Working Paper: Why do people walk in the suburbs? An analysis of how spatial configuration and land use diversity contribute to walkability

By Ilaria Geddes and Laura Vaughan

Abstract

Most current research looking at how planning and urban design can contribute to walkability compares built environment measures such as connectivity, diversity and land use. This working paper contributes to this domain by reporting on a pilot study which used space syntax measures of route choice to analyse self-reported walked routes and planned activities within three outer London suburban neighbourhoods. Using a bespoke questionnaire on a wide array of activities coupled with self-reported route traces the study relates the through-movement potential of the street network to the intensity of routes and land use diversity through each of the three areas. Using data on people’s reasons for walking and actual routes, adjusting for differences between different groups of users, the aim was to see whether urban configuration affects patterns of movement in the suburban realm. The findings show that route availability is associated with increased walking along routes with ‘active’ land uses, notwithstanding the variety of activities taken during a walk. They also reveal clear differences in usage patterns and trip length according to the degree of familiarity with the area as well as the location of physical barriers to walking routes, such as railway lines. Greater use of green spaces is found to be associated with their integration into the spatial network and local inter-visibility. The findings also tentatively suggest that routes with increased network centrality are more likely to be used for multi-purpose trips. The results suggest that improved planning and design can increase walking in an area, leading both to local vitality as well as potentially to the health of individuals.

Keywords: walkability, space syntax, suburban town centres, route choices, London

Highlights

- We compare three smaller than average suburban town centres in outer London.
- We examine activity patterns for people walking around the centres.
- Despite relative low residential density, walking is extensive, activities diverse.
- Walking corresponds to route availability and amount of active uses available.
- We recommend breadth of land uses: not just shopping, not just in the town centre.

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1. Introduction

This article reports on a pilot study which focused on walking patterns and purposes in three suburban neighbourhoods to discover where, how, for how long and why people undertake walking trips in suburban town centres. The study explored the extent to which the built environment – namely non-domestic land uses and route availability – is a factor in differences in walking trips for both residents and visitors to the neighbourhood. It uses space syntax for the street network analysis, which is a validated method for quantifying the influence of urban form on spatial behaviour (Cutumisu and Spence 2009). The space syntax method uses accurate street maps to model large contextual areas and provides detailed measures of street configuration and allows a system of urban space to be analysed at different spatial scales (for example, at a given number of metres from each segment), in terms of its relative accessibility to other spaces at that scale. The burgeoning portfolio of studies using the method shows that streets with greater levels of accessibility have proportionately larger flows of movement – making the method particularly useful in studies such as the one reported here. In addition to space syntax analysis and land use data, the study carried out on-street questionnaires of individuals' trip length and purpose.

The reasoning for undertaking this pilot study is two-fold. Firstly, it attempts to combine the analysis of why people undertake trips with how the built environment influences their route choices and extent of walking. This is because previous studies have tended to separate the analysis of the impact of urban configuration on walking and the analysis of the reasons for which people undertake walking. The authors believe that the two are inextricably linked, as, while on the one hand the reason for undertaking trips may initiate walking, the urban configuration will influence whether the trip is ultimately undertaken on foot or not, as well as its length and route. On the other hand, while the urban configuration may foster and facilitate walking, the reasons for which people undertake trips and whether the needs requiring the trip may be met by the land uses available at a certain scale within a neighbourhood will also shape the ultimate decision of whether the trip will be undertaken on foot and the extent of the walking. A combined understanding of trip purpose and the urban configuration within which the trip occurs is therefore needed to further the understanding of walkability.

Secondly, the study focuses on route choices, namely where people decide to walk to reach their destination and for what purposes. Finding a way to capture and measure the large number of supposedly trivial purposes for which an individual may take a trip on foot was an important aspect of the study’s aim to understand the range of reasons that motivate people to walk. This is a novel approach and use of space syntax, which adds a further layer to the understanding of walkability. The ability of space syntax to analyse the urban configuration in relation to a variety of possible trip length and to relate measures of the urban configuration to data on trip length and purpose makes this analytic approach a powerful tool to aid policy making by providing an understanding of the different scales at which trips are undertaken and for what reasons, hence giving an indication of the extent of the areas on which policy making should focus in order to influence walkability.

2. Background

The literature on the impact of the built environment on patterns of walking identifies land use mix, levels of traffic and pedestrian movement and availability and perceived safety of green spaces as being the most influential factors (Marmot et al., 2010, pp. 130-132). Other factors include high residential density, a variety of land use, good connectivity (i.e. street layout and design to allow
direct routes to destinations); and good accessibility to a variety of destinations or facilities, such as retail facilities in easy proximity (Frank et al., 2005). Studies indicate that people are more likely to be physically active if they live in neighbourhoods with many destinations, such as shops and other facilities, and with many street intersections between residential and commercial districts to enable direct pathways to destinations (Frank et al., 2005) as well as improved accessibility to stores, transit, and recreational areas (Giles-Corti et al., 2005; Song 2005; Moudon et al., 2007). Other studies, particularly those from the health literature, focus on auditing walkability for individuals in neighbourhoods (see for example review by Townshend and Lake (2011)) and consider individual level characteristics. This is not the focus of this study, which addresses the statistical impact of the built environment on a sample population. Overall, the numerous factors relating to the built environment raise not only the question of how does urban morphology influence these factors, the way in which walkability happens, and people’s use of the public realm for everyday walking in an area, but also how this relates to people’s reasons for walking, their choice of routes and hence the extent to which they walk.

