

Children's Independent Movement in the Local Environment

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This paper presents findings from the project CAPABLE (Children's Activities, Perceptions And Behaviour in the Local Environment) carried out at University College London to explore the concept of independent behaviour by children, by examining variation by age, gender and access to open space to see how independence affects their behaviour, both in terms of how they use their time after school and how they behave when outdoors. A further objective is to look at differences between boys and girls in this type of behaviour. Based on findings from questionnaires completed by children aged 8–11 in Cheshunt, Hertfordshire, it is shown that most of the children are allowed out without an adult, but that many of these, particularly girls, are only allowed out with other children. It is also shown that children, particularly boys, who are allowed out without an adult go out more after school, and so have more chance to be active and sociable. The paper then uses data from children who have been fitted with physical activity monitors and GPS (global positioning system) monitors and asked to keep diaries, to show how children's travel behaviour differs when they are with adults from when they are not. Conclusions are drawn in terms of the evidence from this research supporting policies that children should be allowed out more without an adult and with increasing children's volume of physical activity.

The Reduction in Freedom for Children

In Great Britain, in recent years children have suffered a loss of freedom in terms of being allowed to go out of the home without an adult. For example, in 1985/1986, 21 per cent of children aged 5–10 travelled alone to school. By 2005 this had dropped to 6 per cent (Department of Transport, 2002; 2006). Pooley *et al.* (2005) found similar evidence over a longer period from interviews carried out in Manchester and Lancaster. They found that about 40 per cent of people born in 1932–1941 travelled to school alone at the age of 10–11, whereas about 9 per cent of those born in 1990–1991 travelled alone at that age.

Hillman *et al.* (1990) looked more broadly at the issue of children being allowed out

independently. They found that in England, 80 per cent of 7–8 year olds were allowed to go to school alone in 1971. By 1990 this had dropped to 9 per cent. (It may be noticed that the 1971 figure from Hillman *et al.* (1990) for 7–8 year olds is much higher than that from Pooley *et al.* (2005) for older children in the 1940s. Hillman *et al.* asked children what they were allowed to do; Pooley *et al.* considered what children actually did. Pooley *et al.*'s sample may have been allowed to walk alone but chose to travel with friends and siblings). Hillman *et al.* (1990) also looked at various other measures of the freedom allowed to children by letting them undertake various activities unaccompanied: for example, crossing the road, using buses, cycling on roads and going out after dark. In all cases where

the equivalent data were collected in 1971 and 1990, the children had less freedom to go out alone in 1990. They carried out comparable surveys in Germany in 1990, and found that German children were allowed much greater freedom to go out alone than their English counterparts.

Hillman *et al.* (1990) attribute this trend in the loss of freedom by children to the growth in car ownership, noting the paradox that the freedom that increasing car ownership has offered parents has been offset by constraints imposed on them by the perceived need to escort children more because of the increase in traffic danger.

Pooley *et al.* (2005) identify four factors that have affected the journey to school since the 1940s: first, availability of transport technologies in the form of cars; second, an increase in parental choice in education which has led to longer journeys to school on average; third, increasing pace of life, which has led to people attempting to cram more activities into a limited amount of time; and fourth, perceptions of risk, for example the perceived risks from strangers to children out alone. When the discussion is extended from the journey to school to children going out of the home more generally, the list of factors can be expanded. For example, home entertainment technology has expanded rapidly so that children now have a range of opportunities at home to listen to music, play electronic games, and watch multichannel television and this may have reduced the relative attractiveness of going out to play (Holloway and Valentine, 2003). The changing perceptions of risk have partly led to the move from free play to organized activities for children: in the past children would play out on the streets or walk to the local park, now they go to football lessons, dancing classes, and other organized activities, and usually this involves a car journey (Mackett *et al.*, 2005).

Some of the benefits from allowing children out alone have been shown by Van Vliet (1983) who found, from a weekend diary

kept by children in Toronto, Canada, that children who usually travelled without adults on the bus, streetcar and metro went out on more trips from home and did so for a greater range of activities. Other research has shown that independent mobility has positive effects on children's cognitive and behavioural development (Siegel and White, 1975; Risotto and Tonucci, 2002).

