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Neighborhood and developmental differences in children's perceptions of opportunities for play and physical activity

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Abstract

The purposes of this study were to examine perceptions of places to play and be physically active among children from two different urban neighborhoods, and evaluate these perceptions for age-related developmental differences. One hundred and sixty-eight children from grades K-6 (aged 6–12 years old) completed mental maps depicting places where they could play and be physically active. The children were recruited from schools in two neighborhoods—one a high-walkability (H-W) grid-style neighborhood, the other a low-walkability (L-W) lollipop-style (i.e., cul-de-sacs) neighborhood. Analysis revealed that children in the H-W neighborhood depicted more active transportation and less non-active transportation than children in the L-W neighborhood. Children in the lowest grades (K-2) in the L-W neighborhood depicted more play in the home/yard environment than the oldest children, more good weather image events than children in Grades 3–6, and less play outside the home/yard environment than children in Grades 3 and 4. In the H-W neighborhood, the youngest children (K-2) depicted significantly less play in the home/yard environment and less play outside the home/yard environment than older children (Grades 3–6). Thus, both the type of urban neighborhood and children's age moderated perceptions of places to play and be physically active.

Keywords: Urban form; Active transportation; Drawing techniques

Physical activity participation among Canadian children has decreased over the past decade (King et al., 1999) with fewer than half of youth aged 5–17 being sufficiently active for optimal growth and development (Craig et al., 2001). Since physical inactivity is related to the recent rise in the prevalence of overweight and obesity among children (Tremblay and Willms, 2003) it is important to understand more about the factors that influence children's physical activity participation to provide evidence that can be used to create effective interventions.

While many correlates of physical activity have been identified (e.g., Sallis et al., 2000), the importance of the environment in shaping physical activity has been recognized (Duncan et al., 2005). Evidence suggests that neighborhoods have an independent effect on physical activity over and above individual demographic characteristics (Saelens et al., 2003).

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For example, Frank and colleagues (2005) reported that adults living in Atlanta neighborhoods deemed to be high in walkability (based upon an index of land-use mix, residential density, and intersection density) were 2.4 times more likely to meet recommended physical activity guidelines (30 min or more of physical activity per day) than those living in low-walkability neighborhoods. High-walkability neighborhoods typically consist of a grid street network, whereas low-walkability neighborhoods are more likely to be made up of disconnected street networks (Frank et al., 2003). The latter plan is exemplified in the design of the typical suburb and is sometimes referred to as a 'lollipop' neighborhood (Southworth and Owens, 1993) because of the presence of many cul-de-sacs. Suburban sprawl and the way neighborhoods are designed are related to the physical health and bodyweight status of adults residing in those neighborhoods (Sturm and Cohen, 2004).

In comparison to the research with adults, far less is known about the role of neighborhood environment in the physical activity of children and youth. Several recent studies (Gordon-Larsen et al., 2006; Hume et al., 2005; Timperio et al., 2004) found that objective measures of neighborhood design and availability of facilities along with perceptions of the neighborhood were related to physical activity of children and adolescents. Similarly, Churchman (2003) suggested that the road system, zoning practices, and the extent to which children can go places on their own are all influential factors on children's physical activity experiences. Thus, the design of neighborhoods are one aspect of urban form that may influence the physical activity patterns of children who live within them (Krizek et al., 2004). Therefore, one way to develop more knowledge about the influence of urban design on children's physical activity is to compare the experiences and perceptions of children living in high-walkability versus low-walkability neighborhoods.

Developmental ecological perspective

One increasingly popular approach to understanding the influence of the environment on physical activity has been to use various types of ecological models (Davidson and Birch, 2001; Garcia Bengoechea and Johnson, 2000; Spence and Lee, 2003). These models represent adaptations of Bronfenbrenner's bioecological theory (1977, 2001; Bronfenbrenner and Morris, 1998). Within this theory it is hypothesized that social systems are ecological influences that play a significant role in children's development. Some layers of ecological influence (e.g., neighborhood cohesion) are distal, whereas other layers (e.g., parent–child relationships) are more proximal (O'Connor, 2002).

Adaptations of Bronfenbrenner's work to examine environmental influence on physical activity offer useful and important ways of conceptualizing and designing studies intended to improve community health. However, it is also important to note that Bronfenbrenner's theory is a systems theory of *child development*. That is, developmental transitions are viewed as a product of a developmental system which involves a person's biological predispositions and the environmental influences she/he experiences (Lerner, 2002). Although some transitions are experienced by all youth (e.g., for girls, the onset of menarche), each individual will experience these transitions in her/his own unique way, across an individual time frame, with unique outcomes. Therefore, development is influenced not only by biological variables, but also life context, such as family, school, neighborhood, community, society, and surrounding culture. The context can be more objective (e.g., income level) or more subjective, which involves people's perceptions and experiences of the context in which they live (Bronfenbrenner, 2001). In order to understand connections between environment, physical activity, and youth development, it is essential to examine the context effects that they experience from a developmental perspective. If researchers can understand what promotes healthy development for youth, then those forces can be manipulated to shape development.

Because childhood and adolescence represent unique parts of the lifecourse that are important in the development of lifelong physical activity (Perkins et al., 2004), it is particularly important to examine relations between youth physical activity and urban design. Krizek et al. (2004) presented a schematic for examining relations between youth physical activity and community design, which accounts for time spent during the day in travel, time spent at destinations, and time spent engaged in physical activity. Whereas Krizek et al.'s schematic provided a framework for research into youth physical activity and urban design, and the authors acknowledged the importance of examining developmental trends in physical activity, there do not appear to have been any published studies examining developmental trends associated with youth physical activity in different urban environments. The present study was intended to represent an initial step in addressing this gap in the literature.