Space syntax measures of accessibility have been shown in many studies to predict pedestrian and vehicular flows independent of attractors such as shops or train stations (e.g. Hillier et al., 1993 and Hillier, 2009). Other studies have shown a strong correspondence between diversity of land uses and pedestrian movement (Hillier, 1999), and there is a small number of studies which use space syntax measures to study walkability. Joseph and Zimring (2007) showed that routes chosen for recreational walking tend to be accessible and have attractive views, whilst routes chosen for instrumental purposes will tend to have specific destinations along them. They found that routes that are well connected are more frequently used. In an important precursor to the study reported here (Baran, Rodriguez and Khattak 2008), space syntax measures were used to study walking behaviour in New Urbanist and traditional suburban neighbourhoods in the US, whilst elsewhere walking per day has been found to correlate with pavements, street lighting, traffic calming and many features of connected street patterns, especially smaller blocks (Forsyth et al., 2008). In a longitudinal study of built environment characteristics and changes in BMI, the authors show that the “presence of walkable destinations may be more important in influencing healthy weight outcomes than land use mix per se...” (Sarkar, Gallacher and Webster, 2003: 41). Finally, in a study of the effect of access to parks on walking, Koohsari et al. (2013) find that proximity to a park is a weaker factor than street configuration and propose that further research should consider whether the “characteristics of the routes that people traverse to reach [public open spaces] influence the use of, and the likelihood of walking to and within, these important neighbourhood destinations.” Taken together, these findings are suggestive of our hypothesis that the extent and length of walks in suburban neighbourhoods is determined by a combination of built environment factors, including spatial accessibility and land use mix. This pilot study attempts to go a step further in the understanding of walkability, by focusing on route choices and their relationship to the purposes of the trip, hence analysing whether route availability (as assessed by the space syntax measure of ‘choice’) may also play a part in trip length and pattern.

This study formed part of a larger research project (Vaughan, Jones, Griffiths and Haklay 2010) which aimed to test aspects of urbanity in relatively low-density suburban settings, where people are less prone to walk (Bauman and Owen 2009). The study also builds on background information from the Strategic Review of Health Inequalities in England post-2010 (Marmot et al. 2010), for which the first author was a researcher and which identified and collated the evidence relating to aspects of the built environment and their interrelationships with health. The Review identified walkability of neighbourhoods as playing an important role in the health of its residents and found that different built environment aspects of a neighbourhood had different impacts on the levels of people walking for purposes other than exercise (Marmot et al. 2010, pp. 130-132). Following the background and
methods sections, the analysis is split into two: first focusing on the activities carried out by people walking in the study areas, the purpose of their trips and thus the reason why they undertake walking. The second section compares patterns of movement by different categories of people, the length and location of their trips, as well as the relationship between these, the activities and the urban configuration. Conclusions are then drawn on what built environment factors influence the decision to undertake walking trips, their length and pattern. The relevance of the findings is discussed with regards to different aspects of walkability and its impact on health.

3. Methods

3.1 Town centre sample

The cases draw on research conducted for a 3-year research project at UCL (as cited above), which enquired how far the long-term presence of non-domestic land uses in these centres has a morphological explanation. In order to arrive at a fine-scale computation of spatial connectivity and to arrive at independent measures of spatial layout that can be related to pattern of social activities, the study used space syntax proprietary software to map the street and pathway network of the London region within the M25 orbital road (Figure 1) and to measure street and pathway accessibility. Unlike the space syntax studies cited above, we used segment angular analysis—a recent development in the field of space syntax—which allows for a more detailed account of differences along the length of a street, something which is of particular importance in the more diffuse networks found in suburban areas.

Following a geographically stratified random sampling of outer London’s 113 town centres, twenty cases were chosen for the wider study to carry out statistical analysis of morphological, land-use, commuting patterns and a wide range of other socio-economic data (see www.sstc.uct.ac.uk/profile and Griffiths, Vaughan et al. 2008; Jones, Haklay et al. 2008; Vaughan, Griffiths et al. 2009; Griffiths, Jones et al. 2010; Vaughan, Jones et al. 2010). They were selected using a stratified random sampling of each of its north-west, south-west and south-east quadrants, from each of which a single exemplar case was chosen based on its comparability for size as well as the location of transport facilities—the intention being to see if walking patterns were consistent in their patterns across the city. These three cases are the focus of the pilot study reported here: High Barnet (Barnet), South Norwood (Norwood) and Surbiton, with the intention to extend the study in the future.

