 feet of clear space, and two cones	Place two cones 50 feet apart. Make sure there is at least 8 to 10 feet of space beyond the second cone for a safe stopping distance. Tell the child to run as fast as he or she can from one cone to the other when you say "Go." Repeat a second trial.	1. Arms move in opposition to legs, elbows bent			
			2. Brief period where both feet are off the ground			
			3. Narrow foot placement landing on heel or toe (i.e., not flat footed)			
			4. Nonsupport leg bent approximately 90 degrees (i.e., close to buttocks)			
					Skill Score	
2. Gallop	25 feet of clear space, and tape or two cones	Mark off a distance of 25 feet with two cones or tape. Tell the child to gallop from one cone to the other. Repeat a second trial by galloping back to the original cone.	1. Arms bent and lifted to waist level at takeoff			
			2. A step forward with the lead foot followed by a step with the trailing foot to a position adjacent to or behind the lead foot			
			3. Brief period when both feet are off the floor			
			4. Maintains a rhythmic pattern for four consecutive gallops			
					Skill Score	
3. Hop	A minimum of 15 feet of clear space	Tell the child to hop three times on his or her preferred foot (established before testing) and then three times on the other foot. Repeat a second trial.	1. Nonsupport leg swings forward in pendular fashion to produce force			
			2. Foot of nonsupport leg remains behind body			
			3. Arms flexed and swing forward to produce force			
			4. Takes off and lands three consecutive times on preferred foot			
			5. Takes off and lands three consecutive times on nonpreferred foot			
					Skill Score	
4. Leap	A minimum of 20 feet of clear space, a beanbag, and tape	Place a beanbag on the floor. Attach a piece of tape on the floor so it is parallel to and 10 feet away from the beanbag. Have the child stand on the tape and run up and leap over the beanbag. Repeat a second trial.	1. Take off on one foot and land on the opposite foot			
			2. A period where both feet are off the ground longer than running			
			3. Forward reach with the arm opposite the lead foot			
					Skill Score	

Skill	Materials	Directions	Performance Criteria	Trial 1	Trial 2	Score
5. Horizontal Jump	A minimum of 10 feet of clear space and tape	Mark off a starting line on the floor. Have the child start behind the line. Tell the child to jump as far as he or she can. Repeat a second trial.	1. Preparatory movement includes flexion of both knees with arms extended behind body			
			2. Arms extend forcefully forward and upward reaching full extension above the head			
			3. Take off and land on both feet simultaneously			
			4. Arms are thrust downward during landing			
					Skill Score	
6. Slide	A minimum of 25 feet of clear space, a straight line, and two cones	Place the cones 25 feet apart on top of a line on the floor. Tell the child to slide from one cone to the other and back. Repeat a second trial.	1. Body turned sideways so shoulders are aligned with the line on the floor			
			2. A step sideways with lead foot followed by a slide of the trailing foot to a point next to the lead foot			
			3. A minimum of four continuous step–slide cycles to the right			
			4. A minimum of four continuous step–slide cycles to the left			
					Skill Score	
			Locomotor Subtest Raw Score (sum of the 6 skill scores)			

Object Control Subtest

Skill	Materials	Directions	Performance Criteria	Trial 1	Trial 2	Score
1. Striking a Stationary Ball	A 4-inch lightweight ball, a plastic bat, and a batting tee	Place the ball on the batting tee at the child's belt level. Tell the child to hit the ball hard. Repeat a second trial.	1. Dominant hand grips bat above nondominant hand			
			2. Nonpreferred side of body faces the imaginary tosser with feet parallel			
			3. Hip and shoulder rotation during swing			
			4. Transfers body weight to front foot			
			5. Bat contacts ball			
					Skill Score	
2. Stationary Dribble	An 8- to 10-inch playground ball for children ages 3 to 5; a basketball for children ages 6 to 10; and a flat, hard surface	Tell the child to dribble the ball four times without moving his or her feet, using one hand, and then stop by catching the ball. Repeat a second trial.	1. Contacts ball with one hand at about belt level			
			2. Pushes ball with fingertips (not a slap)			
			3. Ball contacts surface in front of or to the outside of foot on the preferred side			
			4. Maintains control of ball for four consecutive bounces without having to move the feet to retrieve it			
					Skill Score	

Skill	Materials	Directions	Performance Criteria	Trial 1	Trial 2	Score
3. Catch	A 4-inch plastic ball, 15 feet of clear space, and tape	Mark off two lines 15 feet apart. The child stands on one line and the tosser on the other. Toss the ball underhand directly to the child with a slight arc aiming for his or her chest. Tell the child to catch the ball with both hands. Only count those tosses that are between the child's shoulders and belt. Repeat a second trial.	1. Preparation phase where hands are in front of the body and elbows are flexed			
			2. Arms extend while reaching for the ball as it arrives			
			3. Ball is caught by hands only			
					Skill Score	
4. Kick	An 8- to 10-inch plastic, playground, or soccer ball; a beanbag; 30 feet of clear space; and tape	Mark off one line 30 feet away from a wall and another line 20 feet from the wall. Place the ball on top of the beanbag on the line nearest the wall. Tell the child to stand on the other line. Tell the child to run up and kick the ball hard toward the wall. Repeat a second trial.	1. Rapid continuous approach to the ball			
			2. An elongated stride or leap immediately prior to ball contact			
			3. Nonkicking foot placed even with or slightly in back of the ball			
			4. Kicks ball with instep of preferred foot (shoelaces) or toe			
					Skill Score	
5. Overhand Throw	A tennis ball, a wall, tape, and 20 feet of clear space	Attach a piece of tape on the floor 20 feet from a wall. Have the child stand behind the 20-foot line facing the wall. Tell the child to throw the ball hard at the wall. Repeat a second trial.	1. Windup is initiated with downward movement of hand/arm			
			2. Rotates hip and shoulders to a point where the nonthrowing side faces the wall			
			3. Weight is transferred by stepping with the foot opposite the throwing hand			
			4. Follow-through beyond ball release diagonally across the body toward the nonpreferred side			
					Skill Score	
6. Underhand Roll	A tennis ball for children ages 3 to 6; a softball for children ages 7 to 10; two cones; tape; and 25 feet of clear space	Place the two cones against a wall so they are 4 feet apart. Attach a piece of tape on the floor 20 feet from the wall. Tell the child to roll the ball hard so that it goes between the cones. Repeat a second trial.	1. Preferred hand swings down and back, reaching behind the trunk while chest faces cones			
			2. Strides forward with foot opposite the preferred hand toward the cones			
			3. Bends knees to lower body			
			4. Releases ball close to the floor so ball does not bounce more than 4 inches high			
					Skill Score	
					Object Control Subtest Raw Score (sum of the 6 skill scores)	

Appendix E. Early Childhood Attention Deficit Disorder Evaluation Scale ECADDES – School Version Rating Form

SCHOOL VERSION RATING FORM

Stephen B. McCarney

COVER SHEET

RATING GUIDELINES

- The student should be rated by educators with primary observational opportunities who interact directly with the student during instructional situations.
- Any number of educators may rate the student. Each person should independently rate (i.e., without conferring with others) the student using a separate rating form.
- It is not necessary to complete the rating of a student in one day. Several days may elapse before the rater is able to complete the scale.
- It is recommended that the rater read each quantifier with the item before rating the item. Using item 28 as an example, the rater would first read, "Does not grab things away from others," then "One to several times per month grabs things away from others," then "One to several times per week grabs things away from others," then "One to several times per day grabs things away from others," and finally "One to several times per hour grabs things away from others."
- If the rater has not personally observed the student demonstrate the behavior, the rating should be

  [0]

  DOES NOT ENGAGE IN THE BEHAVIOR.

- If the rater has observed the student for more than one month and the behavior has been demonstrated one to several times (i.e., one to three times), the rating should be

  [1]

  ONE TO SEVERAL TIMES PER MONTH.

- If the behavior has been demonstrated one or more times per week, even several times per week (i.e., one to four times), the rating should be

  [2]

  ONE TO SEVERAL TIMES PER WEEK.

- If the behavior has been demonstrated at least once a day or more than one time a day (i.e., one to four times), the rating should be

  [3]

  ONE TO SEVERAL TIMES PER DAY.

- If the behavior has been demonstrated at least once an hour and included behavior with unlimited frequency which may even defy accurate counting at extremely high rates, the rating should be

  [4]

  ONE TO SEVERAL TIMES PER HOUR.

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(800) 542-1673

ECADDES-2 SV 5/02
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H A W T H O R N E
Phone: (800) 542-1673 FAX: (800) 442-9509

TO RATER: Rate every item using the quantifiers (0-4) provided. Every item must be rated. **Do not leave any boxes blank.**

DOES NOT ENGAGE IN THE BEHAVIOR	ONE TO SEVERAL TIMES PER **MONTH**	ONE TO SEVERAL TIMES PER **WEEK**	ONE TO SEVERAL TIMES PER **DAY**	ONE TO SEVERAL TIMES PER **HOUR**
0	1	2	3	4

SUBSCALE 1

- ☐ 1. Rushes through activities with little or no regard to accuracy or quality
- ☐ 2. Is easily distracted by other activities in the classroom, other children, the teacher, etc.
- ☐ 3. Does not listen to what other children are saying
- ☐ 4. Does not hear all of what is said (e.g., misses word endings, misses key words such as "do not," etc.)
- ☐ 5. Does not direct attention or fails to maintain attention to important sounds in the immediate environment (e.g., teacher directions, public address system, etc.)
- ☐ 6. Is unsuccessful in activities requiring listening (e.g., games, following oral directions, etc.)
- ☐ 7. Needs oral questions and directions frequently repeated
- ☐ 8. Attends more successfully when close to the source of sound (e.g., when seated close to the teacher)
- ☐ 9. Requires eye contact in order to listen successfully (e.g., one-to-one situation)
- ☐ 10. Fails to demonstrate short-term memory skills (e.g., does not remember two- or three-step directions, does not remember materials needed for a task, etc.)
- ☐ 11. Fails to remember sequences (e.g., events in a daily routine: dressing, brushing teeth, etc.)
- ☐ 12. Has difficulty concentrating (e.g., staying involved in an activity, following a conversation, etc.)
- ☐ 13. Is disorganized to the point of not having necessary materials, losing materials, failing to find materials, etc.
- ☐ 14. Does not perform or complete classroom activities during class time (e.g., does not perform the activity or does not use the time provided, will go on to another activity before completing the first, etc.)
- ☐ 15. Fails to perform activities independently (e.g., continually asks for assistance or reassurance; does not begin, work on, or complete activities without assistance; etc.)
- ☐ 16. Does not remain on task (e.g., is more interested in other activities, sits and does nothing, etc.)
- ☐ 17. Does not listen to or follow verbal directions
- ☐ 18. Forgets (i.e., forgets things, forgets to return things, forgets to do things, etc.)
- ☐ 19. Has a short attention span (e.g., does not sit still while a story is being read, does not keep his/her attention on assigned activities, is easily distracted, etc.)
- ☐ 20. Starts but does not complete activities (e.g., coloring, helping with chores, building with blocks, listening to stories, etc.)
- ☐ 21. Does not prepare for daily routines (e.g., getting ready for lunch, preparing to go outside, etc.)
- ☐ 22. Does not organize responsibilities (e.g., neglects to complete tasks, loses things, is not ready for scheduled activities on time, does not return things, etc.)
- ☐ 23. Fails to follow necessary steps in doing things (e.g., performing chores, getting ready for lunch, preparing to go home, etc.)
- ☐ 24. Changes from one activity to another without finishing the first, without putting things away, before it is time to move on, etc.

_____ **Raw Score**

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SUBSCALE 2

- ☐ 25. Engages in physically dangerous activities (e.g., climbs on things, runs in hallways, etc.)
- ☐ 26. Begins activities before receiving directions or instructions, or does not follow directions or instructions
- ☐ 27. Does not wait his/her turn in activities or games
- ☐ 28. Grabs things away from others
- ☐ 29. Blurts out answers without being called on
- ☐ 30. Interrupts the teacher (e.g., begins talking while the teacher is talking, goes up to the teacher while the teacher is working with other children, etc.)
- ☐ 31. Interrupts other children (e.g., talks while they are talking, makes noises, laughs, etc.)
- ☐ 32. Talks to others during quiet activity periods
- ☐ 33. Moves about while seated, fidgets, squirms, etc.
- ☐ 34. Appears restless (e.g., shifts position in seat, paces about, etc.)
- ☐ 35. Bothers other children who are trying to work, listen, play, etc.
- ☐ 36. Makes unnecessary comments in the classroom (e.g., talks to other children without permission, interrupts, blurts out answers, etc.)
- ☐ 37. Reacts immediately to situations without thinking, is impatient, fails to wait for a turn or for assistance from a teacher, etc.
- ☐ 38. Fails to comply with teachers or other personnel (e.g., refuses to do what he/she is told, goes on doing what he/she was doing, does the opposite of what he/she is told, etc.)
- ☐ 39. Does not consider the consequences of his/her behavior (e.g., knows that his/her behavior will result in a negative consequence but engages in the behavior anyway, engages in physically dangerous activities without regard to being injured, etc.)
- ☐ 40. Intrudes on others (e.g., during private times; when people are talking, trying to work, or involved in activities; etc.)
- ☐ 41. Has accidents which are the result of impulsive or careless behavior
- ☐ 42. Fails to follow a routine (e.g., does things out of order, does not wait for an activity at the scheduled time, etc.)
- ☐ 43. Does not follow the rules of games
- ☐ 44. Leaves seat or assigned area without permission
- ☐ 45. Does not work in a group situation (e.g., does not stay involved in an activity and work productively at a table with peers, with peers nearby, etc.)
- ☐ 46. Hops, skips, and jumps when moving from one place to another instead of walking
- ☐ 47. Handles objects (e.g., twirls pencils, plays with things in work area, spins scissors on pencils, etc.)
- ☐ 48. Talks beyond what is expected or at inappropriate times
- ☐ 49. Does not wait appropriately for assistance from an instructor
- ☐ 50. Engages in inappropriate behaviors while seated (e.g., tips chair or desk, puts feet on desk, touches others as they walk by, taps and makes noises, etc.)
- ☐ 51. Becomes overexcited (e.g., loses control in group activities, blurts out answers, forgets rules, becomes loud, etc.)
- ☐ 52. Demonstrates inappropriate behavior when moving with a group (e.g., fails to stay in line, runs, pushes, etc.)
- ☐ 53. Moves about unnecessarily (e.g., leaves seat, walks around the classroom, rocks, shakes head, etc.)
- ☐ 54. Climbs on things
- ☐ 55. Makes excessive noise (talking, burping, humming, tapping, etc.)
- ☐ 56. Does not play or work quietly

_____ Raw Score

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SCHOOL VERSION RATING FORM

Stephen B. McCarney

PROFILE SHEET

Name of student: _____ Gender: _____
School: _____ Grade: _____
City: _____ State: _____
Date of rating: _____ (year) _____ (month) _____ (day)
Date of birth: _____ (year) _____ (month) _____ (day)
Age at rating: _____ (years) _____ (months) _____ (days)
Rated by (observer's name): _____
Dates during which observation of student occurred:
From _____ To _____
Amount of time spent with student:
Per day _____ Per week _____

SUMMARY OF SCORES

Subscales	Raw Score	Standard Score (Appendix A)	Raw Score SEM (Table 7)
1. Inattentive	_____	_____	_____
2. Hyperactive-Impulsive	_____	_____	_____

Total Scale	Sum of Subscale SS	%ile (Appendix B)
	_____	_____

How well the student is known by the rater (indicate type of interactions): _____
_____
_____

Standard Scores	Subscales: 1 Inattentive	Subscales: 2 Hyperactive-Impulsive	Percentiles	Percentile Rank
20	●	●	>99	●
19	●	●	95	●
18	●	●	90	●
17	●	●	85	●
16	●	●	80	●
15	●	●	75	●
14	●	●	70	●
13	●	●	65	●
12	●	●	60	●
11	●	●	55	●
10	●	●	50	●
9	●	●	45	●
8	●	●	40	●
7	●	●	35	●
6	●	●	30	●
5	●	●	25	●
4	●	●	20	●
3	●	●	15	●
2	●	●	10	●
1	●	●	5	●
0	●	●	<1	●

Important: Before using this scale, read the section titled *Rating Guidelines* on page one.

