Shared space streets: design, user perception and performance

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Abstract

Shared space is becoming an increasingly well-accepted approach to street design, pursuing the improvement of the uses of the street on foot without restricting other modes of movement. This approach introduces some degree of uncertainty about the application of the traffic rules by minimising traffic signs and conventional physical demarcations in order to enable the different users to share the road space and negotiate their movement through and across. Despite existing evidence on reducing traffic accidents and casualties, this type of street design has remained an unorthodox approach. This article addresses the key issues of road safety, user comfort and revitalization aspects of the shared space, raised in the last decade with a focus on the pedestrian users. Based on the analysis of the layout, performance and user perception of six study areas, evidence reveals how these schemes affect safety, comfort, conventional spatial distribution/hierarchy of users, and the public life.

Keywords

Shared space; street design; road safety; pedestrian comfort; street vitality; public space

Introduction

Shared space is a widespread, yet controversial approach to street and public space design, which has attracted a great deal of attention during the last decade among urban designers and those interested in improving the built environment through rebalancing the conventional transportation modal share and enhancing the pedestrian mobility. Controversies include the appropriateness of the term itself, the origin of its denomination, its definition and more importantly concerns regarding the performance and impact on users generated by this design approach.

The term shared space has been used widely in literature since 2000, as well as in media and among city officials—mainly in the European context, but not only. The current proliferation of the term originated with the 2005-08 Interreg III Project named *Shared Space* (2005, 2008a, 2008b). The project was stimulated by the ideas of Hans Monderman and his early experiences in the Netherlands, and the early diffusion of this concept in the UK corresponds to one of the project's partner and main advocates, Ben Hamilton-Baillie (2004, 2008a, 2008b, 2014).

Similarly to the term shared space, different terminologies, such as *woonerf*, encounter zone, home zone, shared street and shared zone have been used for different street layouts that do not segregate pedestrians and vehicles. These definitions have similarities and differences regarding their objectives and design features, as it has been broadly discussed by Karndacharuk et al. (2014a). According to Hass-Klau (1990), the very same term shared space was already used in the UK during 1960-70s, referring to a traffic calming street layout applied to cul-de-sac residential streets. However, the term remained unused as a street design concept for decades and it is only recently that it has been re-coined with a related but different meaning.

Probably because the term was purposely not clearly defined by those responsible for its rebirth and dissemination, currently there are a number of different definitions available: “the meaning […] is evolving as experience is gained and knowledge expands” (*Shared Space*, 2008, p.3). Despite more recent official definitions, such as the one by the Department for Transport (2011) which would be applied only in the UK, the term in this paper is intended to refer to a set of built environment design principles that prefer to “combine rather than separate the various functions of public spaces” and seek to “improve the quality of public spaces and the living environment

for people, without needing to restrict or banish motorized traffic", as originally proposed in the EU project *Shared Space* (2005, p. 5).

On top of the above-mentioned issues, there are others that are related to the functioning and impact of the shared space approach, among which are issues of traffic safety of the shared space schemes, how comfortable users feel sharing the space, and their claimed impact on public life. These concerns are the main purpose of this investigation since they remain unclear after being partially addressed in previous studies as it is further explained in the next section.

Research objectives

Since the early experiences in The Netherlands, shared space schemes are reported to have effectively reduced traffic incidents and accidents (Commission for Architecture and the Built Environment, 2007; Euser, 2006; Hamilton-Baillie, 2008a; Karndacharuk et al., 2014b). Despite the lack of sufficient published research on the matter, the greatest criticisms do not question the objective safety of the schemes, i.e. reduction in casualties, but focus mainly on the subjective or perceived safety and comfort experienced by the users. Among others, Methorst et al. (2007) argued that the decrease in accident/casualty numbers could have been created by an overall reduction of the pedestrians, caused by their discomfort in the implemented schemes.

This is issue of perceived unsafety and discomfort is emphasised for the case of blind or visually-impaired users, according to the Guide Dogs for the Blind Association (GDBA, 2006). The qualitative report prepared for the Department of Transport by MVA Consultancy (2011) showed that four out of twenty blind or visually-impaired users would not use a shared space street again, based on an experience that took place across seven different sites in the UK. Quite recently, Havik et al. (2015) confirmed that the blind users and those having a visual impairment evaluated shared space schemes more negatively, based on the experience of twenty five people in two shared space locations and two conventionally designed settings in the Netherlands.

Imrie (2012, p. 2274) argued that, for many visually-impaired people, shared space is a disabling design "enlarging socio-spatial divisions and inequalities in the urban environment". These concerns were questioned by Parkin and Smithies (2012, p.135) who ultimately suggested that "shared space needs to preserve a safe area for pedestrians" and "provide a rich physical environment of contrasts in terms of surface tactility, colour contrast, and the enhancement of sound and other sensory clues", stressing Methorst et al.'s (2007) claim for safe areas within shared space streets. As a result, tactile and demarcated areas that are not accessible to vehicles, i.e., *safe zones*, and other contributing solutions have emerged in the most recent shared space schemes.

However, the safety and comfort issues that specifically deal with the particular groups of more vulnerable users are not the focus of this research. This investigation intends to focus on the most vulnerable users of shared space streets, from a broader perspective: the average pedestrian. Among the possible conflicts between users, the focus here is placed on the pedestrian-driver interaction, given that the share of cyclists found in the analysed study areas is negligible. Therefore, the main purpose of this research is to investigate how safe and comfortable the pedestrians feel in shared space streets. As it has been advanced and will be further discussed along this paper, recent research by Hammond and Musselwhite (2013), Kaparias et al. (2012) and Moody and Melia (2014) have investigated these issues, but their results remain inconclusive and/or contradictory, demanding for the type of research presented in this article.

In addition, this study tackles another important question that has also remained inconclusive up to date: does the shared space enhance public life? This revitalization potential is claimed by the advocates who claim it can foster for "the multiple uses of streets and spaces for every kind of

social activity" (Hamilton-Baillie, 2008a, p.137) and the governmental publications that refer to it as a "way of enhancing a street's sense of place [the quality which makes a street somewhere to visit and spend time in]" (Department for Transport, 2011, p.6). Recent research by Biddulph (2012), Curl et al. (2015), Karndacharuk et al. (2013), Hammond and Musselwhite (2013) and Moody and Melia (2014) are, again, often inconclusive and/or contradictory, making it pertinent for the new research to further investigate the social issues. This study carefully takes into consideration the work by the above mentioned researchers and build upon their work to develop an applicable set of research methods.

Methodology

This research analyses and compares six different study areas combining a set of different methods, including quantitative and qualitative descriptions of the street design and the adjacent ground frontages and uses, as well as formal and informal observations of human activity to assess the performance. Furthermore, an on-street user survey has been used to investigate pedestrians' attitudes towards the shared space street schemes. Differently to the majority of previous studies, drivers have not been considered in this study, in order to focus more on the pedestrians as more vulnerable users.

Comparing streets

Similarly to the classic street liveability study by Appleyard et al. (1981), the applied methodology compares various sections of the Exhibition Road, which offer different treatments of the street layout. Four different sections of the recently refurbished street account for similar but still different examples of shared space layouts. Two sections of two different streets nearby, Queen's Gate and Cromwell Road, are added as examples of more conventional streets with kerbed footways showing some similarities and differences in terms of adjacent land uses, width of the road, width of the footways, vehicular traffic flows, available sitting spaces and amount of trees.

