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A Methodology for Understanding Design Implications of Active Preschool Play Areas

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The Eden Project, UK
Bright Horizons Family Solutions



Doctoral Thesis

Nilda Graciela Cosco

Motivation to Move:

Physical Activity Affordances in Preschool Play Areas

Overweight crisis for children, even for the youngest 2-5 years old

USA

- More than **10%** of children are obese
(BMI 95th percentile)
- More than **20%** of children are overweight or at risk of being overweight
(BMI 85th percentile)
(Ogden et al, 2002)

UK

- About **7%** of children are obese
(BMI 95th percentile)
- About **18%** of children are overweight
(BMI 85th percentile)
(Office of National Statistics, UK, 2004)

An urgent intervention is needed to avoid a compromised quality of life at an early age

The relevance of childcare

Almost 75% of children with working parents are in some type of child care arrangements

Capizzano et al., 2000

The good news

- **Being outdoors** is the strongest correlate of physical activity (Sallis et. al, 1993)
- **Diverse, rich natural environments** support attentional functioning of children, gross motor development, children's health, and richer play (Grahn, P. et al, 1997 ; Faber Taylor, A. et al, 2001)
- Preschool physical activity **tracks throughout childhood** (Moore et al, 2003)

Policy opportunity

Childcare is a highly regulated institution

State licensing

Almost exclusively focuses on indoor environments. Health and safety.

NAEYC accreditation

Teacher training and child/teacher ratio

Role of designers

Codes, standards, and regulations

Need clear guidance

Research goal

To investigate the association between different types of **play area design** and the level of **physical activity** of 3-5 year old children.

Theoretical framework

- **Concept of affordance**

(Gibson, 1979; Gibson and Pick, 2000)

- **Behavior setting**

(Barker, 1976)

- **Motivation**

Complexity, diversity, and responsiveness

(Yarrow, Rubinstein & Perderson, 1975; Lepper & Henderlong, 2000)

Affordances

Affordances are properties of the environment related to children's capabilities for using them.

They include the **layout** the setting, the **objects** and the **events**.

Eleanor Gibson & Anne Pick, 2000



Behavior setting

Behavior settings are ecological units where the physical environment and the behaviour are indissolubly connected.

Eco-behavioural units that have a clear structure

- Located in time and space
- Composed of entities and events (people, objects, behaviour) and other processes (sound, shade, etc.)
- With identifiable boundaries
- Components are arranged in a functional way and are part of the whole
- 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.

Roger Barker, 1976



Study framework

Three childcare centers

Same provider (BHFS). Triangle area, NC. Dissimilar outdoor play areas.

Sample

30 preschool children per center N=90

Baseline measures • children

- Demographics (age, ethnicity, parent education/center fee)
- BMI
- Test of Gross Motor Development TGMD2 (Ulrich 1985)
- Early Childhood Attention Deficit Disorder Scale EC-ADDES (McCarney 1995)

Baseline measures • teachers

Age, gender, ethnicity, education

Years of experience

Years in center

Director questionnaire

Play area

Preschool Outdoor Environment Scale POEMS

DeBord, Hestenes, Moore, Cosco, McGuinnis 2005

Environment and behavior measures

- **Behavior mapping** linked to physical activity level using SOPARC (McKenzie & Cohen, 2006)
(840 data points)
 - Setting diversity (score 1-4)
 - Setting category (manufactured / mixed / natural)
- **One week accelerometry** (10 children /center N=30)
- **Behavior tracking** of individual children



Center A Grassy area and play equipment



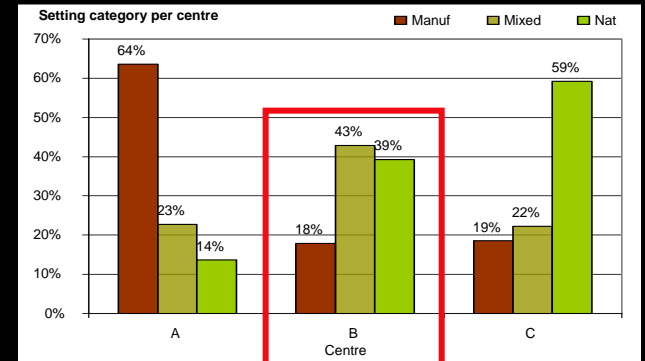
Center B Pathways, vegetation and play equipment

Center B

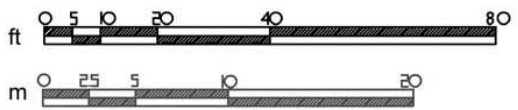
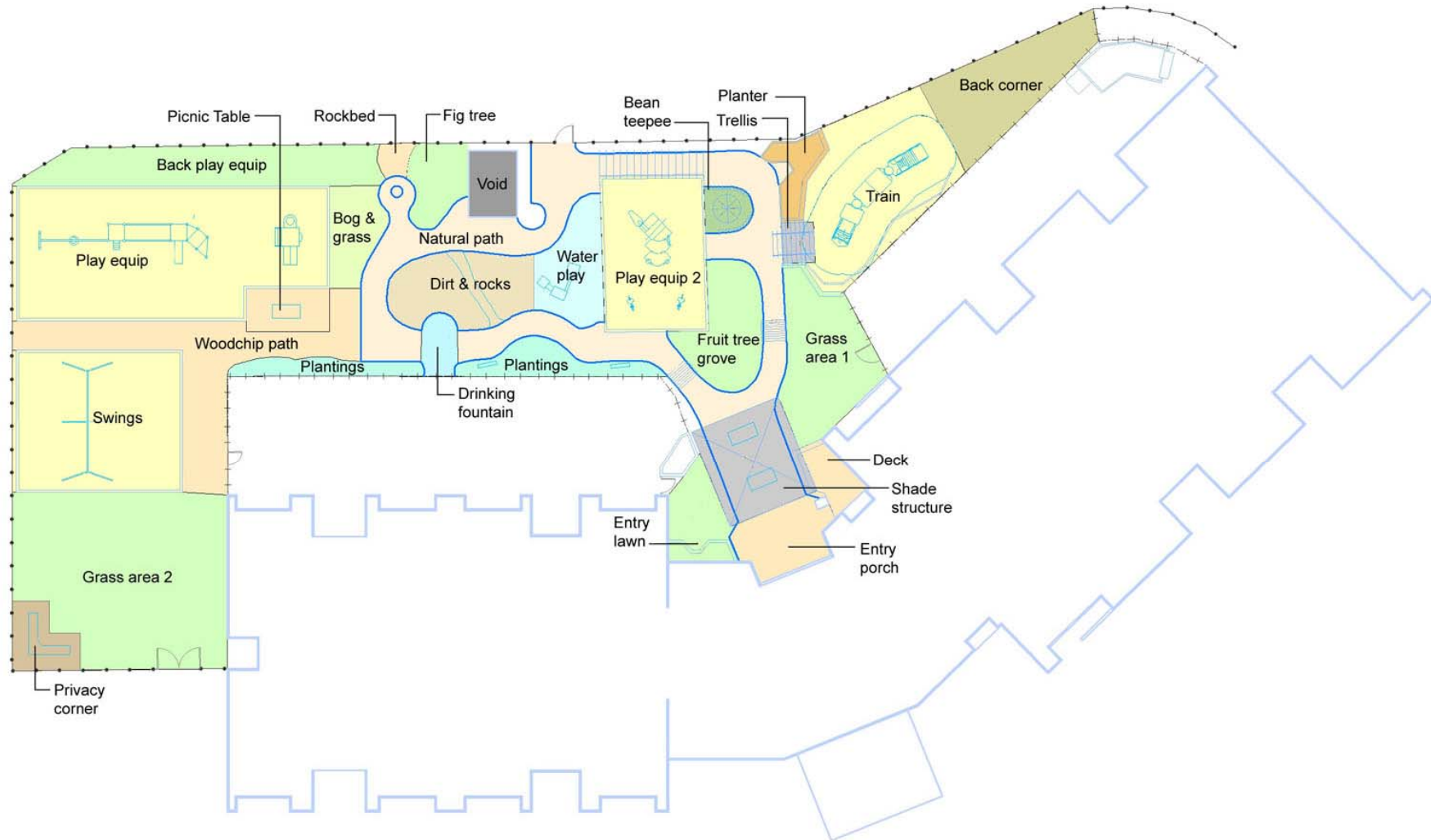
Most active play area as measured by one week accelerometer monitoring