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Appendix F. Centre Profile Questionnaire

Centre: _____ Date _____

1. Age range of children: _____ 2. Total number of children: _____

3. Centre square footage _____ 4. Capacity at any one time: _____

5. Staff: Teachers _____ Assistant teachers _____ Coordinators: _____ Other _____

6. Is there a stated philosophy for the centre? If so, please summarize it in a few words or attach document / flier.

To what extent the following statements characterize the operational philosophy of your centre (5 = strongly →1 = weakly). All responses will be kept confidential.	5	4	3	2	1
7. For the most part, this centre encourages children to follow their own interests rather than follow a curriculum.					
8. Most teachers stress conformity to rules and group expectations.					
9. Most classroom activities are focused on group rather than individual teaching.					
10. I believe the children need strong role models from the staff.					
11. I would characterize this centre as pursuing a “traditional” versus an progressive philosophy on education.					
12. I would characterize the staff as actually practicing an progressive versus a “traditional” mode of teaching.					
13. The centre’s outdoors is as important as the indoors					

14. Do you have a brochure that describes your centre? Please attach a copy to this sheet.

15. Please attach the preschool week schedule showing outdoor playtime.

Thank you very much for taking time to complete this questionnaire.

Appendix G. Teacher Profile Questionnaire

(Completed by Centre Director)

The objective of this form is to develop a profile of the preschool teachers in your centre. Please fill in the below information for all of **preschool teachers** and **assistants**. To preserve anonymity the initials of each teacher will be used as identifier. No complete names will be used, and all information about the centre and staff will be kept strictly anonymous and confidential.

Centre: _____ Director _____ Date _____

Teacher's3initials	Gender	Age range	Education level	Primary Caregiver	Secondary Caregiver	Admin Responsib	Volunteer	Years experience	Years centre

Key

Age range: 20-25, 26-30, 31-35, 36-40, 41-45, 46-50, 51-55, 56-60, 61-65.

Years of Formal Education:

High School 1

High School plus some College 2

College Degree 3

Masters Degree 4

PhD 5

Role:

PCG=Primary Care Giver

SCG=Secondary Care Giver

AR=Administrative Responsibility

V=Volunteer

Use additional sheets if necessary. Thank you very much for your cooperation.

Appendix H. The Observer Configuration

The Observer

Configuration Review - MtoMDec05v3(1)

Location : C:\Documents and Settings\All Users\Noldus\
The Observer\Workspaces\Projects\
MtoMDec05v3(1).opp,.ocp,.opd

Observation recorder: PC

Description

Settings

Setting	Value
Recording method	Continuous
Automatically generate key codes	Yes
Case sensitive	Yes
Duration of Observation	Maximum

Duration: 0-01:30:00

Observation timing based on	Observed Time

Independent Variables

Number of Independent Variables: 6

Independent Variable Name	Type	Values
centre	Nominal	A
		B
		C
		Jordan
		(…Add while scoring)
name	Nominal	
		(…Add while scoring)
gender	Nominal	boy

girl

(…Add while scoring)

weather Nominal clear

overcast

partially cloudy

cloudy

(…Add while scoring)

temperature Numeric 32 to 100

other Nominal (None)

(…Add while scoring)

Subjects

Behaviours

Number of behavioural classes: 10

Appendix I. Environment and Behaviour Analyses

Percent of observed behaviours.

The Observer (percent of observation)

	Centre A			Centre B			Centre C	
Time (sec)	3606.36	1174.5		959.76	3452.27		1164.37	1135.6
min	60.11	19.58		16.00	57.54		19.41	18.93
	A-boy	A-girl		B-boy	B-girl		C-boy	C-girl
climbing	7.7	0	climbing	1.95	0.09	climbing	0	0.97
crawling	8.83	0	crawling	3.28	0.11	crawling	0.54	0
digging	1.09	10.55	digging	2.66	0	digging	0	0
hanging	0.07	0	hanging	0	0	hanging	0	0
jumping	6.43	0	jumping	2.16	0.38	jumping	0	0
kicking	0.11	0	kicking	1.78	0	kicking	0	0
kneeling	2.25	28.59	kneeling	0	5.5	kneeling	20.21	0
lying	0.1	0	lying	0	3.74	lying	0	0
moving	1.31	4.37	moving	3.86	9.97	moving	6.64	3.14
pulling	0	0	pulling	0	6.8	pulling	0	0
pushing	0	0	pushing	0	1.64	pushing	0	0
rolling	0	0	rolling	0.48	1.25	rolling	0	0
running	7.76	4.98	running	27.29	5.43	running	16.96	5.22
runPULL	0	0	runPULL	3.64	4.3	runPULL	0	0
runPUSH	0	0	runPUSH	0	2.17	runPUSH	0	0
sitting	5.77	7.21	sitting	14.54	3.57	sitting	11.6	71.18
sliding	1.19	0	sliding	0	0	sliding	0	0
standing	23.24	23.42	standing	2.65	18.07	standing	8.4	5.64
still	0	0	still	0	0.31	still	0	0
swinging	5.88	0	swinging	0	0	swinging	0	0
walking	27.96	20.89	walking	33.38	27.95	walking	35.65	13.84
walkPULL	0	0	walkPULL	2.33	7.02	walkPULL	0	0
walkPUSH	0.33	0	walkPUSH	0	1.71	walkPUSH	0	0
	A-boy	A-girl		B-boy	B-girl		C-boy	C-girl
group	60.44	73.78	group	56.44	53.2	2children	56.84	80.32
2children	23.94	18.28	2children	22.3	27.06	NOinter	10.01	19.31
NOinter	11.83	7.94	1child	0	10.71	group	33.16	0.38
1child	0	0	NOinter	21.27	9.03	1child	0	0
	Total duration of interval (% of interval)							
	A-boy	A-girl		B-boy	B-girl		C-boy	C-girl
toy2	73.96	74.16	NOtoy	19.6	60.25	dramatic	50.01	80.55
functional	44.35	15.15	onlooking	14.38	30.99	toy1	13.11	64.97
dramatic	38.6	54.97	toy2	1.53	28.09	toy2	7.17	31.98
toy1	23.57	23.94	gamew/rules	0	25.97	transition	5.75	10.63
onlooking	8.69	6.49	functional	35.26	25.35	onlooking	4.21	4.48
social convers	4.89	12.7	toy1	78.88	11.66	social convers	0.43	4.35
transition	3.48	3.57	social convers	41.43	8.07	NOtoy	79.72	3.05
NOtoy	2.47	1.9	dramatic	0	6.48	disengaged	0	0
disengaged	0	0	transition	0	2.47	functional	13.77	0
gamew/rules	0	0	disengaged	0	0.39	gamew/rules	25.83	0
negative beha	0	7.12	negative beha	1.39	0.02	negative beha	0	0
otherinter	0	0	otherinter	7.53	0	otherinter	0	0
	A-boy	A-girl		B-boy	B-girl		C-boy	C-girl
nowheel	100	100	nowheel	92.59	61.45	nowheel	100	100
cart	0	0	cart	7.41	38.55	cart	0	0
	A-boy	A-girl		B-boy	B-girl		C-boy	C-girl
NoNATloose	61.6	38.8	NoNATloose	83.06	90.78	NoNATloose	100	100
NATloo1	21.29	26.68	NATloo2	16.73	0	NATloo1	0	0
NATloo2	17.12	34.52	NATloo1	0.2	9.22	NATloo2	0	0
	A-boy	A-girl		B-boy	B-girl		C-boy	C-girl
NOnatfx	99.44	89.52	NOnatfx	98.2	65.68	NOnatfx	99.65	75.65
natfx1	0.56	10.48	natfx1	1.8	0	natfx1	0.35	24.35
	A-boy	A-girl		B-boy	B-girl		C-boy	C-girl
NOfxelem	67.8	100	NOfxelem	100	99.87	NOfxelem	100	50.82
fxelem1	32.2	0	fxelem1	0	0.13	fxelem1	0	49.18
fxelem2	0	0	fxelem2	0	0	fxelem2	0	0
	A-boy	A-girl		B-boy	B-girl		C-boy	C-girl
none	78.84	82.67	none	58.7	76.7	none	94.15	93.81
positive	14.58	14.15	positive	14.95	12.54	custodial	5.85	1.66
custodial	5.97	3.17	custodial	26.35	10.77	neutral	0	0
neutral	0.56	0	neutral	0	0	positive	0	4.53
negative	0.05	0	negative	0	0	negative	0	0

Non-parametric correlations

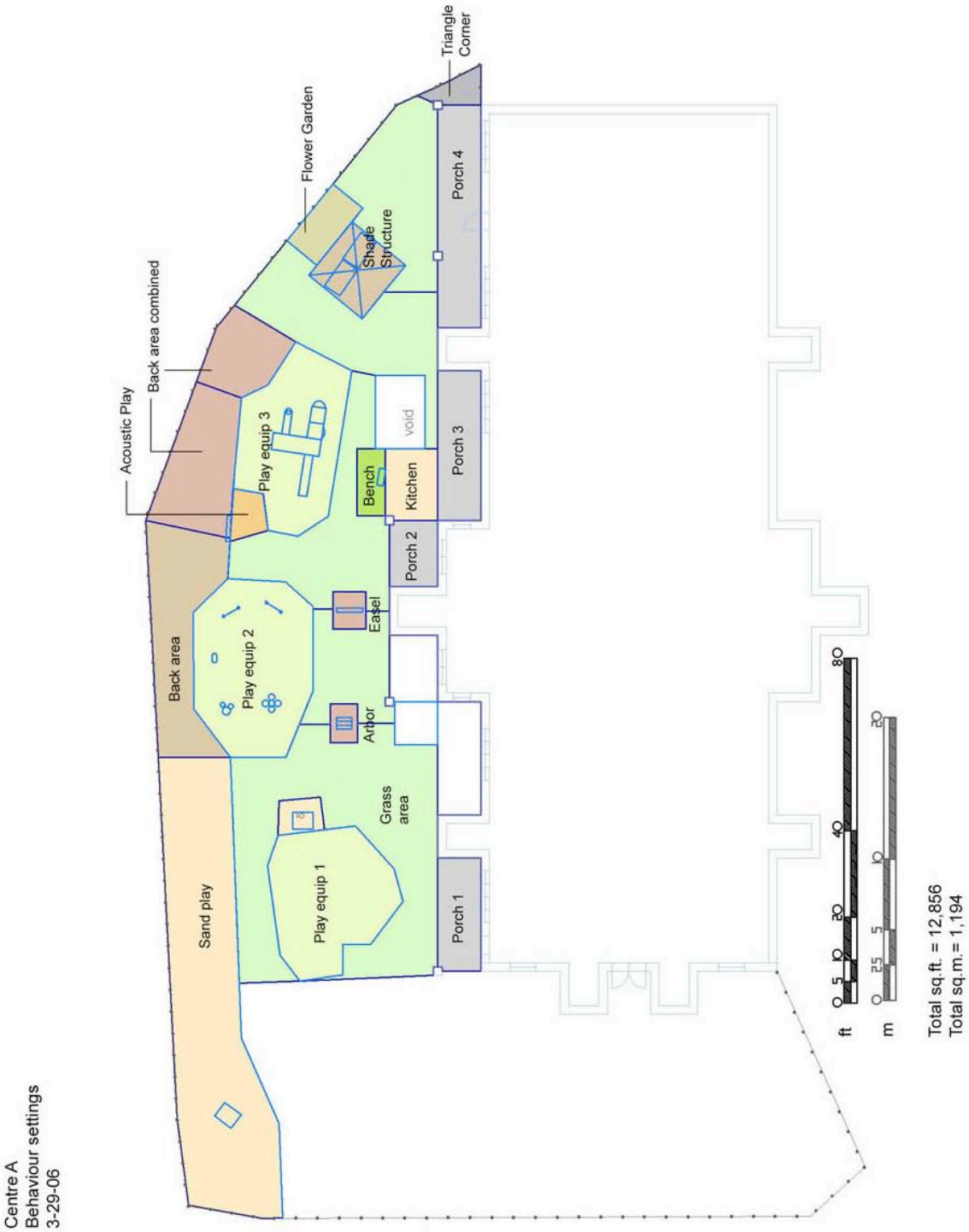
Setting m2 range – pa activity level (1,2,3) – setting diversity (1-4)– setting category (1=manufactured, 2=mixed, 3=natural)				sett m2 range	palevel	diversity	setting category numeric
A	Spearman's rho	sett m2 range	Correlation Coefficient	1.000	.205(**)	-.243(**)	.516(**)
			Sig. (2-tailed)	.	.001	.000	.000
			N	239	239	239	239
		Palevel	Correlation Coefficient	.205(**)	1.000	-.107	.014
			Sig. (2-tailed)	.001	.	.099	.824
			N	239	239	239	239
		diversity	Correlation Coefficient	-.243(**)	-.107	1.000	.165(*)
			Sig. (2-tailed)	.000	.099	.	.011
			N	239	239	239	239
		setting category numeric	Correlation Coefficient	.516(**)	.014	.165(*)	1.000
			Sig. (2-tailed)	.000	.824	.011	.
			N	239	239	239	239
B	Spearman's rho	sett m2 range	Correlation Coefficient	1.000	.294(**)	.120(*)	-.057
			Sig. (2-tailed)	.	.000	.013	.234
			N	432	432	432	432
		palevel	Correlation Coefficient	.294(**)	1.000	.113(*)	.034
			Sig. (2-tailed)	.000	.	.019	.475
			N	432	432	432	432
		diversity	Correlation Coefficient	.120(*)	.113(*)	1.000	.683(**)
			Sig. (2-tailed)	.013	.019	.	.000
			N	432	432	432	432
		setting category numeric	Correlation Coefficient	-.057	.034	.683(**)	1.000
			Sig. (2-tailed)	.234	.475	.000	.
			N	432	432	432	432
C	Spearman's rho	sett m2 range	Correlation Coefficient	1.000	.183(*)	.060	.057
			Sig. (2-tailed)	.	.010	.400	.424
			N	196	196	196	196
		palevel	Correlation Coefficient	.183(*)	1.000	-.032	.058
			Sig. (2-tailed)	.010	.	.654	.416
			N	196	196	196	196
		diversity	Correlation Coefficient	.060	-.032	1.000	.903(**)
			Sig. (2-tailed)	.400	.654	.	.000
			N	196	196	196	196
		setting category numeric	Correlation Coefficient	.057	.058	.903(**)	1.000
			Sig. (2-tailed)	.424	.416	.000	.
			N	196	196	196	196

** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

Appendix J. Behaviour Maps and Tracking Maps

Centre A

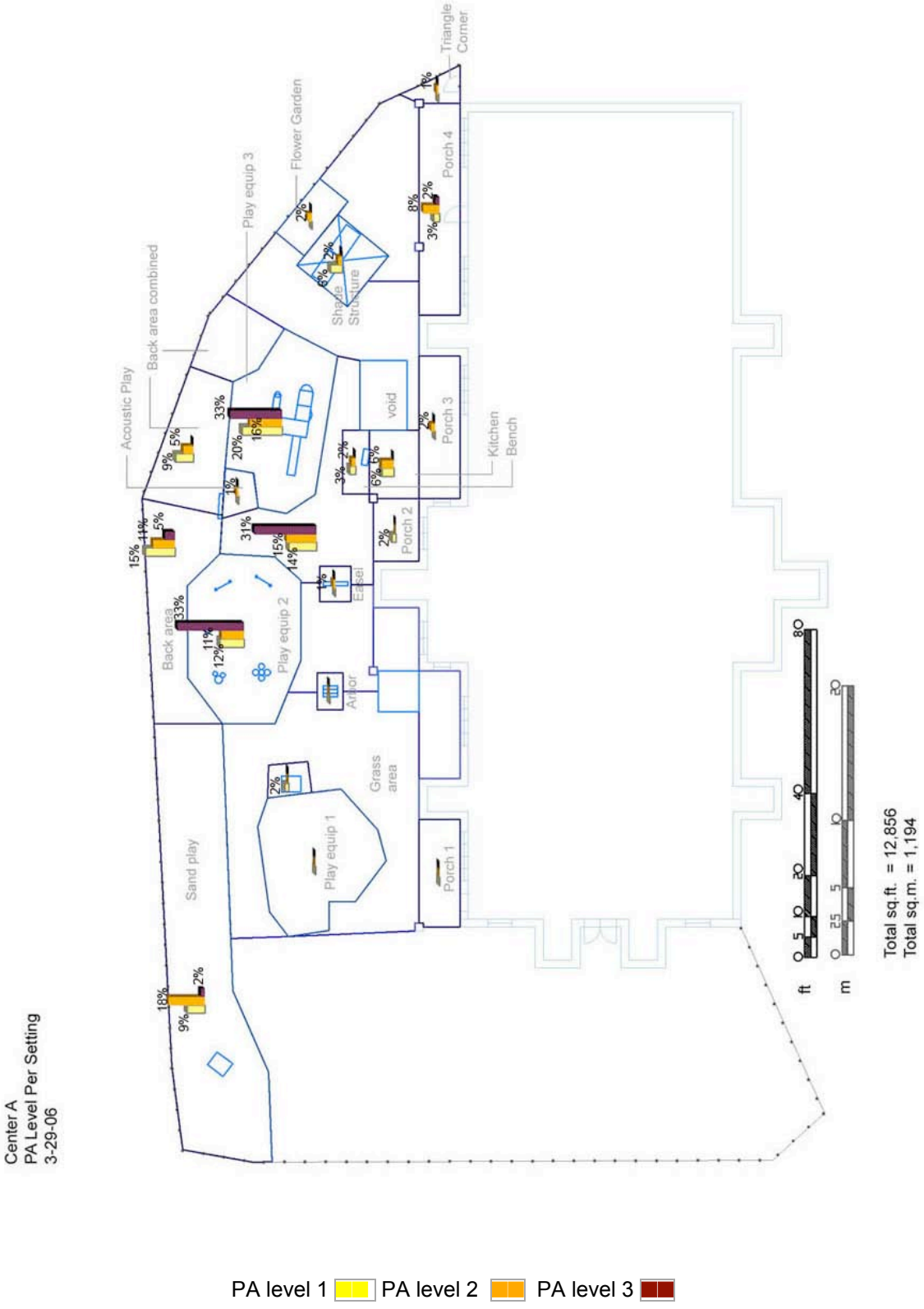
Centre A Map 1. Site layout and behaviour settings



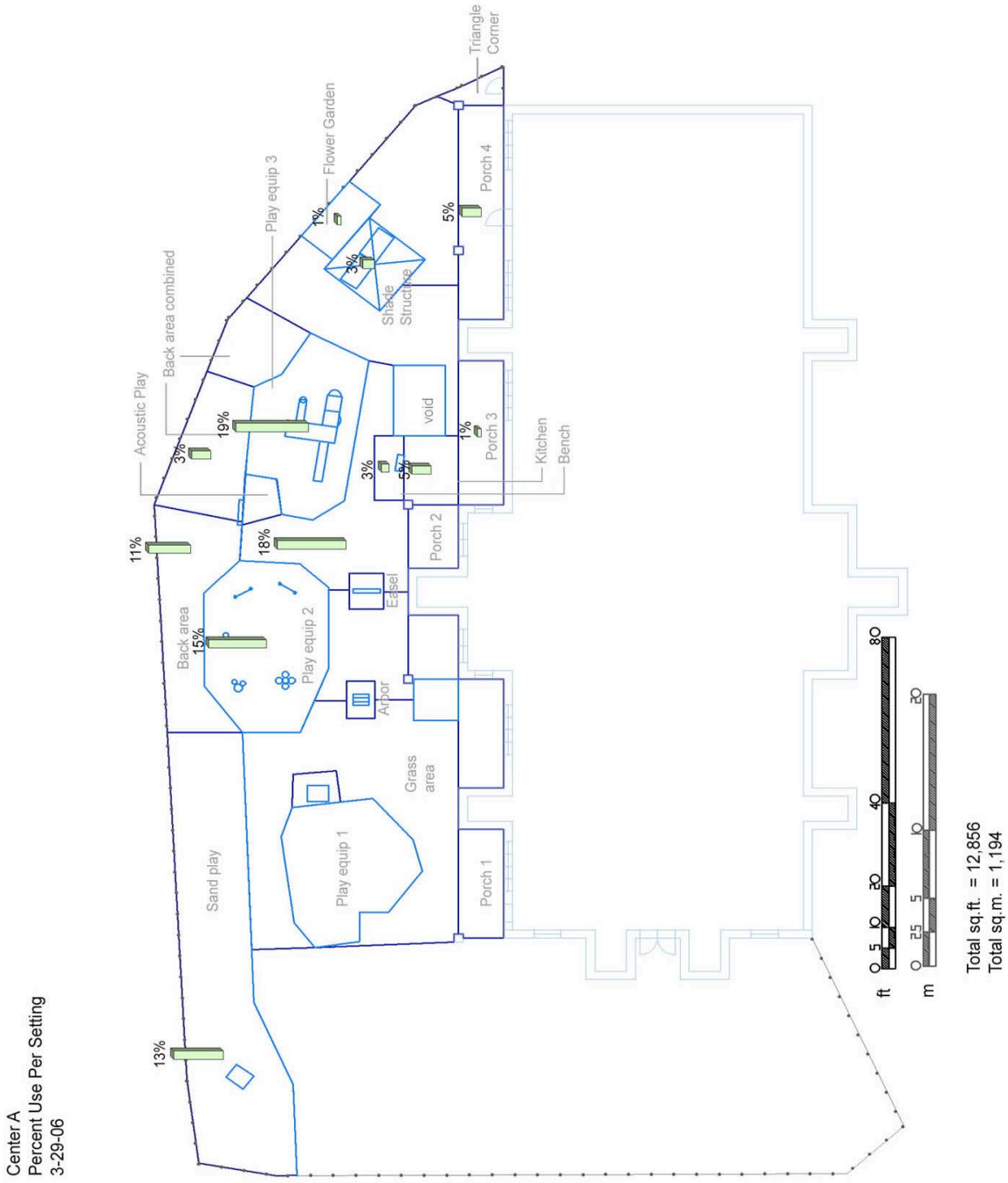
Centre A Map 2. Total compiled data points

Physical activity level	girl	boy	teacher	cart	wheeled toy	parent
1	●	♦	★	■	▲	✚
2	●	♦	★	■	▲	✚
3	●	♦	★	■	▲	✚

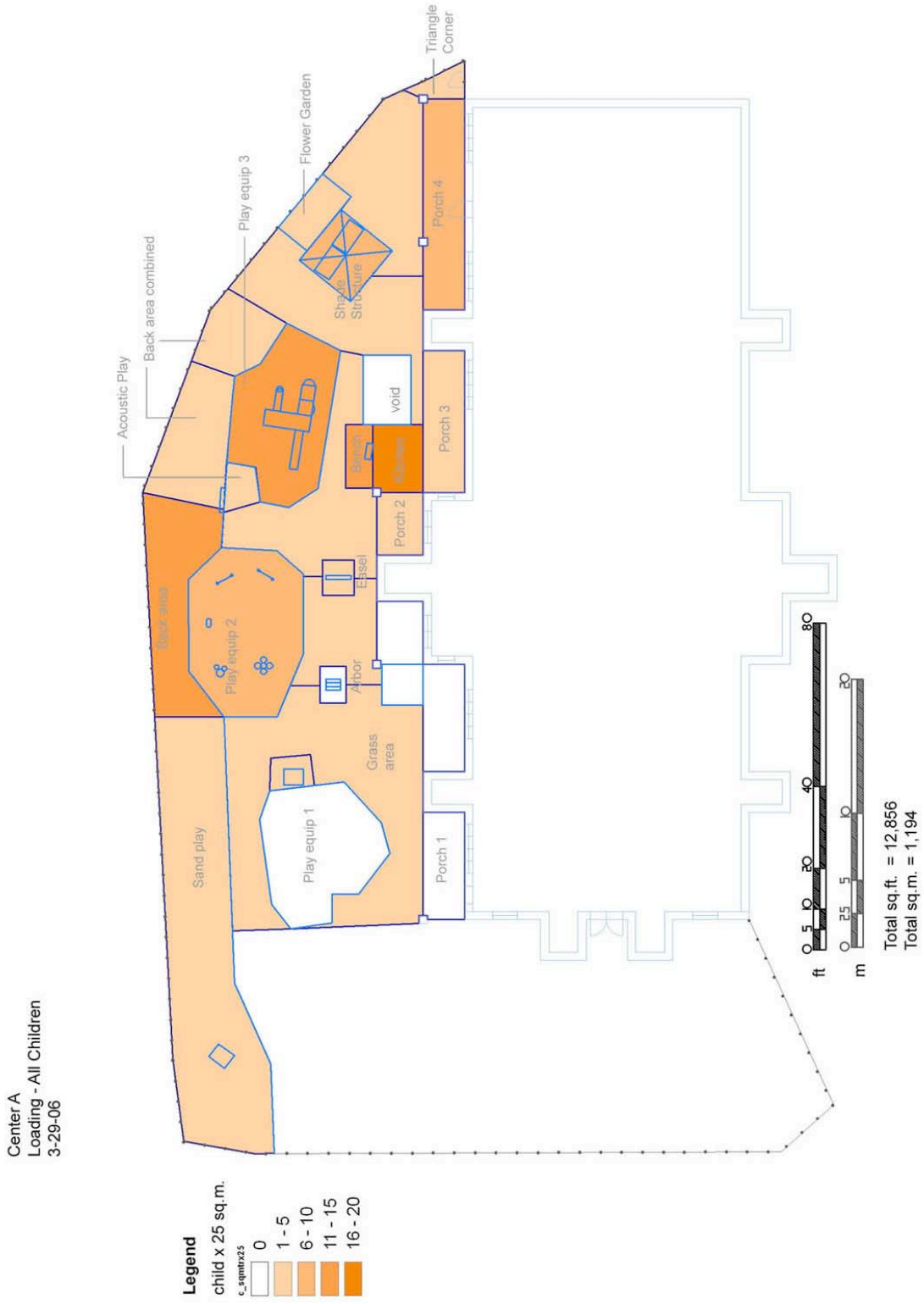
Centre A Map 3. Percent of use bar charts per setting



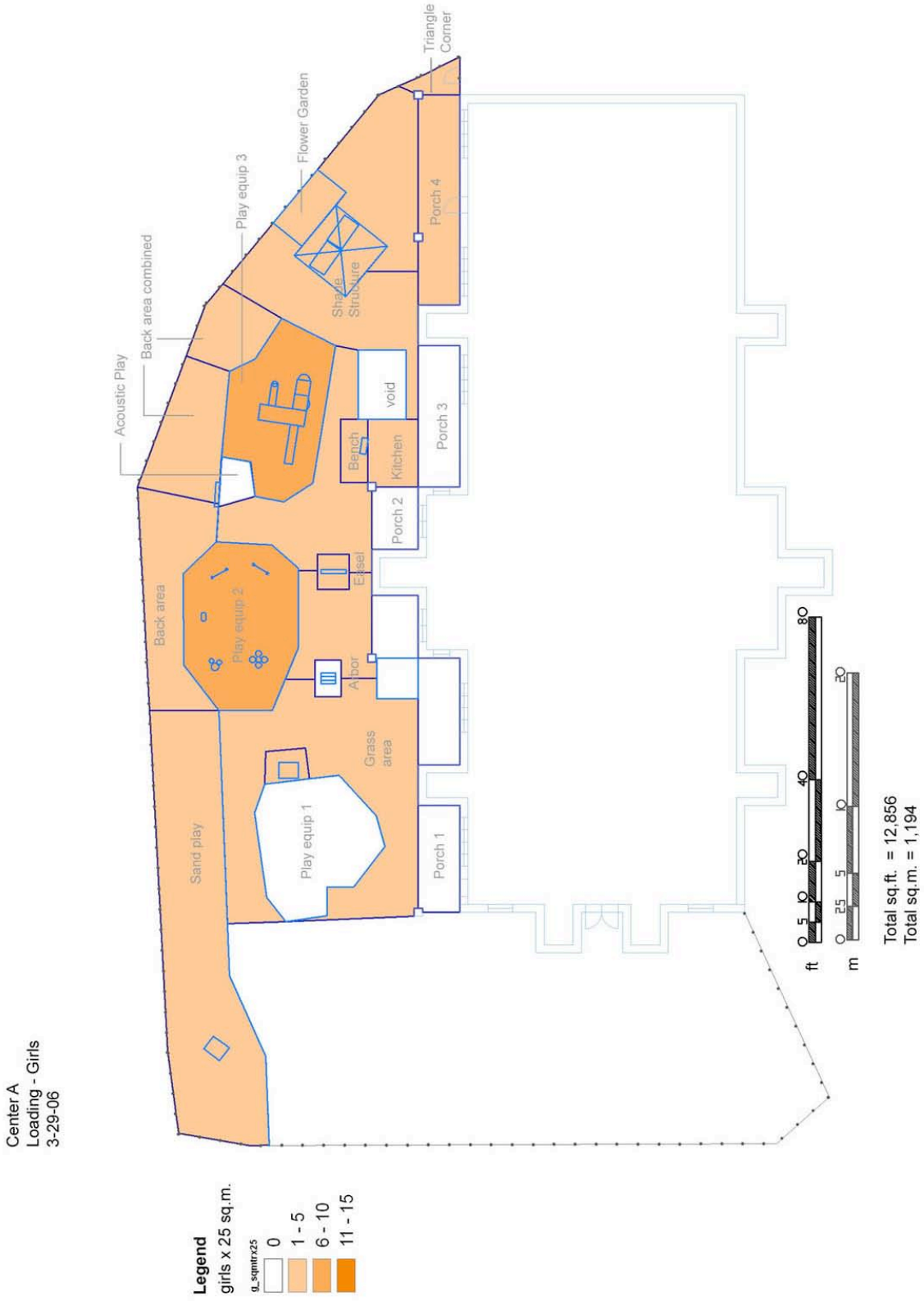
Centre A Map 4. Physical activity level (1-3) bar charts per setting



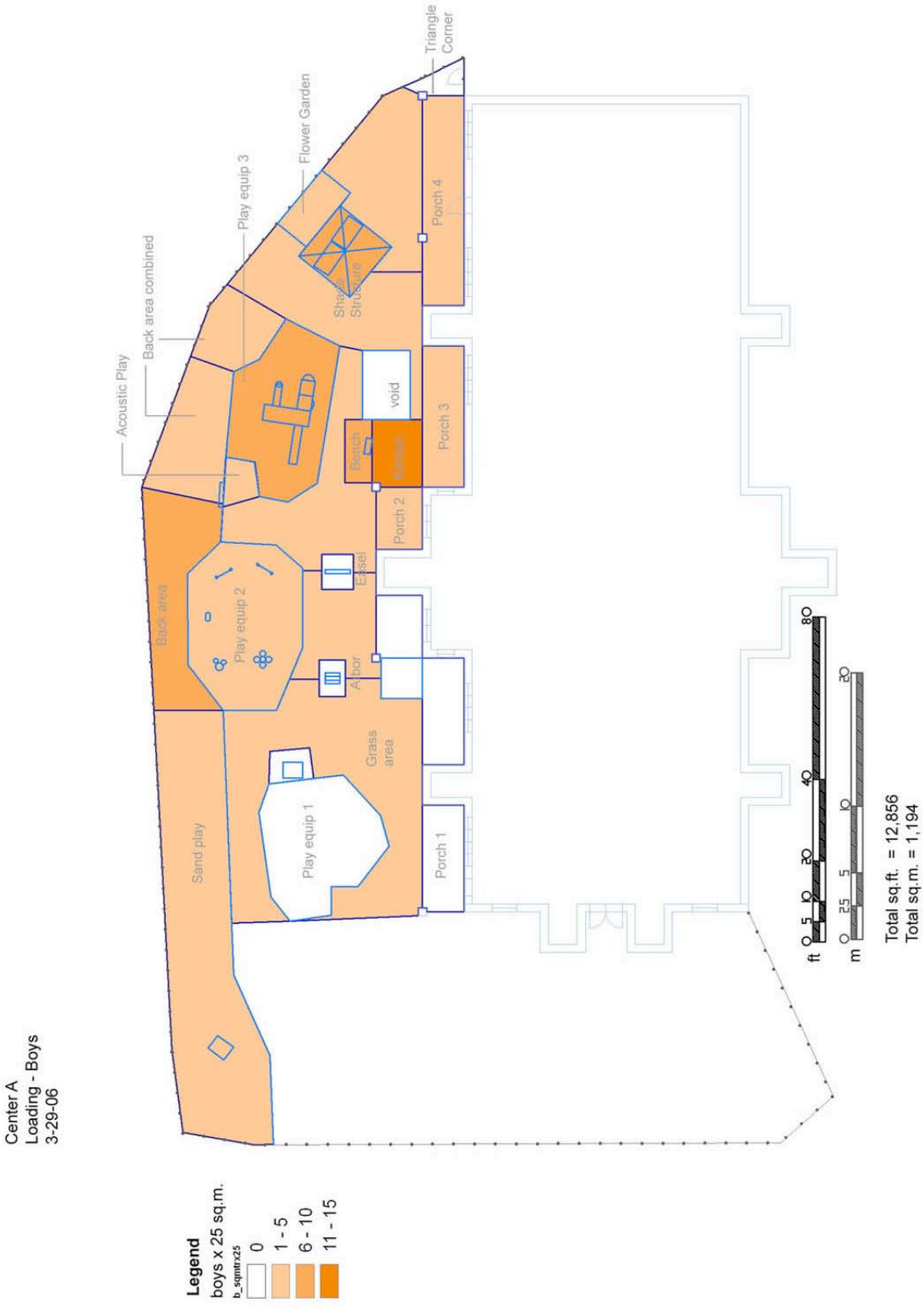
Centre A Map 5. User loading per setting (all children)