These last two are used as a control group, as suggested by Hammond and Musselwhite (2013 p.95). Havik et al. (2015) applied a similar approach, comparing two shared space streets and two conventional streets. Given the peculiarities and variability present along Exhibition Road, not one but two control streets are included in the present research. The specifics are further described in the section describing the study areas.

Observations

A set of on-street systematic observations were performed, including counting, mapping and tracing mainly the pedestrian activity. A previous pilot study by the authors and the available reports by the Royal Boroughs of Kensington and Chelsea (RBKC) on Exhibition Road (MVA Consultancy, 2012, 2013a, 2013b; SYSTRA, 2014), confirmed that lunch hours were the most active daily periods regarding pedestrian activity. Accordingly, a series of systematic observations were carried out from 12:00 to 14:00, both on autumn weekends and weekdays, on November 23rd and 27th, 2013, with no rain and usual London weather conditions for that time of the year (partially cloudy and temperatures around 10 ºC during lunch time). The observations covered in this study are as follows:

a) vehicular and pedestrian hourly volumes were counted for the different street sections based on two 10-minute counts, noting the number of pedestrians walking along the road;

b) the pedestrians crossing the street at each section were counted and mapped for two 10-minute intervals to evaluate the freedom of movement and the assumed priority exhibited by pedestrians when crossing the carriageway; and

c) the location of people standing or sitting, the only stationary activities observed in the area, was also recorded twice from 12:00 to 14:00 at the six street sections to provide objective and comparable data regarding on-street social activity. For sitting, the observations distinguished between people using primary seating (public chairs and benches), secondary seating (bollards, stairs, low walls and other public elements) and tertiary seating (provided by cafés, restaurants etc.), as suggested by Ruiz-Apilánez et al. (2014).

Survey questionnaire

The questionnaire was designed to evaluate people's perception and attitudes towards the different street layouts, taking into account previous research on shared space with similar objectives, namely Kaparias et al. (2012), which used web-based questionnaires about virtual, verbally described street scenarios; Hammond and Musselwhite (2013), which performed 100 on-street questionnaires for Widemarsh St (Hereford, UK); and Moody and Melia (2014) on Elwick Square (Ashford, UK), which included 144 semi-structured interviews.

The survey employed in this research accounts for 305 people that fully answered the following questions:

1) Do you live or work in the area? (a) yes; (b) no.
2) In a scale from 0 to 5, how safe do you feel using this street in relation to traffic? [A subjective slider from 0 (not safe at all) to 5 (very safe) was available for the respondents].
3) In a scale from 0 to 5, how comfortable do you feel using this street in relation to traffic? [A subjective slider from 0 (not comfortable at all) to 5 (very comfortable) was available for the respondents]
4) In a scale from 0 to 5, to what extent do you agree this is a place where you'd stop and socialise? [A subjective slider from 0 (completely disagree) to 5 (completely agree) was available for the respondents]
5) When using the street, beyond which point would you say cars have priority over pedestrians? (a) kerb; (b) drainage gully; (c) trees; (d) benches; (e) parking lane; (f) lamp posts; (g) carriageway; (h) none (cars don't have priority over pedestrians).
6) If crossing this part of the street at any point, would you say: (a) pedestrians have priority over cars; (b) cars have priority over pedestrians; (c) they have equal priority; (d) I don't know.
7) Did you know Exhibition Road before its refurbishment? (a) yes; (b) no;
7.1) (if yes) would you prefer Exhibition Road in its previous conventional layout? (a) yes; (b) no.

Interviewers collected the answers in a tablet, which was offered to the respondents to interact freely through questions 2 to 5.

Data analysis and description of the sample

Data from on-street interviews were analysed using the Statistical Package for Social Sciences (SPSS) for further interpretation. Besides descriptive analysis, inferential statistical analysis was carried out using non-parametric methods: Mann-Whitney or Kruskal-Wallis tests were used depending on whether samples originated from the same distribution for two groups or more than two groups; Kendall's tau-c test was employed for identifying correlation between ordinal data. These provided more confidence in results given the non-normality of the answer distribution to question 2, 3 and 4. A significance level of 0.05 was considered in all tests. The median was considered the most representative measure of central tendency and box-plots graphs were used to represent the sample. The results and specific tests employed to investigate the outcomes on different topics are discussed along the general discussion of this article.

Considering the survey sample, 309 surveys were started and 305 were completed. Only the answers of the latter were considered in the analysis. Respondents were randomly picked but uniformly distributed among the six case examples. The percentages of completed interviews were equally distributed across the study areas, ranging from 16.2 to 16.8%. The majority of respondents (61%) knew and had experienced the previous layout of Exhibition Road and 39% of the interviewed people lived or worked in the area, thus considered regular users, while the remaining 61% did not. Regarding demographics, the gender distribution was 43% female and 57% male; 6% were under 20 years of age, 59% were between 20 and 39, 24% were between 40 and 65, and 11% were over 65.

Selection of case study

In the last decade, a good number of streets have been redesigned adopting shared space schemes in over twenty cities across the UK, including Ashford, Bath, Bolton, Brighton, Edinburgh, Leeds, London, Manchester, Newbury, Oxford, Plymouth, Poynton, Preston, Sheffield, Southampton, and others. Some of them have been chosen as case studies in different investigations on shared space and similar street schemes that allow pedestrians and vehicles to share the same surface, namely Biddulph (2010, 2012b), Curl et al. (2012, 2015), Hammond and Musselwhite (2013), Havik et al. (2015), Kaparias et al. (2013, 2015), Moody and Melia (2014), and MVA Consultancy (2011, 2010).

Exhibition Road, however, is the most disseminated, popular and recognized case among all. This has been a very important reason for selecting this case study, since it makes this study more accessible and understandable to the urban design community, given that a large number of readers might have a first-hand experience of the street. Besides, the project enjoys a good reputation in the profession, having received an RIBA Award and the European Prize for Urban Public Space Special Mention in 2012, and the Civic Trust Award in 2013 (Ruiz-Apilánez and Arnaiz, 2013).

The existence of previous studies on Exhibition Road (Kaparias et al., 2013, 2015; MVA Consultancy, 2012, 2013a, 2013b; SYSTRA, 2014) are also important for its selection, since it allows a broader understanding of the case in which different studies complement each other. Furthermore, Exhibition Road receives an intensive and heterogeneous pedestrian use, including visitors and locals, making it appropriate to investigate if frequency of use and familiarity to shared space schemes has an influence on street users. Lastly, Exhibition Road makes an interesting case study due to the number of similarities and differences that can be found along the full length of the street, including the layout, the adjacent land uses and the traffic flows. All these specifications are detailed in the following section.

Description of the case study and study areas

Exhibition Road is located at the heart of a well-known cultural centre in South Kensington, London, and gives access to some of the city's most popular museums, namely Victoria & Albert, Science, and Natural History museums, as well as prestigious academic institutions such as Imperial College and the Royal Geographical Society. The street is about 800 metres in length with its northern end reaching the edge of Hyde Park and the southern end close to South Kensington underground station.

The previous conventional dual-carriageway layout was extremely congested and showed high pedestrian and vehicular traffic and a streetscape dominated by motor vehicles. The 24-metre-wide cross section used to have two 4-metre-wide footways and a 16-metre-wide dual carriageway, accommodating three lanes for street parking: one on each side and a central one, separating an oversized traffic lane on each side (Figure 1). RBKC promoted the redesigning of

the street layout in order to improve the former situation, which was considered "confusing for visitors and unfriendly to pedestrians" (RBKC, 2012), and to recognize other needs of the place beyond the ones related with vehicular traffic.