The space syntax data were derived from a segment graph mapping the contiguous street network of the Greater London region within the M25 (Figure 1). Each segment (there are over 280,000) constitutes a spatial element, created where road lines intersect or change direction. In this study the focus is on the measure of ‘choice’, which predicts the potential for the street network to support ‘through movement’. This measure expresses the probability that a road segment lies on a route between two other segments at a given distance, allowing for analysis of how suburban centres are embedded in the regional road network (when taking a large scale distance) or number of routes from any place to any other place within a more local ambit, such as the 800 metres radius chosen here, which models a 10-minute walk approximately. The measure of choice was the focus of the study, given that it was seeking an objective measure of route availability in relation to respondents’ own reported trip length and purpose.

Each of the three study areas comprises a main centre with retail, offices, services and food outlets; with local businesses and small scale industries, often located in courtyards or on back streets within
the reach of the town centre. Although the centre is the focus of activity, smaller clusters of non-residential activities were present in other localised spots, in residential areas and on the outskirts of the town centres, especially around hospitals, schools and local convenience shops. Figure 1 shows that whilst the three study areas are distributed across Greater London, in all cases they have major traffic routes passing through or around them. As explained in Griffiths et al. (2010), which analysed these centres to look at their accessibility from a range of distances, it is evident how even smaller town centres have the potential to attract users for a variety of activities. Also apparent from an examination of Figure 1 is how the organization of London’s road network is characterized neither by simple continuity nor discontinuity; rather, areas of built form and open land are present at various spatial levels within the region. They all have a certain degree of local network accessibility and centrality (see Griffiths et al., 2010 for details).

![Diagram of Greater London with accessibility map](image)

*Figure 1* Space syntax graph of Greater London showing choice (or, potential through movement) at radius-n. Underlying mapping © Crown Copyright/database right 2013. An Ordnance Survey/EDINA supplied service.

All three sites are served by either an underground (Barnet) or overground (Norwood and Surbiton) railway station. Barnet’s station is located to the south of the town centre, which includes a well-used enclosed (but top-lit by daylight) shopping centre on the high street; Norwood station is set just off the high street at the end of a short street with retail and office uses, while Surbiton’s station is located at one end of the high street at the edge of an open space used mainly for car parking. In
both latter instances the station and railway tracks divide the neighbourhood two: the high street with its mixed land uses to one side and a primarily residential area to the other side. In both instances the station can be crossed: through a subway in Norwood and through an over passage in Surbiton.

In each of the study areas, a green space was present in or just on the edge of the town centre. In order to gain an understanding of the quality of the green space and therefore its potential for use and impact on health, a researcher recorded whether the green space was demarcated by blank walls, high non see-through fence or vegetation, low or see-through fence or vegetation, and whether the frontage of the surrounding environment was constituted by doors only, windows only, windows and doors together (residential/offices), or ‘live’ uses such as retail and services. These characteristics were recorded because previous studies have shown them to have significant impact on space use and pedestrian movement, as well as on a number of variables relating to walkability, such as levels of crime, fear of crime, and liveability (Hanson, 2000; Chiaradia and Trigueiro, 2005; Hanson and Zako, 2007).

Ravenscroft Gardens in Barnet to the south east of the town centre is a medium sized, well maintained green space surrounded by a see through fence and some vegetation, the building frontage to one side is mainly made up of doors and windows to domestic dwellings and to the other side is mainly made up of ‘live’ uses (retail and food outlets) along a main vehicular road; at the times of observation by the researcher the green space was busy and well used by local individuals and families. In Norwood, the recreation ground was a much wider space, tucked in between the railway and the back of buildings at the edge of the high street to the south of the railway station. The space was well maintained and contained an ‘outdoor gym’, however, it was poorly used at the times of observation: it is mostly surrounded by blank frontages, high opaque fences at the back of houses and high dense vegetation; because of its location there are no streets, and therefore building frontages surrounding the space. In Surbiton, Claremont Gardens is immediately north of the station, about 50 metres from the end of the high street; the space was well maintained and surrounded by very low fences and a mixture of opaque and sparse vegetation, the surrounding building frontage comprised mainly doors and windows of residential buildings. The space was fairly well used at the times of observation, though not as much as the space in Barnet.

Data on non-domestic land uses within an 800m radius of the town centres were used in this study to take account of whether trips were more likely to take place on routes aligned by ‘live’ land uses. The data were obtained from functional activity maps created by the SSTC project (see: [http://bit.ly/18OEJuo](http://bit.ly/18OEJuo)) and derived from an UK Ordnance Survey product: Address Layer 2 (AL2) 2007, which identified major groups of activity generating land uses occurring in and around the town centres: retail, industry, community services and offices and general commercial, for which 41 more detailed Land Use Group descriptions were also used (Jones et al., 2009). Each segment was assigned a value according to the proportion of ground floor non-domestic land use addresses from all ground floor addresses, weighted by segment length.