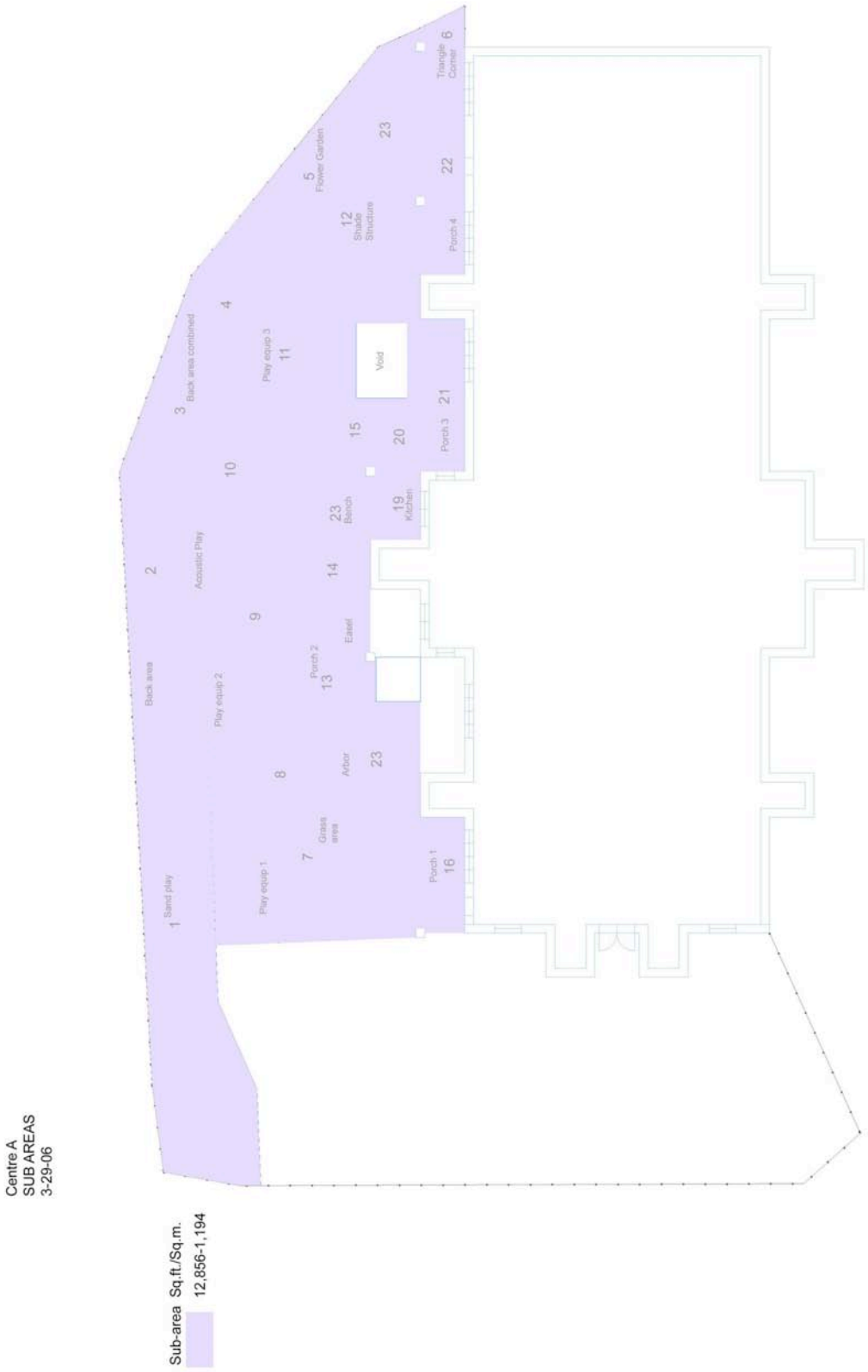
Centre A Map 6. User loading per setting (girls)



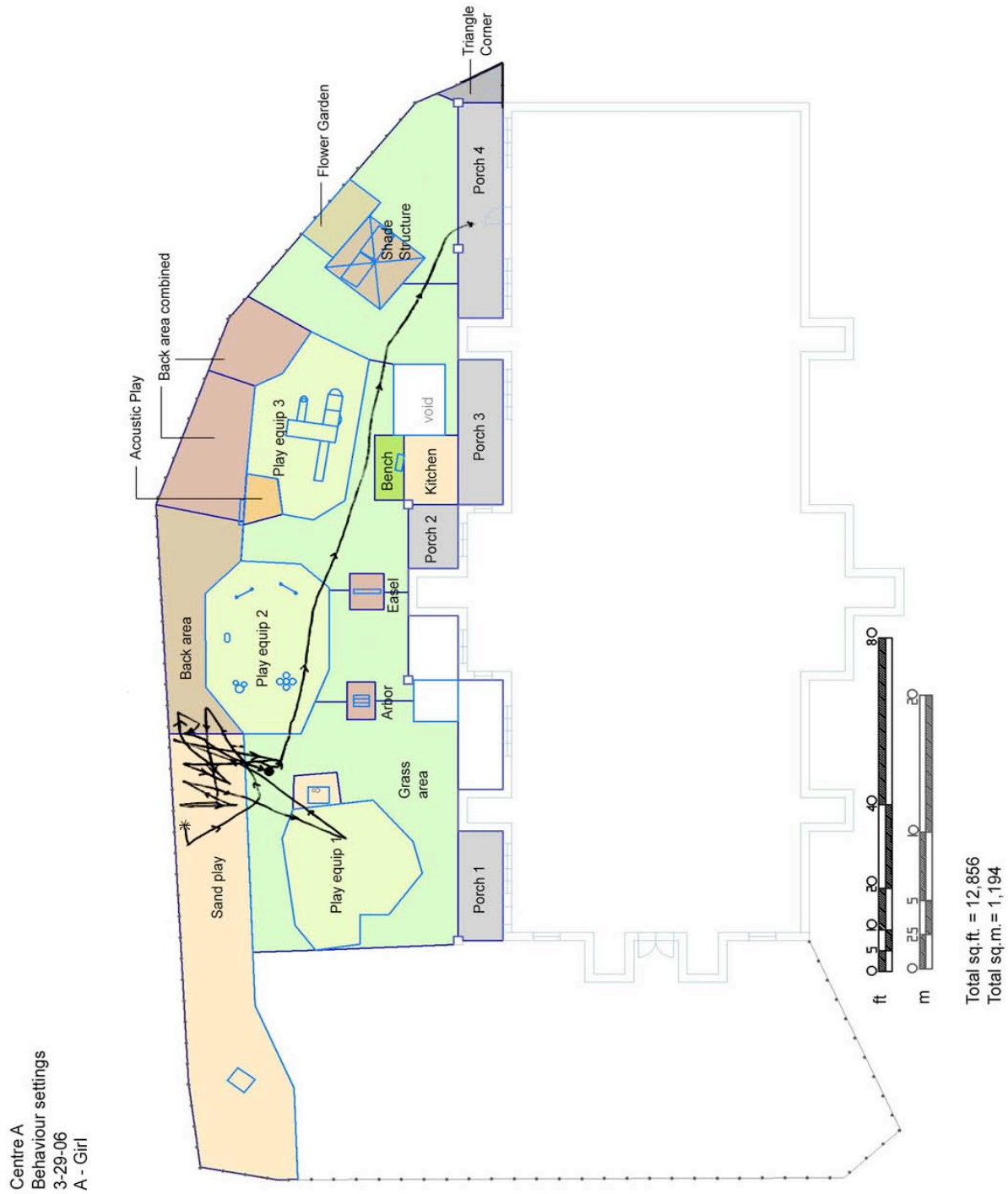
Centre A Map 7. User loading per setting (boys)