[Figure 1 here]

The project was implemented from 2008 to 2011, including a kerb-free single surface with no barriers and minimum street clutter, new street lighting, new benches and trees, a 20 mph speed limit, two 4-metre wide pedestrian *safe zones*, one on each side of the street, delimited by visual and tactile lines which incorporate the gullies, and a wide and direct pedestrian crossing at the intersection with the heavy traffic-loaded Cromwell Road. As a result, the street now has a fairly consistent layout, although showing some differences in different sections regarding the adjacent building frontages and land uses, as well as the street design itself, especially in relation to elements of shared space, which are broadly described in the next section.

Using a set of similarities and differences, four different study areas were identified within Exhibition Road, added by two other study areas with more conventional layouts from nearby Queen's Gate and Cromwell Road, considered as the control group. The former control street is parallel to Exhibition road with well-developed trees and a similar road width and traffic flow, similar land uses along its length, and a more pedestrian friendly layout than what Exhibition Road offered before change. Similar to Exhibition Road, Queen's Gate gives access to Imperial College, but there are no museum entrances, which generates a key difference in terms of pedestrian activity. That is why the other study area in Cromwell Road was identified precisely at the main entrance of V&A Museum. Despite the higher traffic flow, this study area shows a generous footway with plenty of sitting facilities and some fully grown trees, making it potentially attractive to support stationary human activities. The six study areas are located in figure 2 and further described below.

[Figure 2 here]

The four study areas in Exhibition Road (SA1-4) show a 24-metre-wide kerb-free surface homogenously paved, including a 4-metre-wide pedestrian *safe zone* on both sides of the street. Each study area also shows some specific characteristics, not only regarding the adjacent land uses and building frontages, but the relation to the specific design of the street and the presence/absence of elements of shared space. In fact, they obtain different scores, when using the shared space rating (SSR) system used in the operational assessment report for the Department of Transport. This shared space classification questionnaire allows to rate the street according to the characteristics envisaged to encourage sharing. The methods gives different points based on the absence of kerbs or other physical demarcations between the pedestrian and vehicular areas, the homogeneity in surface colour treatment, the presence of other "public space characteristics"—i.e., cafés/markets, benches, greenery or art—the non-demarcation of crossing points, and the absence of road markings, traffic lights, bollards, guard rails and street lamps (see MVA Consultancy, 2010, p. 2.4 for further reference).

The remaining two areas (SA5-6), however, show conventional layouts and therefore a significant physical difference with the previous four and have certain similarities in terms of land uses, building frontages, vegetation and absence of benches.

The average hourly vehicular traffic from 12:00 to 14:00 became available for the six study areas based on the referred systematic counting, whereas the 85th percentile speed provided only for the Exhibition Road cases is extracted from the Phase 4 of the Exhibition Road Monitoring Report (SYSTRA, 2014).

Study area 1 (SA1): Exhibition Road–South

The first study area corresponds with the south end of Exhibition Road, near the underground station. There is an access-only one way traffic and parking is not permitted besides loading and unloading, so motor traffic volume is as low as 79 veh/h and the 85th percentile speed is 14.1 mph.

The south end connects with a perpendicular pedestrian street towards the metro station and the north pedestrian access has one traffic lights crossing on each side of the street. Although there are no benches, there is some secondary seating provided by the generous step around the metro air shafts. This sector is all surrounded by some small shops and lots of cafes and eateries on both sides of the street providing plenty of tables and chairs to sit outside. There are some new trees planted on the west side of the street and some medium size street lamps are aligned with the edges of the pedestrian *safe zone*s. The shared space score for this sector is 31, obtained from the SSR.

[Figure 3 here]

Study area 2 (SA2): Exhibition Road–Museum

The second study area corresponds with the area between the Exhibition Road entrances to the Victoria & Albert and Science Museums. A two way traffic area carrying medium vehicular volumes (573 veh/h) at speeds that remain below 20 mph (18.8 mph) occupies the central east side of the street between the corresponding pedestrian *safe zone* and the high lampposts that are aligned with the street's central line. The delimitation of the *safe zone* on the east side of the street is reinforced by aligned trees and bollards situated at its edge. The central part on the western side of the street is either occupied by perpendicular parking lots, bike racks and benches, or is left free. This sector of the street obtains a shared space score of 25, obtained from the SSR.

[Figure 4 here]

Study area 3 (SA3): Exhibition Road–University

The third study area corresponds with the area in front of the Imperial College on Exhibition Road. The motor traffic volume (639 veh/h) is slightly greater than in the preceding sector, SA2, but speed is above 20 mph (22.8 mph) despite the current 20 mph limit. The layout is almost identical to the one in SA2, but here there is no vertical delimitation between the two-way traffic area and the pedestrian *safe zone* on the east side of the street. There are no bollards and almost no trees planted at the limit of the *safe zone*. The buildings on the east side are mainly houses and offices. It gets a shared space score of 30, obtained from the SSR.

[Figure 5 here]

Study area 4 (SA4): Exhibition Road–North

The fourth study area corresponds with the northern part of Exhibition Road, and south of Hyde Park. It carries more traffic than the other sectors of the street (998 veh/h) and the speed (22.1 mph) is similar to SA3's. Quite differently from the previous sectors of the street, the cross section of the streeet is symmetrical. As it happens along the whole street, except for the southern part, high lamppost are located along its central axis, but here they separate the two traffic streams that occupy the whole central part of the street. In addition, parallel parking is permitted on both sides of the street, by the pedestrian *safe zone*s, which have trees planted along their edges. The buildings on both sides of the street are mainly residential, but there are some institutional buildings as well. The shared space score for this sector is 29, obtained from the SSR.

[Figure 6 here]

Study Area 5 (SA5): Queen's Gate–University

The fifth study area corresponds with the area in front of the Imperial College on Queen's Gate. Similarly to case study number 3, one side of the street has university facilities and the other has buildings that are mainly residential but include some offices and other professional services inside. The layout is almost identical to the layout at Exhibition Road before its implementation, but motor traffic, although still moderate, is significantly higher (1104 veh/h). The 30-metre-wide cross section is mainly symmetrical, with 4-metre-wide footways with trees and a 1-metre-wide central median where street lamps are located. Both carriageways include parallel parking on both sides—i.e., four parking lines in total—and an oversized traffic lane.

[Figure 7 here]

Study area 6 (SA6): Cromwell Road–Museum

The last study area corresponds with the area in front of the main entrance to the Victoria & Albert Museum at Thurloe Place, connecting Cromwell Road and Brompton Road, half a block away from Exhibition Road. The oversized carriageway includes two traffic lanes on each direction with stopping spaces for public transport and tourist buses on both sides and a central lane dedicated for left turnings and taxis. Vehicular traffic volumes are significantly higher than in any of the other cases (2256 veh/h) and so is the speed based on mere observations. The width of the footway in front of the museum along the study area is 15 metres. Besides three benches, the over-50-metre-long entrance steps provide plenty of secondary seating. Mature and significant-in-size plane trees are aligned by the carriageway all along the road but not in front of the steps.

[Figure 8 here]

Safety and comfort

Supporters of shared space, such as Hamilton-Baillie (2008a), advocate for the great performance of this schemes in relation to safety based on the reported decrease in the number of incidents, accidents and injured people (Commission for Architecture and the Built Environment, 2007; Euser, 2006; Karndacharuk et al., 2014b).