In Britain, there is evidence that some children are being forced indoors by intolerant adults who claim that the children cause noise or a nuisance according to a survey carried out by the Children's Society (Children's Play Council, 2003). There are many examples of bans on playing in many areas, including refusal to allow the erection of a netball hoop on a village green in Oxfordshire, and a skateboard park in Cumbria and signs forbidding ball games in many urban areas (*Ibid.*).

The Aims of the Paper

The first objective of this paper is to explore the concept of independent behaviour by children, by examining variation by age, gender and access to open space. The second objective is to see how independence affects their behaviour, both in terms of how they use their time after school and how they behave when outdoors. The third objective is to see if there are differences in the independent behaviour of boys and girls. The analysis is based upon findings from a project entitled CAPABLE (Children's Activities, Perceptions And Behaviour in the Local Environment) which has been carried out at University College London (see <http://www.casa.ucl.ac.uk/capableproject/>). CAPABLE followed on from a project to investigate the effects of the car on children's volume of physical activity and long-term car dependency (see <http://www.cts.ucl.ac.uk/research/chcaruse/>). The most innovative part of that was to fit children with activity monitors and ask them to keep diaries from which it was possible to establish the relative

contribution of various activities, including walking, to children's energy consumption (Mackett *et al.*, 2005).

CAPABLE involved staff from the Centre for Transport Studies, the Centre for Advanced Spatial Analysis, the Bartlett School of Planning and the Department of Psychology all at UCL. In this work, children were fitted with GPS (global positioning system) monitors as well as using the activity monitors and diaries, so that it was possible to establish where the children went for various activities. Another aspect of interest was whether or not the children were allowed out without an adult. Questionnaire surveys were conducted of children and their parents, and various drawing and mapping exercises carried out with the children (Mackett *et al.*, 2006). The fieldwork was carried out in Lewisham in south-east London, and in Hertfordshire, the area immediately north of London.

Methodology

In this paper, results are presented from fieldwork carried out using four research instruments: questionnaires, activity monitors, GPS monitors and diaries.

The questionnaires completed by the children contained questions about their personal details and household, their journey to and from school in terms of length, mode of travel and with whom they travelled, their frequency of use of various modes for other journeys, whether they were allowed to travel without an adult, and about going to organized activities, visiting friends and playing. The questionnaires were completed in class, under the supervision of one of the research team.

The activity monitors used were RT3 tri-axial accelerometers, manufactured by Stayhealthy, USA, which measure movements in three directions, as shown in figures 1 and 2. The RT3s combine all three acceleration vectors to produce an overall vector magnitude (VM) expressed in terms of



Figure 1. The RT3 monitor.



Figure 2. The RT3 activity monitor.

activity counts. These can be converted into activity calories using formulae programmed into the equipment using data on the age, gender, weight and height of the child. Activity calories are calories used in undertaking physical activity. The RT3s can also convert activity calories to total calories, that is, including the calories that are used by the body to function and develop even when the person is passive, by adding on a constant based on the physical characteristics of the person. Activity calories were used in this work in order to facilitate comparison of the results of this work with other research (it is recognized that the formulae for converting the RT3 outputs to activity calories have not been fully validated for such young children). They were set to record movements on a minute-by-minute basis.

The GPS is a satellite-based positioning system. Twenty-four GPS satellites are orbit-



Figure 3. The Garmin Foretrex 201 GPS monitor.

ing the earth at a very high altitude. By picking up signals from these satellites, a GPS receiver can locate the user's position on the ground with a relatively high accuracy of several metres. Several types of GPS equipment were tested, in order to decide the best in terms of precision, battery life and acceptability to the children. The GPS equipment used in the CAPABLE project was the Garmin Foretrex 201 which is small and light-weight so that the children could easily wear it on their wrists all day long, as shown in figure 3. It monitors children's locations at set intervals and records them in its memory in chronological order. These data can be superimposed subsequently on a map or input into a GIS (geographical information system) so that they can be linked with other spatial data and analysed.