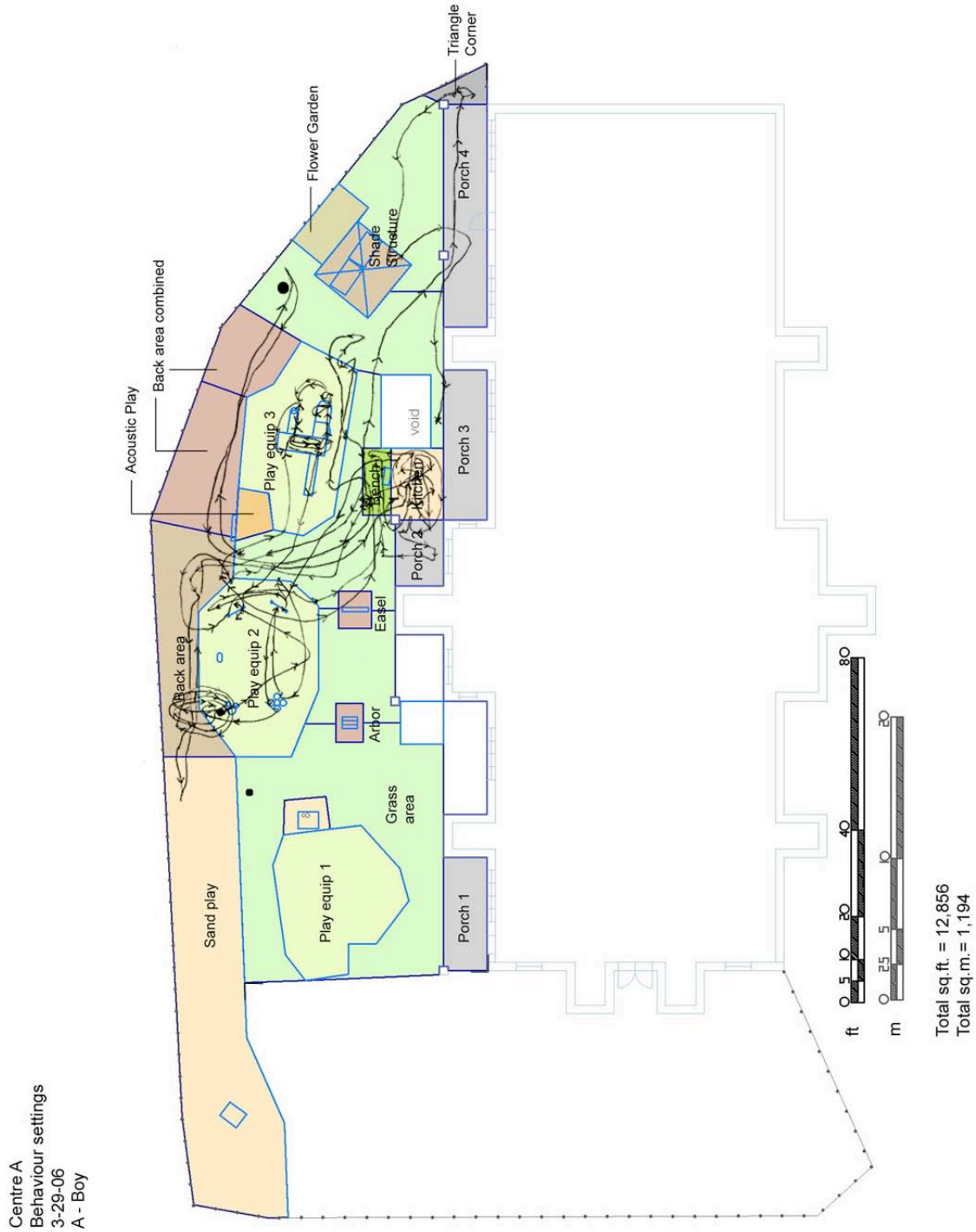
Centre A Map 8. User sub-areas



Centre A Map 9. Tracking episode. Girl

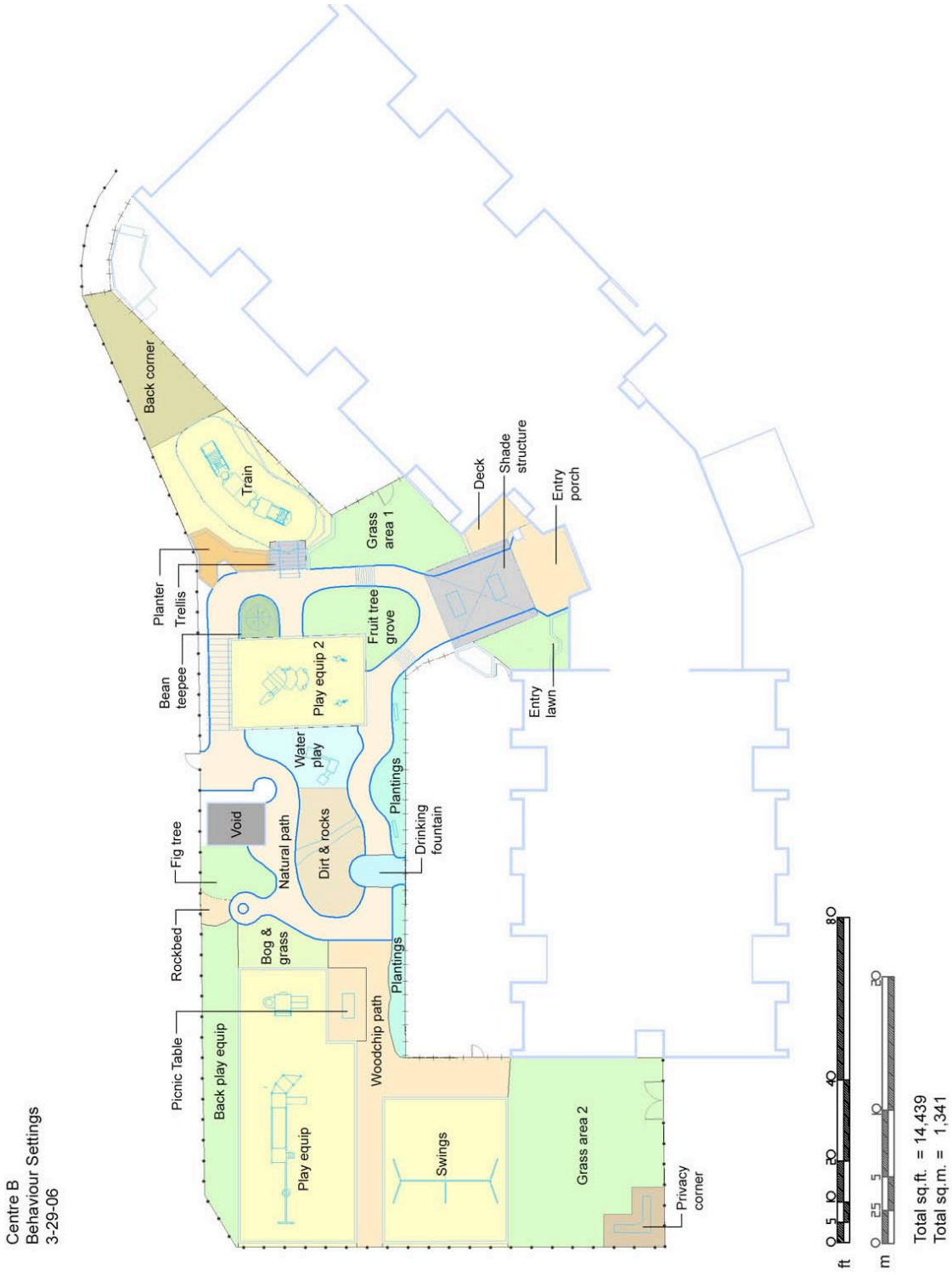


Centre A Map 9. Tracking episode. Boy

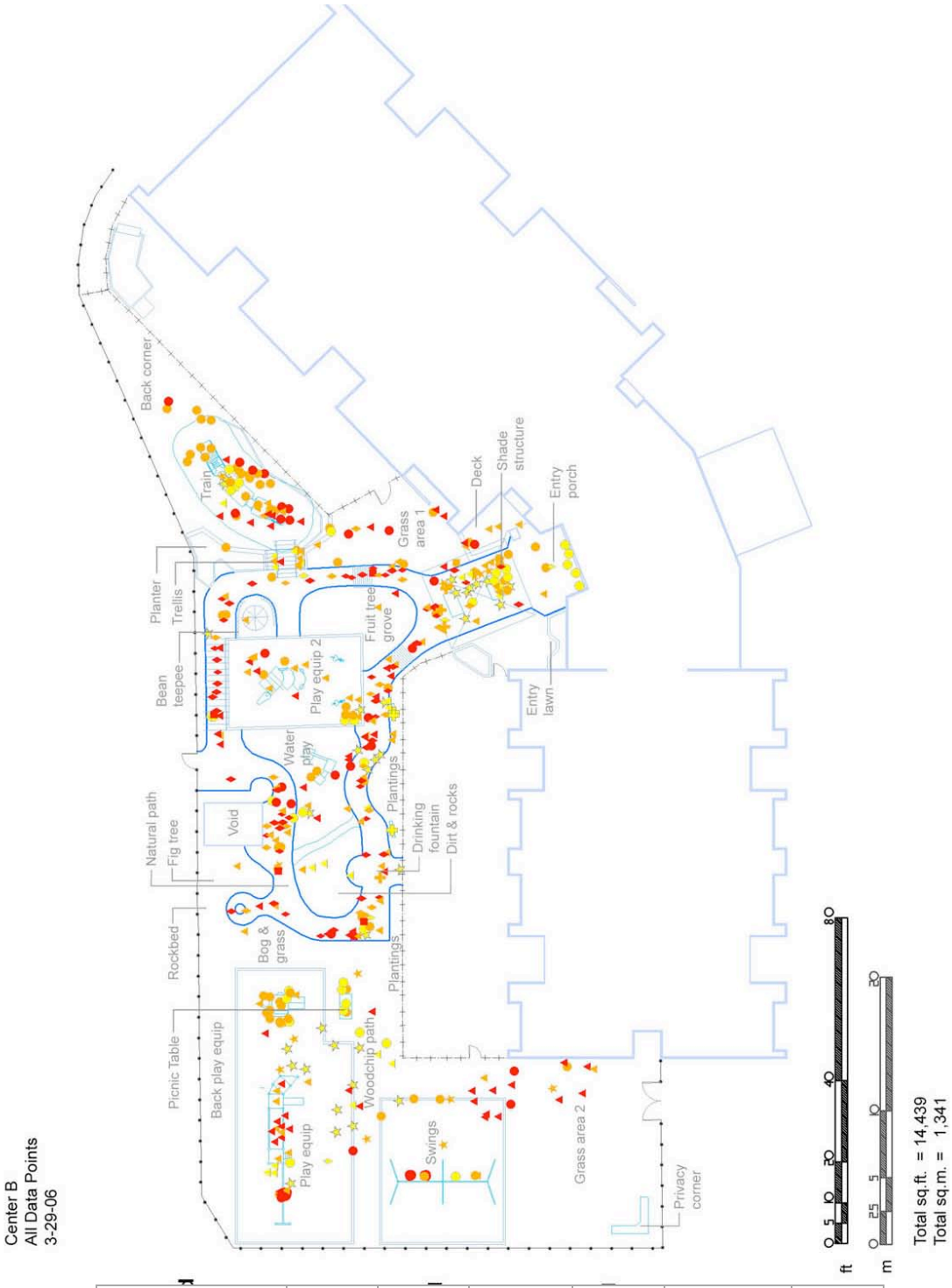


Centre B

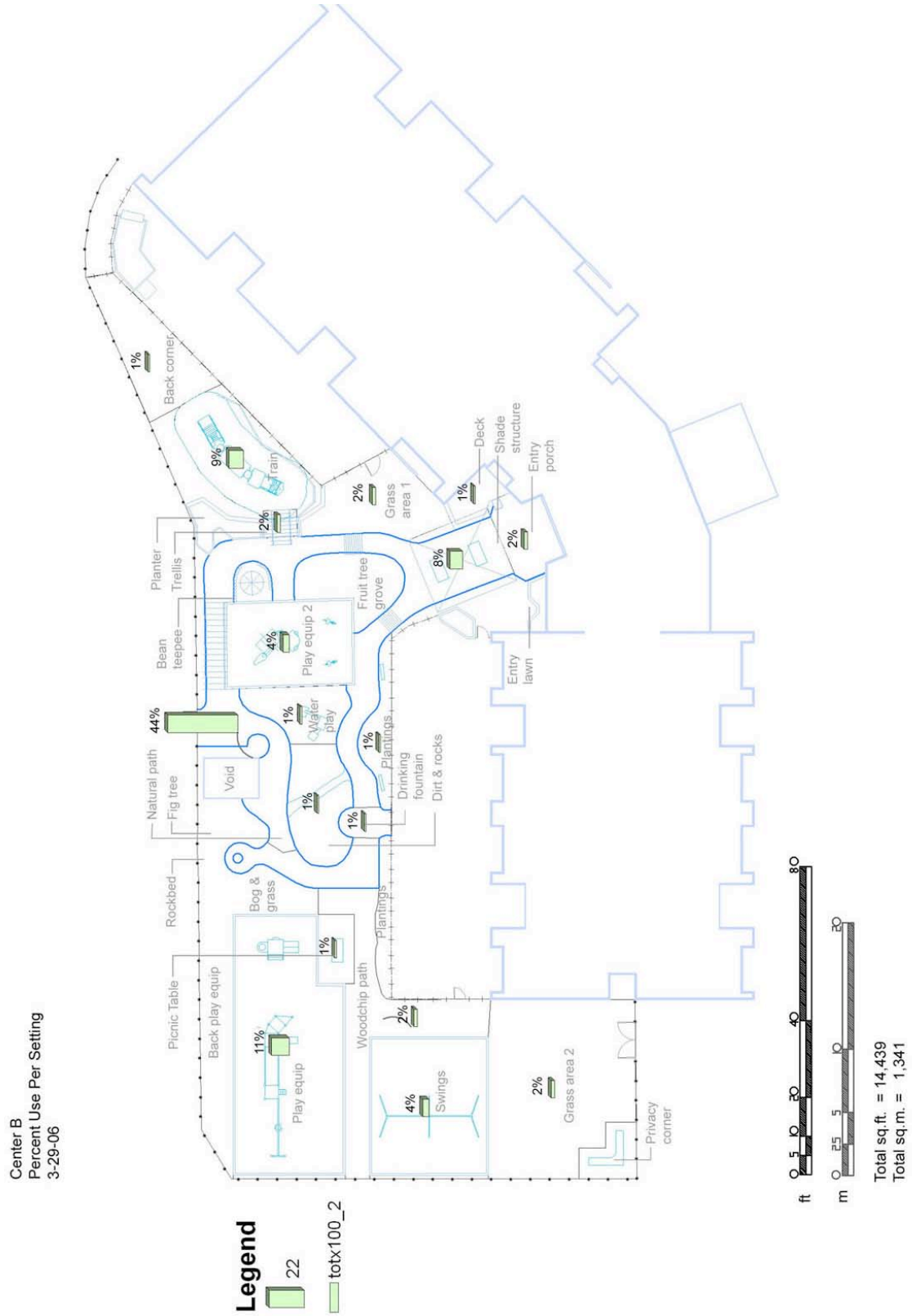
Centre B Map 1. Site layout and behaviour settings



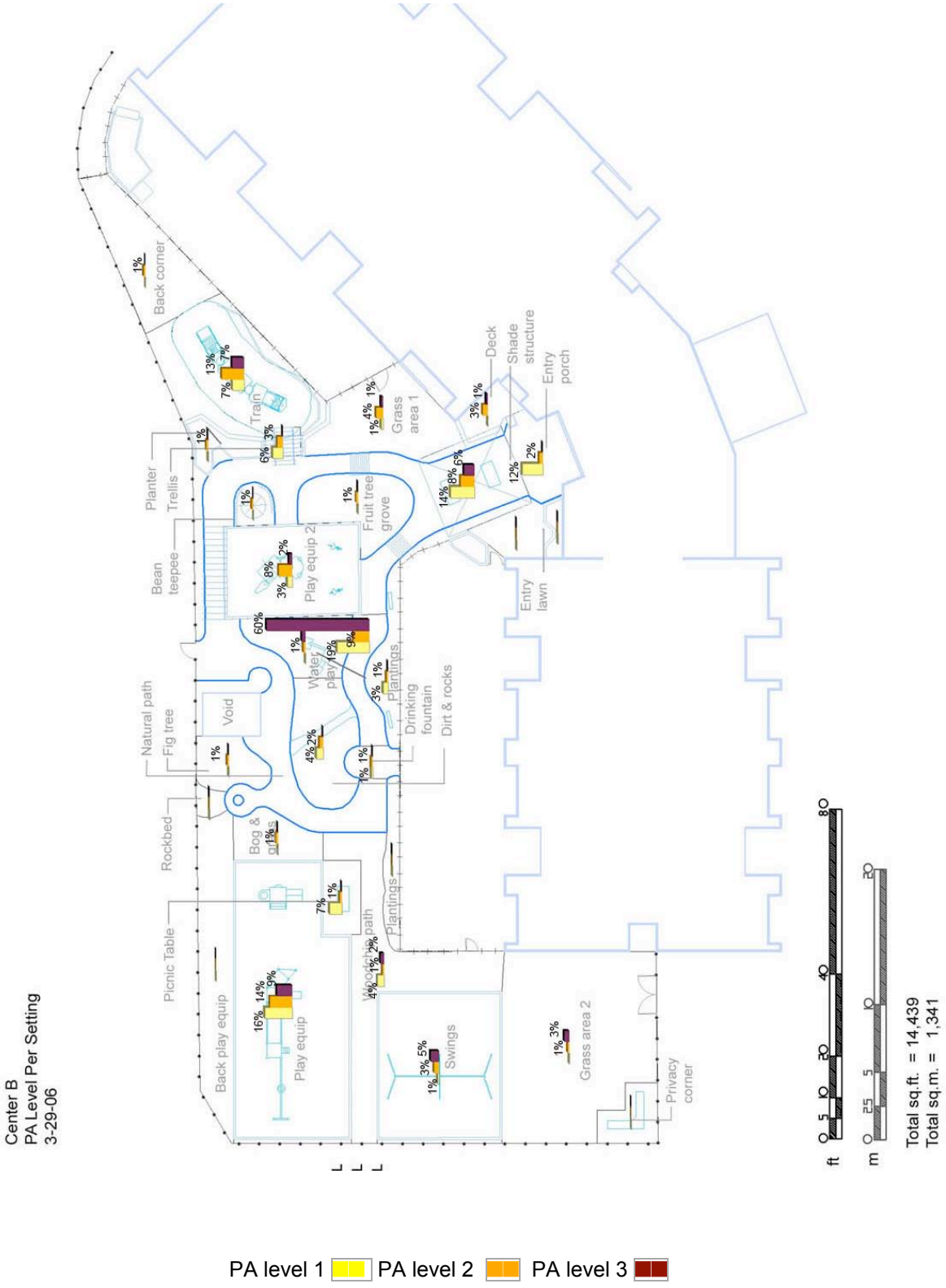
Centre B Map 2. Total compiled data points



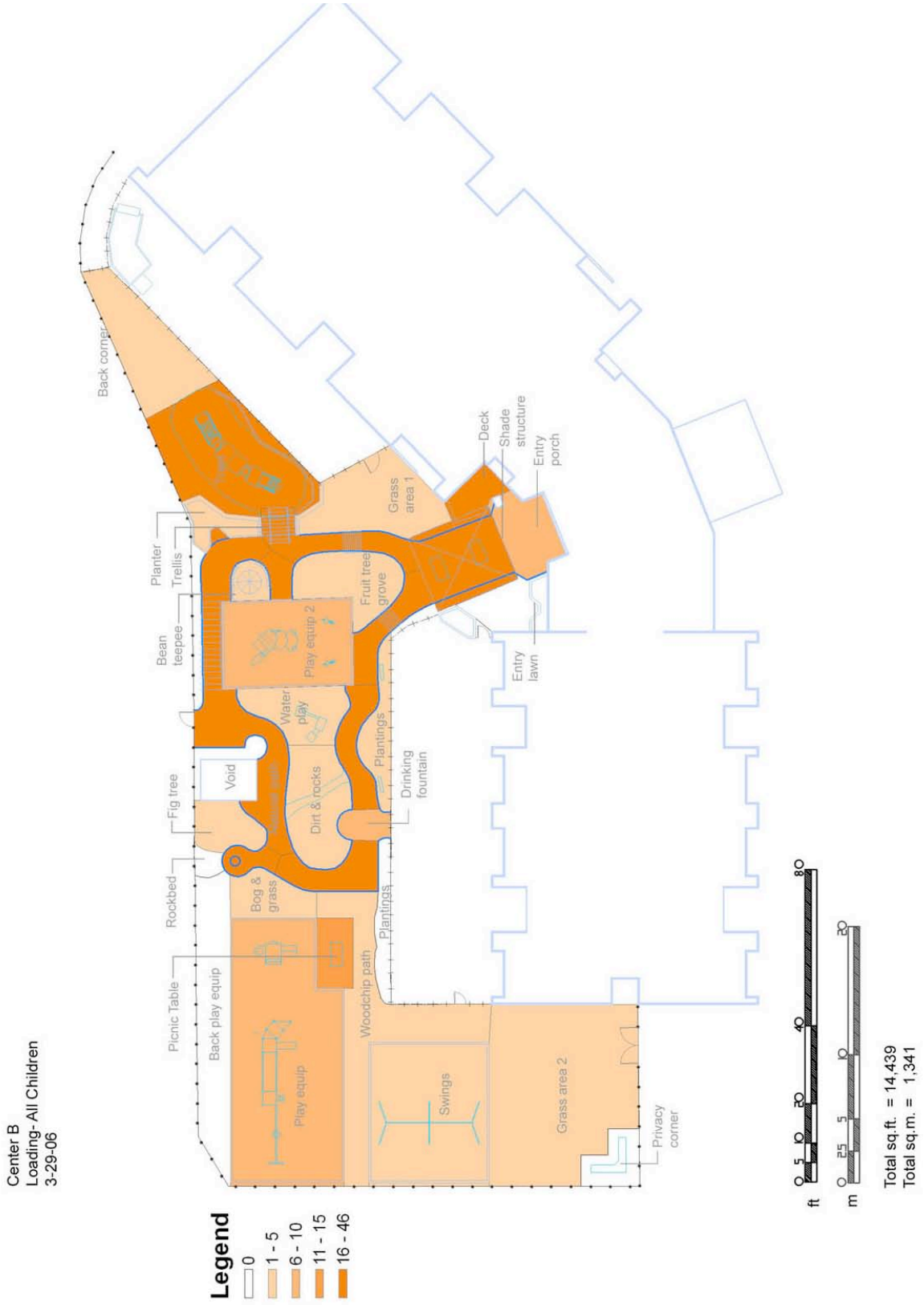
Centre B Map 3. Percent of use bar charts per setting