In relation to the redesigned Exhibition Road, the final RBKC report (SYSTRA et al., 2014) accounts for no accidents and one or two daily incidents of motorised vehicles stopping abruptly, based on five-hour observation periods at six sections of the street (four days in total, one for each of the four phases of the study in May and November, 2012 and 2013). There is no available data on the previous state, but it is claimed that the new layout is not unsafe, based on the reported little number of incidents and accidents

Shared space opponents have argued that the lack of incidents is due to people's avoidance to use the street or using it with greater caution which causes them stress and lack of comfort. In order to shed some light on this discussion, mentioned by Hammond and Musselwhite (2013), Kaparias et al. (2012), and Moody and Melia (2014), pedestrians were asked to rate their perceived degree of safety and comfort in relation to traffic while using the street, in the six study areas. With regards to safety, the scores given by pedestrians are shown in figure 9. The score were consistently high, and it is remarkable how the median is almost identical for all six study areas, with an actual value of almost 4. It is noticeable the similarities in the distribution in quartiles for all cases but for the conventional layout in SA5. In these five cases, the top 25% of the scores is higher than 4.7. Except for SA1, less than 25% of the users at each location rated the perceived safety below 2.5.

[Figure 9 here]

Regarding the comfort, the scores given by pedestrians show the values are consistently higher than for safety, and for all cases, medians are between 4.3 and 5 and it is noteworthy that they reach this maximum value at two locations, SA4 and SA6. At every location, less than 25% of the people ranked the perceived comfort below 3.4.

[Figure 10 here]

Further statistical analysis confirm the remarkable similarities found in the box-plots graphs for both the perceived safety and comfort since no significant differences were detected between the study areas (Kruskal-Wallis test showed $\chi^2 = 2.698$, $p > 0.05$; and $\chi^2 = 2.706$, $p > 0.05$, respectively). According to the user survey, and despite the significant differences in design, vehicular volumes and speeds, the different street layouts are perceived as safe and comfortable—very safe and comfortable indeed, at least when carrying the observed traffic flows.

Looking at the amount of people that walk through different sectors during the lunchtime period, SA1 and SA2 are picked as the busiest ones accommodating around 2000 pedestrians per hour (2290 and 1938 ped/h respectively), whereas a lower number of people walk through SA3 and SA6 sectors (1347 and 1038 ped/h, respectively), and even a lower number through SA5 and SA4 (660 and 423 ped/h, respectively).

Many different factors influence the pedestrian flows of a particular street, but looking at these numbers and understanding the location of the different attractors in the area, it is difficult to argue that the implementation of Exhibition Road is making people avoid the street as it has been suggested for other shared space areas, such as the one in Ashford, Kent (Moody and Melia, 2014).

The influence of familiarity to shared space

Regarding the attitudes, perceptions and concerns of pedestrians to shared space, Hammond and Musselwhite (2013) suggest that pedestrians' confidence in relation to motor traffic might be linked to their familiarity with the non-conventional layout. Kaparias et al. (2015, p. 125) refer to a so-called "settling down" period after users might become accustomed to the new design. Intuitively, it does sound reasonable to think that people might need a certain period to get used to the new layout, and once they are familiar with the new design, they become more confident using it. However, the good performance of shared space with regards to traffic safety is based on the uncertain degree of awareness of the users in dealing with the intentionally less clear rules in the new layout, which might be thought to decrease once they become more familiar with it. Consequently, it would be pertinent to investigate if regular and non-regular users (visitors) have a different perception of the safety and comfort provided by different layouts and, if so, to what extent.

The scores on safety and comfort given at each of the study areas, differentiating between visitors and regular users, are shown in figure 11. In terms of safety, SA2 and SA3 on Exhibition Road were rated slightly higher by regular users than by visitors, but differences were not statistically significant (Mann-Whitney test showed $z = -0.844$, $p > 0.05$; and $z = -0.104$, $p > 0.05$, respectively). Conversely, the higher scores given by non-regular users at the other four locations were statistically significant in SA1, SA4 and SA5 ($z = -3.621$, $p < 0.001$; $z = -3.161$, $p = 0.002$; and $z = -2.752$, $p = 0.006$, respectively), but not in SA6 ($z = -0.383$, $p > 0.05$). In terms of comfort, regular users consistently provided lower scores for all study areas, being of statistical significance only at SA1 ($z = -3.392$, $p = 0.01$) but not at any other study area ($p > 0.05$ in all cases and $z = -0.186$, $z = -1.41$, $z = -0.118$, $z = -1.021$, and $z = -0.632$ for SA2 to SA6).

[Figure 11 here]

Focusing on the four occasions that scores are significantly different, and taken into account the different layouts and performances of the three locations where it happens, this study does not support the notion that shared space users gradually and over time become more confident in using this type of street layouts. What the analysis of the surveys implies though is that regular users are more critical about the safety and comfort performance of the streets. It is therefore suggested that people examine more critically the streets they are familiar with, which is something that should be taken into consideration in future research.

Pedestrians' perceived realm and assumed priority

According to the original concept of the shared space, in such layouts, traffic rules are desired to become to some extent uncertain to users, so they have to negotiate their movements and encourage to use the whole width of the street. It is crucial in this respect to recognise how different layouts do in reality inform pedestrians and how they perceive street function in relation with the motor traffic.

Two of the questions included in the questionnaire were aimed at investigating how pedestrians understand the functional distribution of the street's cross section and the existing hierarchy between them and drivers. The answers given by the pedestrians are discussed and put in context along the corresponding two parts of this section.

The limits of the pedestrian domain

Firstly, users where asked to indicate beyond which point they felt cars had priority over pedestrians, choosing between "none: cars don't have priority over pedestrians" and a set of physical elements (lamp posts, kerb, drainage gully, benches, trees) and conventional function-related areas (parking area, carriageway). The distribution of answers at different locations are plotted in figure 12. Given the asymmetrical layout of the sections and to better understand the answers, please notice all interviews in Exhibition Road were made on its western side.

[Figure 12 here]

Examining the two conventional layouts, for SA6 it is shown that over 90% of pedestrians set the limit of the pedestrian domain at the kerb or the carriageway, which correspond to the same spatial limit in this specific conventional layout with no parking. For SA5, where parking is permitted by the footways, it is noticeable that 69% of respondents located the limits of the pedestrian domain at the kerb and 22% opted for the parking area.

In the shared space layouts the answers vary a lot between the study areas. In the case of SA4, which despite having a levelled cross section, also has linear parking between the designated *safe zones* and the traffic thoroughfare, it is mostly understood as a conventional layout. Similarly to SA5, 62% of the respondents in SA4 set the limits of their domain at the drainage gullies (similar to the 69% that opted for the kerb in SA5) and 20% at the parking area (very similar to 22% in SA5). The perceived limits change drastically in SA3, where only 18% refer to the gully, more people (31%) mention the parking area (perpendicular and far less continuous here) and 54% set the limit in the middle of the road (lamp posts and carriageway refer to the same limit here).

This shift in user perception is evident in SA2, where 70% of respondents refer to the middle of the street as the boundary of the pedestrian domain, and 18% state that cars do not have priority over pedestrians at any point. In SA1, the same 88% of pedestrians choose these two options, only 35% thought that vehicles did not have priority at all and 53% referred to the carriageway. This progressive extension of the perceived pedestrian limits is confirmed by the statistical analysis showing a significant direct correlation with the different locations (Kendall's tau-c test showed

$\tau_c = 0.631$, $p < 0.001$). It is inferred that a broader pedestrian domain is perceived in shared space streets than in those with conventional layouts.