Center C Natural environment with segregated play equipment area



Proportion of manufactured, mixed and natural settings per center

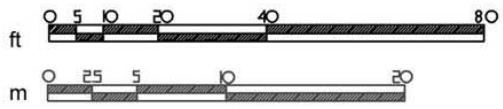
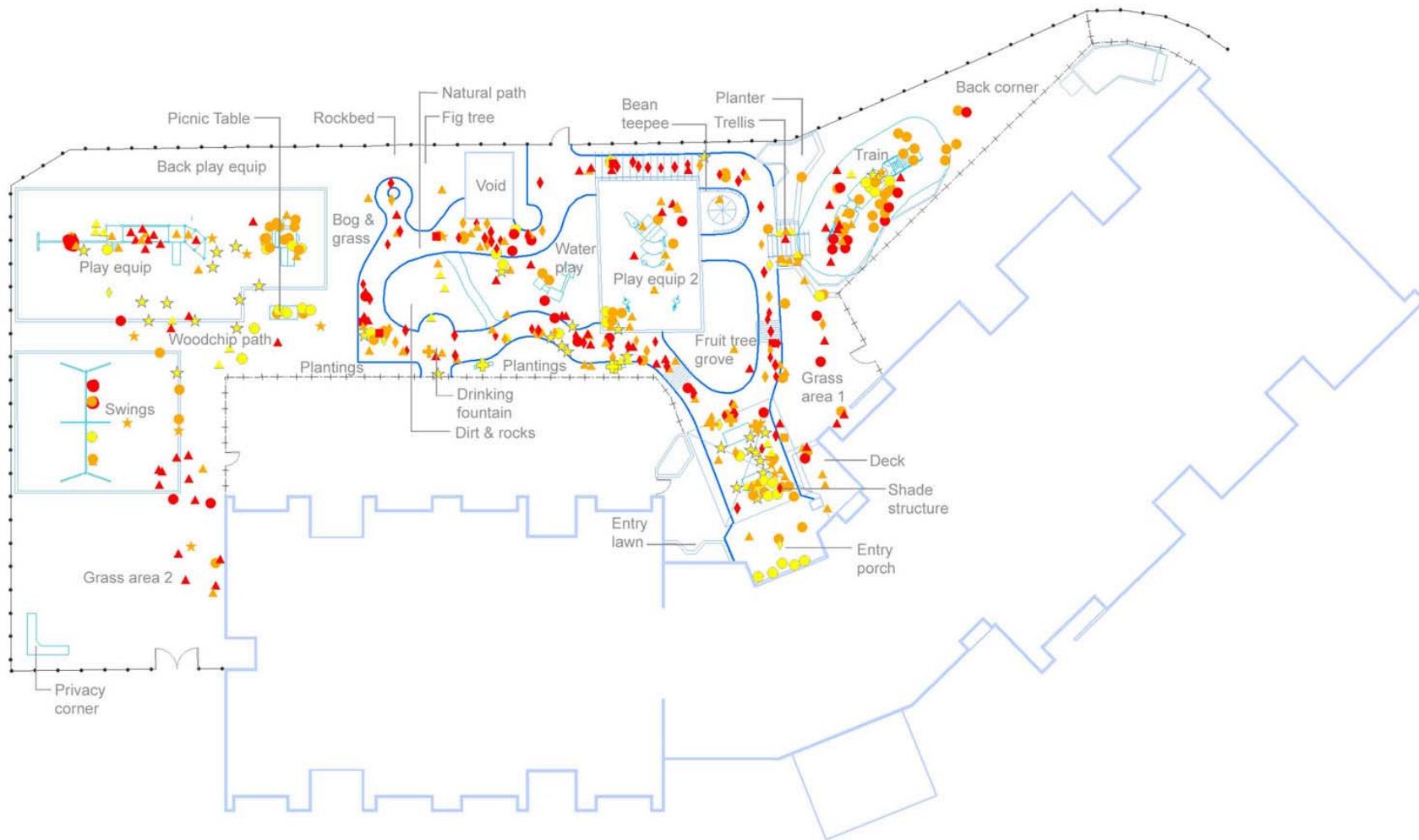