Trost *et al.* (2000) have shown that 4 days of monitoring of physical activity in children are required. In this study, the volunteers were asked to wear the monitors from a Wednesday to a Monday, with data being collected for the 4 days, Thursday, Friday, Saturday and Sunday. These days were chosen so that both school days and weekend days were included.

The children were asked to complete a travel and activity diary for the 4 days. An example extract from the diary is shown in figure 4. The RT3 output was used as a visual aid by the child and a researcher to identify high-activity events shown in the trace which had not been previously mentioned in the diary.

The data were initially entered into Excel spreadsheets. Programs written in Visual Basic were used to integrate the data from the GPS and RT3 monitors into an Access database to give greater flexibility for analysis. The data from the three sources had to be reconciled using the time information. The times from the GPS monitors were regarded as accurate. In order to maximize the data collected from the GPS monitors they were set to obtain a reading for the current location at every possible opportunity. Occasionally this meant a large number of points within a very short space of time. It was decided to simplify the analysis by averaging the data in two dimensions to give the location every minute. This simplified reconciliation with the data from the RT3s which were set to collect data in one minute intervals using times set from a computer. It was much more

Location		What did you do there?	
Morning	I began the day at Home <input type="checkbox"/> Somewhere else <input type="checkbox"/> Please say where	I woke up at :	
		I put my sensors on at :	
		I left at :	
▼ Then I went to	I got there at : I travelled by I travelled: • by myself <input type="checkbox"/> • with an adult <input type="checkbox"/> • with other children <input type="checkbox"/>	I left at :	
▼ Then I went to	I got there at : I travelled by I travelled: • by myself <input type="checkbox"/> • with an adult <input type="checkbox"/> • with other children <input type="checkbox"/>	I left at :	

Figure 4. The activity and travel diary.

complex to reconcile these two data sets with the children's diaries. Travel diaries have long been suspected of under-recording trips (Stopher and Greaves, 2007): this is one of the first opportunities to demonstrate explicitly that trips are missed out from diaries. There were cases when the GPS trace made it clear that the child had gone out and the diary showed no such entry. Considerable effort was put into adjusting the times in the diaries to be consistent with the GPS monitors where this could be done unambiguously. Because of difficulties with the GPS equipment, for example, significant loss of points or failure of the battery charger, and children forgetting to complete their diaries, not every child provided a complete set of data. The events recorded in the children's activity and travel diaries were classified, using a typology shown in Mackett *et al.* (2005).

The final aspect of the data assembly was to establish the nature of the place where the GPS points were located. This was done in two ways: field observation and GIS. In this paper the nature of the places (or land use) has been based on the Ordnance Survey MasterMap topology layer which has been used in a GIS to classify all the land parcels into different types, such as buildings, natural environment, general surface, path, road or track, roadside, structure and so on. For this paper, all the points on private spaces, such as garden attached to houses have been eliminated. The remaining points have been allocated either to the MasterMap category 'Roads, tracks and paths' or to 'Other space', which is essentially public open space of some sort. In the paper, the former will be referred to as 'road', the latter as 'open space'. It is recognized that this is rather crude, but it reflects the difficulty of this type of work, which partly arises from the nature of the GPS equipment which can only locate with a precision of about 10 metres.

The results below are shown for three types of activity: 'playing', 'clubs' and 'walking'. 'Playing' is an informal activity in which children make decisions for themselves, and

usually interact with other children. 'Clubs' here refers to a structured activity organized by adults for the benefit of children. Some activities could come under both headings: a tennis lesson would be included as 'clubs' whereas a group of children involved in an informal game of tennis would be included as 'playing'.

Sample of Schools and Children Participating in the Research

A number of schools in Hertfordshire and Lewisham were involved at various stages in the research. The schools were selected on the basis of their willingness to co-operate. The results being presented in this paper are for two schools in Cheshunt, Hertfordshire: Flamstead End and Burleigh Primary. According to the OFSTED reports carried out under Section 5 of the Education Act 2005 (Hertfordshire County Council, 2007), Burleigh Primary '... pupils come from a wide range of social backgrounds, but they are average, overall'. At Flamstead End, '... the local area is one of very mixed housing, with some pockets of social need'.