It is possible that children view their entire environment as a play opportunity, so that play opportunities are not confined to parks, playgrounds, and backyards, but also include streets, alleyways, wasteland, and natural/wild environments (Abu-Ghazzeh, 1998; Tranter and Doyle, 1996). However, it has been argued that in recent years children's physical activity and play have become constricted, controlled, privatized, and subject to adult supervision (Blades et al., 1998; Buckingham, 2000; Matthews et al., 1999). Similarly, the predominant approach to researching children's experiences of play and physical activity is to conduct 'research on' rather than 'research with' or 'research for' children (Darbyshire, 2000). In the present study we sought to obtain children's views and provide them with opportunities to portray their play and physical activity environments (Darbyshire et al., 2005). Understanding more about neighborhood opportunities for play and physical activity from children's perspectives may provide useful information for the creation of child-friendly cities (Tranter and Pawson, 2001).

Recent studies have involved children as community participants. Using mapping and photographic techniques and accelerometers with 147 10-year-old Australian children, Hume et al. (2005) examined relations between children's perceptions of their environment and objectively measured physical activity. Qualitative data revealed that shared or social space in the family home was important in the lives of the children studied, so that the home became a haven from outside influences. Children who had limited physical environments at home also demonstrated low levels of activity. Interestingly, boys who reported more opportunities for sedentary activities in the home were more vigorously active and spent less time being sedentary. This finding was consistent with the notion that physical activity and sedentary behaviors can coexist (Marshall et al., 2002). Among girls, food locations were positively associated with moderate physical activity; likely a result of the girls walking to these food destinations in their local neighborhood. Although this study provided some initial insights, Hume et al. (2005) concluded that "children's perceptions of their environments and how they relate to physical activity are not well understood" (p. 12).

MacDougall et al. (2004) used focus groups, drawing/mapping techniques, and photographic methods with children aged 4–12 years in metropolitan and rural South Australia to examine their understandings of physical activity, play, and sport. Results revealed that the terms 'sport' and 'play' represented distinctly different meanings to the children. Play represented activities that were 'owned' by children and was described in terms of fun, spontaneity, interactions with friends, and the absence of competition or aggression. Sport, on the other hand, was viewed as being 'owned' and controlled by adults. The terms physical activity and exercise were 'adult' terms that had little meaning for children. We used these findings in designing the present study and focusing on places that children thought represented places to play *and* be physically active. We included the term 'and be physically active' to ensure that children reported physical rather than social play activities.

In summary, one way to advance knowledge in this area is to compare the perceptions of children living in two types of urban environments to establish differences and similarities in their views of these environments. This study was intended to address two gaps in the literature. First, it is unknown whether living in a high-walkability or a low-walkability neighborhood influences children's perceptions of play and physical activity. Second, age-related developmental differences in children's perceptions of play and physical activity in their neighborhoods have not previously been examined. Accordingly, the first purpose of this study was to examine perceptions of places to play and be physically active among children from two different urban neighborhoods. The second purpose was to examine these environmental perceptions for age-related developmental differences.

Method

Neighborhoods

Children were recruited from two different elementary schools located in two neighborhoods in the city of Edmonton, Alta., Canada. One school was located in an older grid-style neighborhood (see Fig. 1). The other school was located in a newer lollipop-style neighborhood (see Fig. 2). To determine if a difference in walkability existed between