Total sq.ft. = 14,439
Total sq.m. = 1,341

Center B
 All Data Points
 3-29-06

Legend

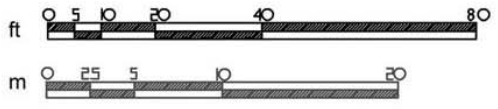
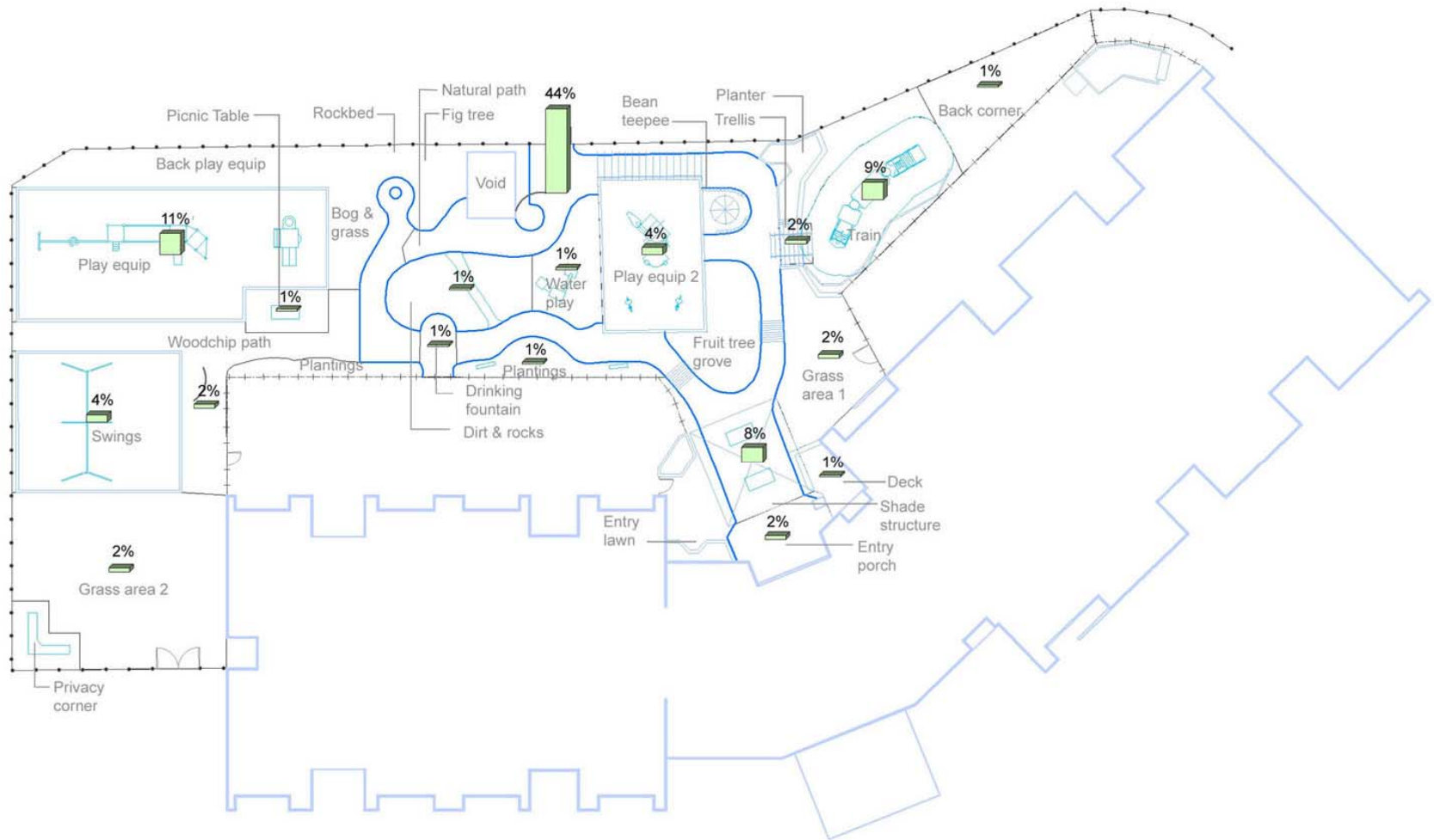
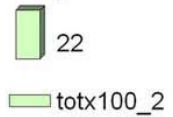
- T**
- ★ 1
- ★ 2
- G**
- 1
- 2
- 3
- Gcart**
- 2
- 3
- Gwheel**
- ◆ 1
- ◆ 2
- ◆ 3
- B**
- ▲ 1
- ▲ 2
- ▲ 3
- Bwheel**
- ◆ 1
- ◆ 2
- P**
- ⊕ 1
- ⊕ 2



Total sq.ft. = 14,439
 Total sq.m. = 1,341

Center B
 Percent Use Per Setting
 3-29-06

Legend



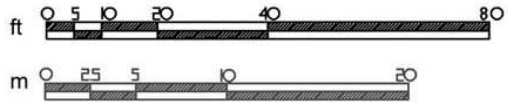
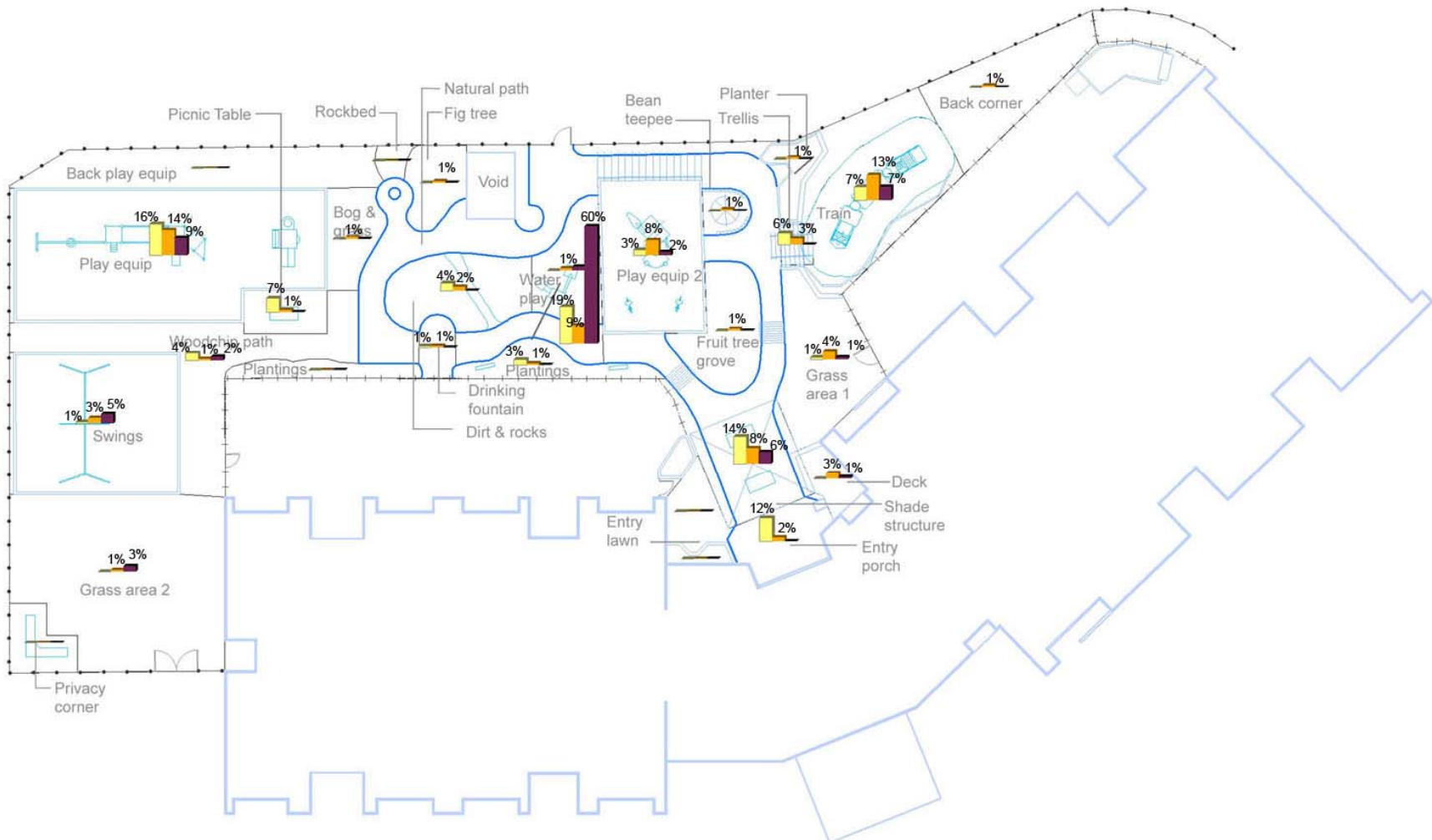
Total sq.ft. = 14,439
 Total sq.m. = 1,341