All children in Years 4, 5 and 6 were invited to take part, which means that the children were aged 8 to 11. These are the top three years of primary school. The children were given a briefing by the researchers and then given a letter to take home to their parents or guardians. The letter explained about the project and sought written permission for their children to participate. All children who wished to take part, who had parental permission, were included in the study. This was partly to avoid selection bias and partly to avoid disappointing children who wished to participate. Up to 20 children could take part at any one time, a constraint imposed by the quantity of equipment available and the time required to manage the data collection. The participating children all had their height and weight measured, because these values needed to be input into the activity monitors, along with their age and gender, in order to

convert the results from arbitrary ones to meaningful ones, using calibrated functions programmed into the software.

As shown in table 1, 330 children at the two schools in Cheshunt completed questionnaires. Of these, 162 children wore the GPS and RT3 monitors and completed diaries and provided some data. The latter is not a large number, but it should be borne in mind that the children were being asked to wear two pieces of equipment, one of which required charging every night, and keep a diary of their activities and travel, for 4 days. This was demanding of both child and researcher time. Relatively few of the children provided comprehensive data because of practical problems such as difficulties recharging the batteries in the GPS monitors and forgetting to complete their diaries or to wear the monitors. The focus of this paper is on children's independent behaviour in the local environment, and so only walking, playing and organized clubs are considered. Some of the children only recorded trips made by car to outside the local area, and so these children were eliminated from the analysis. Other children only recorded very short periods outside when both the RT3 and GPS monitors were functioning. Because it takes some time after leaving a building for the GPS monitors to function accurately, all periods of less than 5 minutes outside

were eliminated. This left useable data on 82 children making local trips, as shown in table 1.

The data were collected in the period from October 2005 to March 2006, which includes winter in Britain and therefore not an ideal time to collect data on outdoor activities. The data were collected at this time because the work was being carried out through schools and it was necessary to avoid the Summer Term (April to July) because of examinations.

The results are presented in the next section. The results from the questionnaires were analysed using SPSS (Statistical Package for the Social Sciences) Version 14.0 for Windows. Since they are categorical data, they have been tested for statistical significance by using the two-sided Pearson chi-square test (χ^2) which is used to test whether differences between the numbers of cases are significant at the 5 per cent level. The outcomes are shown in terms of the χ^2 value, the number of degrees of freedom (df) and the p value corresponding to the calculated χ^2 value, which needs to be 0.05 or less for the χ^2 value to be significant. The results from the GPS and RT3 monitors are tested using a two-sided t-test for independent samples and an analysis of variance F-test since these are continuous data. The values of t or F, df, and p are shown. Differences that are statistically

Table 1. The children in the survey.

	Boys			Girls			Total		
	Questionnaire	GPS data		Questionnaire	GPS data		Questionnaire	GPS data	
		Total	Local trips		Total	Local trips		Total	Local trips
Year 4 (age 8–9)	63	25	11	48	32	16	111	57	27
Year 5 (age 9–10)	54	33	17	63	36	20	117	69	37
Year 6 (age 10–11)	57	16	7	45	20	11	102	36	18
Total	174	74	35	156	88	47	330	162	82

Source: CAPABLE children's questionnaires and CAPABLE surveys using GPS and RT3 monitors and diaries.

significant are indicated in **bold** in the tables of results.

Results

There are stages of independence from adults that a child goes through. When very young a child will be always accompanied by an adult. At some point in his or her life, a child will be granted full independence and be allowed to go anywhere without an adult. Between these two stages a child may be allowed to go out with friends or older siblings, but not alone. Table 2 shows the percentages of children in these three categories from the questionnaires completed by the children (in the second, third and fourth columns). The final column shows the percentage of children allowed out without an adult, either alone or with other children, and is the sum of the second and third columns.

It can be seen that most of the children are allowed out without an adult, but that nearly one-third of them are only allowed out with other children. Slightly more boys are allowed out without an adult than girls (85 per cent compared with 81 per cent), but there is a much larger difference when the percentages allowed out alone are considered (63 per cent compared with 48 per cent), implying that more parents of girls only allow them independence if they are accompanied by other children. The differences between boys and girls have been tested for statistical

significance. The greater number of boys than girls allowed out alone is statistically significant, as is the greater number of girls than boys allowed out with other children but not alone. However there is not a statistically significant difference between the number of boys and girls who are only allowed out with an adult. This suggests that parents are equally willing to allow boys and girls out without an adult, but in the case of girls this is likely to be conditional on there being other children present.