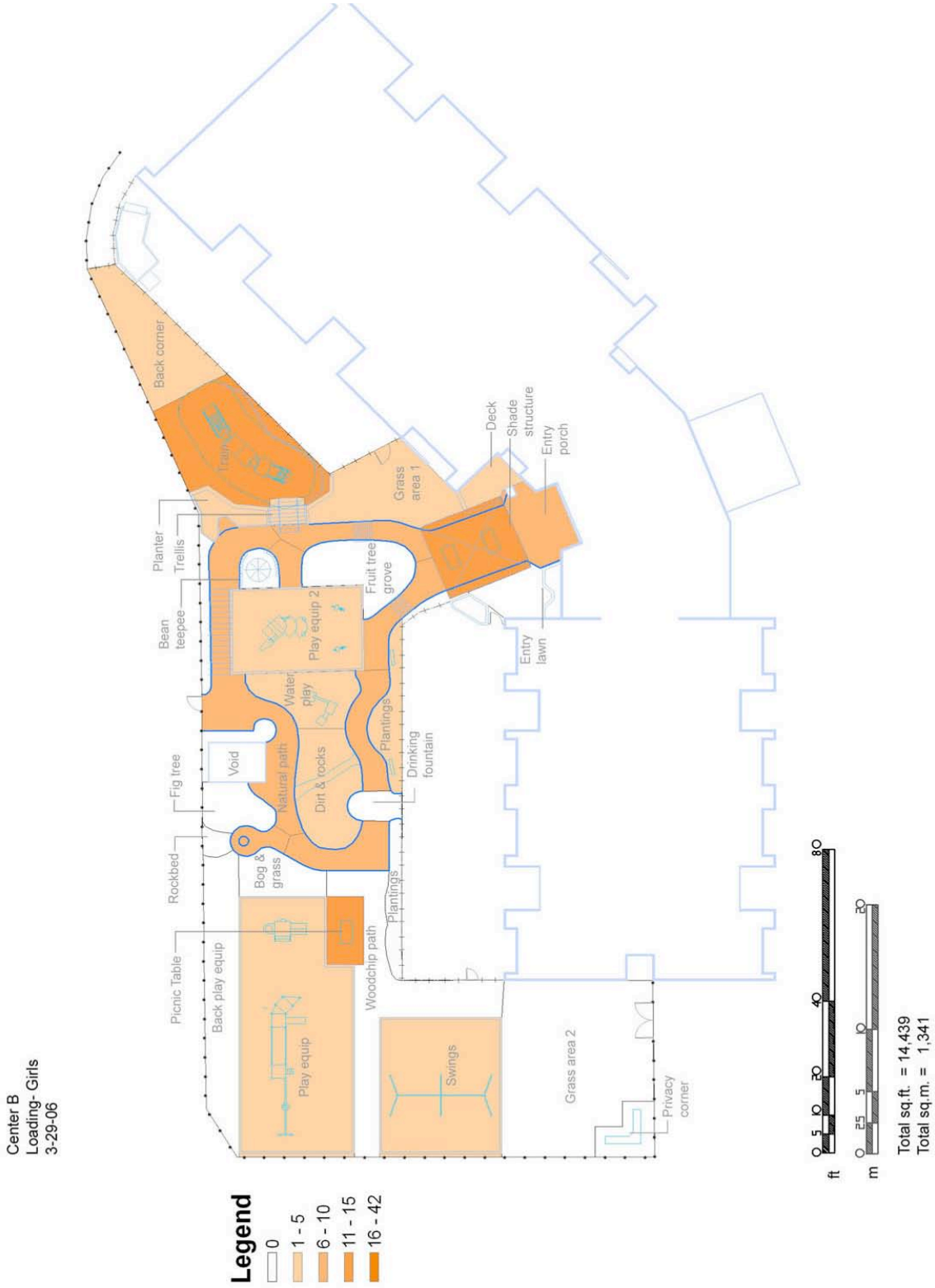
Centre B Map 4. Physical activity level (1-3) bar charts per setting



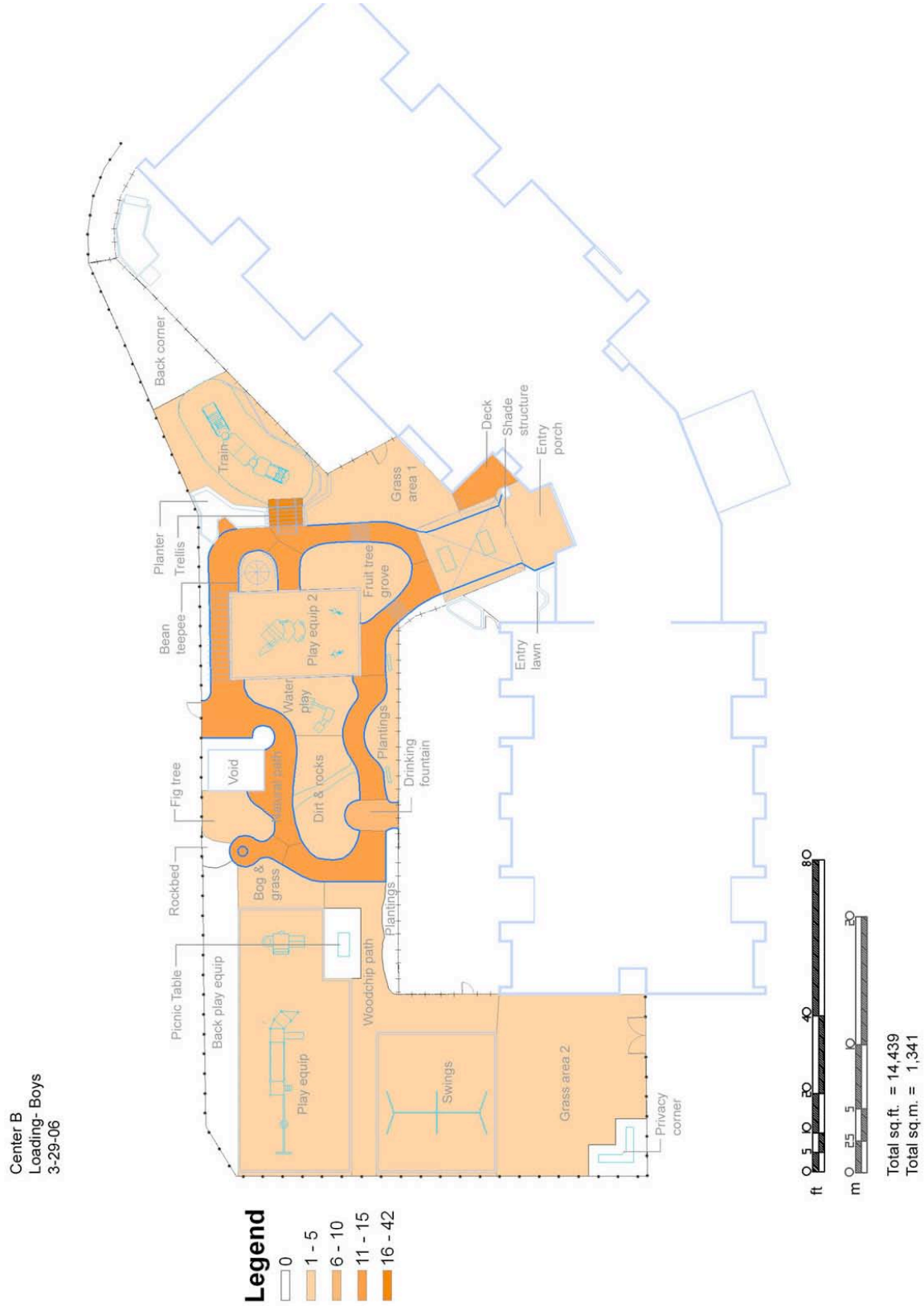
Centre B Map 5. User loading per setting (all children)



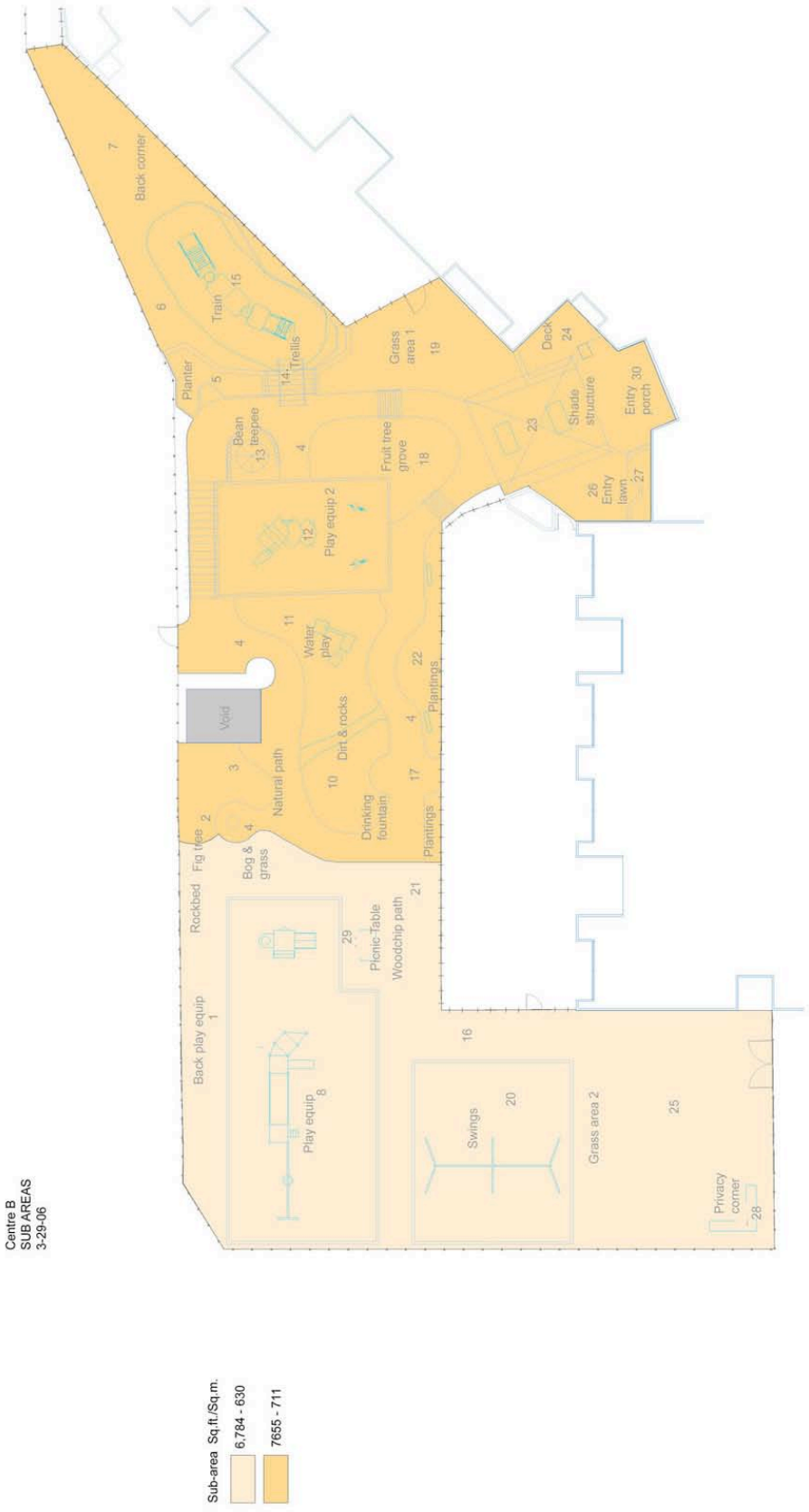
Centre B Map 6. User loading per setting (girls)



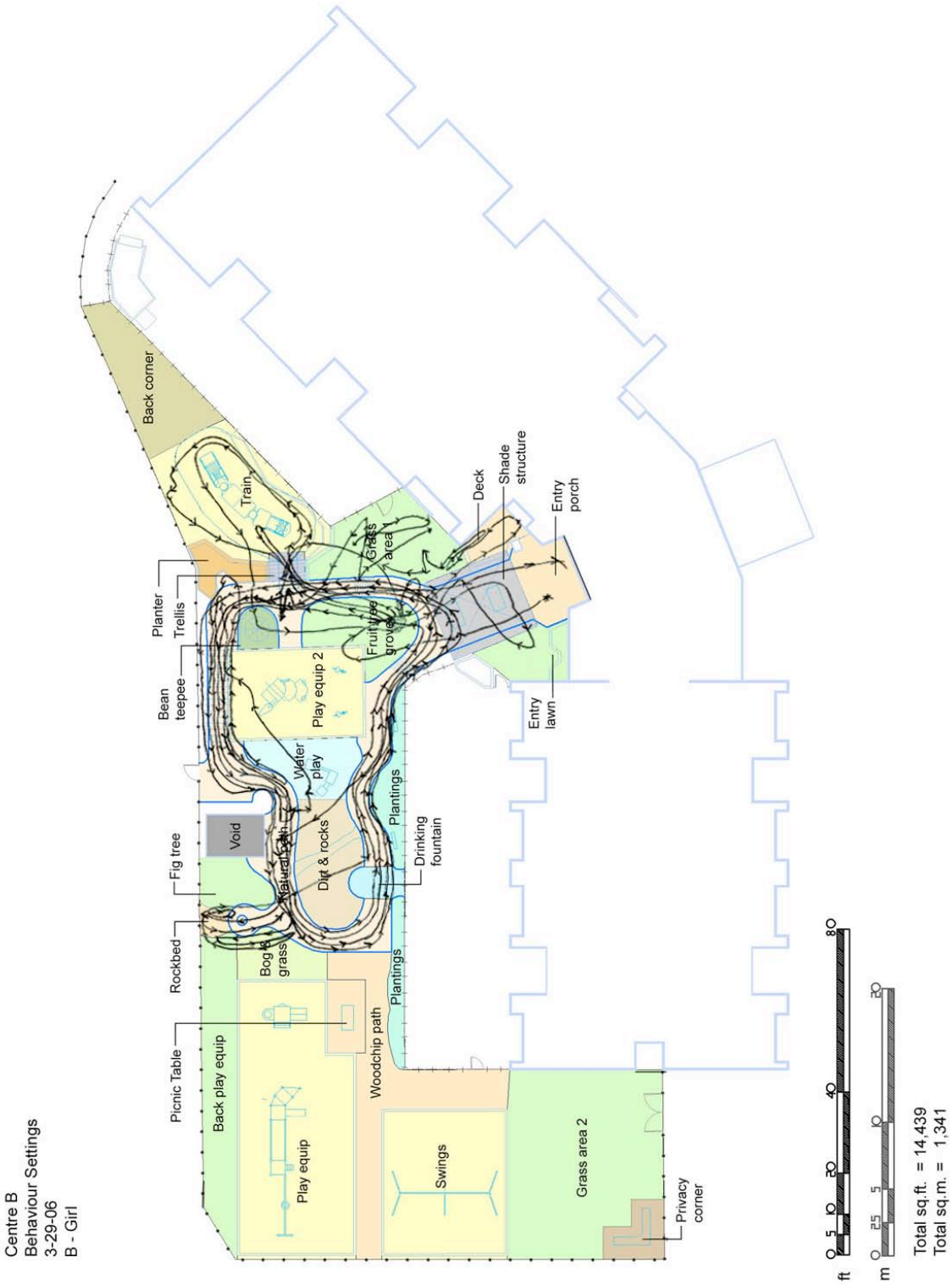
Centre B Map 7. User loading per setting (boys)