Center B
 PA Level Per Setting
 3-29-06

Legend



- PA_1_ALL
- PA_2_ALL
- PA_3_ALL



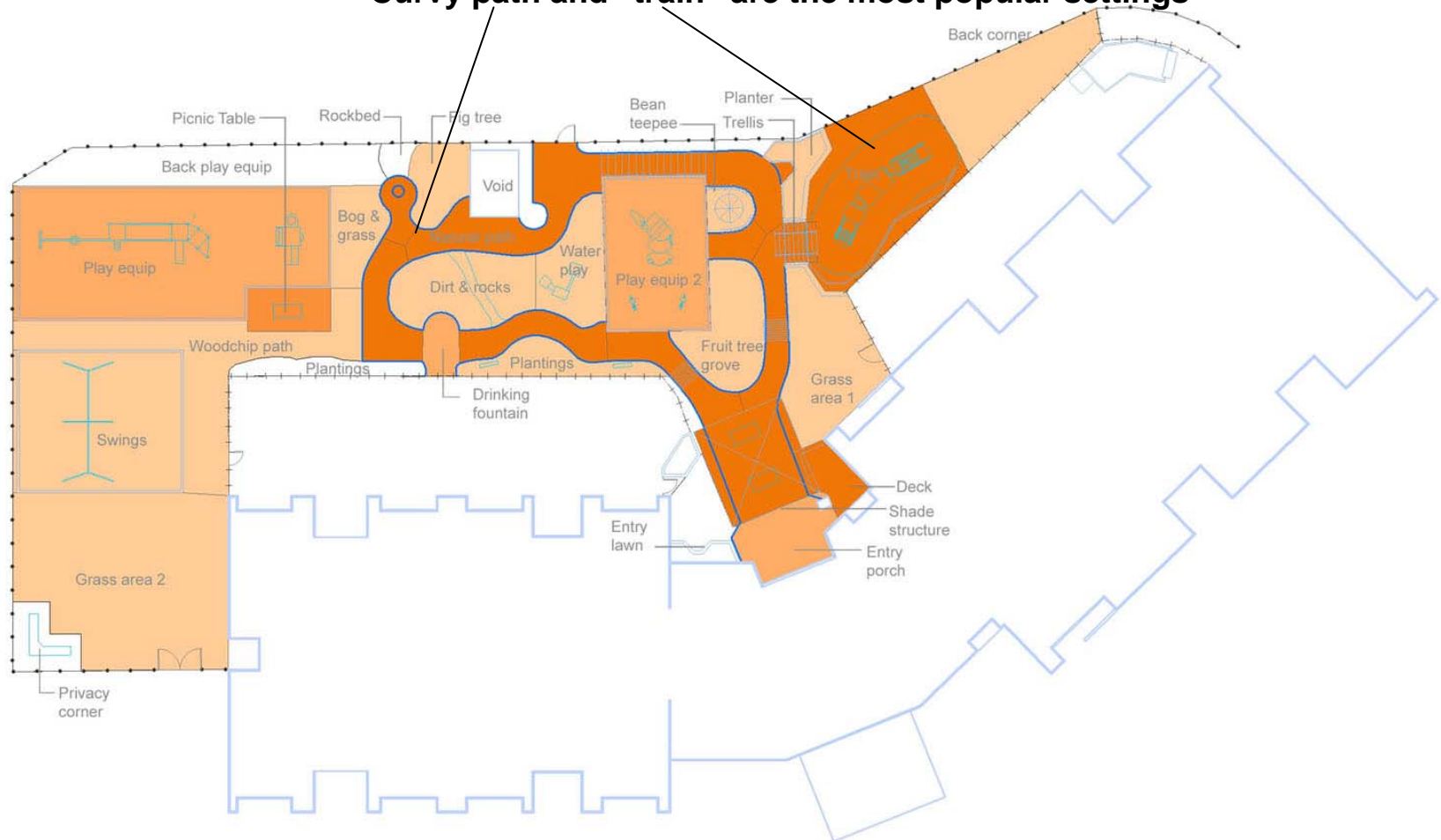
Total sq.ft. = 14,439
 Total sq.m. = 1,341

Center B
 Loading- All Children
 3-29-06

**Center B. Behavior map showing number of children per setting.
 Curvy path and "train" are the most popular settings**

Legend

- 0
- 1 - 5
- 6 - 10
- 11 - 15
- 16 - 46



Total sq.ft. = 14,439
 Total sq.m. = 1,341

Physical activity and setting characteristics

Setting m2 range – physical activity level – setting diversity (1-4)– setting category (1=manufactured, 2=mixed, 3=natural)

| | | | | palevel |
|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| A | Spearman's rho | sett m2 range | Correlation Co efficient | .205(**) |
| | | | Sig. (2-tailed) | .001 |
| | | | N | 239 |
| | palevel | Correlation Co efficient | Sig. (2-tailed) | . |
| | | | N | 239 |
| | | | diversity | Correlation Co efficient |
| | diversity | Correlation Co efficient | Sig. (2-tailed) | .099 |
| | | | N | 239 |
| | | | setting category numeric | Correlation Co efficient |
| | setting category numeric | Correlation Co efficient | Sig. (2-tailed) | .824 |
| | | | N | 239 |
| | | | B | Spearman's rho |
| Sig. (2-tailed) | .000 | | | |
| N | 432 | | | |
| palevel | Correlation Co efficient | Sig. (2-tailed) | . | |
| | | N | 432 | |
| | | diversity | Correlation Co efficient | .113(*) |
| diversity | Correlation Co efficient | Sig. (2-tailed) | .019 | |
| | | N | 432 | |
| | | setting category numeric | Correlation Co efficient | .034 |
| setting category numeric | Correlation Co efficient | Sig. (2-tailed) | .475 | |
| | | N | 432 | |
| | | C | Spearman's rho | sett m2 range |
| Sig. (2-tailed) | .010 | | | |
| N | 196 | | | |
| palevel | Correlation Co efficient | | Sig. (2-tailed) | 1.000 |
| | | | N | 196 |
| | | | diversity | Correlation Co efficient |
| diversity | Correlation Co efficient | | Sig. (2-tailed) | .654 |
| | | | N | 196 |
| | | | setting category numeric | Correlation Co efficient |
| setting category numeric | Correlation Co efficient | | Sig. (2-tailed) | .416 |
| | | | N | 196 |

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

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

Step 1

Size of setting is highly significant ($p < .001$)

Center and **gender** are significant ($p < .05$).

Step 2

Size of setting and **center** are highly significant ($p < .001$)

Gender is significant $p < .005$.

