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Children's active travel, local activity spaces and wellbeing: A case study in Perth, WA

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ABSTRACT

Children's neighborhood spaces have the potential to enhance their wellbeing by affording active and independent travel. Drawing on a case study of 49 children aged between 9 and 13, living in a suburb of Perth, Western Australia, this study adopts a capability approach to understand how children's travel in the neighborhood environment supports their wellbeing. A mixed methods approach is used to explore children's activity spaces: 1) GPS tracks; 2) children's activity diaries; 3) surveys; and 4) children's photo/pictorial collages. Activity spaces and affordances are used to inform the capability framework. We compare the realized local activity spaces (as confidence ellipses) to the potential activity spaces, indicative of the children's potential to achieve wellbeing, and draw on children's photographic and pictorial evaluations of their neighborhood to provide a qualitative perspective on the range of affordances. The results show substantial constraints to the children's active travel and independent mobility, contrasting with the positive view of the neighborhood the children hold. Children were mainly chauffeured at short distances that could have easily been walked or cycled, yet the photo-collage reveals a rich diversity of places and activities children access and desire to reach and use. The capability framework offers insight into some of the factors limiting children's travel, but also highlights the agency children have in shaping their own travel behavior.

1. Introduction: children's travel in urban environments

Pioneering studies on children's urban and rural lives by geography and planning scholars in the late twentieth century, such as Lynch and Banerjee (1977), Ward (1978), and Hillman et al. (1990) have led to the increased recognition of the place-based effects on the wellbeing of children. The local environment can afford children space for active travel (walking and cycling), and consequently the means to achieve various types of wellbeing benefits. Active travel enables children to access places important for their development and social connectedness such as schools, parks, libraries, shops and recreation centers (Freeman and Tranter, 2010; Loebach and Gilliland, 2016a). Children who walk or cycle to school engage in routine physical activity and are also more likely to engage in other types of moderate to vigorous activity within school environments and extracurricular activities that support their physical health (Mackett et al., 2005). Importantly, walking and cycling, unlike the car, are modes of travel that children can undertake without adult accompaniment, and therefore also afford children independence. Being independently mobile has been linked with higher rates of physical activity in children (Mackett et al., 2007; Wen et al., 2009) and the development of cognitive skills through providing opportunities to develop spatial awareness (Rissotto and Tonucci, 2002), as well as increased resilience and strategies to deal with risk (Malone, 2007). Safety and security represent main concerns for parents, leading them to restrict independent mobility of their children (Garrad, 2009; Jago et al., 2009; Ergler et al., 2013; Foster et al., 2014). As an alternative to limiting mobility, the accompaniment of children (with siblings, parents, or friends) becomes a means to make a safer, secure environment enabling active travel (Faulkner et al., 2015).

There has been an observed decline in children's independent mobility and active travel in developed countries (Faulkner et al., 2015; Loebach and Gilliland, 2016b). This is also the case in Australia, where the rates of children's active and independent travel to school has decreased since the 1990s from 61% to 32% in 2012 (Schoeppe et al., 2015); this is despite growing evidence that local environments provide many opportunities for enhancing children's wellbeing. Children are now more dependent on their parents than previous generations, and are now labelled as the "bubble wrapped", "back seat", and "battery reared" generations, compared

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to the "free range" previous generations (Malone, 2007; Loebach and Gilliland, 2016a). The potential reasons for the decline are numerous, with research identifying influential factors such as the increased distances between schools and households (Gleeson and Sipe, 2006; Malone, 2007; Schoeppe et al., 2015 Curtis et al., 2015); increased household incomes and car ownership and use (Timperio et al., 2004; Malone, 2007; Van der Ploeg, et al. 2008; Woolcock et al., 2010); more traffic on the roads leading to increased real and perceived risk of pedestrian injuries (Timperio et al., 2004); and the overall perceived convenience of car travel compared to walking and cycling (Lang et al., 2011). The modern lifestyle children lead is also increasingly characterized by a range of extracurricular activities (Barker, 2011), thus necessitating increased mobility in urban settings.

Any inquiry into the relationship between children's active and independent travel and their wellbeing is required to address a range of individual, social and cultural factors. The World Health Organization (WHO, 1948) defines health as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity". Multiple sources of data are therefore necessary to provide insight into this multi-faceted concept of wellbeing, which encompasses social and household relations, individual factors, and the built environment. Complex, multifaceted problems call for different methodologies to triangulate, validate, integrate information and provide complementing views of the researched phenomena, consequently enabling deeper understanding of the key factors. A mixed methods approach has been used to understand children's health and social capital (Baum et al., 2009); independent mobility (O'Brien et al., 2000) and everyday mobility (Christensen et al., 2011); development of a sense of place (Lim and Barton, 2010); and experience of local environments (Mitchell et al., 2007). Researchers have responded in different ways, some for example drawing upon interviews with children (Ergler et al., 2013; Loebach and Gilliland, 2016b), whereas others have utilized visual methods and photography to situate children within the contexts they are evaluating (Mitchell et al., 2007).

This study investigates the links between children's travel in their local neighborhood and wellbeing, using a case study of a middle-class suburban neighborhood, centered on a primary school in Perth, Western Australia. Two concepts, activity spaces and affordances, are incorporated within a capabilities framework (Sen, 1993). A mixed-methods research design is applied for investigation. The combination of methods includes: multivariate data analysis of children's travel behavior; spatial analysis and visualization of realized and potential activity spaces; and a content analysis of photographs taken by children during their daily activities, reflective of the quality of their local activity spaces. The methods used provide insight into the range, mode and volume of travel and children's reflection on their local neighborhoods. The paper provides a 'proof-of-concept' for how to combine rich sources of data in examining children's affordances and capabilities/functionings as ways of measuring wellbeing in relation to travel and activity spaces. In doing so, the research informs future studies utilizing mixed method research design to achieve a better understanding of how children's wellbeing is shaped by their local travel activity spaces.

The structure of the paper is the following: Section 2 reviews the relevant literature on the capability approach with a focus on children's active travel, then discusses the potential for activity spaces and affordances to capture travel behavior relevant to children's wellbeing within the local urban environment. Section 3 describes the case study and sources of data, while Section 4 presents the methods of analysis used for investigation. Results of the analysis (multivariate statistics, visualization of activity spaces, and photo collage analysis) are given in Section 5 and discussed in Section 6.

2. Background

2.1. Children's wellbeing and the capability approach

There is now a well-developed body of literature linking routine travel behavior and people's wellbeing. Individuals' subjective wellbeing, through happiness or feelings of wellbeing, has been linked to travel or mobility via the experience of travelling and the activities undertaken whilst travelling, access to activities that travel affords, and wellbeing associated with the potential for travel, even if not realized (Reardon and Abdallah, 2013; de Vos et al., 2013). However, a critique of subjective wellbeing is that individuals may adapt their preferences and mental states to suboptimal living conditions and therefore not be fully aware of the potential to enhance their wellbeing (Qizilbash, 2006). Others have argued that an enriched understanding of the role of travel and mobility on wellbeing requires going beyond subjective conceptualizations of wellbeing (Nordbakke and Schwanen, 2013).