Another important aspect of childhood independence is how it changes with age. Table 3 shows the three types of independence by year group. As would be expected, independence generally increases with age, but, for the boys, the Year 4 boys are allowed greater independence than the Year 5 boys, which is interesting and partly reflects the relatively small numbers. Notwithstanding this anomaly, all of the increases with age are statistically significant except for the decrease in being allowed out with older siblings and friends for girls.

The next issue to be considered is the types of travel that they are allowed to do without an adult, since there is a major difference between being allowed to walk a short distance along the child's own road to a friend's home and being allowed out to wander freely and use public transport (in most cases the children were not asked if they were allowed to do the activity alone or with

Table 2. Percentage of children allowed out independently by gender.

	<i>Allowed out alone</i>	<i>Allowed out with older siblings and friends but not allowed out alone</i>	<i>Only allowed out with an adult</i>	<i>Total</i>	<i>Allowed out without an adult</i>
Boy	63	22	15	100	85
Girl	48	33	19	100	81
All	56	27	17	100	83
χ^2	7.075	4.919	0.794	-	0.794
df	1	1	1	-	1
p	0.008	0.027	0.373	-	0.373

Source: CAPABLE children's questionnaires.

Table 3. Percentage of children allowed out independently by year group and gender.

	<i>Allowed out alone</i>		<i>Allowed out with older siblings and friends but not allowed out alone</i>		<i>Only allowed out with an adult</i>	
	<i>Boy</i>	<i>Girl</i>	<i>Boy</i>	<i>Girl</i>	<i>Boy</i>	<i>Girl</i>
Year 4 (age 8–9)	52	33	32	44	16	23
Year 5 (age 9–10)	50	44	26	27	24	29
Year 6 (age 10–11)	86	69	7	29	7	2
χ^2	19.772	12.321	11.486	3.896	6.163	12.340
df	2	2	2	2	2	2
p	0.000	0.002	0.003	0.143	0.046	0.002

Source: CAPABLE children's questionnaires.

other children). Table 4 shows the percentage of children allowed to travel without an adult in various ways. The highest proportion is for travelling to friends' homes, which, as implied above, may just be along the road. A high proportion, 63 per cent, is allowed to cross main roads, which is rather higher than the proportion allowed to go out for a walk. It may be the case that some of the children walk to school and have been trained to cross one or more main roads on the way, but are not allowed to walk freely. The travel activity that the lowest proportion of children is allowed to do without an adult is travel by bus. This partly reflects the fact that bus journeys, by definition, imply travelling considerable distances from home. More boys are allowed to participate than girls for all the travel activities. The table shows that four of these differences are statistically significant: visiting friends' homes, crossing

main roads, going out for a walk, and cycling on main roads. For the other two, travelling to organized activities and going on buses the differences between boys and girls are not statistically significant.

An important subsequent issue is whether the presence of local open space is associated with children being allowed greater independence, since the availability of facilities where children can meet and play may encourage some parents to allow their children to go out without an adult. Table 5 shows the percentages of children allowed out independently for groups divided into whether or not they said they had access to a local park or to a communal area. Of the eight possible relationships shown, the only one where having access to open space is associated with a significant difference is for boys being allowed out alone if they have access to a nearby park. Otherwise having

Table 4. Percentage of children allowed out without an adult to travel in various ways.

	<i>Boys</i>	<i>Girls</i>	<i>All</i>	χ^2 for differences between the genders		
				χ^2	<i>df</i>	<i>p</i>
Visit friends' homes	82	65	74	11.237	1	0.001
Cross main roads	69	56	63	6.365	1	0.012
Go out for a walk	55	42	49	4.973	1	0.026
Travel to organized activities	53	45	49	2.165	1	0.141
Cycle on main roads	42	24	33	11.760	1	0.001
Go on buses	35	28	32	2.029	1	0.154

Source: CAPABLE children's questionnaires.