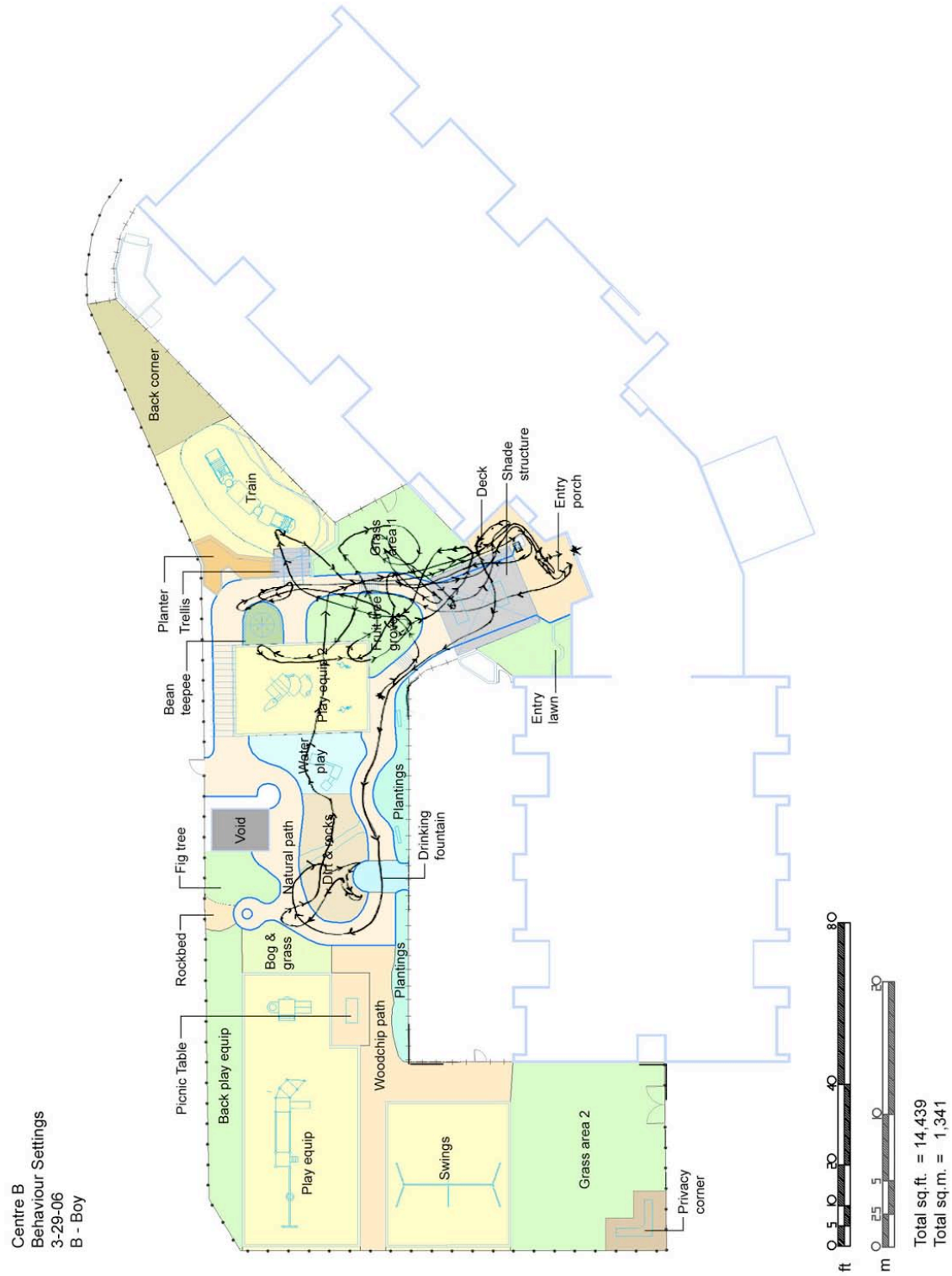
Centre B Map 8. User sub-areas



Centre B Map 9. Tracking episode. Girl



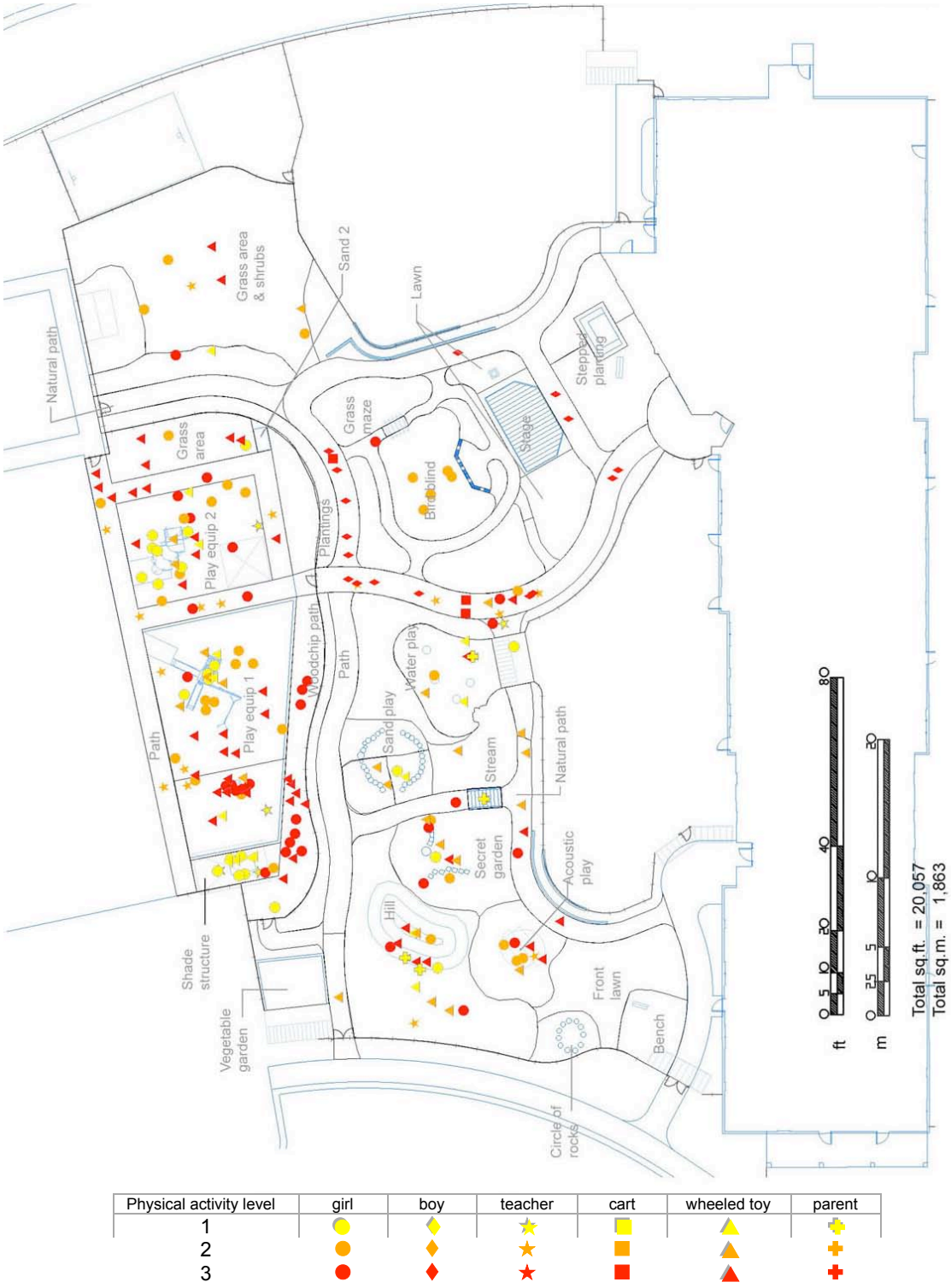
Centre B Map 10. Tracking episode. Boy



Centre C

Centre C Map 1. Site layout and behaviour settings

Centre C Map 2. Total compiled data points

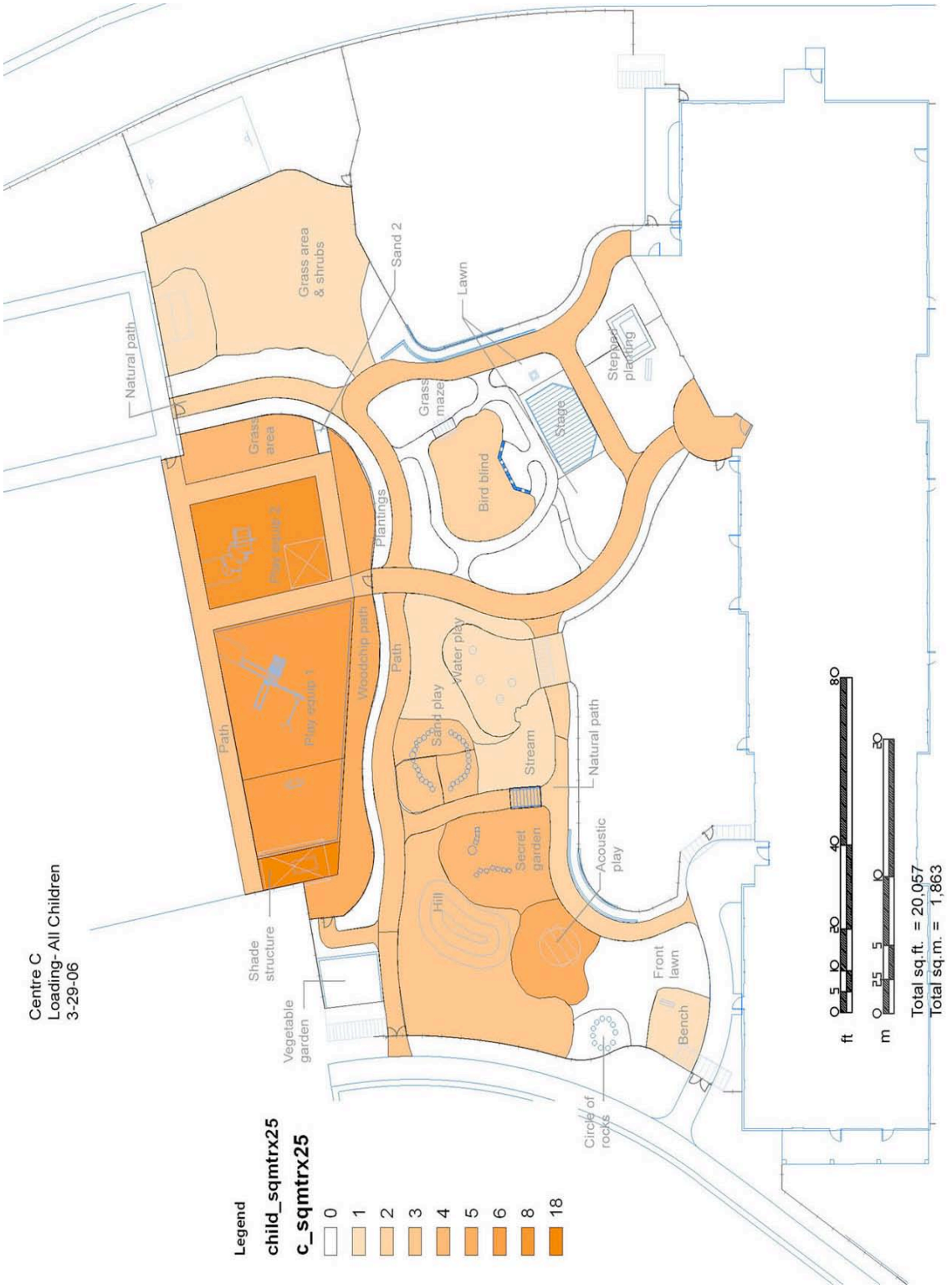


Physical activity level	girl	boy	teacher	cart	wheeled toy	parent
1						
2						
3						

Centre C Map 3. Percent of use bar charts per setting

Centre C Map 4. Physical activity level (1-3) bar charts per setting

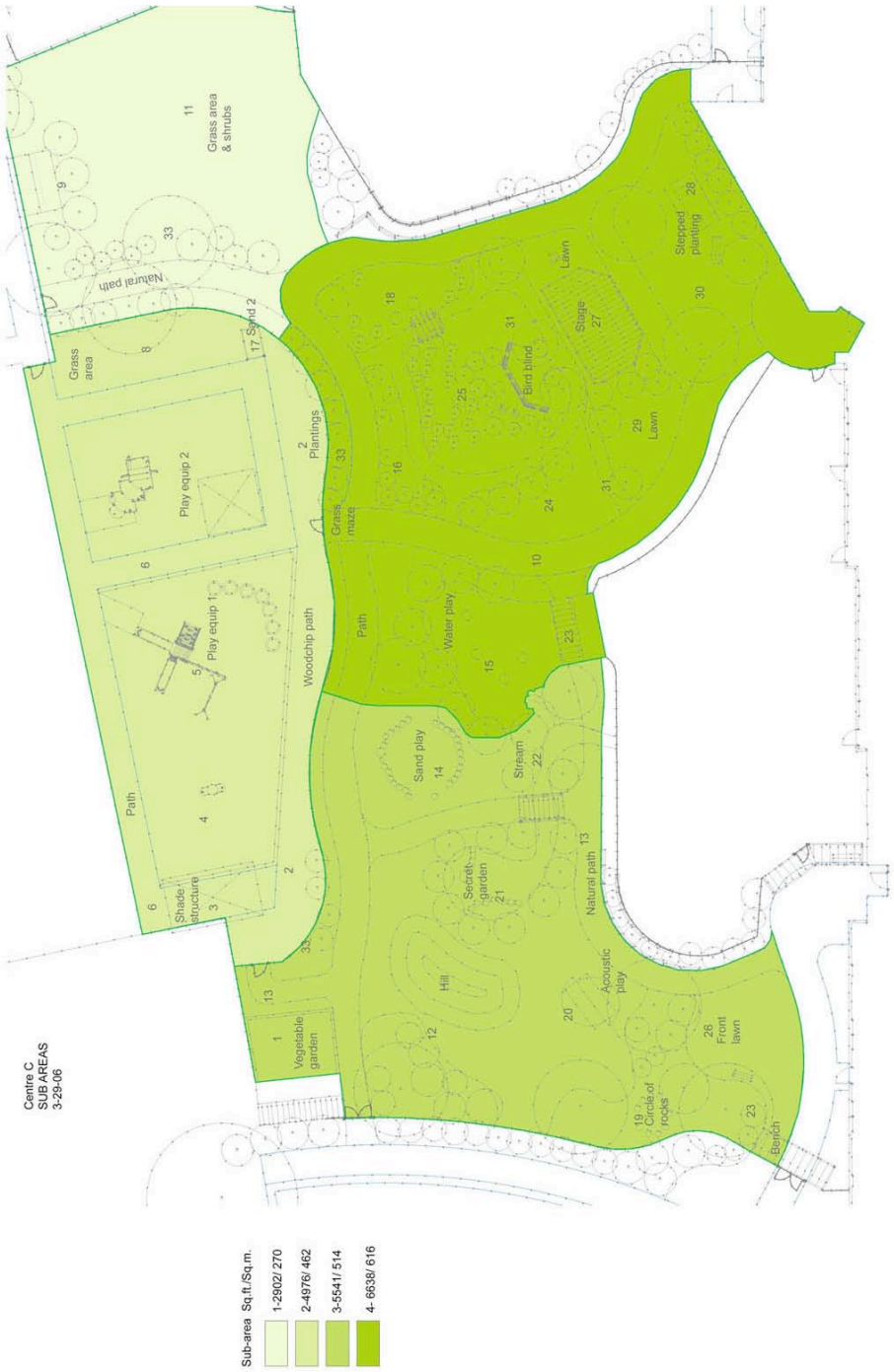
Centre C Map 5. User loading per setting (all children)



Centre C Map 6. User loading per setting (girls)

Centre C Map 7. User loading per setting (boys)

Centre C Map 8. User sub-areas



Centre C Map 9. Tracking episode. Girl

Centre C Map 10. Tracking episode. Boy

Appendix K. Human Subjects Review Presentation

Research purpose

Children are intrinsically motivated to be active, spending extraordinary amounts of time and energy learning basic skills such as walking, talking and socializing. Young children, in particular, learn about the surrounding world by physically interacting with it. For young children, life is movement and sensory stimulation (Piaget 1952). An unwelcome paradox is that, even most children are naturally driven to stay active, US young children are showing signs of sedentary lifestyles and overweight. More than 10% of children two to five years old are overweight (above the BMI 95th percentile) and more than 20% for children of the same age are at risk of being overweight (Ogden et al., 2002). These figures have serious implications in terms of future health problems especially for low-income children (Mei et al., 1998) as overweight children often become overweight adolescents (L. Moore et al., 2003). These astonishing facts suggest the quality of life of many children is becoming compromised at an early age.

A factor to take into account is the quality of the environment where children grow up. According to the National Survey of America's Families, in 1999, almost three-quarters (73%) of children under five with employed parents were in a childcare arrangement other than care by a parent (Capizzano et. al., 2000). This percentage represents 8.7 million preschool children spending most of their waking hours in childcare centers. In effect, in the last two decades, childcare centers have become a highly significant environment for young children in the US.

The **purpose** of this study is to investigate the extent to which different types of play areas in childcare centers afford 3-5 year old children's physical activity and support the motivation to move. Results will be interpreted using with a variety of quantitative and qualitative methods.

Subject population

Subjects will be recruited from three childcare centers belonging to the same childcare provider in the Triangle area.