A capability approach offers a potentially rich exploration of the relationship between children's travel in their local neighborhood and wellbeing. Developed by Sen (1993) and Nussbaum (2000) to address limitations in evaluating wellbeing in the field of development economics, the capability approach has been increasingly used as an evaluative framework in a diverse range of disciplines including design (Oosterlaken, 2009), urban planning (Basta, 2016), and transport planning (Beyazit, 2011). The capability approach goes beyond evaluating wellbeing as an end state (such as the subjective experience of being happy), and instead conceptualizes wellbeing as having the capability to freely select alternative combinations of various valuable functionings, which are different ways of 'doing' or 'being' (Sen, 1993). According to the capability approach, individuals have the freedom to reason and select functionings, such as being healthy or being independently mobile, from a set of all possible functionings they could achieve, known as a capability set. These sets of capabilities are dependent on an individual's capacity to convert resources available within particular social, structural and spatial contexts. Fig. 1 illustrates the basic elements of the capability approach.

The multifaceted conceptualization of wellbeing intrinsic to the capability approach creates a number of possibilities for understanding the role of local travel in shaping children's wellbeing. As Robeyns (2006) explains, the capability approach is deliberatively equivocal and relies on specifications of the evaluative framework to be made fit-for-purpose. This means differential weighting may be given to specific components within the framework. For example, an evaluation may focus on conversion factors over achieved functionings. For this purpose, the capabilities approach has been used to understand the relationship between travel behavior and wellbeing in marginalized groups including older person's mobility resources in Stockholm, Sweden (Ryan et al., 2015), and has been used to inform transport related factors relevant to minimum incomes standards in the UK (Smith et al., 2012). Alternatively, a framework may place greater emphasis on the choices individuals make when selecting available functionings. This may be relevant when an individual has a capability set that supports health and wellbeing, but makes decisions that do not allow them to achieve health-related functionings.

2.2. Activity spaces and affordances

To adapt a capability approach to evaluate the potential and actualized functionings associated with children's local settings it

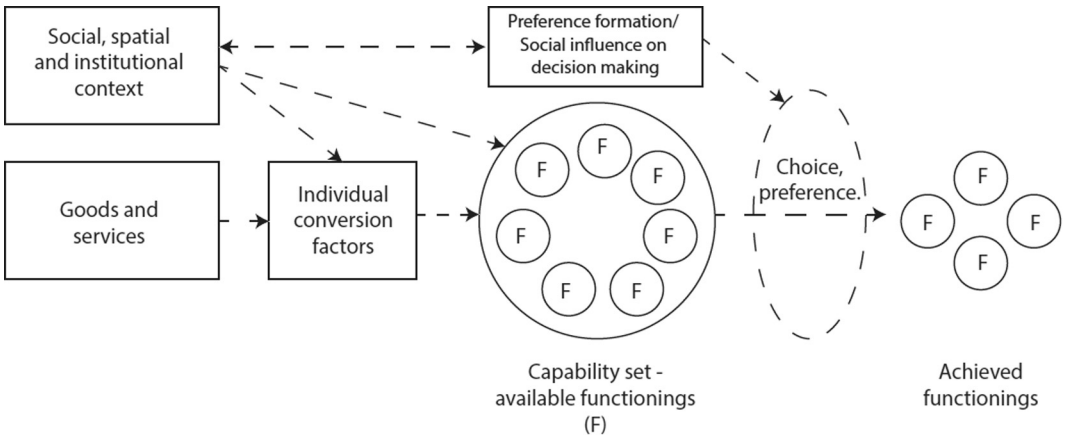

Fig. 1. Capability approach - conceptual framework (adapted from Robeyns, 2005).

is necessary to use appropriate conceptual and methodological apparatus to explore key components of the capability approach. We draw upon two such tools for this purpose: activity spaces and affordances, which are presented in detail next.

2.2.1. Activity spaces

Few tools are able to simultaneously account for space and time in understanding daily activity and travel patterns (Hägerstrand, 1970; Kwan, 2000; Weber and Kwan, 2003). Activity spaces for human activities integrate many dimensions that underlie spatial behavior: the distribution and concentration of the activities, and the intensity of using space to satisfy those activity needs, given various institutional, budget, social and temporal constraints. Activity spaces used in transport reflect the demand for daily activities conducted by individuals in various locations. They also indicate the ability of urban and transport services to satisfy that need, thus, they encapsulate both demand and supply. If the opportunities are plenty and lie near to home locations, travelling further to reach desired destinations is not necessary. Conversely, the lack of diverse services and opportunities, combined with various constraints, will require larger urban areas to be covered. Activity spaces are useful not only for measuring the spatial arrangements of travel and the use of urban space to satisfy daily activity needs, but also for indicating the spatial awareness of the individuals traversing the space (Newsome et al., 1998; Golledge, 2002; Axhausen et al., 2004; Botte, 2015).

As expected, activity spaces are strongly conditioned by the key fixed locations of the household or individual activities: home, work, school and other frequently visited activity locations. They were coined "pegs" of activity by Golledge and Stimson (1987), as the schedule of daily activities depends on them, and consequently, the shape, scale and inherent structure of resulting activity space geometries. However, for children, the local activity space can contain opportunities to access 'third places', places other than home and school that provide opportunities for children to navigate the unfamiliar (Witten et al., 2015). Whereas most studies looked at households and adults, there has been some derivation of activity spaces for children and students (Christian et al., 2015; Loebach and Gilliland, 2016a). For example, Christian et al. (2015) measured activity space as road network distances from home and determined the number of opportunities within 400 and 1600 m activity spaces to understand relationships between exposure to neighborhood destinations and time in front of a television or computer screen.

A characteristic of activity spaces that contributes to an evaluation of capabilities is that a distinction can made between a *potential activity space* and a *realized activity space* (Patterson and Farber, 2015). Potential activity spaces reflect conditions where activities may be conducted locally, but for some reason the urban space is not used or is underutilized. It can be hypothesized that a child who has a large realized activity space has a larger capability set, or available functionings, to choose from. A more restricted local activity space may limit children's quality of life if it reduces access to activities such as play, social interaction or exploring. Fleuret and Atkinson (2007) have highlighted the difficulty to accurately measure potentials, which means that usually actualized capabilities are measured.

2.2.2. Affordances

The second conceptual tool, the notion of affordance, has been used widely in relation to children's relationship with their local environment (Heft, 1988; Chawla and Heft, 2002; Kytta, 2002; Rudner, 2012; Yatiman et al., 2012; Ergler et al., 2013). In New Zealand, Ergler et al. (2013) used affordances to study various contextual influences on children's wellbeing through play. The concept of affordances is drawn from Gibson's (1979) theory, posing that we perceive the environment, not in terms of its appearance of form, but through the various functions that its form and materiality affords us. A tree, for example, can have a number of affordances for children including the capacity to climb, as a place to rest, or providing some connection to nature. Kyttä (2004) theorized that affordances can be 'actualized' or 'potential'. Kyttä (2004) developed a typology of potential affordance separated into three interdependent fields: the field of promoted action, or culturally and socially appropriate affordance; the field of free action, or the emergent and latent potential for environments to support new affordance through adaptation and reflexivity of individuals; and the field of constrained action, where environments settings or features limit affordances.