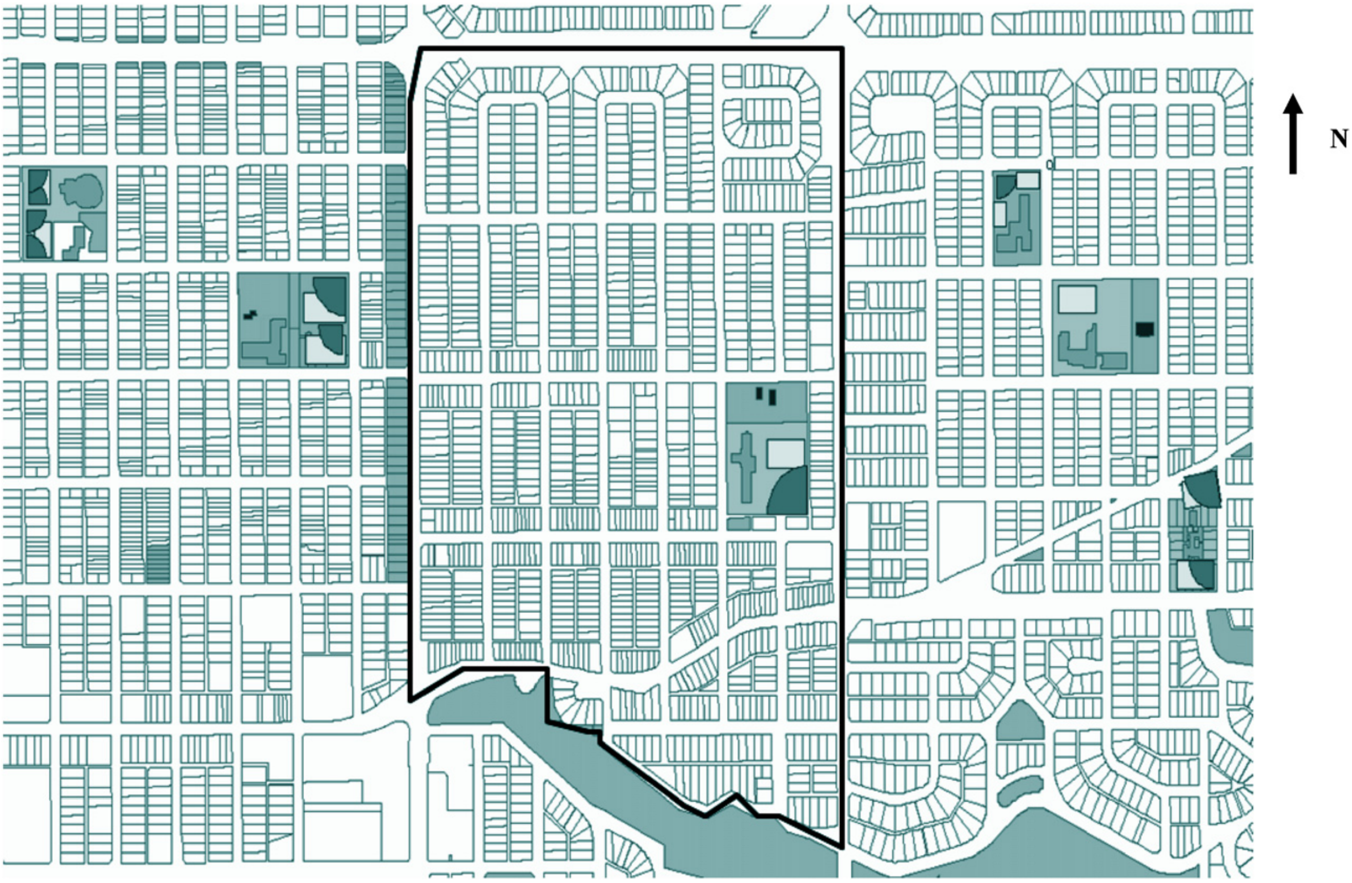

Fig. 1. Map of high walkability neighborhood.

the two neighborhoods, we calculated an index of walkability (Frank et al., 2006) for all neighborhoods in Edmonton. Specifically, with the aid of Arc GIS 8.3 (ESRI, 2004), each neighborhood was rated for residential density, connectivity of streets, and extent of mixed land use. A z-score was calculated for each variable for each neighborhood. Those z-scores were then summed across the three variables. A score of 6.00 or more indicates a highly walkable neighborhood while a score less than 0 suggests a less than average neighborhood in terms of walkability. Based upon this analysis the grid-style neighborhood would be considered walkable to highly walkable ($z = 5.08$) while the lollipop-style neighborhood would be considered low on the walkabilty index ($z = -3.37$). Thus, we refer to the grid-style location as a Higher-Walkability (H-W) neighborhood and the lollipop-style location as a Lower-Walkability (L-W) neighborhood.

The H-W neighborhood ($n = 2267$ residents) is located just to the west of the downtown district of Edmonton and is approximately 0.92 km^2 in size. It consists mainly of single detached dwellings (87.4%) with 71% of all dwellings being owned (City of Edmonton, 2005). The L-W neighborhood ($n = 2636$ residents) is several kilometres to the east of the downtown district and is 0.97 km^2 in size. All of the dwellings are single detached with 94% ownership (City of Edmonton, 2005). We calculated the total length of alleyways in the two neighborhoods and the density of alleyways to neighborhood size. The H-W neighborhood had more alleyways in terms of length (10,202.27 m) than the L-W neighborhood (3472.37 m). Given that the size of the neighborhoods was similar, the density of alleyways was much higher in the H-W (12.17 km/km^2) versus the L-W neighborhood (3.67 km/km^2).

In the H-W neighborhood the median family income in 2000 was $52,448 with 51% of adults reporting a high school, trade school, or college diploma and 28% of residents holding a university degree of some sort (Statistics Canada, 2001). In the L-W neighborhood the median family income is $66,482 with 52% reporting a high school, trade school, or college diploma and 16% having a university degree of some sort (Statistics Canada,