CHILDREN'S INDEPENDENT MOVEMENT IN THE LOCAL ENVIRONMENT

Table 5. Percentage of children with or without access to open space allowed out independently.

		<i>Boys</i>		<i>Girls</i>	
		<i>Allowed out alone</i>	<i>Allowed out without an adult</i>	<i>Allowed out alone</i>	<i>Allowed out without an adult</i>
Has access to nearby park?	Yes	71	86	54	75
	No	51	82	39	84
	χ^2	6.648	3.060	0.604	1.852
	df	1	1	1	1
	p	0.010	0.800	0.437	0.174
Has access to communal area?	Yes	79	93	63	82
	No	60	83	45	81
	χ^2	3.618	1.785	2.898	0.011
	df	1	1	1	1
	p	0.057	0.182	0.089	0.918

Source: CAPABLE children's questionnaires.

Table 6. Percentage of children with different degrees of independence carrying out activities after school often.

	<i>Boys</i>				<i>Girls</i>			
	<i>Allowed out alone?</i>		<i>Allowed out without an adult?</i>		<i>Allowed out alone?</i>		<i>Allowed out without an adult?</i>	
	Yes	No	Yes	No	Yes	No	Yes	No
Stay at home often	50	69	74	54	56	74	66	65
χ^2	6.131		3.710		5.372		0.002	
df	1		1		1		1	
p	0.013		0.054		0.020		0.964	
Go to a friend's home often	77	58	74	48	76	73	79	57
χ^2	6.906		7.097		0.204		6.098	
df	1		1		1		1	
p	0.009		0.008		0.651		0.014	
Go somewhere outdoors often	77	60	75	48	76	68	73	67
χ^2	5.365		7.568		1.261		0.482	
df	1		1		1		1	
p	0.021		0.006		0.261		0.487	
Go somewhere indoors often	54	72	60	63	52	48	80	70
χ^2	5.887		0.069		2.846		1.467	
df	1		1		1		1	
p	0.015		0.793		0.092		0.226	

Note: The children classified as carrying out the activity 'often' are the ones who ticked the boxes marked 'weekly', '2 or 3 days a week', or on 'most days'; the ones classified as not carrying out the activity often ticked the 'never or hardly ever', or 'monthly' boxes.

Source: CAPABLE children's questionnaires.

open space nearby does not seem to make a significant difference (for boys, having access to a communal area does have a significant impact on being allowed out alone at the 10 per cent level, as it does for girls, to a lesser extent).

After exploring children's modes of transport, the project team sought to investigate whether being allowed out independently is associated with particular activities after school. Table 6 shows the percentages of children allowed out independently broken down by whether they stay at home frequently after school, go to a friend's home, go somewhere else which is outdoors (for example, the street, park or woods), or go somewhere indoors (for example, a leisure or shopping centre, or swimming pool). The strongest relationship is for boys who are allowed out alone: they are more likely to be at home less often, and go to a friend's home, or go somewhere outdoors more often; they are likely to go to somewhere indoors less often, but these activities may be associated with going with parents (reflecting the fact that some children are taken out shopping by their parents because they do not want to leave the child alone at home). These relationships are all statistically significant. For boys, being allowed out without an adult is statistically related to going to a friend's home often and to going to outdoor places, possibly because they can or do involve being with friends. Staying at home frequently has the expected direction of difference but is not significant at the 5 per cent level, but is at the 10 per cent level. For girls the

relationships between after-school activities and independence are not so strong. Girls who are allowed out alone are more likely to stay at home less often, and girls who are allowed out without an adult are more likely to go to a friend's home often.

Having examined the places that children say they go to in general and the sort of trips they make locally from the questionnaires, attention will now be focused on the micro-level travel behaviour of the subset of those that wore the monitors and completed the diaries.

Tables 7 to 13 show the speed of movement in metres per second over the ground based on the locations of the GPS points every minute, the intensity of movement in 10^{-2} activity calories per minute from the RT3s and the angular movement calculated by averaging the change of angle in degrees in the vectors from the GPS from one minute to the next.