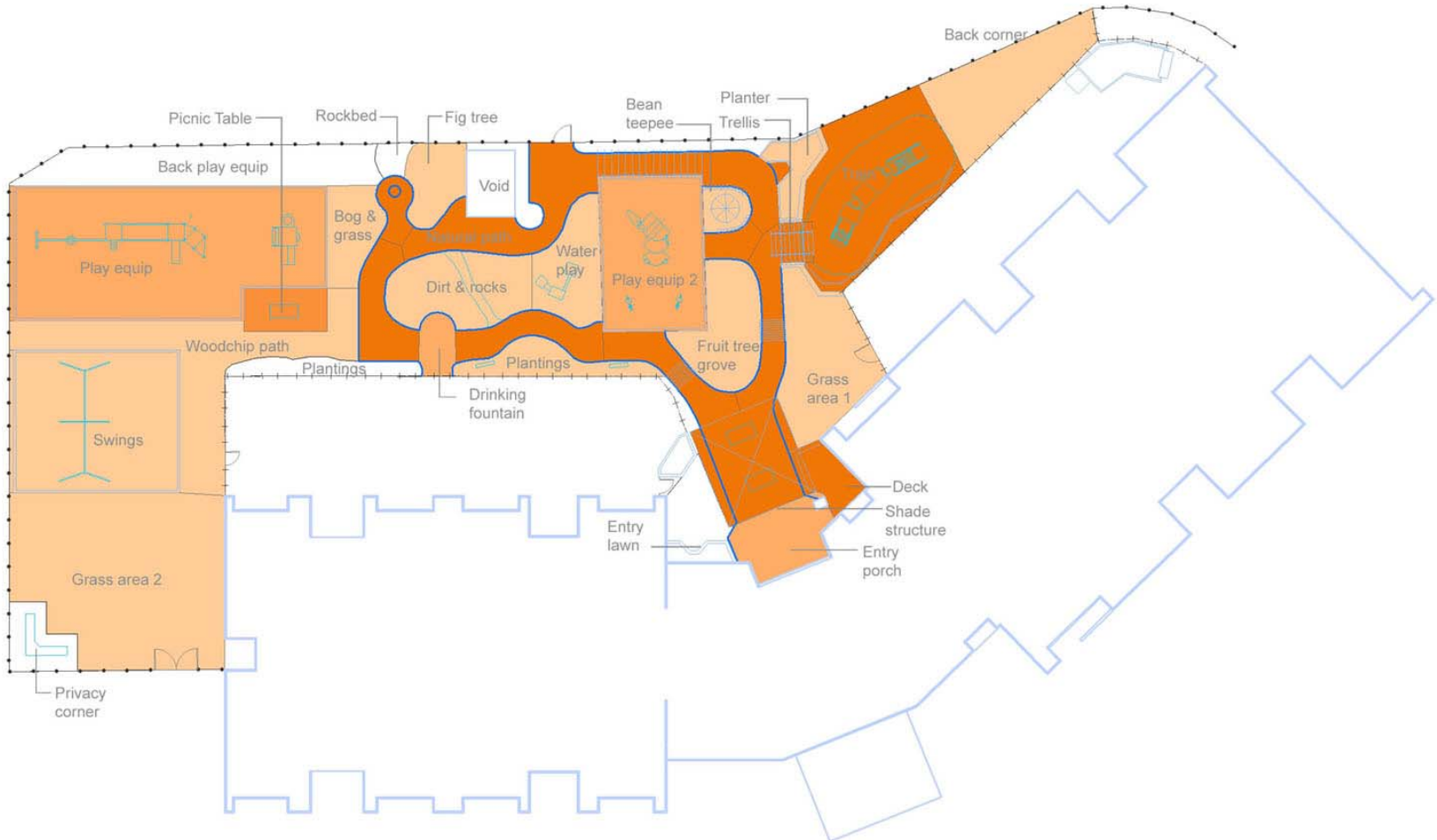
| | | B | S.E. | Wald | df | Sig. | Exp(B) |
|-----------|-----------|-------|------|--------|----|-------------|--------|
| Step 1(a) | diversity | .144 | .117 | 1.524 | 1 | .217 | 1.155 |
| | m2range | .155 | .035 | 20.173 | 1 | .000 | 1.168 |
| | centre | | | 6.963 | 2 | .031 | .000 |
| | centre(1) | -.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.

Center B
 Loading- All Children
 3-29-06

Legend

- 0
- 1 - 5
- 6 - 10
- 11 - 15
- 16 - 46



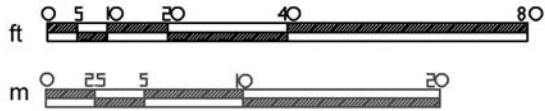
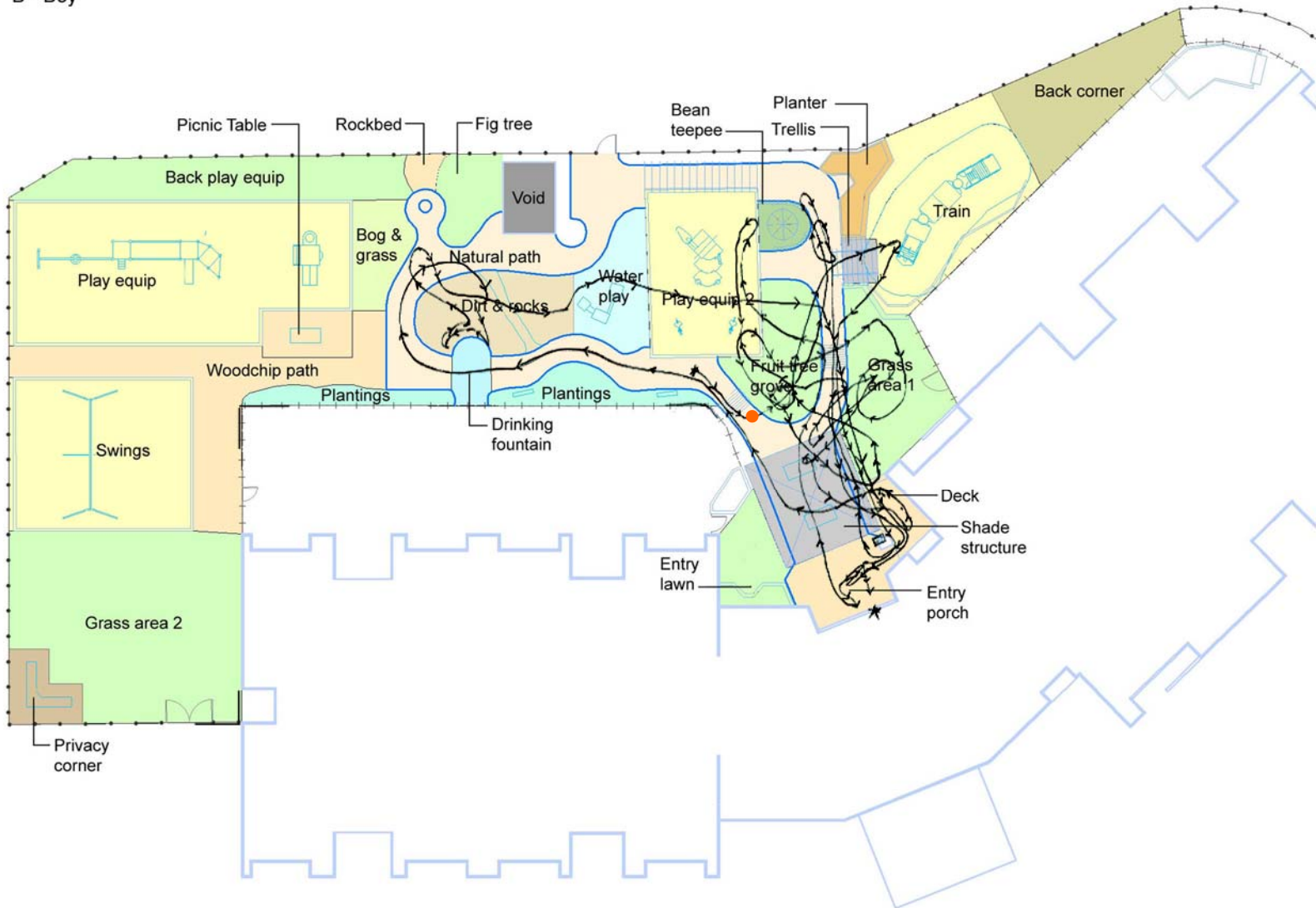
Total sq.ft. = 14,439
 Total sq.m. = 1,341