### 3.2 Street questionnaire data

The study took a sample of people walking in and around the town centres. Survey locations were selected to provide a range of high, medium and low levels of street network accessibility.

The researchers asked respondents if they lived or worked locally and what their primary and other purposes for walking were. Although demographic data were recorded systematically, including age
range, ethnicity and accent as observed by the researcher in order to give an idea of the variety of backgrounds of the interviewees, the sample size for this pilot study did not allow for statistically reliable breakdown by gender, age and other demographic factors, although it might be of interest for a future more extended study. In addition, researchers tended to be more successful in engaging responses from people of visibly the same ethnicity. It is possible that the proportion of respondents may be marginally biased towards the same ethnicity as the researcher. There were around 50% men and 50% women across the sample.

The questionnaire was developed in conjunction with the project advisors to devise questions that would reveal as much detail as possible on everyday activities that are typically not accounted for in studies of this nature - which tend to focus on shopping and tend not to allow for multiple activities at the required level of detail. The number of categories in the questionnaire was therefore very wide and was aimed at capturing the diversity of purposes for which trips are undertaken (See appendix 1 for a sample questionnaire). We intentionally created similar purpose categories to allow for language differences; for example taking children to school and attending school or meeting friends or family could be reported instead of visiting friends and family. These were aggregated at the data entry stage. The ‘other category’ was also aggregated post facto.²

Other questions related to the mode of transport to the centre, route walked and to be walked and origin and destination of route. Respondents were asked to draw on a map of the local area their walking route, from their starting point up to the point of interview, and also the point of interview up to their planned end point. The resulting drawings were aggregated within a geographical information system, to further exclude any risk of revealing personal information such as home addresses.³

The questionnaire took place in 2008 as part of the wider suburban town centre study and was repeated in 2010 in order to focus on issues of walkability, but using the same methods. The two sets of results were checked to ensure comparability and the study sites were checked to ensure there were no changes to infrastructure and street layout. The sample size differed between 2008 and 2010 (193 and 70 responses respectively). In order to ensure the two sets of data could be aggregated, the percentage of reported activity in each study area was correlated and found to be statistically significant in all study area - in Barnet the correlation between the two datasets had an R-Squared of 0.693 (p<.0001) in Norwood it was 0.517 (p=.0029) and in Surbiton 0.499 (p=.0042) - meaning that the two datasets could be combined – although it is possible that differing underlying patterns in the two periods will have been overlooked.

² The questionnaire also comprised an ‘other’ category under which respondents mostly listed various services, including hairdresser/barber, laundry, solicitor, removal van, checking train times and bank. Further activities reported in the ‘other’ category included ‘being on holiday’ which was classed as ‘doing nothing/hanging out’, optician and therapist, which were classed as ‘doctors/hospital/dentist’, and job interview and job hunting, which were classed as ‘business meeting’. The various categories were summarised further as following: education: take children to/from nursery/playschool/school + school/college/university; socialising: meet friends/family + visit friends/family + waiting for friends/family; work: work here + business meeting; eating and drinking: coffee/tea/drink + eat + lunch club + pub/bar; services: services (this was mainly from the ‘other’ category and included hairdresser/barber, laundry, solicitors, bank) + post office + post a letter; on route: catching a train/bus/tube + passing through; financial transactions: get money + collect pension + bills (pay bills + charge gas/electricity key).

³ The study was checked for ethical clearance and was deemed to be exempt as human participants cannot be identified, nor is there risk that disclosure of the human participants’ responses outside the research could reasonably place the participants greater at risk of criminal or civil liability or be damaging to the participants’ financial standing, employability, or reputation.
The study was carried on Wednesdays, outside of the school holidays and during the periods 10am-12pm and 2pm-5pm, in order to avoid commuting rush hours, as well as lunch break trips and to maximise a diversity of trip purposes, whilst seeking to exclude commuting to/from work and school.

The study used a bespoke questionnaire, so precluding comparison to other studies within the published literature. However, given the paucity of space syntax studies of walkability in the published literature, the study may serve as a baseline for other such research and we accordingly provide access to the study methods for interested researchers.

3.3 Spatial data

The route traces were entered in a geographical information system (MapInfo GIS) as a single polyline and start, end and pick-up point were recorded, although the routes were entered and analysed as whole trips. Despite a small likelihood of a change to the route, the decision to consider the trip as a whole was taken due to the need to gain an understanding of the nature and full extent of people’s trips, and because the whole route nevertheless represents the intentionality and purpose of the trip. Routes lengths were measured automatically in GIS by calculating polyline length.