In combination, activity spaces and affordances have been used to explore children's activities and associated wellbeing in local environments. In Canada, Loebach and Gilliland (2016b) combined GPS and subjective data sets to explore the size of children's neighborhood activity space and the affordances associated with independent play. However, to our knowledge there is no research that uses these concepts within a capability framework. By using a capability approach, combined with the concept of affordances, it is possible to interrogate the multiple domains where children's wellbeing is shaped by their local travel. Affordances potentially offer insight into wellbeing from a capability perspective, as they represent the functional qualities of the environment and enable or restrict different ways of 'doing' or 'being'. Furthermore, the notion of potential affordances provides insights into conversion factors that enhance and limit the ability of children to translate

resources into a capability set and then allow them to freely choose a range of functionings that define their wellbeing. Yet, an integrated view of the wellbeing, making use of affordances and functionings (Sen, 1993), which are assessed using objective and subjective measures such as activity spaces and photo-collages, has not emerged. Realized activity spaces derived from children's regular walking and cycling behavior provide a useful connection to a capabilities because they indicate the spatial capacity of children to actualize affordances within their local neighborhood through active and independent mobility. Fig. 2 illustrates the conceptual framework informing this research. We see this paper as an important contribution to understanding new ways in which travel affects children's wellbeing.

3. Data collection

3.1. Case study and sample

Given the need to explore children's perceptions and behavior across multiple spatial and social domains – household, school, recreation, social networks – a case study approach was used to understand the children's realized and potential functionings within their walkable neighborhood activity space. A case study approach allows a rich understanding of the social and built environments contexts that are relevant to children's wellbeing. The case study was a primary school in a suburb of Perth, WA, approximately 12 km from the Perth CBD, and 5 km from the coastal city of Fremantle. Fig. 3 illustrates the regional context of the case study.

The neighborhood surrounding the primary school has seen gradual subdivision of lots between two major highways since the 1950s resulting in the land use being predominantly a patchwork of primarily residential cells with varied road network designs (mixed grid pattern, curvilinear, and cul-de-sac street designs). The urban form is typical of much suburban development in Australian cities developed at that time. It is primarily low density residential housing with small suburban shopping centres. Some light industrial land uses are scattered amongst the residential area, with the concentration of industry increasing in close proximity to a major highway that dissected the area to the south of the school. The city has over 600 hectares of open space, distributed across over 200 parks. According to Western Australian State Government policy the school was classified as a local intake area school (WA Department of Education, 2015), meaning priority

Fig. 3. Case study location within the Perth metropolitan regional context. Source: adapted from WAPC (2013).

is given to students living within 1.25 km. The pattern of land use and urban form is consistent over the enrolment catchment of the school. The socio-economic status of the LGA was higher than the average for the Perth metropolitan area (ABS, 2012): average weekly household income of AUD$1619 compared to AUD$1459 for the total metropolitan area; and 77.1% home ownership amongst the families in the study (n = 38) compared to 69.1% in the metropolitan area.

The recruitment of participants was conducted with consultation and assistance from the principal and teachers in the school.

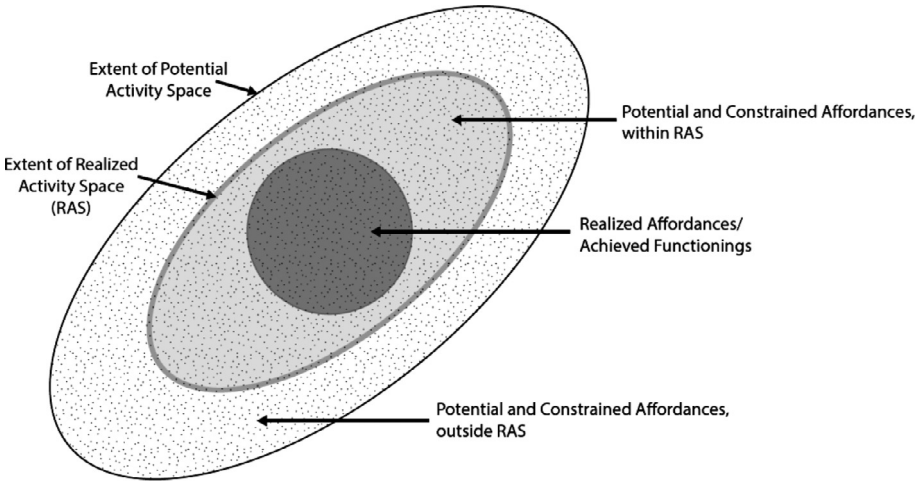

Fig. 2. Conceptual framework integrating Activity Spaces, Affordances and Capabilities (achieved functionings). Activity spaces are defined by individual children's active travel behavior. Source: the authors.

Children within three school year groups (141 in total) were verbally briefed and provided with written information regarding the research project. Of these children, 49 participated. Both children and parents completed surveys on travel patterns, independent mobility and perceptions of the neighborhood. The participant year groups consisted of children aged between nine and 13 years old. This age group was selected because it represented the ages children in developed countries begin to become independently mobile (Hillman et al., 1990), although it is important to note there is variation across different cultural contexts (Waygood and Susilo, 2011).

3.2. Data sources

3.2.1. Geospatial data

To establish the children's potential and actual local activity spaces, the 49 children were given GPS devices and asked to attach the devices to their arms for four days: two weekdays and two weekend days. Given the limited number of GPS devices (20), the tracking was undertaken across three different weeks, from 31st May to 28th June 2012 (first group – 19 children; second group – 20 children; third group – 10 children). For validation purposes, 39 of the 49 children also completed travel diaries on the days they carried GPS. The weather on the days the children wore the GPS devices was mild, with some short periods of light rainfall.

The GPS were set to record locations at 15-s intervals, resulting in about half a million GPS points. In the software ArcGIS 10.2.2, groups of GPS points representing different trips were manually identified using a combination of information sources: Landgate aerial photography, Open Street Map topographic maps, the children's travel diaries, the 'Distance' field recorded by the GPS, Google Street View and the local knowledge of the researcher who regularly cycles in the vicinity of the school.

A 'trip' was considered to occur when the child moved to a new cadastral location (e.g., going from home to school), but not when they were moving around within a location (e.g., running around inside a park). Also, when the child had not changed her/his location for more than two minutes, this was considered a stop between trips. When the child was indoors, no trip was recorded. The process was time-consuming, but assisted the research team to obtain a high degree of accuracy and remove known technical and administration errors. A total of 471 trips were identified.

Each group of GPS points representing a trip was given a unique identification number and linked to a database created from the completed travel diaries. The GPS points were also attributed with a travel mode, using the same classification as the trip diaries (walking, cycling, car, public transport, other). This was manually assigned based on an interpretation of speed, route and time of day. For validation purposes, when possible, the mode recorded by the child in the travel diary was compared to the inferred travel mode. Next, the points were converted to a line GIS file where each line represents the route of a trip, and for which distance and duration calculations were made. Each line was attributed with an origin and destination, primarily to identify trips starting or ending at "home".

3.2.2. Survey data

The 49 children and their parents also completed surveys. The purpose of the surveys was to gain insight into individual and household scale factors related to children's mobility, and also the licences that parents imposed on their children to travel independently in their neighborhood. The licences represent an important capability for children, giving them the freedom to expand their potential range of available functionings. Four licences to travel, adapted from Hillman et al. (1990) were categorized: the licence to travel to school independently; the licence to travel from school independently; the licence to cross roads alone; and the licence to ride a bike on a main street alone. Demographic information was also collected.