Centre B
Behaviour Settings
3-29-06
B - Boy



Total sq. ft. = 14,439
Total sq.m. = 1,341

B-boy behavior tracking



Timers

| | |
|-----------|----------|
| Start | 00:00:00 |
| Current | 00:00:34 |
| End | 01:30:00 |
| Elapsed | 00:00:34 |
| Observed | 00:00:34 |
| Maximum | 01:30:00 |
| Remaining | 01:29:25 |

Channels

| | | |
|------------------------------|--------------------------|---------------------------------|
| [setting] sett04 | [PA type] running | [socialinteract] 2children |
| [play] onlooking | [toy] NOtoy | [wheel] nowheel |
| [sandLeaves] NoNATloose | [treeShrub] NOnatfx | [playeqFstruct] NOfxelem |
| [teacherinterv] none | | |



Video Control

Event Log

| RECORD | TIME | BEHAVIOR |
|--------|-------|------------|
| 1 | 0.00 | sett04 |
| 2 | 0.00 | running |
| 3 | 0.00 | NOinter |
| 4 | 0.00 | onlooking |
| 5 | 0.00 | NOtoy |
| 6 | 0.00 | nowheel |
| 7 | 0.00 | NoNATloose |
| 8 | 0.00 | NOnatfx |
| 9 | 0.00 | NOfxelem |
| 10 | 0.00 | none |
| 11 | 6.76 | 2children |
| 12 | 8.56 | functional |
| 13 | 16.46 | sett14 |
| 14 | 20.70 | toy1 |
| 15 | 23.40 | walking |
| 16 | 26.46 | sett04 |
| 17 | 30.03 | NOtoy |
| 18 | 31.53 | onlooking |
| 19 | 33.46 | running |
| 20 | 37.90 | sett23 |
| 21 | 44.90 | sett24 |
| 22 | 66.00 | sett23 |
| 23 | 69.40 | toy1 |

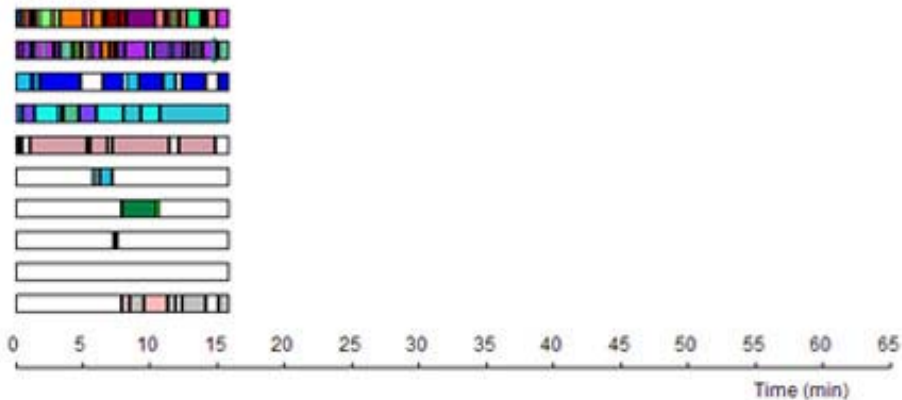
| | | | | | |
|-------------|--------|-------------|--------------------|-------------------|-------------------|
| [setting] | sett18 | [PA type] | sitting | functional | NoNATloose |
| sett01 | sett19 | bending | sliding | gamew/rules | [treeShrub] |
| sett02 | sett20 | climbing | standing | negative behavior | NOnatfx |
| sett03 | sett21 | crawling | still | onlooking | natfx1 |
| sett04 | sett22 | digging | swinging | otherinter | natfx2 |
| sett05 | sett23 | hanging | walkPULL | social conversat | [playeqFstruct] |
| sett06 | sett24 | jumping | walkPUSH | transition | NOfxelem |
| sett07 | sett25 | kicking | walking | [toy] | fxelem1 |
| sett08 | sett26 | kneeling | xxxx | NOtoy | fxelem2 |
| sett09 | sett27 | lying | [socialinteract] | toy1 | [teacherinterv] |
| sett10 | sett28 | moving | 1child | toy2 | custodial |
| sett11 | sett29 | pedaling | 2children | [wheel] | negative |
| sett12 | sett30 | pulling | NOinter | cart | neutral |
| sett13 | sett31 | pushing | group | nowheel | none |
| sett14 | sett32 | rolling | [play] | trike | positive |
| sett15 | sett33 | runPULL | constructive | [sandLeaves] | |
| sett16 | sett34 | runPUSH | disengaged | NATloo1 | |
| sett17 | sett35 | running | dramatic | NATloo2 | |

Enter behavioral element code

Customization (1).cus MtoMDec05v3(1).prj

B-Boy

| Subject | Behavioral Class |
|---------|------------------|
| Subject | setting |
| Subject | PA type |
| Subject | socialinteract |
| Subject | play |
| Subject | toy |
| Subject | wheel |
| Subject | sandLeaves |
| Subject | treeShrub |
| Subject | playeqFxstruct |
| Subject | teacherinterv |



| Legend | | | | | | | | | |
|-----------|---------------|------------|---------------|------------|---------------|----------|---------------|-------------------|---------------|
| Behavior | Color/Pattern | Behavior | Color/Pattern | Behavior | Color/Pattern | Behavior | Color/Pattern | Behavior | Color/Pattern |
| 2children | [Blue] | NONatfx | [White] | climbing | [Purple] | group | [Dark Blue] | negative behavior | [Red] |
| NATloo1 | [Green] | NOtoy | [White] | crawling | [Olive] | jumping | [Dark Green] | none | [White] |
| NATloo2 | [Dark Green] | NoNATloose | [White] | custodial | [Grey] | licking | [Magenta] | nowheel | [White] |
| NOfxelem | [White] | bending | [Teal] | digging | [Cyan] | moving | [Light Green] | onlooking | [Purple] |
| NOinter | [White] | cart | [Light Blue] | functional | [Cyan] | natfx1 | [Maroon] | otherinter | [Light Green] |

| Behavior | Color/Pattern | Behavior | Color/Pattern | Behavior | Color/Pattern | Behavior | Color/Pattern | Behavior | Color/Pattern |
|----------|---------------|----------|---------------|----------|---------------|------------------|---------------|----------|---------------|
| positive | [Pink] | sett10 | [Dark Red] | sett18 | [Light Green] | sitting | [Teal] | walkPULL | [Red] |
| rolling | [Light Green] | sett11 | [Olive] | sett19 | [Light Green] | social conversat | [Cyan] | walking | [Purple] |
| runPULL | [Orange] | sett12 | [Purple] | sett23 | [Orange] | standing | [Blue] | | |
| running | [Purple] | sett14 | [Blue] | sett24 | [Pink] | toy1 | [Light Pink] | | |
| sett04 | [Grey] | sett15 | [Light Green] | sett30 | [Purple] | toy2 | [Red] | | |