As mentioned above, the space syntax measure of ‘choice’ was used – this models the potential ‘flow’ of movement through public space (streets, squares, pathways and so on) and is calculated by counting the number of shortest paths connecting all spaces to all other spaces within a specified distance along the pathways (as opposed to ‘as the crow flies’) and are described in radii of distance. Measures of choice at different radii are representative of different levels of movement: for example global choice, measuring the number of shortest paths connecting all spaces to all other spaces within the spatial model tends to highlight main thoroughfares through a system, especially vehicular roads; choice at a small radius, such as 400 – 800 metres tends to predict short walking journeys. For this analysis the radii of 800m and 2000m were chosen: the 800m radius would cover short to medium walking journeys in the immediate town centre, while the 2000m radius would cover the longest walking journeys within the wider study area; these were chosen because they matched the median route length of residents across all three sites and longest route length across the sites (the broader suburban town centres study considered all scales between 400 and 3000, see Vaughan et al, 2010).

In order to check the relationship between the intensity of the routes (namely the proportion of routes passing through any single street segment), the diversity of activities for which the routes were undertaken (namely the proportion of different activities reported for the relevant routes) and urban configuration (as measured by choice 800m and 2000m), twenty locations were sampled per site to constitute a mixture of major and minor roads. The geographical information system formula for selecting and computing intersecting objects was used to compute the number of reported walked routes passing through and the proportion of all activities for which the routes on the relevant segment were undertaken and each segment was assigned a value based on the proportion of non-residential uses present on the segment. A linear regression was created between the space syntax values and the intensity of routes, and between the space syntax values and the diversity of activities. The regression coefficients (R-squared) of the models were calculated using an online statistical calculator www.graphpad.com
4. Results

In order to consider the extent to which built environment factors influence the decision to undertake walking trips, their length and pattern the following analysis took place.

4.1 Trip Analysis

In order to test whether walks differed between multi and single-purpose trips or between those who were shopping (whether in combination with another activity or just shopping) and those who were carrying activities other than shopping, the responses were categorised accordingly.

In addition, despite the expectation that the sampled centres (which fall low down in the retail hierarchy) have a primary retail focus (Hall, Marshall and Lowe 2001), we found that the majority of respondents were out and about for reasons other than or additional to shopping (see table 1). For two of the cases there was also little difference between trip length for people shopping and those who were not shopping, despite the expectation that people shopping would stay closer to the ambit of the retail centre. Barnet has noticeably longer trips for people not shopping, unlike the other two study areas.

<table>
<thead>
<tr>
<th></th>
<th>Proportion shopping (%)</th>
<th>Trip length for people Shopping (m)</th>
<th>Trip length for people not shopping (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barnet (n=93)</td>
<td>48</td>
<td>734 (399-1209)</td>
<td>843 (383-1356)</td>
</tr>
<tr>
<td>Norwood (n=90)</td>
<td>33</td>
<td>692 (318-954)</td>
<td>722 (335-978)</td>
</tr>
<tr>
<td>Surbiton (n=85)</td>
<td>40</td>
<td>1024 (619-1488)</td>
<td>746 (403-1099)</td>
</tr>
</tbody>
</table>

Table 1: Trip characteristics of respondents shopping (whether as a single or one of several activities) and not shopping at all. Trip length is the median for each group measured in metres (inter-quartile ranges in parentheses).

Figure 2 is particularly illuminating for discussions of the role of smaller centres as it shows an analysis of all additional activities reported by people who stated shopping as an activity - whether they deemed shopping as a primary or a secondary activity - to see whether they are a by-product of shopping. The chart shows a wide array of activities undertaken additional to shopping. Whilst some of these may be related to the act of shopping itself, such as taking out money - others such as eating/drinking may either form part of a leisure shopping trip or as a respite from a necessary trip. Another group of 'additional' activities seem to be distinct from shopping; undertaken as part of an intentionally multi-purpose trip where one activity does not require the other and is not closely related to shopping: such as attending healthcare facilities, working, or visiting a place of worship.
The extent to which people walk more or for longer in settings where there is a greater diversity of activities is another aspect of the research question. The questionnaire responses were therefore analysed to see the proportion of people who had undertaken their trip for single as opposed to multiple purposes. Whilst all three cases show a significant proportion doing the latter (see Table 2), Barnet has an exceptionally high proportion of 55%, something we explore further in the Discussion below. We did not identify any significant differences in route lengths between the two groups, other than in the case of Surbiton.

<table>
<thead>
<tr>
<th></th>
<th>Proportion carrying out multiple activities (%)</th>
<th>Trip length one activity (m)</th>
<th>Trip length multiple activities (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barnet (n=93)</td>
<td>55</td>
<td>863 (383-1262)</td>
<td>776 (408-1286)</td>
</tr>
<tr>
<td>Norwood (n=90)</td>
<td>42</td>
<td>660 (328-900)</td>
<td>780 (409-1111)</td>
</tr>
<tr>
<td>Surbiton (n=85)</td>
<td>48</td>
<td>746 (400-1094)</td>
<td>1037 (519-1417)</td>
</tr>
</tbody>
</table>

Table 2: Characteristics of trips for one - or multiple – activities. Trip length is the median for each group measured in metres (inter-quartile ranges in parentheses).