3.2.3. Photo-collage

A photo-collage method drawing on an approach used by Castonguay and Jutras (2009) was conducted with the same group of children who completed the survey. The intent was to capture children's perceptions and evaluations of achieved, potential and constrained affordances (Kyttä, 2004) in their local neighborhood. The children were given disposable cameras and asked to take photographs of what they liked and hated about their neighborhood. The exercise took place a week before the first GPS data collection in order to not influence normal daily travel activity. After the photographs were developed, the children were asked to construct three thematic collages using their photographs, annotations and drawings. The three themes were: *"What I love about my neighborhood"* (actualized affordances); *"What I hate about my neighborhood"* (constrained affordances); and *"What I think my perfect neighborhood is"* (perceived, but not actualized affordances), indicating elements of an ideal local neighborhood space. The annotations and drawings were particularly useful for the 'perfect neighborhood' collages, as they allowed children to freely imagine a range of functionings that could be afforded in local activity spaces. 144 photo-collages were collected; 48 each of the 'Hate', 'Love', and 'Perfect' collages. The photo-collage data contributed to an understanding of the range of functionings afforded by children's local activity spaces, and the method provided an evaluative space complementary to the open and reflective nature of the capability approach to understanding wellbeing.

4. Analysis

4.1. Multivariate analysis

A combination of multivariate statistics, visualization and geospatial analytics was applied to understand the role of local travel in enhancing children's wellbeing. Realized activity spaces (RAS) for each child were determined using a confidence ellipse (two standard deviations, 95%), 50 m trip buffer and convex hull in ArcGIS, based on all active trips that started or ended at home. The choice of three types of activity spaces metrics responds to the limitations of a single measure to represent the individual's spatial experiences (e.g., Axhausen et al., 2004; Rai et al., 2007; Botte, 2015), each definition emphasizing certain characteristics of the spatial spread. Standard distances (circle buffer with the radius equal to the standard deviation of distances from home or other set value) entail symmetry around home, therefore tend to exacerbate the effect of spatial outliers; convex hulls cover the maximum geographical extent of the data, considering all points equally important, thus may potentially exacerbate the effect of spatial outliers; buffers of routes ('network bands') tend to underestimate the activity spaces and emphasize the travel over the fixed locations, requiring information on routes; confidence ellipses are less sensitive to outliers, are easy to compute, and weigh the activity space towards the most frequented locations, but they may overestimate the size of activity spaces.

The RAS were then compared with a potential activity space, defined as an ellipse with the same orientation and axes' ratio as the RAS confidence ellipse, but with the length of the long axis representing a 60 min walk, (30 min walk each way along the axis from the centre of the RAS) at the average walking speed for that child (see Table 3 below). For the two children who had no walking trips (only cycling), the average walking speed of all children was used. This comparison was expected to provide some indication

on the extent to which children have the potential to use their opportunities to be physically active in their neighborhood, given the restrictions applied by their parents. Our hypothesis is that enriched spatial experiences of children (larger RAS) correspond to greater perceived and actualized affordances, with positive effects on wellbeing, whereas smaller RAS compared to potential activity spaces are indicative of constrained actions/affordances.

4.2. Content analysis photo-collages

A thematic coding of the content of children's photo-collages was conducted using Hyperresearch, a qualitative analytic software tool. Affordances were identified in the photo-collages using an analytic framework drawing on literature on behavior settings (Heft, 1988). Four categories were used to guide the coding of images and accompanying text: the activities featured in the images or texts; the objects prominently framed in the image, and sometimes drawn next to photographs; the emotions, attitudes or affect noted in any text; and the place or setting where the photograph was taken, and/or taken from. A frequency analysis of codes was conducted across each of the four categories. Then, a qualitative analysis of the main themes identified actualized, constrained and perceived affordances captured by the collages. Affordances indicated the functionings available to children in their local environments. Following a capability approach, positive functionings identified in the photocollages, either realized or latent, were assumed to be associated with positive states of wellbeing. Cross-analysis of affordances and gender, age, level of independent mobility, and extent of RAS, provided insight into the factors that constrained the children's active travel behavior and hence potentially their wellbeing.

5. Results

5.1. Descriptive statistics

The sample included 18 boys and 31 girls, mostly 10 years old or over (Table 1). Cross-tabulations of age and responses to the four licences (travel TO school; travel FROM school; licence to cross main roads; and licence to ride a bike on main roads) indicated that 12 children did not have any independent mobility (parents answered 'no' to all licence questions), while nine children were independently mobile, and the remaining had some constraints. No significant differences were noticed in licences granted to girls and boys ($p \gg 0.05$). Given the small sample size, care has been taken to avoid generalizations based on the analysis.

Statistics of children's daily travel are provided in Table 2 and of their individual walking trips in Table 3. Table 2 shows that a third of the sample did not report any active travel and that boys and girls did not differ significantly ($p \gg 0.05$) in the overall average duration and distance of their daily GPS recorded trips.[1] On average, the children made 27% of their trips by active modes of transport. Active travel represents only 2.2% of the total distance, but 15% of the daily travel time of the children. Weather conditions did not have any significant ($p \gg 0.05$) impact on the children's active travel.

The results indicate a variation, and whereas girls record longer total distances and times by all travel modes, boys engaged in more active travel on average and travelled for longer distances by walking or cycling. This was also found by previous research and is attributed to the higher independent mobility levels boys enjoy compared to girls (Schoeppe et al., 2015). Only two children achieved 60 min of physical activity from travel, so the majority failed to meet the WHO recommendation of daily physical activity for children (WHO, 2010) by means of travel (Strong et al., 2005). This is primarily because most of the GPS-recorded daily trips were by car, even at distances where walking and cycling are feasible. Furthermore, 63% of the car trips were at distances under 3 km, one in three trips under 1.5 km, and one in six trips under 1 km. Comparable results were found in Canada by Morency and Demers (2010), where 33% of children trips under 1 km were motorized.

The dominance of car-based travel is shown in Fig. 4.

In terms of walking, children travelled at distances up to 3 km, with an average of 432 m and 7 min per trip (Table 3). On average, boys were likely to walk and cycle longer distances (about 1 km more per day or 0.5 km more per walking trip) and for more time (10 min more per day or 4 more min per trip). This average value is about half of the distance from home to the outer boundary of a child's local activity space reported by Loebach and Gilliland (2016a) in London, Canada, which is 980 m. No significant differences were noted in relation to age.

Most of the walking trips occurred during the weekend (57%). Whereas walking to school only accounted for 15% of trips, returning home accounted for 29% of walking trips. Outdoor activities was the second highest purpose for walking trips (25%) as shown in Fig. 5.

Given the small number of children in this dataset, tests comparing active travel behavior per day and child are not possible. Instead, the comparison of the individual trips (Table 4) confirms boys appear more active, walking longer than girls and at higher speeds. This concurs with Klinker et al. (2014).

5.2. Local activity spaces (realized and potential)

As indicated in Section 4, the analysis was conducted in two steps: 1) derivation of local activity spaces based on the GPS-identified trips; and 2) potential activity spaces. Various metrics were tested: convex hulls, buffers, and confidence ellipses (CE). Their analysis highlighted the benefits of CE, by providing not only the extent of the area used by children in their daily travel, but also the direction/orientation of their mobility.

Fig. 6 presents the variability of buffer area, convex hull and 95% CE for the realized activity spaces as a function of the maximum distance from home. As expected, the measures covary substantially, yet the CE is larger and displays non-linearities not captured by the buffers approach.