It is only in SA1 and SA2 that a significant number of people, 35% and 18% respectively, stated that cars did not have priority over pedestrians at any point within the street section. Considering how shared space is conceived to work, it is evident that it is not necessarily understood in this way by the large majority of pedestrians. Similarly to others authors, Karndacharuk et al. (2014a) argue that over time, pedestrians might become more assertive and take greater control of the street space, but based on this study, there is no evidence to support such an argument. As shown in the previous section, time itself does not prove to work in the direction that one might hope things to change.

As it has been described in the methodology section, while counting pedestrians to determine the flows, those walking along the carriageway were counted separately. The different percentages observed along the different study areas verifies some of what has been discussed on the results of the survey. In the two conventional layouts, SA5 and SA6, all pedestrians walking along the street remained on the footways, and in SA4 pedestrians walked predominantly along the designated *safe zone*s. Similarly, in SA3 people used the whole section but the carriageway. However, in SA1 and SA2 a noticeable percentage of pedestrians (7% and 12%, respectively) walked along the carriageway—which in these sectors corresponds with the part between the centre of the road and the *safe zone* along the east side buildings.

Although both SA1 and SA2 did carry a large number of people, the highest flow observed (SA2) was no higher than seven people per minute per meter—considering only the width of the *safe zone*s, not the whole width of the street. This flow is much smaller than those observed to make people walk out of the footways and use the carriageway in conventional streets—around thirteen people per minute per meter, according to Jacobs (1993). It is therefore argued that, if people walk down the carriageway along this sections it is not because there is a lack of safe pedestrian space available. It is suggested that these people feel they have the right to use this part of the road at these two locations, yet they step out and occupy a different part of the street when a motor vehicle approaches.

Positioning in the street and assumed priority

In order to clarify further the above mentioned issue, pedestrians were also asked more precisely and directly about their perceived crossing priority. If they wanted to get to the opposite side of the street at any given point along each of the study areas, which one had the priority, pedestrians or drivers? People could choose to say that they did not know, state that none of them had priority over the other, or actually select between pedestrians and drivers.

Only 8 out of the total 305 respondents answered “I don’t know” (2.6%). Looking at each individual study area, the maximum number of pedestrians which reported to feel unclear about the priority were in SA2, but they were only 3 (5%). This low numbers of people who were not sure about the priority is in conflict with the behavioural assumption that users might get confused in a shared space environments. Quite the contrary, the research shows that people seem to be confident about a modal crossing hierarchy when they use the street. The answers obtained at each location are plotted in figure 13.

[Figure 13 here]

In order to understand how pedestrians’ assumptions relate with the applying traffic regulations, it is important to point out that in the two conventional streets, where it can be assumed that all users are aware that cars do have a legal priority, less than 75% agreed with this assumption. This suggests that about 20-30% of people might be answering to this questions based on their own

behaviour or personal values regarding transportation modal priorities, rather than considering actual traffic regulations.

Considering the people who believed cars had priority over pedestrians, three groups can be differentiated among the study areas. In the first group (SA4, SA5 and SA6), over 70% of pedestrians considered that cars had priority. In the second group (SA2 and SA3) approximately 50% of pedestrians agreed with the vehicular predominance, and in the third group (SA1) only 30% stated that cars had priority over the pedestrians. Again, there are large discrepancies across the four shared space sections studied.

To contrast what pedestrians reported with their actual behaviour, the observed crossing behaviour was also studied in the six areas. To establish a more significant assessment, the comparisons focus on equal-in-length stretches that include designated pedestrian crossings—except for SA3 which has no designated crossing in the whole stretch.

The registered 5-minute interval of maximum crossing activity at each location are presented in figure 14, indicating the number of those using the designated pedestrian crossings and those crossing at other points of the street. SA4 is not taken into consideration since its low pedestrian activity, especially in terms of crossing, made it irrelevant for the study.

[Figure 14 here]

The analysis of the traces and the number of crossings reveals two facts. First, the highest absolute and relative numbers of crossings outside the designated crossings are found in SA1 and SA2—being much higher than in SA5 and SA6. Second, the traces are much more homogenously distributed along SA1, SA2 and SA3 than they are in SA5 and SA6.

The observed crossing patterns suggest that pedestrians behave more freely and make a broader use of the street surface in shared space streets than in those with conventional layouts. In this regard, it is informative to compare SA3 and SA5 to find out how differently a similar number of people—entering and leaving the university campus—behave on the equivalent street stretches to the west and east of Imperial Collage, at Exhibition Road and Queen's Gate, respectively.

The great contrast observed among the different study areas and within those in Exhibition Road confirms that the actual street designs do make a difference in how the space is used and also shows how the different treatments of shared space do impact differently in the pedestrians' perception and behaviour.

Socialisation

Shared space is claimed to foster social activity (Department for Transport, 2011; Hamilton-Baillie, 2008a) although the available research has not been conclusive on this matter. On one hand, Biddulph (2012) found that shared streets in residential areas (UK home zones) were more successful than conventional traffic-calming solutions—albeit this would mainly benefit children and the ones looking after them—and Karndacharuk et al. (2013) found increases in pedestrian occupancy after shared space street implementation. On the other, Curl et al. (2015) did not find evidence of positive change in outdoor social activity. While Hammond and Musselwhite (2013) found that 57% of the users of a shared space scheme in Hereford, UK would stop and socialise; 65% reported "no" to the same question asked by Moody and Melia (2014) for another case in Ashford, UK.

Due to the significant disagreement between the findings of various studies and in order to allow comparison with them, the questionnaire designed for this investigation included the question

“On scale of 0 to 5, to what extent do you agree this is a place where you’d stop and socialise?” The scores people provided at each location are shown in figure 15.

[Figure 15 here]

In this case, the results vary again greatly across study areas in general and also across the shared space ones. SA1 is seen by the majority of pedestrians as a great place to socialise, with over 50% of the people giving the maximum score. In both SA2 and SA3, the median is slightly over 3 and the range of responses vary greatly, from 0 to 5. This variation is also true for the remaining three locations (SA4-SA6), only in these cases scores are lower and their medians remain between 1.1 and 1.9. Further statistical analysis confirms the described significant differences between these three different groups: SA1; SA2-SA3; and SA4-SA6 (Kruskal-Wallis test showed $\chi^2 = 60.796$, $p < 0.001$); while revealing no significant differences in the intensions to socialise between regular and non-regular users at every location (Mann-Whitney test showed $p > 0.05$ in all cases, and $z = -1.244$, $z = -1.796$, $z = -0.463$, $z = -0.325$, $z = -0.9$, and $z = -0.606$, for SA1 to SA6, respectively).

In this sense, the ground floor uses and frontages greatly affect the perception of pedestrians (Borst et al., 2008; Gehl, 2010; Jacobs, 1993). Therefore, the differences perceived between areas with similar ground floor uses—e.g., SA2 and SA6 (both sharing museum entrances), and SA3 and SA4 (both sharing university campus entrances) suggest that these significant discrepancies in the users' perception are related with the substantial changes in the street design and therefore that shared space schemes have the potential to modify the social appeal of the street.

The actual social activity at the different study areas was systematically mapped to contrast people’s perception. The observations of how people occupy the street while getting engaged in more optional and social stationary activities partially confirms what has been discussed about the survey and incorporates further information to the analysis. In order to facilitate the comparison between locations, the observed stationary human activities, including standing and sitting—using primary, secondary or tertiary seating—have been plotted in equal-in-length stretches of the six study areas, showing the busiest snapshot from 12:00 to 14:00 (Figure 16).