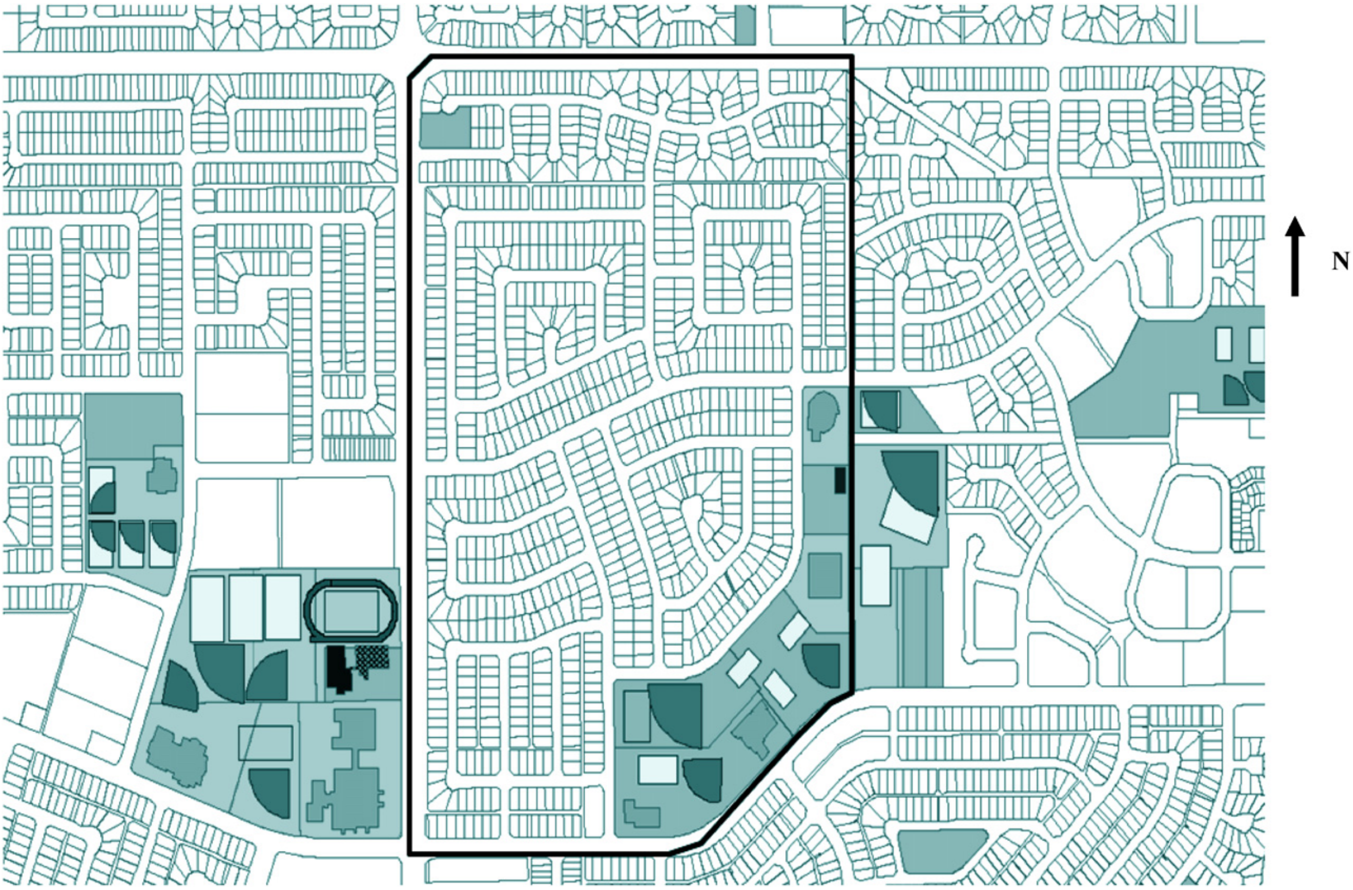

Fig. 2. Map of low walkability neighborhood.

2001). Since the median family incomes for Alberta and Edmonton were $55,200 and $56,400, respectively, in 2000 (Statistics Canada, 2001), these two neighborhoods could be considered middle- to upper middle-class by provincial and city standards. Thus, these neighborhoods shared similar geographical and demographic characteristics, but were distinctly different in terms of walkability (residential density, street connectivity, and mixed land-use).

Participants

In total, 168 children aged 6–12 years from grades K-6 participated in this study. From the school in the H-W neighborhood we recruited 9 children from Kindergarten, 17 from a combined Grades 1 and 2 class, 8 from Grade 3, 7 from Grade 4, 16 from a combined Grades 5 and 6 class, and 7 from a mixed class. From the school in the L-W neighborhood we recruited 12 children from Kindergarten, 26 from Grade 1, 6 from Grade 2, 12 from Grade 3, 10 from Grade 4, 11 from Grade 5, and 27 from Grade 6. Because of the low number of students in some classes, the classes were collapsed into K-2 (6–8 years), 3 and 4 (ages 9 and 10 years), 5 and 6 (ages 11 and 12 years) grade groups within each school for analysis purposes.

Procedure

The study was approved by the Research Ethics Board in the Faculty of Physical Education and Recreation at the University of Alberta and the Edmonton Public School Board. Each school principal was contacted by the Principal Investigator to request permission to conduct the study. Consent forms and information packages were delivered to the schools for children to take home to parents. Children's data were included in this study only if we received completed and signed informed consent forms from their parents/guardians prior to data collection. Data were collected via three visits to the school in the H-W neighborhood and four visits to the school in the L-W neighborhood. Data collection was arranged in order to accommodate class schedules. Within each class the researchers introduced the study to the children and requested that all children participate in the activities. However, information provided by those children for whom we had not received informed consent were not included in the study.

Data collection

We used a mental mapping technique to obtain data. Mental mapping refers to a process of forming mental representations of one's spatial environment (O'Laughlin and Brubaker, 1998; Tranter and Doyle, 1996). While neighborhood resources can be measured objectively (e.g., GIS mapping), and adolescents' perceptions of physical activity resources can be measured using questionnaires assessing perceived availability of environmental resources (Fein et al., 2004), quantitative measures of perceived environmental for elementary school aged children are not yet available. Given the purpose of our study, we required a technique that enabled an assessment of children's mental representations of their urban environment. Mental mapping is a combination of spatial and environmental cognition referring to an internalized representation of space (Kitchin, 1994). Studies using mapping techniques reveal how people acquire, use, and interact with environmental information and inform decision making in spatial behaviour (Lynch, 1960; Golledge and Timmermans, 1990). Such mapping techniques have been used in previous studies of children's perceptions of their environment (Blades et al., 1998; Blaut et al., 2003; Darbyshire et al., 2005; Hume et al., 2005).