Table 7 shows the differences in the walking patterns when the children were accompanied by an adult. The children walked faster and straighter when accompanied by an adult compared with when no adult was present. There was not a significant difference in the energy used, suggesting that children are as active when no adult is present, but they behave in a more meandering fashion, possibly interacting with other children or the environment, and so moving across space less quickly.

As Table 8 shows, the boys tended to move faster than the girls and used more energy, while the girls were meandering in a more

Table 7. Effects of adult accompaniment on children's walking patterns.

	<i>Accompanied by an adult?</i>		<i>t</i>	<i>df</i>	<i>p</i>
	<i>No</i>	<i>Yes</i>			
Speed	0.7	0.9	6.49	1039*	<0.0005
Intensity	6.2	6.5	1.44	878*	0.152
Angle	52	39	4.19	800*	<0.0005

Note: * Equal variances not assumed.

Source: CAPABLE surveys using GPS and RT3 monitors and diaries.

Table 8. Gender differences in children's walking patterns.

	<i>Boy</i>	<i>Girl</i>	<i>t</i>	<i>Df</i>	<i>p</i>
Speed	0.9	0.8	2.48	820*	0.013
Intensity	7.3	6.1	5.81	844*	<0.0005
Angle	38	46	2.52	855*	0.012

Note: * Equal variances not assumed.

Source: CAPABLE surveys using GPS and RT3 monitors and diaries.

relaxed way, perhaps interacting more with friends.

Looking at how the children behaved when no adult was present, as shown in table 9, it can be seen that the differences between boys and girls in terms of speed and intensity were greater than when they were accompanied by an adult, but there was no significant difference in the average angle turned.

One of the purposes of using the GPS equipment was to see whether children behaved differently in different local environments, as shown in table 10. The children walked faster, straighter and more intensely on the road compared with when they were walking in open space (parks, fields, woods, and so on). Open space offers more opportunity to play and meander about.

Tables 11 and 12 show the effects of adult

accompaniment on children's movements on roads and open spaces. On the road, the presence of an adult made a significant difference to children's patterns of movement: faster, straighter and more energetic, whereas off the road, the differences were not significant. Walking on the road is more likely to be part of a trip with a time constraint, such as to school, whereas walking across open space, even when with an adult, may be more relaxed, perhaps offering more opportunity to play.

Table 13 shows the movement patterns in different activities. Walking was the activity which used the most calories and was the fastest. Playing was the slowest, but not the least energetic, with more calories used than in clubs, confirming previous findings for different children (Mackett *et al.*, 2005).

Table 9. Gender differences in children's unaccompanied walking patterns.

	<i>Boy</i>	<i>Girl</i>	<i>t</i>	<i>df</i>	<i>p</i>
Speed	0.8	0.6	2.21	127*	0.029
Intensity	7.5	5.9	3.37	155*	0.001
Angle	52	52	0.091	451	0.927

Note: * Equal variances not assumed.

Source: CAPABLE surveys using GPS and RT3 monitors and diaries.

Table 10. Children's walking patterns in different types of environment.

	<i>Road</i>	<i>Open space</i>	<i>t</i>	<i>df</i>	<i>p</i>
Speed	0.8	0.7	4.05	1498	<0.0005
Intensity	6.7	5.8	4.66	1614	<0.0005
Angle	41	49	2.34	571*	0.019

Note: * Equal variances not assumed.

Source: CAPABLE surveys using GPS and RT3 monitors and diaries.

Table 11. Effects of adult accompaniment on children's walking patterns on roads.

	<i>Accompanied by an adult?</i>		<i>t</i>	<i>df</i>	<i>p</i>
	<i>No</i>	<i>Yes</i>			
Speed	0.7	0.9	7.25	1047	<0.0005
Intensity	6.4	6.9	2.05	750*	0.041
Angle	51	36	4.47	669*	<0.0005

Note: * Equal variances not assumed.

Source: CAPABLE surveys using GPS and RT3 monitors and diaries.

Table 12. Effects of adult accompaniment on children's walking patterns in open spaces.