[Figure 16 here]

The snapshots emphasise the differences between the complete lack of activity in SA4 and SA5 and the bustle in SA1, with lots of people sitting outdoor although there is no primary seating available. This of course has to do with the existing ground floor uses of the buildings, such as cafes and restaurants, which provide plenty of tertiary seating. However, the use of the shared space available beyond the *safe zone*s (former footways) suggests a symbiotic relationship between the adjacent land uses and public space uses, with a strengthening intensifying effect.

Observations however are not helpful to confirm the differences observed by users between SA2 and SA3 (both sociability medians above 3.0), and SA6 (below 2.0). It is suggested that those two areas of Exhibition Road (SA2 and SA3) do have some undeveloped potential to engage people in stationary activities. It can be easily imagined that incrementing seating possibilities and introducing some other attractors—e.g., street food vendors (Whyte, 1980)—would probably mean a decisive transformation of those locations in terms of their social activity.

Users’ overall outlook

As it has been already highlighted, shared space is to some extent a rather controversial approach to street design, towards which people have expressed different opinions on its key aspects, sometimes varying greatly depending on the particularities of each design and location, as it has been shown in this study. In order to grasp a final overall opinion of the general public, and in the

absence of data on the prior-to-implementation state, Hammond and Musselwhite (2013) asked users to self-report a before and after comparison. 74% of those who had experienced the street before and after preferred the new shared space design. This clear positive attitude towards the new layout was taken with some reservation by the same researchers, arguing that only people actually using the street participated in the survey, so it might be possible that those not so in favour of the new layout could be avoiding the street and, thus, had not been taken into consideration.

It can also be argued that people could be more likely to be in favour of the implemented scheme, just because of it newness, in opposition to the poorer state that might have presented the previous old layout. Probably in order to cancel this new-old dichotomy, Moody and Melia (2014, p. 7) reformulated the question and asked people if they would "prefer traditional pavements and traffic light crossings" instead. In this case 64% of the people preferred the more conventional layout.

The present study takes into consideration all those who knew Exhibition Road before its implementation, either if they were using shared space schemes (SA1-SA4) or conventional layouts (SA5 and SA6). Pedestrians were asked if they preferred the previous layout of the street. A substantial majority of 72% preferred the new shared space layout. This percentage turned out to be remarkably consistent across all locations: 71% in the case of those using the shared space and 73% of those walking in the conventional streets.

Considering these results and some of the differences found in the users' perception and performance of the different locations, it would have been informative to ask if there was a particular section or layout that users particularly preferred over the others. This will be taken into consideration for future research.

Conclusion

This study aimed to further enhance our understanding of how safe and comfortable pedestrians might feel in a shared space environment, as well as our understanding of the potential of this street design approach in enhancing public life. The analysed study areas have shown how the average pedestrians find shared space layouts safe and comfortable in relation to traffic, at least as safe and comfortable as more conventional streets. However, and rather differently to what has been suggested by other authors before, this research indicates that the perception and attitude of pedestrians do not improve with time nor rely on the familiarity of these users with a specific shared space scheme.

This does not mean that people are non-responsive or unaffected by street design. This research reveals that, at least for the six study areas, the very opposite is true by, firstly, showing how the perceived limit of the pedestrian domain varies greatly depending on the street layouts, and secondly, by illustrating the movements along and across the streets and how the perceived crossing priority between pedestrians and drivers differ across the study areas.

The capacity of shared space schemes to enhance public life has been investigated by previous research, but the outcomes have not been conclusive. The study confirms that street design is a powerful tool to transform the built environment and influence people's perception and use of the street space in relation to public stationary and social activity. However, ground floor building frontages and uses also play a decisive role in this regard, being even more decisive some times.

Considering this research and that by other authors cited along this text, it is suggested that shared space can no longer be approached as a homogeneous element and it is necessary to understand that questions such as "do share space streets work?", "are shared space streets safe?", and the alike might no longer be valid questions in the same way that questions, such as "do pedestrian

streets work?" or "are highways safe?" would be considered too general or unspecific to be answered in any accurate way.

In the view of recent efforts to create simplistic evaluation tools to quantify the degree of shared space, as the one used in the report for the Department for Transport (MVA Consultancy, 2010), this research suggests that shared space should be rather considered as a street and public space design approach that is beyond the mere inclusion/exclusion of a number of features, e.g. traffic signals, levelled surface, kerbs, clutter and demarcations, benches, greenery or art, traffic signals. Conversely, more comprehensive methods including both qualitative and quantitative techniques are required,—some of which have been included in the same report.

Based on some of the similarities and differences found in Exhibition Road, it must be emphasized that users' perception and performance of shared space, cannot be advanced based on the accumulation of "elements of shared space" (Kaparias et al., 2013, p. 115). Rather, it is the street layout as a whole what happens to make a difference. A deep and detailed understanding of its design, its environment and its surroundings is necessary to assess any future implementation.

After over a decade of shared space practice, including a good number of successful examples and some research, it is suggested that more research should be required probably not to keep questioning the core concept itself, but to test and evaluate the different outcomes, in order to better understand the particularities of different cases in the eventual design considerations, user perception and performance.

In this regard, the lack of consistent and comparable before and after case studies, and the importance of enabling accurate comparison between future studies should be emphasised. The present investigation has made an effort to establish a dialogue with the other researchers by carefully considering their methods and findings to incorporate or discuss them as appropriate. The spirit has been to make it as useful as possible for the urban design community and it is encouraged that forthcoming research operate in a similar way.

Lastly, it must be stressed that the shared space approach to public space design do encourage a "focus shift from project to process" (Besley, 2010, p.6) and highlight the importance of including participatory design techniques. However, this research and most of the research that has been published to date, have focused on the evaluation of implemented projects and not in the implementation process. This should be taken in consideration not only by public administrators and designers, but also for future research.

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Figures

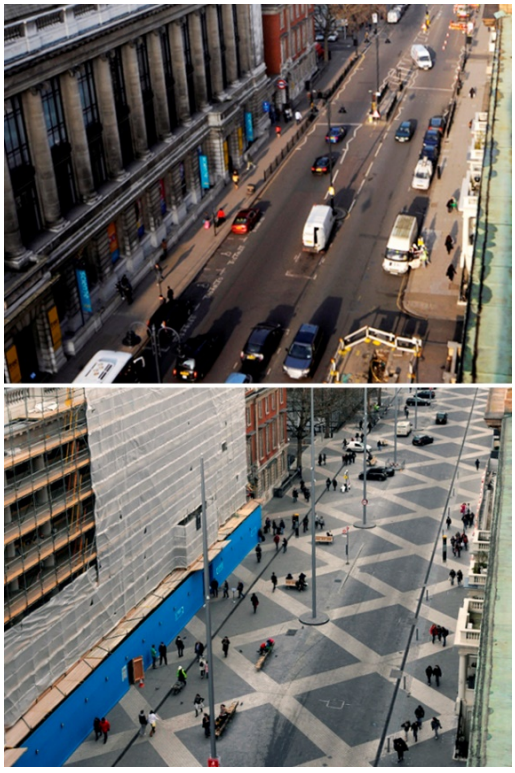

Figure 1. Exhibition Road by the V&A and Science museum: (above) before, and (below) after. Source: Royal Boroughs of Kensington and Chelsea