Other than shopping, window shopping and working (which would include respondents who work in the area on a regular basis as well as respondents visiting the area as part of their job), other popular activities related to necessary daily routine within each study area (attending school, college or university, or journeys with children to/from nursery or school, or going to work). A different group of activities includes less frequent, but regular activities: eating and drinking, attending healthcare appointments, and visiting friends and families (socialising). A third group includes irregular or optional activities, such as ‘doing nothing’ or ‘hanging out’, going to the library, going to the park, etc.
Most activities undertaken relate to actions that are necessary on a regular basis, such as procuring groceries and food, attending work or school, etc. The analysis, however, also highlighted a wide spread of other activities that are part of everyday action in the life of a neighbourhood. Interestingly, very few reported undertaking a trip in order to visit a green space, despite the fact that many routes passed along the green spaces in Barnet and Surbiton.

The degree of familiarity with an area shaping the pattern and extent of walking was tested initially by comparing differences between residents and non-residents in their activity patterns. Figure 3 illustrates this, showing that shopping and using the local services, including education and healthcare facilities were more typical of residents, while work, on lunch break and socialising tended to be more common for non-residents, indicating a number of commuters into the town centre and people coming from other areas to visit local friends or relatives. Analysis of how walking routes might differ across the two groups is discussed below.

![Figure 3: Comparison of all activities reported by residents (N=201) and non-residents (N=62) in all sites.](image)

The following analysis shows that differences between residents and non-residents were much greater than the comparisons made above: In all three study areas non-residents took much shorter trips than residents (see table 3 and figures 4-6).
Table 3: Trip characteristics comparing residents and non-residents. Trip length is the median for each group measured in metres (inter-quartile ranges in parentheses).

<table>
<thead>
<tr>
<th></th>
<th>Proportion of self-reported ‘non-resident’ respondents (%)</th>
<th>Trip length for residents (m)</th>
<th>Trip length for non-residents (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barnet (n=93)</td>
<td>26</td>
<td>982 (512-1445)</td>
<td>388 (261-776)</td>
</tr>
<tr>
<td>Norwood (n=90)</td>
<td>20</td>
<td>743 (503-962)</td>
<td>299 (162-1116)</td>
</tr>
<tr>
<td>Surbiton (n=85)</td>
<td>23</td>
<td>929 (614-1390)</td>
<td>579 (261-924)</td>
</tr>
</tbody>
</table>

The pattern of walking for the two groups can be observed in figures 4-6, which show that in all three cases residents spread out beyond the town centre much more than non-residents. It is also evident that loops or circuits of walking are formed by the former group, whilst non-residents tend to concentrate on the main roads. The railway line which bisects Norwood and Surbiton is a major barrier to movement to people unfamiliar with the area, limiting activity to the area around the town centre in both cases. Taking Surbiton, which has a particularly challenging barrier, given that the only crossing near the town centre requires crossing a high bridge within the station, the result is that residents who do any shopping to the south east of the station are evidently preferring the secondary high street, Ewell Road, rather than taking the shortcut through the station.

Figure 4: Walking routes reported by residents (left) and non-residents (right) in Barnet. Underlying mapping © Crown Copyright/database right 2013. An Ordnance Survey/EDINA supplied service
Figure 5: Walking routes reported by residents (left) and non-residents (right) in Norwood. Underlying mapping © Crown Copyright/database right 2013. An Ordnance Survey/EDINA supplied service.

Figure 6: Walking routes reported by residents (left) and non-residents (right) in Surbiton. Underlying mapping © Crown Copyright/database right 2013. An Ordnance Survey/EDINA supplied service.

The extent to which availability of routes within the network supports walking is explored in the following section.
4.2 Spatial analysis

This section considers the spatial context for each of the three sites in order to study the relationship between urban configuration, land uses and movement routes.

Characteristics of trip length compared across sites showed that the median trip length was broadly similar across the three sites (Barnet 833m, Norwood 720m, and Surbiton 903m), however analysis of interquartile ranges (Barnet 388-1316m, Norwood 328-954m and Surbiton 472-1328m) showed wider differences, while a statistically significant difference between the sites was determined by one-way ANOVA \(F(2,265) = 3.387, p = .035\). The fact that Barnet and Surbiton have longer routes should be considered alongside the findings reported above, in that Barnet has the highest proportion of people undertaking multiple activities and the longest walks by non-shoppers, while Surbiton has the longest walks by shoppers and by those undertaking multiple activities. The fact that Barnet has a particularly dense network of pathways seems to enable many short circuits to be made around, through and within the area. Observations made on site bear this out, showing relatively large numbers of people on the back routes lying behind the high street. On the other hand, Surbiton has developed a secondary high street (Ewell Road) which enables avoiding crossing the railway station and provides further retail and services, thus attracting pedestrian movement. These facts taken together seem to suggest that the configuration of the street network is a contributory factor in increased walking, while the availability of diverse land uses reinforces the effect of the urban configuration in enabling movement.