- **Settings**

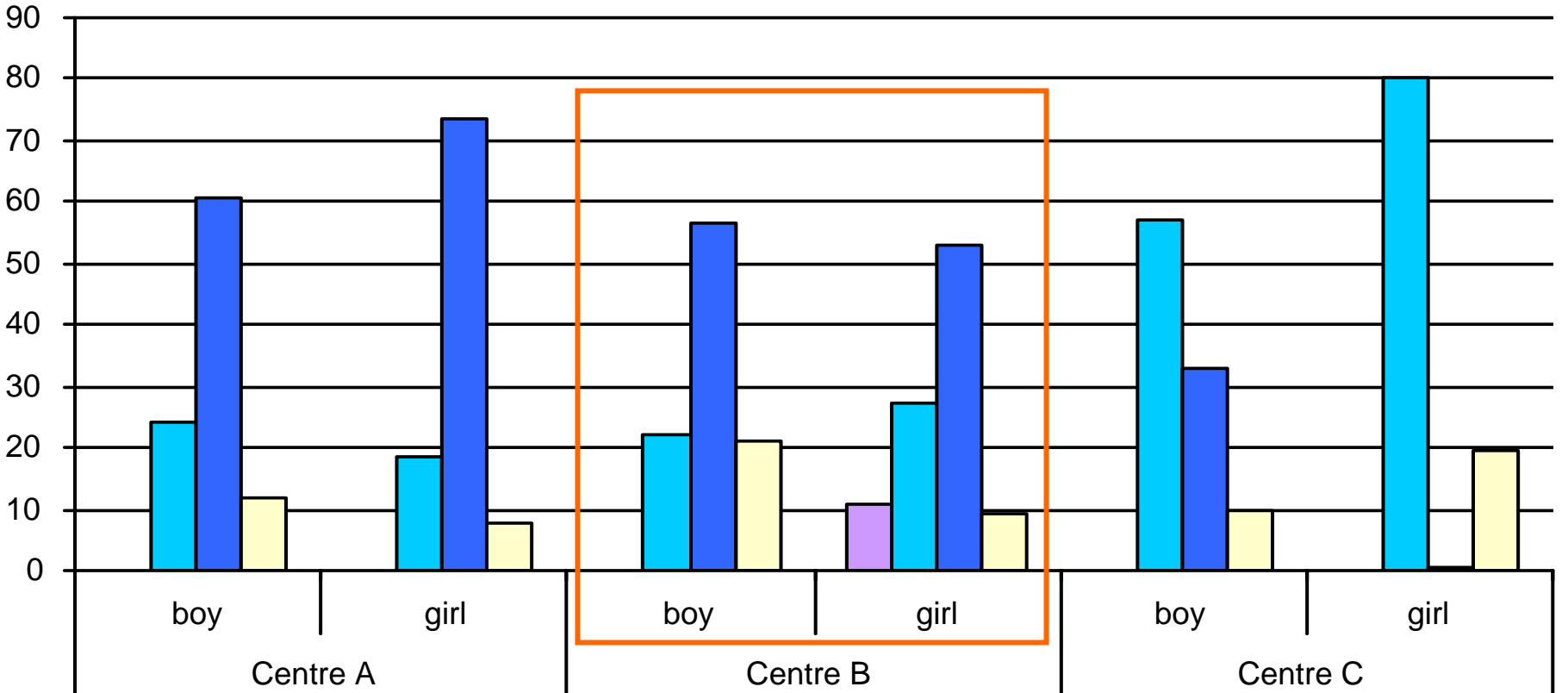
- shade structure that was set up for group play (20.47%, 3.2 minutes)
- adjacent deck where toys and play materials are stored (17.85%, 2.85 minutes)
- play equipment 2 (15.57%, 2.49 minutes)
 - lawn, the natural path and train, passed by the water play area, trellis, and tree grove.

- **Physical activity type**

- walking and running (both activities combined 60%, 9.6 minutes).

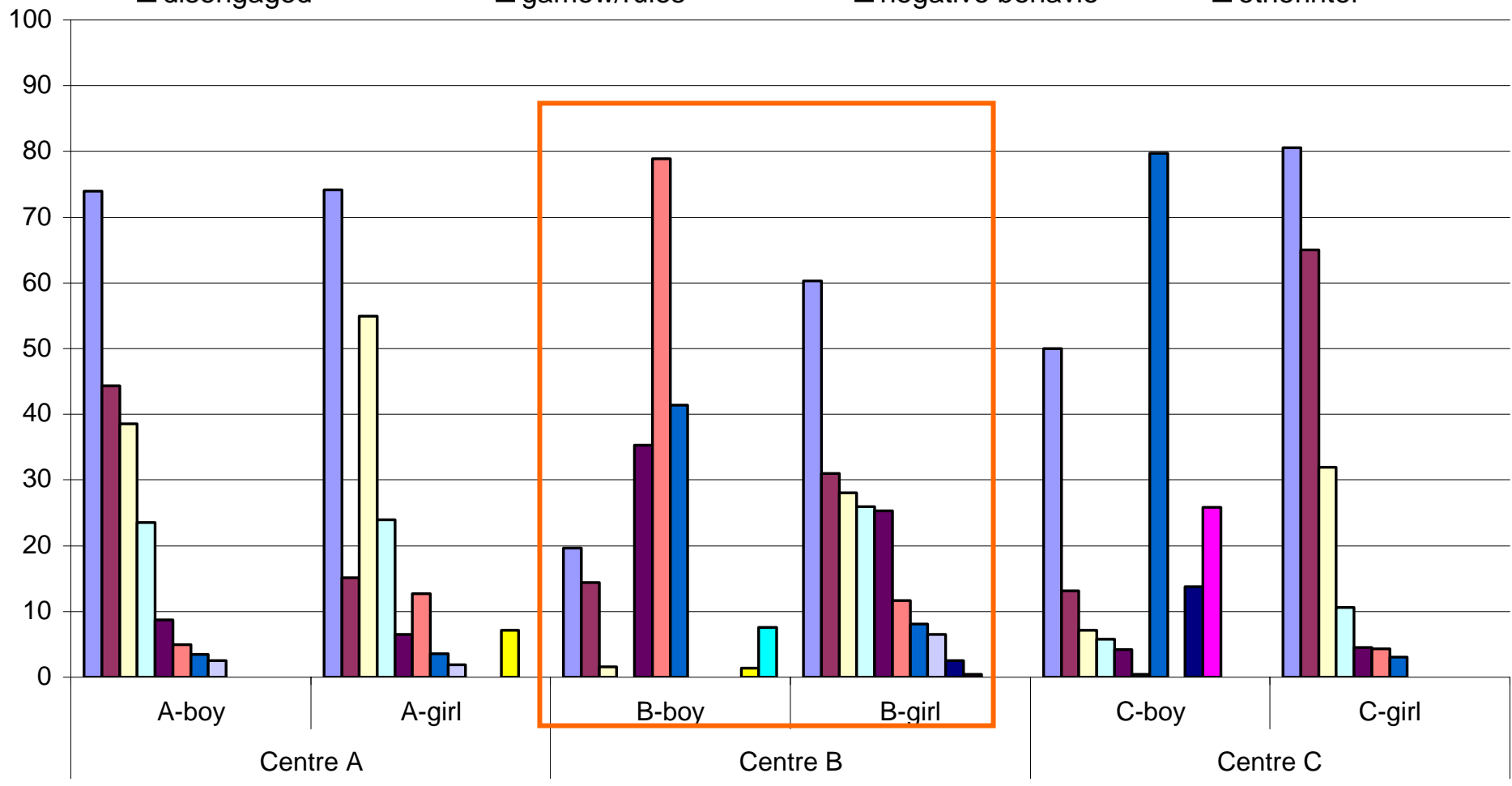
Observed social interactions(percent)