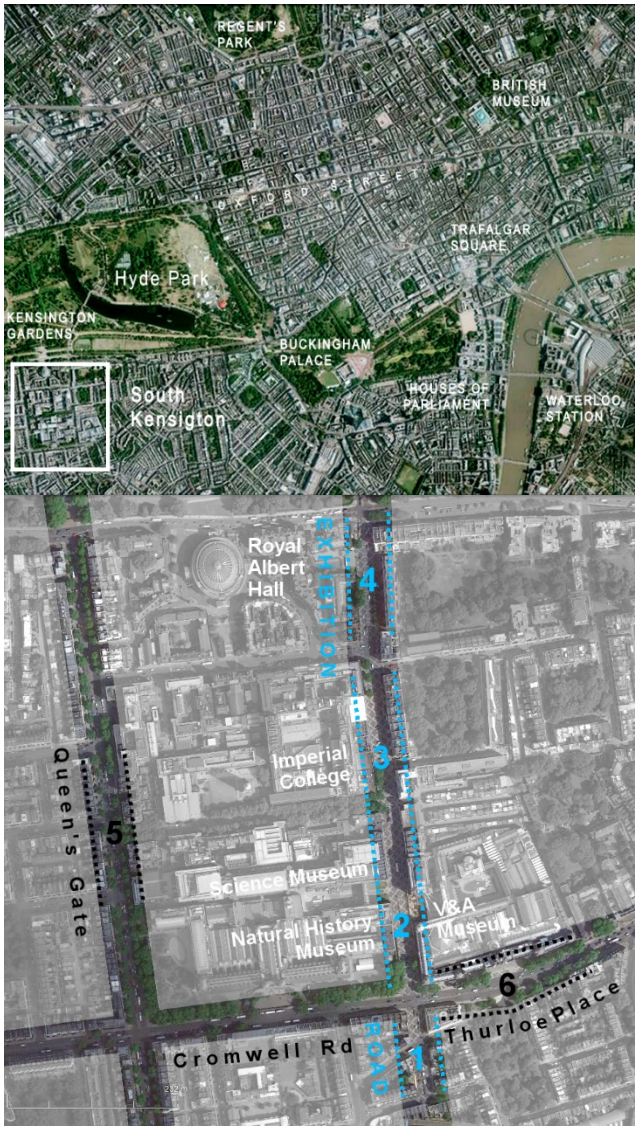

Figure 2. Location of the six study areas in London (above) and South Kensington (below). Shared space: (1) Exhibition Rd–South, (2) Exhibition Rd–Museum, (3) Exhibition Rd–University, (4) Exhibition Rd–North; Conventional layouts: (5) Queen's Gate–University; (6) Cromwell Rd–Museum. Source: aerial photos from © Google Earth.

Figure 3. Study area 1: Exhibition Road–South. The view from the southern part looking northwards. Source: © Google Earth.

Figure 4. Study area 2: Exhibition Road–Museum. The view from the intersection with Cromwell Road looking northwards. Source: © Google Earth.

Figure 5. Study area 3: Exhibition Road–University. The view near Imperial College Road looking northwards. Source: © Google Earth.

Figure 6. Study area 4: Exhibition Road–North. The view from the roundabout looking northwards. Source: © Google Earth.

Figure 7. Study area 5: Queen's Gate–University. The view near the intersection with Imperial College Road looking northwards. Source: © Google Earth.

Figure 8. Study area 6: Cromwell Road. The view from the eastern part looking westwards. Source: © Google Earth.

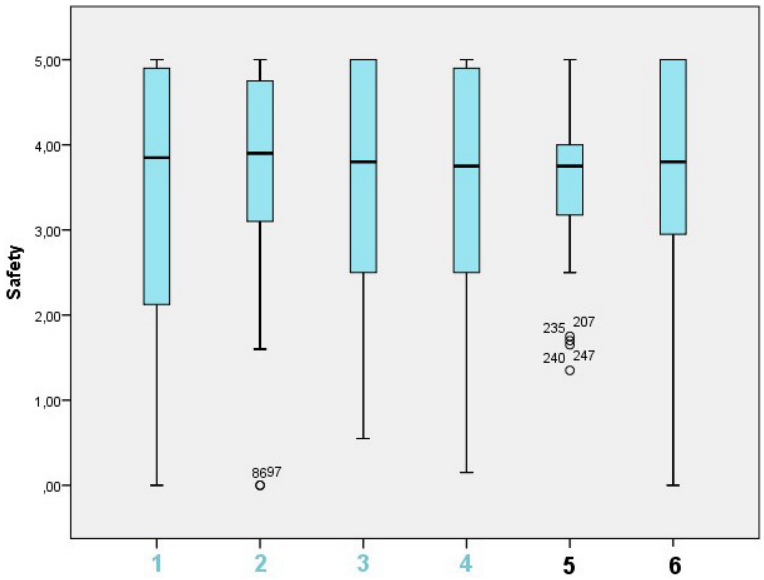

Figure 9. “In a scale from 0 to 5, how safe do you feel using this street in relation to traffic?” Boxplot of the scores from 0 (not safe at all) to 5 (very safe) given by pedestrians at each of the six study areas. Shared space: (1) Exhibition Rd–South, (2) Exhibition Rd–Museum, (3) Exhibition Rd–University, (4) Exhibition Rd–North; Conventional layouts: (5) Queen’s Gate–University, (6) Cromwell Rd–Museum.

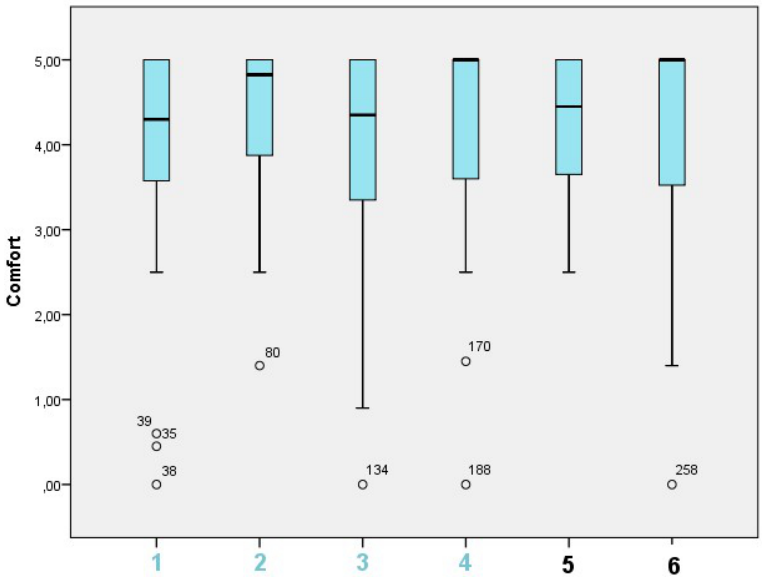

Figure 10. “In a scale from 0 to 5, how comfortable do you feel using this street in relation to traffic?” Boxplot of the scores from 0 (not comfortable at all) to 5 (very comfortable) given by pedestrians at each of the six study areas. Shared space: (1) Exhibition Rd–South, (2) Exhibition Rd–Museum, (3) Exhibition Rd-University, (4) Exhibition Rd–North; Conventional layouts: (5) Queen’s Gate–University, (6) Cromwell Rd–Museum.