In the present study children were asked to draw mental maps of the places where they could play and be physically active in their neighborhood. As a warm-up exercise to familiarize the children with the demands of mental mapping they were provided with paper and crayons and asked to draw all the places where they could play and be physically active in their school. The investigator provided an example drawing (of places to play in the school) to help the children understand the exercise. Data derived from this first exercise were not included in our subsequent analysis, but rather this exercise helped to ensure that the children understood the data collection protocol. Then, the children were given a large piece of paper with the written instruction to 'Draw a map of all the places in your neighborhood where you can play and be physically active.' The investigator read out this instruction and clarified any queries or questions. The children were not provided an example for the neighborhood mapping exercise in order to minimize any experimenter effects. As the children drew, the investigators asked clarification questions without influencing the content of the maps, and asked children to label obscure items (Parameswaran, 2003). Examples of children's drawings from the H-W neighborhood (Fig. 3) and the L-W neighborhood (Fig. 4) have been provided.

Data analysis

Images drawn on the mental maps were itemized and qualitatively analyzed by a team of five coders (the lead investigator, a co-investigator and three research assistants) working together (Patton, 2002). This process involved first assessing every picture and creating a list of all the different types of images drawn by the children. Initially every coding decision was discussed by the entire group until we achieved consensus about the label to be used for the image. Then, once a broad coding scheme had been created, the coders worked in groups of two, with the lead investigator working with both groups. If the coders encountered a new or obscure image, all five members of the team discussed the coding of that image. We proceeded with the analysis only when consensus (4 of 5 coders) was obtained. Any images that were simply too obscure (and had not been labeled by the children) were removed from the analysis.

Once the list of basic images had been created, similar images were grouped together as themes. For example, different images of playing around the home (e.g., play in yard, playing on a trampoline, playing with pets in the yard) were coded into a 'higher-order' theme that reflected the essential shared characteristics of the images (e.g., 'play in the home/yard'). This process produced eight main themes. The frequencies by which different themes were represented were then tallied. Next, in order to comparatively analyze these themes, a 2 (schools) $\times$ 3 (grade categories) analysis of variance (ANOVA) was then conducted on the frequencies of themes for the neighborhood maps data. Significant interactions were followed up with analyses of simple effects and post hoc contrasts.

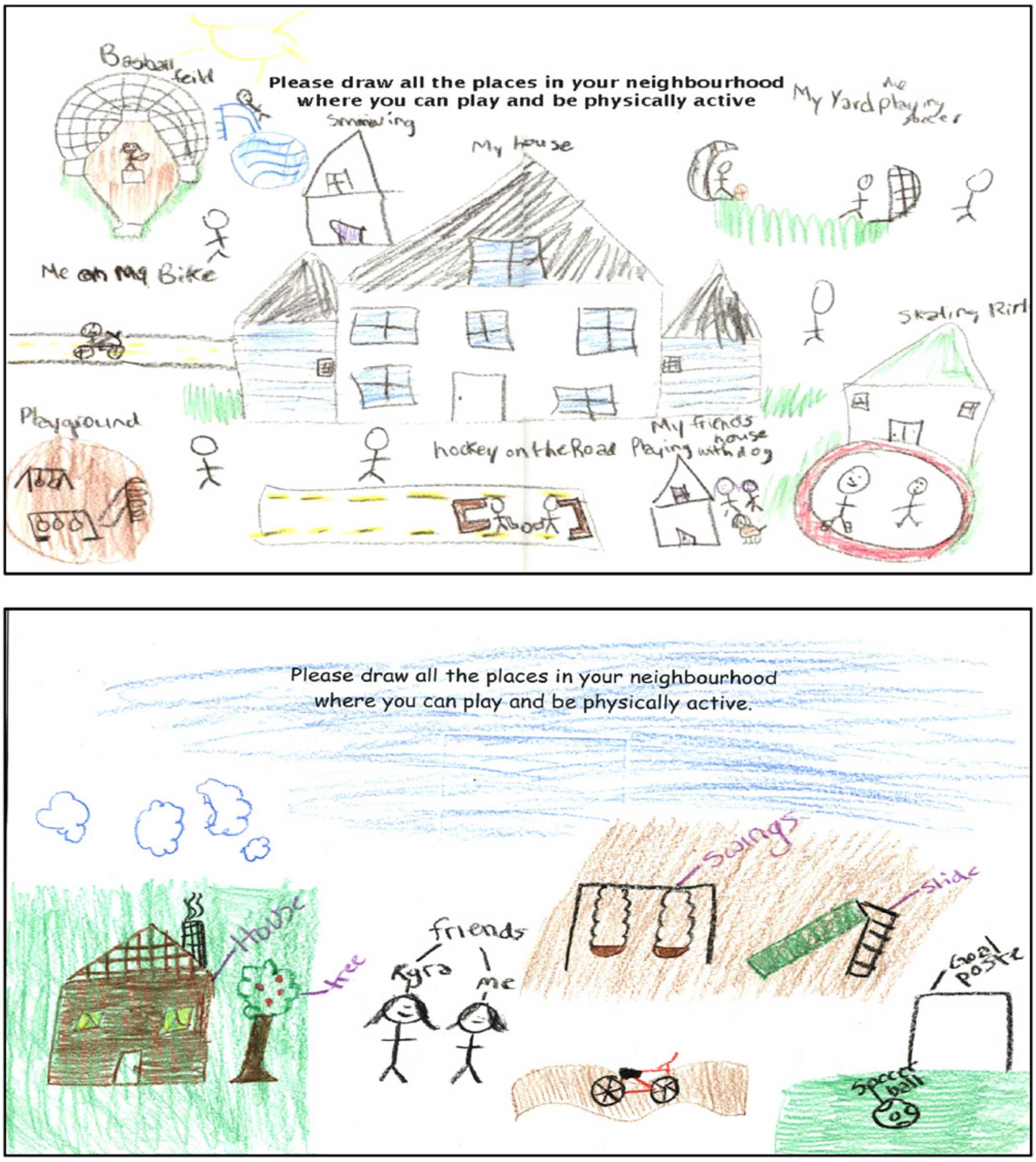

Fig. 3. Examples of Mental Map from Children in H-W Neighborhood.