The charts clearly display a clustering of points for distances under 500 m, confirming that with very few exceptions, children in this study did not walk or cycle outside of their immediate local environment. As indicated, this is lower than the average distances presented in Loebach and Gilliland (2016a) for children's travel in Canada.

Fig. 7 presents the areas of realized and potential local activity spaces for the 23 children who had active trips starting or finishing at home. The ratio between the realized and potential area is an indicator of potential active mobility, which shows that none of the children reached or exceeded the area that can be covered in 30 min by walking, with 17 children displaying ratios under 20%. Consistent with previous findings, boys have potential activity spaces twice as large as the girls (hence substantially larger capability sets) and are more likely to reach their potential activity space (44%), compared to the girls (12%). Age has not contributed in any significant or systematic way to the relative size of the activity spaces, nor parent restrictions, suggesting that although many of the children have the freedom to walk in their neighborhood

[1] The GPS recorded data is underestimating daily travel, due to a number of reasons (technical issues, non-compliance, etc.). However, with the data available, the exact bias cannot be assessed. Only 188 out of 471 trips in the GPS data had matches in the travel diaries.

Table 1
Sample description.

		Gender		Total	No Licences	Some licences	All four licences
		Boys	Girls				
Age	9–10	10	17	27	11	10	3
	11	5	11	16	1	10	4
	12–13	3	3	6	0	3	2
Total		18	31	49	12	23	9

Note: The total number of responses for licences is 44, because five parents did not answer the question.

Table 2
Total travel per day.

	Total travel				p	Active travel				p
	Girls (n = 31)		Boys (n = 18)			Girls (n = 20)		Boys (n = 12)		
	Mean	Std. Deviation	Mean	Std. Deviation		Mean	Std. Deviation	Mean	Std. Deviation	
Minutes	41.09	52.33	30.10	26.29	0.411	13.96	18.48	14.73	13.36	0.901
Distance (km)	22.91	59.25	14.17	25.14	0.556	0.81	0.73	1.38	1.40	0.134

Note: Only eight children reported cycling, with a total number of 16 trips.

Table 3
Walking trips distances and durations.

Variable	Minimum	Maximum	Mean	Std. Deviation
Minutes	0.5	32.75	6.69	5.67
Distance (m)	18	2908	431.82	454.78
Speed (km/h)	1.27	6.17	3.69	1.05

Note: Short walking trips correspond to movements from activities co-located spatially (e.g., shopping strips, plazas).

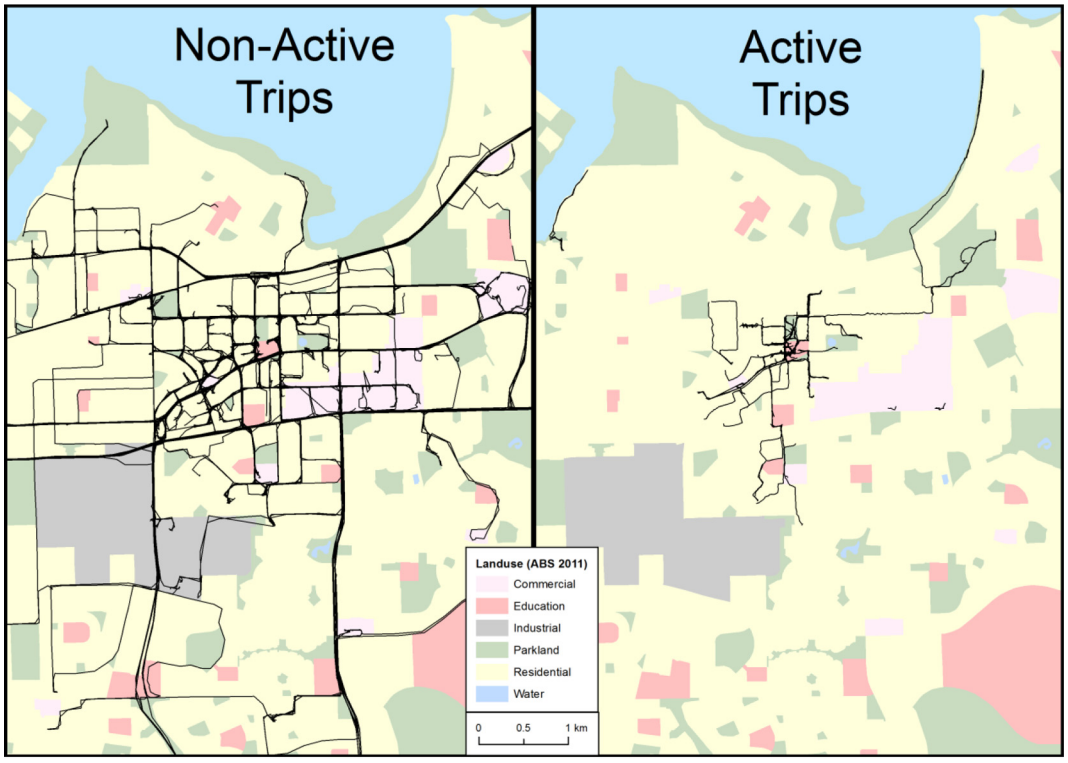

Fig. 4. Maps of non-active trips (left) vs active (right) in the vicinity of the school. The land-use is based on Australian Bureau of Statistics 'meshblocks' (2011).

independently they chose not to. Only nine unaccompanied trips identified in all the GPS data (six walking and three cycling), but accompaniment was only known when the trip had a match in the travel diary data and the travel diary indicated trips were accompanied. The total number of active trips (walking and cycling) that were in the GPS data and had accompaniment information from the travel diaries was 34. We estimate that only about a quarter of active trips were unaccompanied.

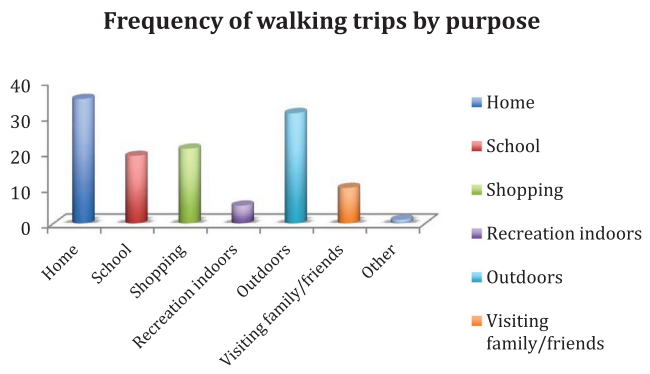

Fig. 5. Walking trips by purpose.

5.3. Photo-collages

The photo-collages were analyzed according to the categories outlined in Section 4.2. Table 5 illustrates a summary of the relative frequency of codes occurring in each of the three collages from all children. Further disaggregated analysis comparing frequency of codes was conducted between children with different levels of independent mobility, gender, age, and high and low realized activity spaces of 30 min walk.