Correlation between route availability and number of reported routes running through a street segment showed a strong relationship between choice 800 (the likelihood that a route forms part of any journey between two points up to 800m away from each) and the proportion of all routes reported to have been taken on each street segment (R-squared = 0.467 and \(p < .0001\)). The relationship continued at the wider scale, choice at a 2000m radius – for this measure the significance of the relationship between the amount of routes undertaken was slightly lower than for the 800m radius (R-squared = 0.395 and \(p=.0015\)), perhaps because fewer long routes are undertaken on foot than shorter routes.

Analysis between route availability and proportion of all activities undertaken was made by correlating the proportion of activities on each segment with its space syntax value. Here the significance of the relationship was similar for both measures (R-squared=0.434 and \(p=.0004\) for choice 800m, and R-squared=0.446 and \(p=.0003\) for choice 2000m); possibly because some land uses, which are often located slightly further away from the town centre (for example schools or hospitals) require longer journeys, and possibly because carrying out multiple activities within one journey might require covering a wider area. Interestingly there is a statistically significant relationship between choice 2000 and the median length of routes (R-squared=0.311 and \(p=.0139\), but not choice 800 and median length (R-squared=0.140 and \(p=.2778\)); this might again point to the fact that some non-residential land uses are spread out throughout the wider neighbourhood, while routes necessarily encompass some residential areas just outside the town centre.

The aforementioned study into the success of smaller town centres showed the importance of the presence of a wide range of non-domestic land uses in generating local and larger scale patterns of movement. The study suggested that a diversity of activities contained within suburban town centres – ranging from light industry to the local courthouse - collectively contribute to their liveliness (Vaughan et al, 2010). The current study analysed the data on non-domestic land uses in order to see if people preferred routes with a higher diversity of land use or whether people’s own diversity of activity corresponded to land use diversity.
Analysis of the relationship between non-domestic uses and the likelihood that a street would form part of a chosen route showed a highly significant statistical correlation – taking all three study areas together - between the proportion of non-domestic land uses on a segment and the number of reported routes running through it (R-Squared: 0.669; P < 0.0001). Similarly, analysis of the number of routes running through a street segment and the proportion of activities reported by people using that route gave a similarly significant result, showing that people carrying a greater number of activities tended to prefer routes with a higher diversity of land uses (R-Squared: 0.628; P < 0.0001).

The spatial analysis overall suggests that there is a three-way relationship between the urban morphology, the location of land uses and the routes which people choose to undertake in order to carry out specific activities. Whilst space syntax analysis on its own predicts walking flows, it is evident that non-domestic land uses create a multiplier effect, reinforcing the spatial effect with the provision of uses which attract movement over and above the natural effects of the street network itself. In other words, walking in these three suburban locations tends towards routes where a greater opportunity to reach a higher number of places and thus carry out more than one activity is available. This is in line with previous findings about walkability and availability of varied land uses (Frank et al., 2005).

In terms of route patterns, there was a clear difference between the shape and extent of movement between residents and non-residents, with residents covering a wider spread of routes and non-residents preferring to remain on routes which higher ‘choice’ values. This may be partly due to residents’ better knowledge of the areas, as well as the fact that visitors to an area might come for one specific reason/to reach one specific place, while residents undertake routes across some of the residential areas where they live and may combine more than one purpose in each trip, thus visiting and covering different areas within the same trip.

5. Discussion and Limitations

This study set out to consider what built environment factors influence the decision to undertake walking trips, their length and pattern. As mentioned at the start of this article, the received wisdom about smaller town centres is that their vitality is dependent on the presence of retail. Planning policy – at least in the UK – reinforces this approach, frequently reducing the role of the town centre to its viability as a retail hub - especially in smaller centres. Smaller centres - such as those studied here - then inevitably begin to fall beneath the policy radar, since they are viewed as lacking potential as settings for walkability and sociability and are seen as part of a pattern of retail decline, frequently dismissed as local shopping areas that are likely to wither over time (Griffiths et al, 2008). In a suburban setting such assumptions become yet more problematic, given the expectation that the principal mode of transport within suburbs is the private car, with trips on foot to be minimal.