Results

Thematic analysis

Images drawn to describe places in their neighborhoods where children could play and be physically active were coded into eight themes which are described below:

Play in home/yard: This theme reflected images relating to the child's home or yard. It included images that depicted general structural features of the immediate home environment (i.e., My house, My yard, Fence, Friend's house, Neighbor's house); images of children playing with objects in back or front yards (i.e., Playhouse, Trampoline, Fire pit); images of children playing games with friends (i.e., Family, Friends/people, Tag, Hide and seek); images of children playing with their pets (i.e., Cat, Dogs, Hamster); and images of children fighting (i.e., Fighting brother, Snowball fights, Sword fighting) in their home or yard.

Play outside the home/yard: These images depicted children playing outside of their immediate home/yard setting. It included children playing with natural features of the environment (i.e., Climbing tree, Tree, Grass, Hills, Field, Camping, Friend's pond) and children playing in playgrounds.

Active transportation: Images coded into this theme showed children engaging in active modes of transportation (i.e., Bike, Bike/friends, Canoeing,

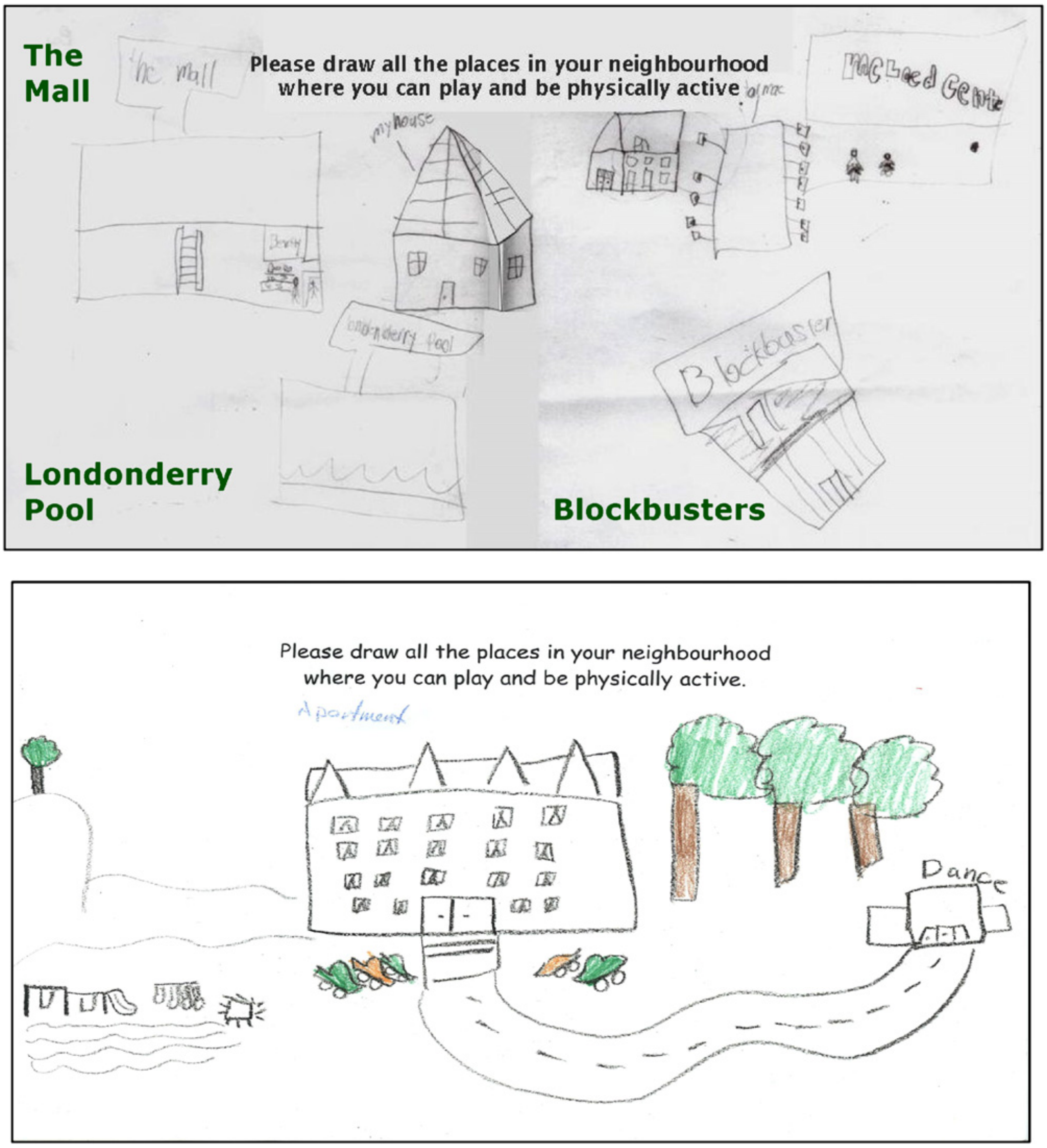

Fig. 4. Examples of Mental Maps from Children in L-W Neighborhood.

Heely, Walk in River Valley, Scooter, Walk from school, Rollerblading, Sidewalk, Path). Some of these images were independent (i.e., the children were alone) and at other times they were with friends or adults.