1child 2children group noSocInterac

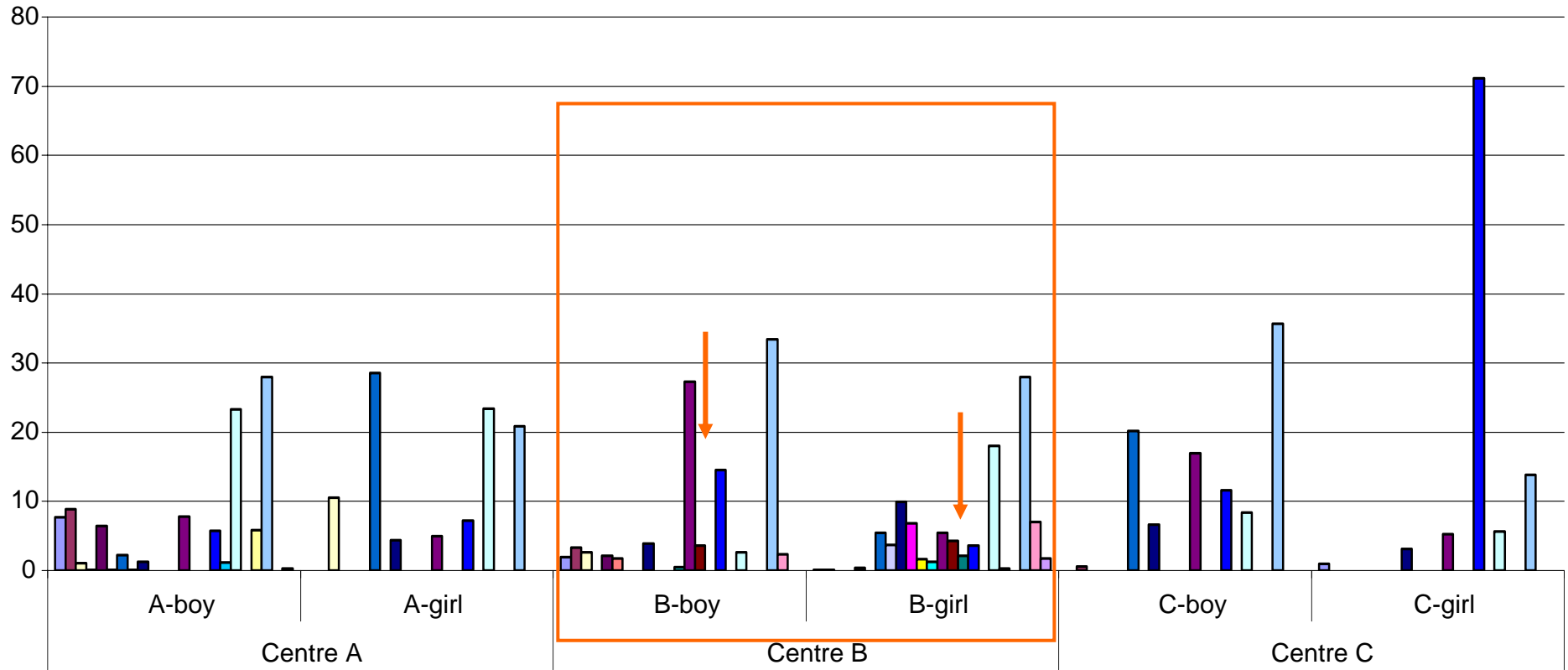
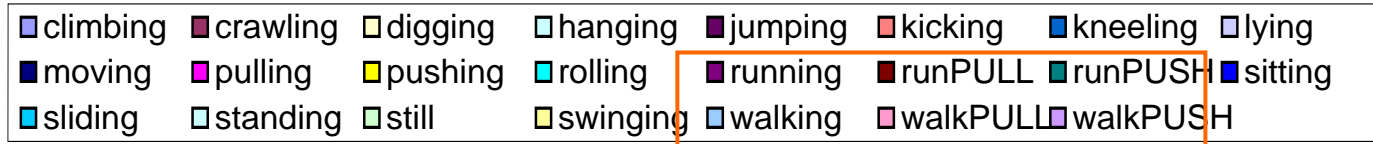


Play

- toy2
- onlooking
- disengaged
- functional
- social conversat
- gamew/rules
- dramatic
- transition
- negative behavior
- toy1
- NOtoy
- otherinter



Physical activity



Findings

- The **most active play area** contained a mix of natural and manufactured elements.
- The most active behavior setting was a **wide, curvy, wheeled toy pathway** (largest setting).
- Followed by open areas.

Findings

- **Compact play areas**, where greater numbers of children play together, are likely to support increased activity.
- **Diverse play areas** seems to support more varied physical activity.

Limitations

High quality centers

- State of North Carolina licensing “Five Stars”

- NAEYC accreditation

Geographical location

- South of the frost line

- Piedmont region (i.e. region of rolling hills and pine woods)

Seasonality

- Fieldwork performed during the mild temperature season

Sample

- Middle class children with educated parents

- Homogeneous population

Future research

Measuring Physical Activity Affordances in Preschool Outdoor Environments.

NIEHS. PI. Prof. Robin Moore

Opportunity for replication

Center A

Under construction. Adding tricycle pathways

Center B

Added outdoor classroom

Center C

Outdoor play with larger number of children

New applications

Parks, schools, streets....

Parachute ride!

Thanks