Elegibility

Child subjects will be selected in the age range 3-5 years old enrolled in the three selected childcare centers. All children 3-5 years old attending each selected childcare center will be part of the study, There will be no exclusionary procedures for the selection of children. A small sub-sample of children representative of the sample (demographics, height and weight, and developmental level) will be chosen for further behavior observation. Childcare center selection is based on the type of outdoor play areas.

Procedures

Selected childcare centers conduct periodic screening of enrolled children. The following information from each child will be compiled by the researcher: High/Scope® Child Observation Record (COR); Test of Gross Motor Development; weight and height. The researcher will not administer any test to children. The researcher may be present taking notes when the Test of Gross Motor Development is administered by the teacher or preschool coordinator.

Children's behavior will be observed (with their knowledge and prior parental consent) during playtime in the childcare outdoors. Teacher's behavior will be similarly observed (with their knowledge and prior consent) during outdoor playtime. Parents will also be asked to fill a survey stating their level of education.

What will subjects be asked to do?

For the observational part of the project, children and adults will be asked to behave as they naturally would during outdoor playtime. During the drawing session, children will be asked to draw their play area. A sub-sample of six to eight children from each center (total of 18 to 24 subjects) representative of the sample will be asked to use an accelerometer during two days to measure their level of physcial activity when they are at the childcare center. Accerelometers are small electronic devices that clip on the children's belt. Accelerometers do not interfere with normal children's movements or activities.

How much time will be required of each subject?

As much time as every group uses to stay outside everyday.

Potential Risks

We do not forsee any potential risks. Children will perfom daily play activities as accustomed.

Preserving Confidentiality

A subject list will be created with contact information for the practical purposes of carrying out the field work. Each subject will be assigned an ID# on the list. To preserve confidentiality, only these numbers will be used and all other references to individual subjects during the data analysis phase. At the conclusion of the study, the sample list and original field records will be shredded.

Photography

Still photography and video (both digital), will be used to record interactions with the play area environment with prior release. A selection of the still photographs will be used to illustrate children's physical activity. Video recordings will be used to code for behavioral interactions with the environment. An archive of the photography and video clips with releases will be retained by the PI at the conclusion of the study for possible use in publications and academic presentations.

Potential Benefits

There is the likelihood that some teachers, childcare directors, and parents will benefit indirectly from the information imparted about the importance of children's daily physical activity to counteract sedentary lifestyles at early age.

Collaborators

Additonal investigators are not anticipated.

Survey instruments

Questions to be asked include the following:

For parents

Child age.

Child height and weight.

Ethnicity.

Education level of parent.

For teachers

Age.

Education level.

Years of experience.

For childcare director

Please characterize your childcare center using a scale 1-5

For the most part, this center encourages children to follow their own interests rather than follow a curriculum.

Most teachers stress conformity to rules and group expectations.

Most classroom activities are focused on group rather than individual teaching.

I believe the children need strong role models from the staff.

I would characterize this center as pursuing a “traditional” versus an “open” philosophy on education.

I would characterize the staff as actually practicing an “open” versus a “traditional” mode of teaching.

The center’s outdoors is as important as the indoors

Do you have a brochure that describes your center? Could you attach a copy to this sheet?

Appendix L. Parent Consent Form

North Carolina State University

Informed Consent Form

Active Living Research – Robert Wood Johnson Foundation

Motivation to Move:

Physical Activity in Outdoor Preschool Areas

The Natural Learning Initiative, College of Design

CHILD NAME…….

Please initial your understanding of each paragraph, below, on the line provided. Do not initial each paragraph until and unless you understand it.

DESCRIPTION

The purpose of this study is to investigate the extent to which different types of play areas in childcare centers afford 3-5 year old children's physical activity and support the motivation to move as a measure to counteract sedentary lifestyles in early childhood. _____

PROCEDURES

During the usual outdoor playtime your child's group will be observed to assess children's physical activity level. Some still photography and video will be taken of children's outdoor activities. _____

The teacher / preschool coordinator will ask children to draw their play area. In an individual session the researcher will ask your child to perform simple physical activities such as bouncing a ball, kicking, catching, throwing, running, sliding, hopping, and jumping to asses her/his gross motor development _____

Your child might be individually observed while playing freely as she/she typically would. _____

Your child might be asked to wear an accelerometer (small device that record body motion) during one day to assess her/his physical activity intensity during outdoor play. _____

RISKS

The goal of this project is to observe the actual use of the outdoor play areas and it involves no unusual risk. _____

BENEFITS

The information communicated about the effect of outdoor play environments on physical activity intensity of young children, will bring awareness to parents and teachers about the importance of creating supportive play environments to counteract sedentary lifestyles. _____

CONFIDENTIALITY

The information gathered by the researcher will be kept strictly confidential. The data resulting from the participation of your child will be combined with others who take part in the study and used in presentations of the research results but her/his identity will not be revealed. An identification code will be created for each child. _____

CONTACT

If you have any questions at any time regarding the study or the procedures, you may contact the Principal Investigator, Nilda Cosco, Education Specialist, The Natural Learning Initiative, College of Design, NC State University, Campus Box 7701, Raleigh, NC 27695-7701 or by telephone (919) 515-8345. If you feel you have not been treated according to the descriptions in this form, or your rights as a participant in research have been violated during the course of this project, you may contact Dr. Matthew Zingraff, Chair of the NCSU IRB for the Use of Human Subjects in Research Committee, Box 7514, NCSU Campus (919/513-1834) or Mr. Matthew Ronning, Assistant Vice Chancellor, Research Administration, Box 7514, NCSU Campus (919/513-2148) _____

PARTICIPATION

The participation of your child in this study is voluntary; you may decline her/his participation. If you decide your child participates, you may withdraw her/him from the study anytime. If your child withdraw from the study before data collection is completed her/his data will be destroyed. _____

CONSENT

I have read and understand the above information. I have received a copy of this form.

I agree to participate in this study.___ _____ _____

Name (please print) Signature Date

PHOTO RELEASE

I agree to permit my child to be photographed as part of the study activity. I understand that her/his picture may be shown in presentations of the research results but her/his name will not be used in any way. However, she/he may be recognized. You may decline your child to appear in pictures.

_____ _____ Signature
Date

VIDEO RELEASE

I agree to permit my child to be videotaped as part of the study activity. I understand that her/his image may be shown in presentations of the research results but her/his name will not be used in any way. However, she/he may be recognized. You may decline your child to appear in video images..

_____ _____ Signature
Date

WITNESS

I witness that the above individual understands the information contained in this form. He or she has received a copy of this form. He or she agrees to participate in this study.

_____ _____ _____

Name (please print) Signature Date

_____ _____ _____

Project Investigator Signature Date

Appendix M. Teacher Consent Form

North Carolina State University

Informed Consent Form

Active Living Research – Robert Wood Johnson Foundation

Motivation to Move:

Physical Activity in Outdoor Preschool Areas

The Natural Learning Initiative, College of Design

TEACHER ……..

Please initial your understanding of each paragraph, below, on the line provided. Do not initial each paragraph until and unless you understand it.

DESCRIPTION

The purpose of this study is to investigate the extent to which different types of play areas in childcare centers afford 3-5 year old children's physical activity and support the motivation to move as a measure to counteract sedentary lifestyles in early childhood. _____

PROCEDURES

During the usual outdoor playtime your group will be observed (prior consent). Since you will be overseeing the group, you may be observed as well. Some still photography and video will be taken of the outdoor activities. An additional interview and is anticipated to deepen the understanding of what design features (natural or manufactured) support your children's physical activity. _____

RISKS

The goal of this project is to observe the actual use of your childcare outdoor play areas and it involves no unusual risk. The goal of the subsequent interview is to record the opinions of teachers about children's use of the play areas. You will not be asked to talk about anything that you would not normally talk about in your daily working day. _____

BENEFITS

The information communicated about the importance of children's daily physical activity to counteract sedentary lifestyles at early age may bring to you awareness about the importance f having an outdoor environment that supports children's daily physical activity. _____

CONFIDENTIALITY

The information gathered by the researcher will be kept strictly confidential. The data resulting from your participation will be combined with others who take part in the study and used in presentations of the research results but your identity will not be revealed. _____

The photographs and video taking during the project will be used to document the research study. The photographs and video episodes may be used in presentations of the research results but your name will not be used; however, you may be recognized. You may decline to be included in the photographs / video images. _____

CONTACT

If you have any questions at any time regarding the study or the procedures, you may contact the Principal Investigator, Nilda Cosco, Education Specialist, The Natural Learning Initiative, College of Design, NC State University, Campus Box 7701, Raleigh, NC 27695-7701 or by telephone (919) 515-8345. If you feel you have not been treated according to the descriptions in this form, or your rights as a participant in research have been violated during the course of this project, you may contact Dr. Matthew Zingraff, Chair of the NCSU IRB for the Use of Human Subjects in Research Committee, Box 7514, NCSU Campus (919/513-1834) or Mr. Matthew Ronning, Assistant Vice Chancellor, Research Administration, Box 7514, NCSU Campus (919/513-2148) _____

PARTICIPATION

Your participation in this study is voluntary; you may decline to participate. If you decide to participate, you may withdraw from the study anytime. If you withdraw from the study before data collection is completed your data will be returned to you or destroyed. _____

CONSENT

I have read and understand the above information. I have received a copy of this form.

I agree to participate in this study.___ _____ _____

Name (please print) Signature Date

PHOTO RELEASE

I agree to permit myself to be photographed as part of the study activity. I understand that my picture may be shown in presentations of the research results but my name will not be used in any way. However, you may be recognized. You may decline to appear in pictures.

_____ _____ Signature
Date

VIDEO RELEASE

I agree to permit myself to be videotaped as part of the study activity. I understand that my image may be shown in presentations of the research results but my name will not be used in any way. However, you may be recognized. You may decline to appear in video images.

_____ _____ Signature
Date

WITNESS

I witness that the above individual understands the information contained in this form. He or she has received a copy of this form. He or she agrees to participate in this study.

_____ _____ _____

Name (please print) Signature Date

_____ _____ _____

Project Investigator Signature Date

Appendix N. Logistic Regression

Case Processing Summary

Unweighted Cases(a)		N	Percent
Selected Cases	Included in Analysis	841	100.0
	Missing Cases	0	.0
	Total	841	100.0
Unselected Cases		0	.0
Total		841	100.0

a If weight is in effect, see classification table for the total number of cases.

Dependent Variable Encoding

Original Value	Internal Value
1	0
2	1

Categorical Variables Codings

			Parameter coding	
		Frequency	(1)	(2)
centre	A	239	1.000	.000
	B	406	.000	1.000
	C	196	.000	.000

Block 0: Beginning Block

Classification Table(a,b)

Observed			Predicted		
			pa2level		Percentage Correct
			1	2	
Step 0	pa2level	1	0	168	.0
		2	0	673	100.0
	Overall Percentage				80.0

a Constant is included in the model.

b The cut value is .750

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	1.388	.086	258.923	1	.000	4.006

Variables not in the Equation

			Score	df	Sig.
Step 0	Variables	diversity	8.254	1	.004
		m2range	20.653	1	.000
		centre	13.775	2	.001
		centre(1)	12.188	1	.000
		centre(2)	9.763	1	.002
		genum	4.958	1	.026
	Overall Statistics		41.867	5	.000

Block 1: Method = Backward Stepwise (Likelihood Ratio)

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	42.728	5	.000
	Block	42.728	5	.000
	Model	42.728	5	.000
Step 2(a)	Step	-1.533	1	.216
	Block	41.196	4	.000
	Model	41.196	4	.000

a A negative Chi-squares value indicates that the Chi-squares value has decreased from the previous step.

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	798.394(a)	.050	.078
2	799.926(a)	.048	.076

a Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	12.174	8	.144
2	26.468	8	.001

Contingency Table for Hosmer and Lemeshow Test

		pa2level = 1		pa2level = 2		
		Observed	Expected	Observed	Expected	Total
Step 1	1	36	37.141	65	63.859	101
	2	25	25.414	63	62.586	88
	3	30	20.113	49	58.887	79
	4	18	19.494	68	66.506	86
	5	11	15.619	69	64.381	80
	6	11	13.835	70	67.165	81
	7	11	12.156	70	68.844	81
	8	9	8.974	67	67.026	76
	9	11	7.144	59	62.856	70
	10	6	8.108	93	90.892	99
Step 2	1	32	30.633	52	53.367	84
	2	28	28.448	66	65.552	94
	3	15	21.436	75	68.564	90
	4	31	16.556	44	58.444	75
	5	7	11.351	50	45.649	57
	6	10	14.222	63	58.778	73
	7	15	14.759	70	70.241	85
	8	9	8.987	60	60.013	69
	9	8	4.551	33	36.449	41
	10	13	17.057	160	155.943	173

Classification Table(a)

Observed			Predicted		
			pa2level		Percentage Correct
			1	2	
Step 1	pa2level	1	90	78	53.6
		2	171	502	74.6
	Overall Percentage				70.4
Step 2	pa2level	1	66	102	39.3
		2	150	523	77.7
	Overall Percentage				70.0

a The cut value is .750

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1(a)	diversity	.144	.117	1.524	1	.217	1.155
	m2range	.155	.035	20.173	1	.000	1.168
	centre			6.963	2	.031	
	centre(1)	-.438	.244	3.221	1	.073	.645
	centre(2)	.181	.237	.581	1	.446	1.198
	genum	.394	.178	4.900	1	.027	1.483
	Constant	.154	.403	.147	1	.702	1.167
Step 2(a)	m2range	.152	.034	19.776	1	.000	1.164
	centre			14.824	2	.001	
	centre(1)	-.522	.235	4.924	1	.026	.593
	centre(2)	.255	.229	1.248	1	.264	1.291
	genum	.400	.178	5.058	1	.025	1.492
	Constant	.558	.239	5.434	1	.020	1.747

a Variable(s) entered on step 1: diversity, m2range, centre, genum.

Model if Term Removed

Variable		Model Log Likelihood	Change in -2 Log Likelihood	df	Sig. of the Change
Step 1	diversity	-399.963	1.533	1	.216
	m2range	-410.505	22.617	1	.000
	centre	-402.673	6.953	2	.031
	genum	-401.665	4.935	1	.026
Step 2	m2range	-410.989	22.052	1	.000
	centre	-407.282	14.638	2	.001
	genum	-402.511	5.095	1	.024

Variables not in the Equation

			Score	df	Sig.
Step 2(a)	Variables	diversity	1.528	1	.216
	Overall Statistics		1.528	1	.216

a Variable(s) removed on step 2: diversity.

Casewise List(b)

Case	Selected Status(a)	Observed	Predicted	Predicted Group	Temporary Variable	
		pa2level			Resid	ZResid
99	S	1**	.865	2	-.865	-2.536
106	S	1**	.867	2	-.867	-2.557
107	S	1**	.867	2	-.867	-2.557
130	S	1**	.867	2	-.867	-2.557
132	S	1**	.867	2	-.867	-2.557
133	S	1**	.867	2	-.867	-2.557
135	S	1**	.867	2	-.867	-2.557
142	S	1**	.867	2	-.867	-2.557
177	S	1**	.867	2	-.867	-2.557
180	S	1**	.867	2	-.867	-2.557
181	S	1**	.867	2	-.867	-2.557
182	S	1**	.867	2	-.867	-2.557
198	S	1**	.867	2	-.867	-2.557
514	S	1**	.906	2	-.906	-3.098
515	S	1**	.906	2	-.906	-3.098
521	S	1**	.906	2	-.906	-3.098
522	S	1**	.906	2	-.906	-3.098
527	S	1**	.906	2	-.906	-3.098
530	S	1**	.906	2	-.906	-3.098
531	S	1**	.906	2	-.906	-3.098
558	S	1**	.907	2	-.907	-3.124
580	S	1**	.907	2	-.907	-3.124
581	S	1**	.907	2	-.907	-3.124
588	S	1**	.907	2	-.907	-3.124
627	S	1**	.907	2	-.907	-3.124
628	S	1**	.907	2	-.907	-3.124
629	S	1**	.907	2	-.907	-3.124
632	S	1**	.907	2	-.907	-3.124
795	S	1**	.923	2	-.923	-3.454
796	S	1**	.923	2	-.923	-3.454
817	S	1**	.867	2	-.867	-2.548
818	S	1**	.867	2	-.867	-2.548

a S = Selected, U = Unselected cases, and ** = Misclassified cases.

b Cases with Studentized residuals greater than 2.000 are listed.