Non-active transportation: This theme referred to images of children engaging in non-active modes of transportation (e.g., cars). These images were distinctly different to the active transportation images in that non-active transportation did not involve any form of physical exertion (such as walking or riding a bike).

Sports: Images coded in this theme were depictions of sports that appeared to be both 'more organized' (i.e., Basketball, Baseball, Diving, Football, Gymnastics, Hockey, Snowboarding, Skiing, Cubs/scouts, Martial arts, Paintball, Swimming, Soccer) and 'less organized' (i.e., Badminton w/ Family, Frisbee with friends, Road hockey with friends, Running, Skateboarding, Skating). We coded more and less organized sports together because we were unable to suitably differentiate between the two.

Non-active: This theme referred to images of play that did not involve physical activity (i.e., Gameboy, Video Game).

Structures: This theme included buildings (i.e., School, Church) and stores that featured in the drawings (i.e., Blockbuster, Bentley, Convenience store, Dentist, Mall).

Good weather images: This theme referred to drawings that reflected good weather conditions (i.e., sun, blue skies).

Comparative analysis

Descriptive statistics (means and standard deviations) for each thematic variable are presented in Table 1. Analysis revealed that children in the H-W neighborhood depicted more active transportation than children in the L-W neighborhood [$F(1,151) = 18.48$, $p<0.0001$, $\eta^2 = 0.11$]. Conversely, children in the L-W neighborhood depicted more non-active transportation events than children from the H-W neighborhood [$F(1,151) = 7.32$, $p = 0.008$, $\eta^2 = 0.046$]. Significant effects of grade were also observed for active transportation [$F(2,151) = 13.22$, $p<0.0001$, $\eta^2 = 0.15$] and non-active transportation events [$F(2,151) = 8.38$, $p<0.0001$, $\eta^2 = 0.10$]. Specifically, children in Grades 3 and 4 depicted more non-active transportation than younger or older children and children in K-2 depicted less active transportation than older children. No significant interactions were found for either theme.

Significant interactions between neighborhood and grade category were observed for play in the home/yard environment [$F(2,151) = 11.64$, $p<0.0001$, $\eta^2 = 0.13$], play outside the home/yard environment [$F(2,151) = 4.74$, $p = 0.01$, $\eta^2 = 0.06$], and good weather images [$F(2,151) = 4.94$, $p = 0.008$, $\eta^2 = 0.06$]. Analyses of simple effects of grade (with follow-up simple contrasts comparing Grades K-2 to the other grades) for the L-W neighborhood revealed that children in Grades K-2 depicted more play in the home/yard environment than children in Grades 5 and 6 [$F(2,100) = 7.37$, $p = 0.001$, $\eta^2 = 0.13$], more good weather images than children in Grades 3–6 [$F(2,100) = 31.19$, $p<0.0001$, $\eta^2 = 0.38$], and less play outside the home/yard environment than children in Grades 3 and 4 [$F(2,100) = 5.23$, $p = 0.007$, $\eta^2 = 0.10$]. For H-W neighborhood, the youngest children (Grades K-2) depicted significantly less play in the home/yard environment [$F(2,51) = 6.59$, $p = 0.003$, $\eta^2 = 0.21$] and significantly less play outside the home/yard environment [$F(2,51) = 9.83$, $p<0.0001$, $\eta^2 = 0.28$] than older children (Grades 3–6). No effect of grade was observed for good weather images in the H-W neighborhood.

Table 1
Descriptive statistics for themes

Grade categories		HE	POHE	SP	N	STR	W	AT	NAT
School A									
K-2	Mean	1.84	0.95	0.33	0.00	0.12	0.63	0.21	0.19
	SD	1.40	0.90	0.52	0.00	0.50	0.58	0.47	0.39
	N	43	43	43	43	43	43	43	43
3 and 4	Mean	1.91	1.68	0.95	0.05	0.09	0.00	0.59	0.64
	SD	0.97	1.09	1.05	0.21	0.29	0.00	0.73	0.79
	N	22	22	22	22	22	22	22	22
5 and 6	Mean	0.92	0.87	1.32	0.05	0.21	0.03	0.50	0.16
	SD	1.08	1.04	1.42	0.23	0.74	0.16	0.69	0.37
	N	38	38	38	38	38	38	38	38
School B									
K-2	Mean	1.42	0.50	0.63	0.04	0.00	0.29	0.38	0.00
	SD	1.18	0.66	0.71	0.20	0.00	0.62	0.49	0.00
	N	24	24	24	24	24	24	24	24
3 and 4	Mean	2.79	1.57	1.29	0.00	0.07	0.14	1.14	0.29
	SD	1.37	1.02	1.20	0.00	0.27	0.36	0.66	0.61
	N	14	14	14	14	14	14	14	14
5 and 6	Mean	2.94	1.56	1.38	0.13	0.38	0.13	1.31	0.06
	SD	1.88	1.03	1.50	0.34	0.62	0.34	1.20	0.25
	N	16	16	16	16	16	16	16	16

(HE=Home environment; POHE = play outside home environment; SP=sports; N=non-active; STR=structures; W=weather; AT=active transportation; NAT=non-active transportation).