Outdoor settings, particularly parks and open spaces, afforded the highest number of functioning in the 'Love' and 'Perfect' collages. Affordances requiring physical activity included playing organized sports, playing with friends, climbing trees and over play equipment, however more passive activities such as resting, relaxing, and sitting on benches also featured. One child featured photographs of stones and trees, noting she liked to keep objects as *"a memory of my trip"*. Streets were also common settings and afforded many positive functioning for children, including walking to school, being with friends, playing in the cul-de-sac, and also appreciating nature such as street trees, gardens and wildlife. Streets were also referred to in children's 'Hate' collages, but these all related to lack of facilities (such as paths) and barriers to walking (including busy roads). One child's 'Hate' collage contains a photograph of a truck that is parked across the footpath. The annotation reads: *"House getting built. Truck parked in the middle of the footpath* ☹". References to cycling were not frequent but when included, cycling was associated with streets outside children's homes, which appeared to be an important place valued by the

Table 4
Walking trips distances and durations by gender.

	Male (n = 44)		Female (n = 90)		ANOVA	
	Mean	Std. Deviation	Mean	Std. Deviation	F	p
Distance (m)	894	790	354	343	30.519	<0.001
Minutes	9.90	7.78	5.63	4.35	16.576	<0.001
Speed (km/h)	4.25	1.27	3.47	1.02	14.199	<0.001

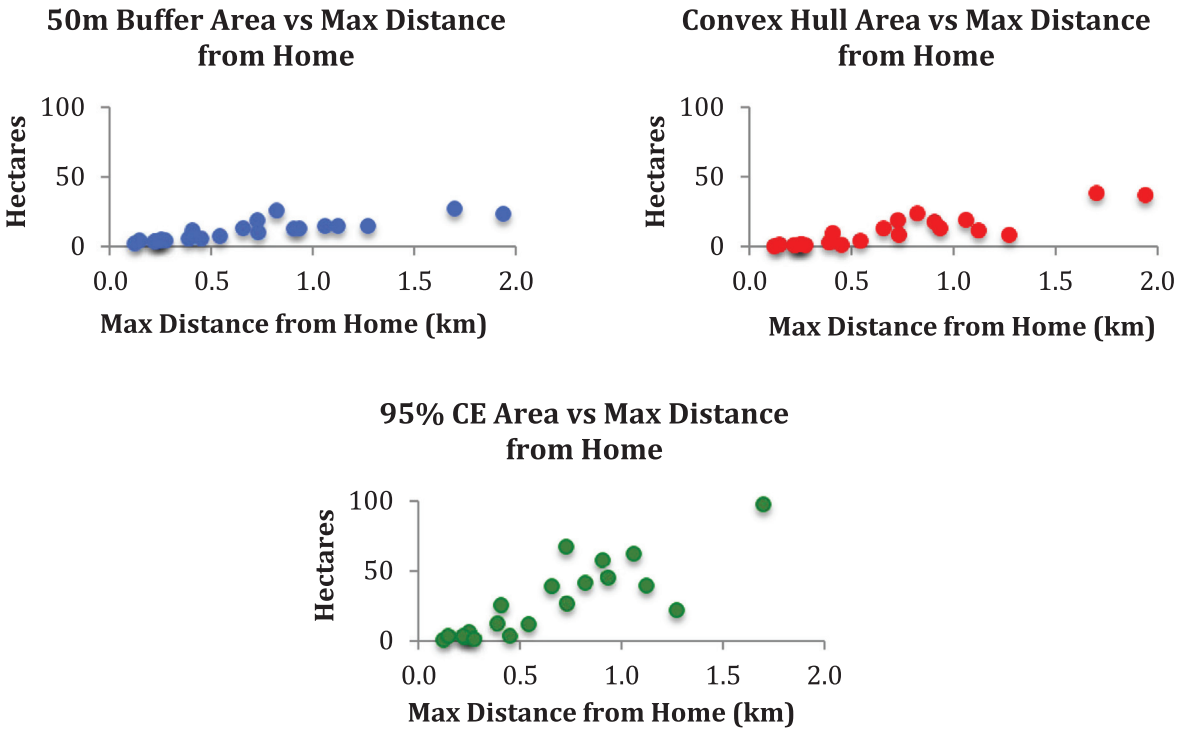

Fig. 6. 50 m Buffer area, Convex Hull, and 95% CE vs max distance from home for actual travel.

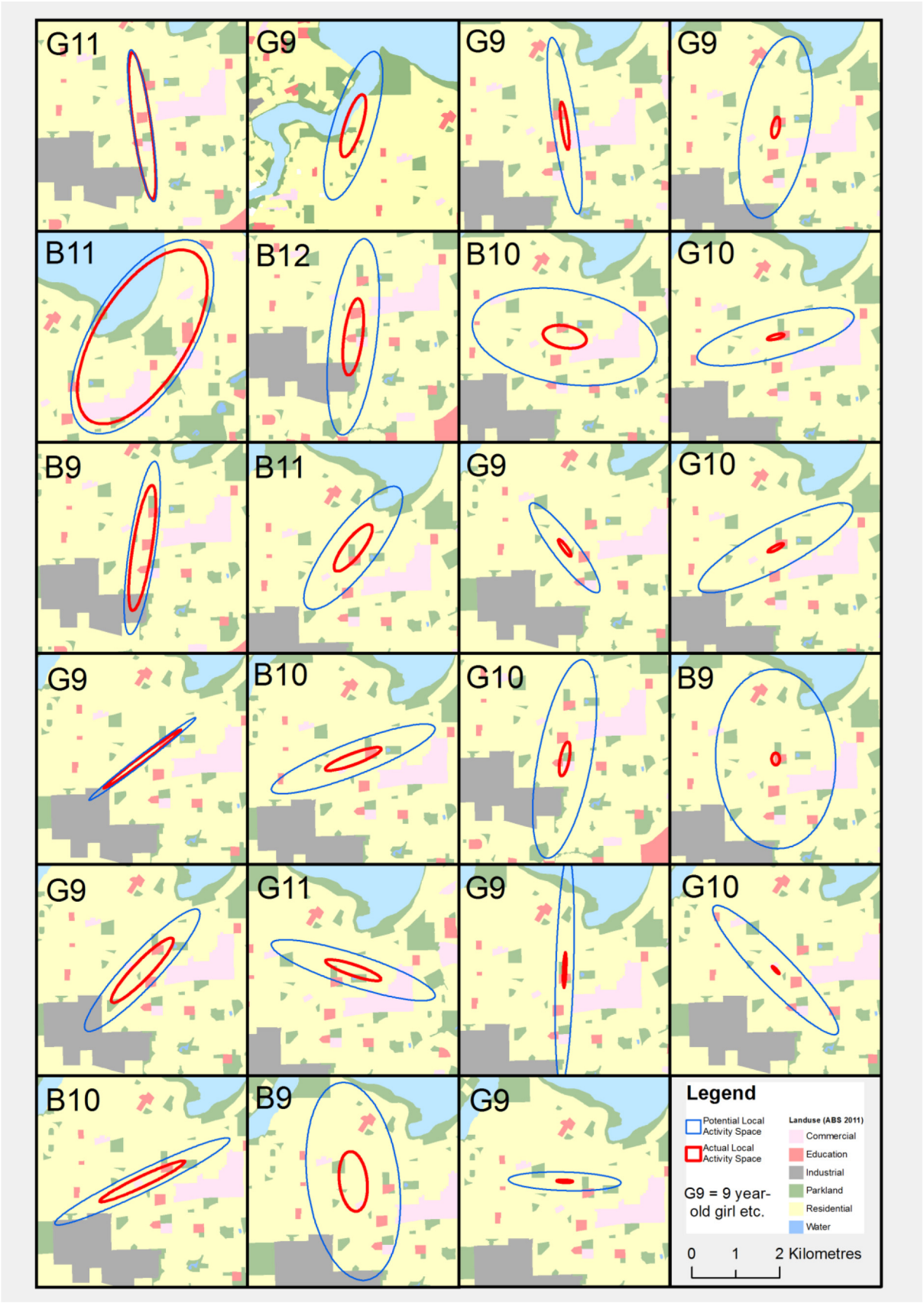

Fig. 7. Potential and realized activity spaces for 23 children (The child with the highest realized activity space, relative to their potential, is shown top left, descending to the lowest relative realization bottom right).