	<i>Accompanied by an adult?</i>		<i>t</i>	<i>df</i>	<i>p</i>
	<i>No</i>	<i>Yes</i>			
Speed	0.6	0.7	1.29	425	0.196
Intensity	5.5	5.9	0.75	137*	0.457
Angle	58	46	1.47	118*	0.144

Note: * Equal variances not assumed.

Source: CAPABLE surveys using GPS and RT3 monitors and diaries.

Table 13. Children's movement patterns in different activities.

	<i>Walking</i>	<i>Playing</i>	<i>Clubs</i>	<i>F</i>	<i>df</i>	<i>p</i>
Speed	0.8	0.3	0.5	89.78	2451	<0.005
Intensity	6.5	5.2	4.1	56.32	2600	<0.005
Angle	43	77	91	131.23	2305	<0.005

Source: CAPABLE surveys using GPS and RT3 monitors and diaries.

Clubs were the activity involving the greatest amount of angular movement, possibly in the course of sport such as tennis and football.

The findings from the GPS and activity monitors and diaries show that accompaniment by an adult affects children's movement in the local environment, that children behave differently in different types of place, and that boys and girls have different patterns of movement.

Conclusions

This paper has presented some results from an ambitious project to understand how children interact with the local environment. The focus has been on whether the children are allowed out without an adult and the implications of this for where they go out

of the home, and the nature of their walking behaviour and how this is influenced by gender differences and whether or not they are accompanied by an adult.

About 56 per cent of the children were allowed out on their own, with more boys being allowed out than girls, but many girls were allowed out without an adult if other children were present. There was a wide range in the proportion of the children who were allowed to undertake various types of local travel, ranging from making very local trips to friends or recreational cycling near home, to going out on longer trips involving using buses or cycling on main roads, but, generally, more boys were allowed to undertake these activities than girls. Having access to a local park had a significant impact on the number of boys allowed out alone but

not on girls. Being allowed out alone had a significant impact on the frequency with which they went out after school, for both boys and girls. For boys, those who were allowed out alone went to friends' homes and went somewhere outdoors after school more often than those who were not. Girls who were allowed out without an adult were also more likely to go to friends' homes often.

The nature of children's walking behaviour has been considered, in terms of their speed of travel, their energy consumption and their angular movement. It was found that the children walked more slowly when they were not with an adult, but this was, partly, because they tend to move about laterally to the main direction of movement, particularly boys. This much more sinuous type of walking may well be associated with exploring the environment and socializing, both of which are very important aspects of children's development which are facilitated by allowing children to go out without an adult. The boys tended to walk faster and more intensively than the girls who tended to meander about more, particularly when they were not accompanied by an adult. Walking trips on the road tended to be faster, straighter and more energetic than those on open space. On the road the presence of an adult made a significant difference to the way the children moved about whereas it did not on open space. It was shown that walking uses more activity calories than playing and clubs, with playing using more than being at clubs.

The implications of this work for policy and design of the built environment relate mainly to the concept of children being allowed out without an adult. It has been shown elsewhere (Mackett *et al.*, 2005) that children use more activity calories when out of the home than when in it, hence there are benefits in terms of physical activity in reducing the barriers to them being allowed out of the home. Boys who live near a local park are more likely to be allowed out alone, which suggests that provision of local open

space may well increase children's level of physical activity by allowing more children to go out alone, and so go out more often. When they are out, children behave in a more exploratory way when not accompanied by an adult, which may well reflect playing, interacting with friends and exploring the local environment. Children who are allowed out without adult are more likely to go to friends' homes after school, and so have a richer social life.

In sum, our research suggests that there are significant benefits to allowing children to go out without adults, thus providing sound evidence to support arguments for policies and designs of the local built environment that help to overcome the barriers that prevent children being allowed out unaccompanied by an adult. This means designing environments that children feel comfortable in and that parents feel confident that they can let their children use unaccompanied by an adult. From the literature it is clear that children are allowed out without an adult much less than they used to be. It will take further research to establish exactly what they gain from the more exploratory type of movement that children indulge in when adults are not present, but it is based on them deciding where to go and what to do, and that is an important part of growing up. It is being lost to children who are not allowed out without an adult, and that may be a very great loss with many implications.

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