Discussion

The first objective of this study was to compare the mental representations of places to play and be physically active in the neighborhood among children from an H-W and an L-W neighborhood. We observed differences with regard to active/non-active transportation. Travel between destinations is a central concept in Krizek et al.'s (2004) schematic of community design and youth physical activity. That is, they decomposed their model into time spent in travel and time spent in destinations. Although we did not examine time spent engaged in activities, we found that children residing in an H-W neighborhood depicted more active transportation than children in the L-W neighborhood, and children in the L-W neighborhood depicted more non-active transportation than children from the H-W neighborhood. Parental provision of (non-active) transportation has been positively associated with extra-curricular team sports and activity class participation for US elementary and middle school children (Hoefer et al., 2001; Sallis et al., 1999; Sallis et al., 1992). In the Hoefer et al. study, use of neighborhood parks explained 5.1% of variance for boys total physical activity, after adjusting for parental transportation. This suggested that active boys found ways to access physical activity locations by walking or bike riding, leading the authors to conclude that the availability of neighborhood parks and playgrounds may stimulate physical activity that does not rely on adult transport. In their study of Australian children, Hume et al. (2005) speculated that girls who reported more images of food locations along with moderate levels of physical activity (as measured by accelerometers) did so because they were involved in active travel between locations. Based on our present findings, and consistent with previous assertions, we speculate that children in the H-W neighborhood reported more active travel images because their neighborhood was more promotive of walking and active transportation. This conclusion is speculative, but it offers direction for future research that examines the modes of travel used by children in different types of urban neighborhoods.

Some significant developmental differences were also observed. Younger children in the L-W neighborhood reported more play in the home/yard, and good weather images than older children. Alternatively, the youngest children in the H-W neighborhood depicted less play in and outside of the home environment than older children. These findings could be attributed to the cul-de-sacs that dominate L-W neighborhoods offering more opportunities for parental supervised play in and around the home than grid-style urban plans. That is, cul-de-sacs are relatively safe from through traffic and young children can play in front yards and in the cul-de-sac in close proximity to their parents (Veitch et al., 2006). However, when children get older, and perhaps able to venture farther from home to play, the advantages of the cul-de-sac could be less apparent. This may be because older children have more freedom to play further from the home than younger children, but in the cul-de-sac dominated L-W neighborhoods the lack of street connectivity restricts children's movement. Rather than simply walk through a back alley to play with friends, children in L-W neighborhoods may have to walk several hundred metres through the poorly connected road system to get to a house that is only a short distance away 'as the crow flies.'

We suspect that the walkability of neighborhoods may be less important for younger children and more important for older children because younger children are more dependent on adults, whereas older children become more independent (Churchman, 2003). The present findings could be interpreted to mean that cul-de-sac-style urban plans offer opportunities to supervise the play of young children but restrict the play activities of older children. On the other hand, it could be that grid-style urban plans facilitate play and peer interactions among older children. These interpretations are speculative and must be confirmed through additional investigation.

The mental mapping technique provided a useful approach in obtaining mental representations of children's environment, and this technique has been successfully used before (e.g., Blades et al., 1998; Darbyshire et al., 2005; Hume et al., 2005). However, some important limitations must be highlighted. One limitation of mental mapping is related to the two-dimensional representation of three-dimensional landscapes (Soini, 2001). Mapping can also suffer due to participants' lack of motivation or ability to draw (Lilley, 2000; Mark et al., 1999). Another issue was that we provided minimal instructions to reduce the effect of experimenter instructions on the maps that were produced. It could be argued that we obtained rather superficial or shallow 'symbols' of places children consider to be good places to play and be physically active (Soini, 2001). The ways in which instructions are provided to children can influence the content of the maps they draw (Parameswaran, 2003). If we had provided more explicit instructions we may have obtained more detailed information about certain images (e.g., less versus more organized sports) that would have improved the depth/detail of the maps provided and the precision of our analysis. However, we may have also unduly influenced the content of the maps. Thus, researchers must carefully consider the instructions given to children when using this technique.

Mental mapping also creates analytic challenges. In the present study analyzing images collectively as a team of five researchers enabled us to reach a degree of consensus. However, even the consensus of four out of five researchers leaves some margin for alternative interpretations. We also had to exclude some images that were simply too obscure to code, and could not differentiate between more and less organized types of sporting activities, even though such activities may have distinctly different meanings and activity components for the children we studied (Darbyshire et al., 2005). These analytic challenges are caveats that should be considered when judging the findings of this study.

Additionally, this study has limitations that provide directions for future research. We did not obtain objective data about the children's actual level of physical activity participation. In the future it will be important to obtain objective physical activity data (using accelerometers for example) in order to compare children's subjective perceptions of play and physical activity with their actual activity levels in different types of neighborhoods (cf., Hume et al., 2005). In that respect, Krizek et al.'s (2004) schematic may be useful for differentiating between travel and destination activities. Another limitation was that we used age as the only indicator of development. Development is age-related, but not age-dependent, thus the assessment of social, intellectual, and physical markers of child development would have improved our research design.

Our data indicated that urban design influenced children's mental representations of play and physical activity resources in their neighborhoods. We also found that these mental representations were moderated by age. Therefore, we conclude that both the type of neighborhood and age moderated children's perceptions of places where they could play and be physically active. This highlights the importance of providing developmentally appropriate opportunities for play and physical activity in neighborhoods. Cul-de-sacs may be appealing for parents with young children because of the relative safety that they offer (Veitch et al., 2006), but these advantages may decrease as children age. Alternatively, grids may offer some advantages for older children's physical activity. A solution could be to integrate some of the positive features of cul-de-sacs (i.e., lack of through-traffic) with some of the positive features of grids (i.e., high walkability). In providing suggestions for urban planning, we believe that it is important to obtain and understand children's perspectives about their neighborhoods and incorporate these views into urban design. However, in addition to including children in the planning process, it is also important that planners and other advocates push for policies to create urban environments that facilitate children's play and physical activity (Tranter and Doyle, 1996). To this end, mental mapping techniques offer one means to access children's perspectives of their neighborhoods.

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