Table 5
Summary of content analysis reporting three highest codes (frequencies).

Categories	Hate Collage	Love Collage	Perfect Collage
Activities/behavior	Walking (4) Taking a photo in the car (4) Sport (4)	Sports (15) Play (15) Resting/relaxing (4) Passenger in a car (4) Shopping (4) Walking the dog (4)	Play (11) Sport (7) Skateboarding (5)
Agents/Objects	Car (8) Traffic (6) Bins (5) Rubbish (5)	Friends (12) Family (8) Other children (6)	Trees (10) Other children (5) Vegetation (5) Wildlife (4) Pets (4)
Places	Streets (13) Parks or reserves (12) School (10)	Park or open spaces (17) Sporting ground (15) Home (15)	Park or open spaces (22) Streets (12) 'My street' (11)
Attitudes/feelings	No facilities (7) Dirt (6) "Busy roads" (5) "Don't hate anything" (5)	Proximity (7) Safety (4) Fun (4)	Proximity (8) Expansiveness/Scale (4) Safety (4)

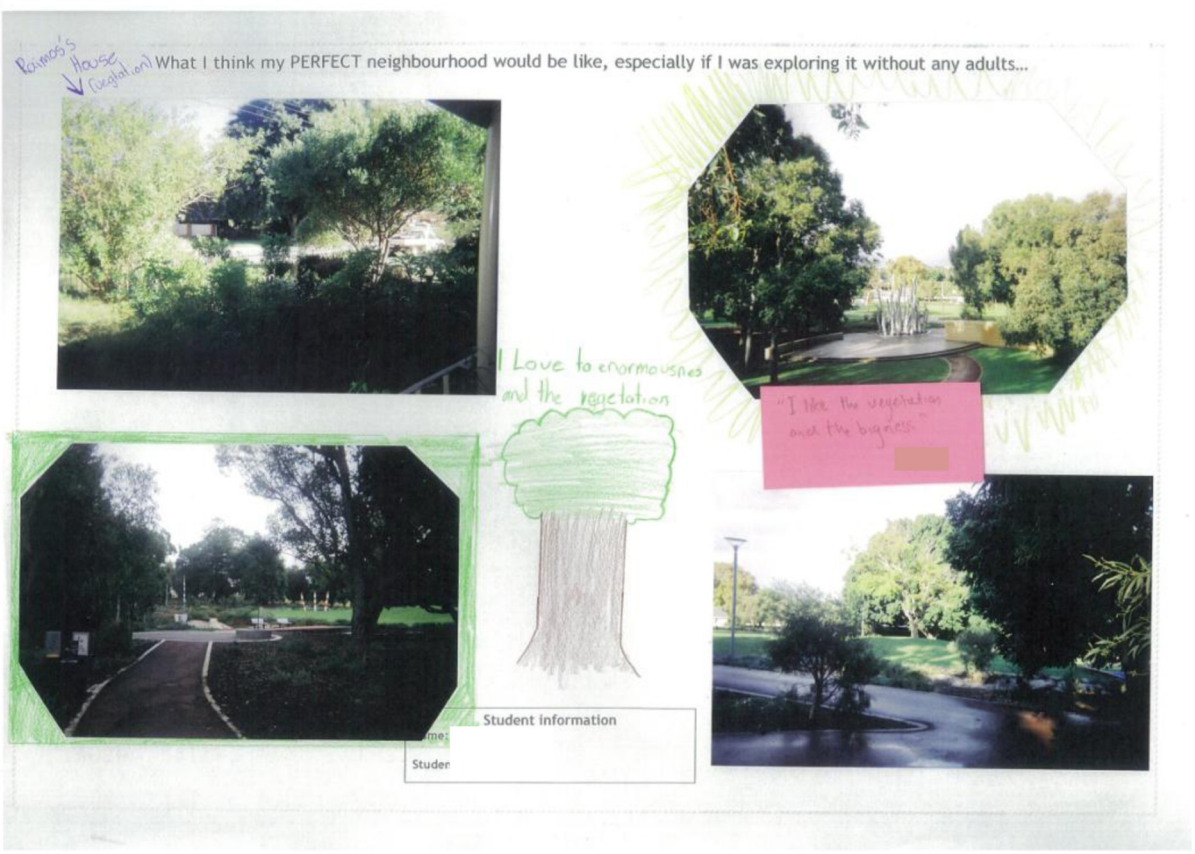

Fig. 8. Example of a Perfect photo-collage from a child with high-realized local activity space (81% of the 30 min potential activity space).

children for enabling play, activity and socializing. Relating to this, the theme of proximity was relatively common in the children's 'Love' and 'Perfect' collages, with children indicating they would like to live closer to parks and natural spaces.

The photo-collages of boys and girls, children of different ages and children with varying licences to be independent were compared yet did not reveal any substantial variation. A comparison of photo-collages between children with high and low ratios of realized to potential local activity spaces while revealing similar themes on positive functionings in the neighborhood, showed a striking difference in that natural spaces and parks featured more prominently in the photo-collages of children with high-realized local activity spaces. Children with low-realized local activity spaces tended to include photographs of their home environment and more formal outdoor settings, like organized sports venues, reflecting the tendency for children to lead more "bubble wrapped" lifestyles and "backseat" modes of mobility (Karsten, 2005). Figs. 6 and 7 illustrate these differences (Figs. 8and 9).

There was a more noteworthy difference evident in the 'Hate' collages of children with high- and low-realized activity spaces. Children with the lowest realized activity spaces made no references to street features that constrain activities such as walking, cycling and playing. Furthermore, references to being driven were only noted in the group of children with low-realized activity spaces. Alternatively, aspects such as heavy traffic, unsafe crossings, lack of facilities and bullies were common amongst children with high-realized activity spaces, suggesting that these children were more aware of their neighborhood spaces. One child with a high-realized local activity space noted: *"This is the street I walk down to get to the park. It would be nice if there was a path*". Accordingly, children with higher-realized activity spaces were more critical of barriers to walking and cycling in streets and actively sought to propose ways their environments could change to support more walking and activity in the neighborhood.

6. Discussion

This research adds to the body of knowledge with a new case study and a novel methodology. We have employed activity spaces and affordance as conceptual tools to explore what Fleuret and Atkinson (2007) refer to as 'spaces of capability', or the place based resources, functionings and capabilities relevant to children's local travel. As children's active travel affords physical activity, play, exploring and social engagement, the volume of walking and cycling is of interest to understanding the role of local activity spaces in shaping children's wellbeing. In our case study, insight into the children's capability to achieve wellbeing is gained by using potential activity spaces based on WHO standards.