The findings here showed such assumptions to be broadly incorrect: a large proportion of people walking were doing so in order to carry out a diverse range of activities and a similarly large proportion were combining shopping with other activities, while the majority was undertaking trips for reasons other than shopping. The trip length was much greater than would be anticipated if people were using their cars to reach the town centre. This alone points to the potential for smaller town centres to support and encourage walking – and to research along the lines reported here to an increased understanding of town centre vitality and viability (Ravenscroft 2000).
Whilst the results were broadly comparable across the three cases, the results also showed that Barnet and Surbiton had the longest walks and a greater number of people undertaking more than one activity; Barnet also had the largest number of circuitous walks. Research in the US (Conroy Dalton 2007) has demonstrated that a higher proportion of shorter circuits is indicative of less sprawl, or in other words, greater urbanity. Although this study's capacity did not allow for a testing of Conroy Dalton's findings, it seems likely that Barnet's longer history has allowed it to evolve a greater amount of network centrality (its settlement dates back to the 16th century, in contrast with the other two sites, which were only fully settled from the mid to late nineteenth century onwards), which, as suggested by Hillier, allows for increased diversity of activity in the area (Hillier 1999) and so has contributed to its sustained vitality.

It should be noted that the scope of the project was confined to a daytime weekday picture, although it is evident from local knowledge that night-time economy in these locales is quite limited, so surveys at these times would not be particularly informative. The weather was fair in all three study areas, with a brief period of rain at the beginning of the data collection in Surbiton, which may have had a small impact on the number of people undertaking walking trips, using green space and stopping to respond to researchers.

6. Conclusions

The research reviewed at the start indicated that increased street connectivity corresponds strongly with higher levels of walking. Previous research has also suggested that land use mix is broadly associated with increased walking in an area, but does not measure the variety of activities at the street scale, as was done here. The analysis here found that higher route availability (as measured by ‘choice’) corresponds to an increase in the number of people walking along a given street segment; it also found a relationship between ‘choice’ and the variety of activities undertaken along a route. These relationships were stronger at 800 metres radius, the scale that corresponds to the median length of routes reported. Most activities are carried out within the core of the town centre, where there is a wider mix of land uses. At 2000 metres radius the relationship still existed, highlighting the usage of non-residential land uses in the outskirts of the neighbourhood as well as the maximum length of routes recorded. Whilst any policy recommendation might point to focusing on the network distance of 800 metres, it is important to highlight the 2000 metres ‘background’ activity that corresponds to the wider residential hinterland of the town centre; rather than having a zoned town centre with a blank canvas of houses beyond it, a graduation from busy to quiet activities seems to best serve the need for overlapping routes and activities within and beyond the town centre.

This suggests that all three centres seemed to have peak vitality at a scale that matches a walk of around twenty minutes. Whilst the self-reported routes may have been subject to misreading of the maps by respondents, they were guided in doing so by the researchers. Furthermore, planned routes for the continuation of the journey may have diverged from the route plotted on the map during the interview. However, the survey still provides a reliable picture of planned routes even though changes to the planned routes might have occurred following the interview. Nevertheless, given that the routes were drawn in the field and then redrawn on a computer it is important to not apportion too much weight to marginal differences in route length.

The analysis found that whilst few respondents to the questionnaire mentioned walking in order to go to green spaces, many of their routes involved walking alongside the green spaces in Barnet and Surbiton, where parks are within full view of the main roads and aligned with non-domestic or
residential doorways. This was not the case in Norwood, where very few routes made use of the principal green space available - the recreation ground - which is segregated from the roads and characterised by the presence of high vegetation, fences and blank walls surrounding it. This finding potentially contributes to the findings of Koohsari et al. (2013), regarding accessibility to green spaces as it indicates that availability of green space in the town centre is not necessarily the lone factor influencing the likelihood of walking to or through green space, and that other characteristics, such as visibility and perceived safety, play an important role in their use.

Our results highlight a number of factors which aid the understanding of walkability:

- **Route availability**, not just connectivity, accessibility and land use mix, influences route choices and length.
- **The scale** at which walking trips are undertaken concentrates within town centres (at a 800m radius) but also extends to the wider neighbourhood (at 2000m radius) – an important finding for planning and policy making focusing on walkability, which suggests that a wider radius, not just the town centre, should be considered.
- **The use** of green spaces tends to be a by-product in walking trips undertaken for purposes other than visiting a green space and only occurs when green spaces are highly accessible, on the routes of choice for people undertaking various activities, and surrounded by ‘live’ frontages which encourage movement and activity in the surrounding area.

Finally, whilst the focus of this study has not been on health outcomes, it is evident from the literature reviewed here that an increased attention to the impact of urban design decisions on the extent of people walking in residential settings is likely to contribute to the beneficial health effects from walking, whether within town centres or alongside or within a green space. The potential for smaller centres to contribute to sociability and local vitality has been highlighted by this study and indeed a recent RIBA report (RIBA Building Futures 2013) forecasts that cases such as these have potential to adapt to new societal needs due to their natural evolution as central, walkable places, an importance which will only increase in a low-carbon future" (p. 20).

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