Our sample of children was not very active. Their trips were short, including many driving trips that could have easily been walked. This unsettling finding is also shown in other research. For example, in Montreal. Morency and Demers (2010) found that 33% of all trips under 1 km (31.2% of all trips made by children 5–14 years) were motorized. Only nine children were granted the licences to walk TO and FROM school, cross the roads and ride a bike on the main roads unaccompanied, which shows that even in a green, safe, friendly neighborhood children are not "free range". This is consistent with the results obtained by Loebach and Gilliland (2016a), who found that 95% of all the active time spent within the activity space was within 400 m from home. Boys seem to walk longer distances and have larger realized activity spaces, confirming previous findings that gender is an important conversion factor allowing children to expand the spatial range of potential functionings associated with local travel (Klinker et al., 2014); yet, this was still minimal compared to the potential they could reach (25%). Only four children reached 50% of the potential activity space that can be covered in 30 min by walking, even with good access to recreational and shopping facilities (about 9% of the suburb area), local parks (almost 9% of the area within a 30 min walk of the school), and the river shore.

Despite the understanding that children can achieve physical activity through other means, the limited functionings achieved by the children through active travel is concerning, considering the role active travel may contribute to children's wellbeing and the well documented consequences of sedentary lifestyle: prevalence of impaired metabolic health, cardio-respiratory fitness, obesity (Cooper et al., 2006; Roth et al., 2012) and lower cognitive performance and mental and social development (Rissotto and

Fig. 9. Example of a Perfect photo-collage from a child with low-realized local activity space (1.3% of the 30 min potential activity space).

Tonucci, 2002; Villanueva et al., 2012). These effects are especially damaging for children (Nishimura et al., 2013), given their early developmental stages. As already highlighted, reduced independent mobility associated with unrealized local activity space may decrease children's opportunities to learn about their neighborhood (Rissotto and Tonucci, 2002) and affect negatively their mood compared to children who use more active travel (Westman et al., 2016).

In our study, an evaluation of the capability sets derived from children's realized activity spaces provide little evidence that the local neighborhood is currently utilized as a resource to enhance children's wellbeing through active and independent mobility. However as Noah (2015, p. 463) suggests, a subjective understanding of activity spaces is important to enable *"a more comprehensive understanding of individuals' and families' neighborhood and activity spaces*", and hence elucidate active travel heterogeneity and motivations within the same geographical space. The photo-collages show how children evaluated their own neighborhood and provided a different and more optimistic picture of the potential for local activity spaces to afford functionings associated with enhanced wellbeing. Drawing on the capability approach, the local neighborhood affords children a rich variety of positive functionings in line with a broader concept of wellbeing: socializing, being active, playing organized sport, collecting objects and keepsakes, and finding a private space. While the data from the photo-collages was not during the same time period as the GPS data (in order to avoid distortion to normal travel patterns), the children's interpretations of neighborhood indicated the high value placed on parks, natural spaces and play spaces to achieve a range of functionings associated with wellbeing.

Children embodied the role of 'environmental change agents' (Malone, 2013), actively evaluating the potential functionings afforded by their local activity spaces to see how their own and other children's wellbeing could be enhanced through more active and independent travel. A critical stance was taken by some children noting the lack of pedestrian infrastructure, barriers to walking, the distance of places to their homes and the need to improve the safety of crossings, indicating what Kyttä (2004) refers to as the field of constrained action, or perceived functionings that children can convert into achievable 'doings' and 'beings'. However, children's use of their potential local activity space is not entirely shaped by the design of their neighborhood, but also by the licences to be independently mobile granted by parents. Yet, even when these licences to travel independently in the local neighborhood existed, few active and independent trips were recorded, suggesting other limiting factors for achieving independent and active travel as a key functioning for children. The freedom to reason and choose from various potential functionings is implicit within the capability approach and this, in a sense, problematizes the notion of a licence for independent mobility as a measure of children's wellbeing. Given that the photo-collages contained children's evaluation of the constrained affordances associated with dangerous road crossings, lack of infrastructure and other threats such as bullies and older children, it is also possible that some children in our sample just decided not to make opportunities to travel independently.

It has been well documented that studies using mixed methods to capture objective and subjective data on children's travel activity can be onerous and result in attrition in the sample size. This was certainly our experience with this research. Therefore, a trade-off is needed between the range of socio-behavioral and spatial data required and the representativeness of the resulting data. The single case-study methodology and small sample do limit generalizations regarding children's wellbeing in their local, mobility environments. Furthermore, although a more holistic indication of wellbeing was sought there were relevant activities that were not captured. One issue is that although the low level of active travel is concerning, this represents only travel-related walking and cycling, without including physical activity within the confines of school or other planned sportive events (team sports, swimming, etc.). However, the in-depth data collection and analysis provides an important contribution to the knowledge of how local activity spaces can provide for and inhibit children's wellbeing. In this respect, our approach of developing evidence of the factors shaping children's wellbeing using a capability approach or providing qualitative insights into activity spaces, represents a 'proof of concept' which may be further tested and applied in other contexts.

7. Conclusion

Children's activity spaces involving active modes of travel continue to shrink worldwide, regardless of the opportunities of having activities within the proximity of home, which children could explore. This paper reported on a case study in Perth, Western Australia, using a capability approach to explain some of the complexities of children's wellbeing as it is shaped by their local neighborhood activity spaces. While many of the children in the case study seem to have more of the *"indoor and backseat childhoods*" (at least compared to previous generations), there is a positive outlook towards children's healthy development through children's own evaluations of their local activity spaces. The findings indicate there is much potential for a capability framework to build on existing studies that use geo-spatial tools (such as activity spaces) and concepts such as affordances to develop a deeper understanding of how children's independent and active travel can lead to enhanced wellbeing. Furthermore, the capability approach's emphasis on potential and realized functionings and the agency to select pathways to wellbeing, provide an opportunity for new conceptualizations of children's independent and active travel and may suggest new approaches for planners and policy makers to consider.

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Appendix A

The Activity Space measured as a bivariate confidence ellipse (CE) represents the area in which the child travels and spends time for various activities with a certain probability within a day (e.g. 95%).

The size and the orientation of the confidence ellipse are determined mathematically as follows (also, please refer to Schönfelder and Axhausen, 2003; Buliung and Kanaroglou, 2006; Rai et al., 2007; Botte, 2015):

$$\left(\frac{x-\bar{x}}{a}\right)^2+\left(\frac{y-\bar{y}}{b}\right)^2=1 \quad (1)$$

where $\bar{x},\bar{y}$ represent the Easting and Northing coordinates of the centre of gravity of the set of activity locations and a and b are the lengths of the major and minor elliptical axes.

The parametric form of the ellipse rotated by angle θ is:

$$x = a\cos t\cos\theta - b\sin t\sin\theta + \bar{x} \tag{2}$$

$$y = a\cos t\sin\theta + b\sin t\cos\theta + \bar{y} \tag{3}$$

where the orientation θ provides the angle at which the area is minimum.

The area of the ellipse is given by:

$$A = \pi 6\sqrt{S} \tag{4}$$

where S is the determinant of the covariance matrix

$$|S| = s_{xx}s_{yy} - s_{xy}^2 \tag{5}$$

with

$$s_{xx} = \frac{1}{n-2}\sum_{i=1}^{n}(x_i - \bar{x})^2 \tag{6a}$$

$$s_{xy} = \frac{1}{n-2}\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y}) \tag{6b}$$

$$s_{yy} = \frac{1}{n-2}\sum_{i=1}^{n}(y_i - \bar{y})^2 \tag{6c}$$

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