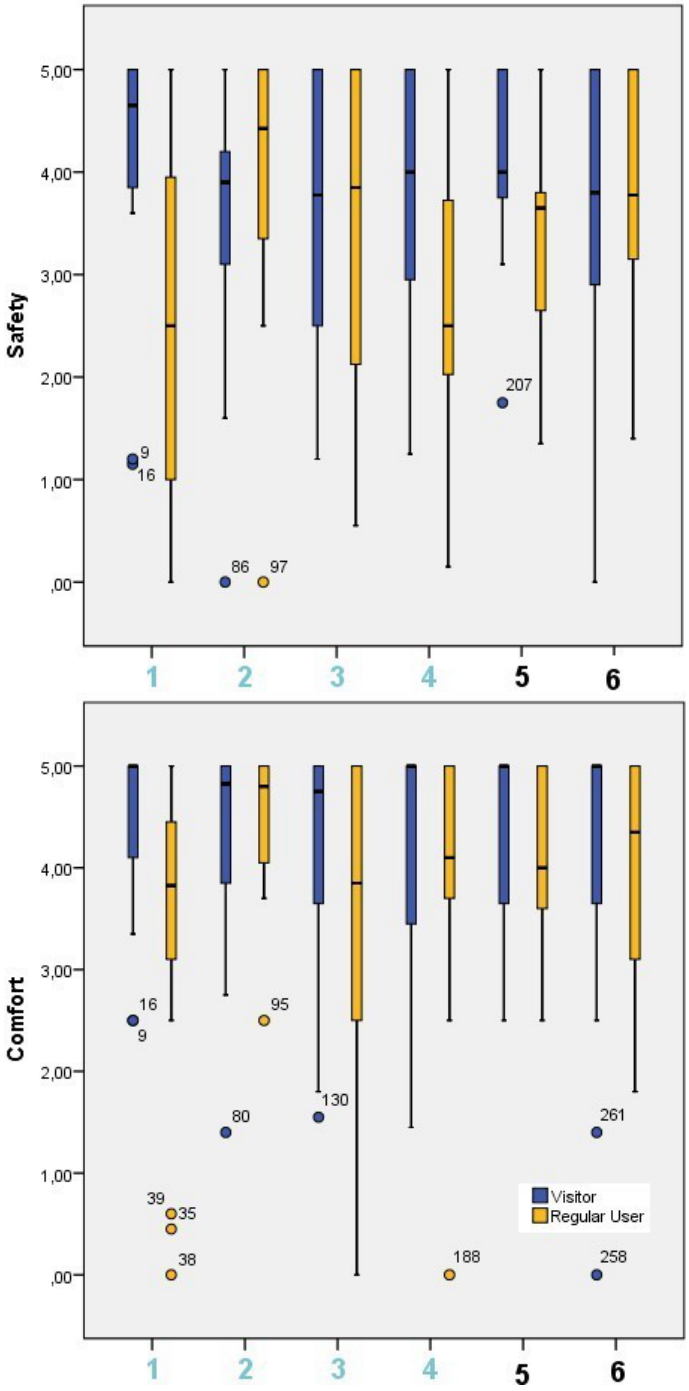

Figure 11. Boxplots of the scores on safety (above) and comfort (below) from 0 (not safe/comfortable at all) to 5 (very safe/comfortable) given by visitors (blue) and regular users (orange) at each of the six study areas. Shared space: (1) Exhibition Rd–South, (2) Exhibition Rd–Museum, (3) Exhibition Rd-University, (4) Exhibition Rd–North; Conventional layouts: (5) Queen's Gate–University, (6) Cromwell Rd–Museum.

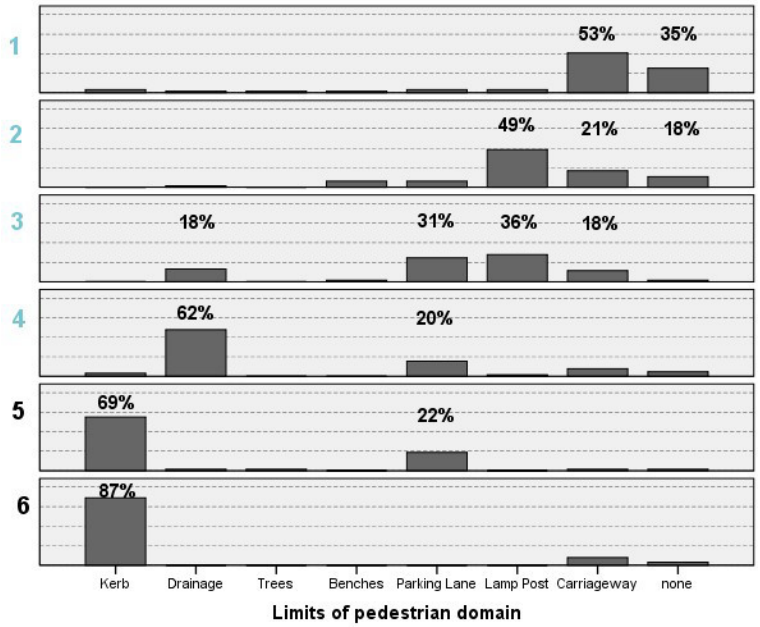

Figure 12. “When using the street, beyond which point would you say cars have priority over pedestrians?” Percentages of answers obtained at each of the six study areas. Shared space: (1) Exhibition Rd–South, (2) Exhibition Rd–Museum, (3) Exhibition Rd-University, (4) Exhibition Rd–North; Conventional: (5) Queen’s Gate–University; (6) Cromwell Rd–Museum.

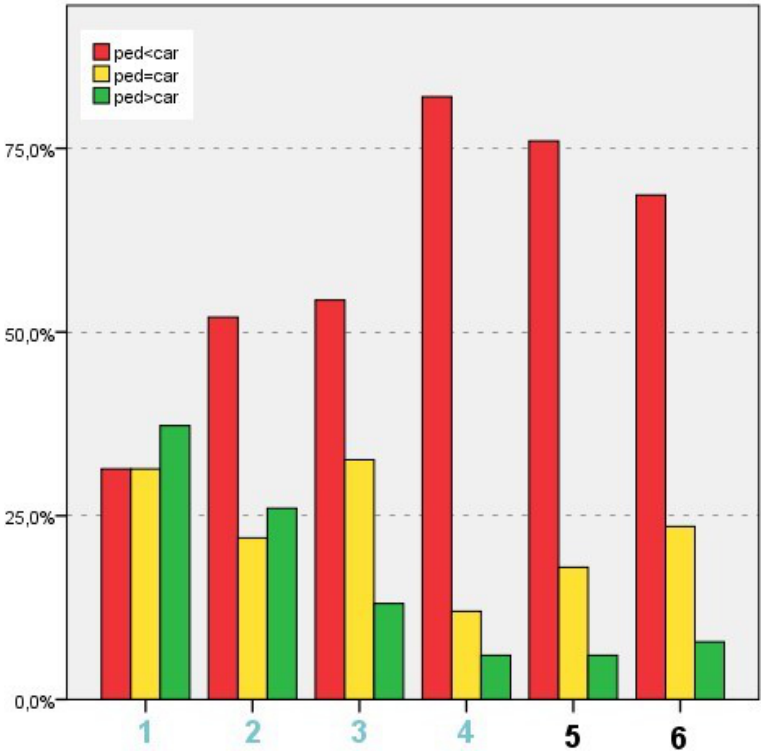

Figure 13. “If crossing this part of the street at any point, would you say: (a) pedestrians have priority over cars [green]; (b) cars have priority over pedestrians [red]; (c) they have equal priority [yellow]; (d) I don’t know [not plotted due to lack of responses]” Percentages of answers obtained at each of the six study areas. Shared space: (1) Exhibition Rd–

South, (2) Exhibition Rd–Museum, (3) Exhibition Rd-University, (4) Exhibition Rd–North; Conventional layouts: (5) Queen's Gate–University, (6) Cromwell Rd–Museum.

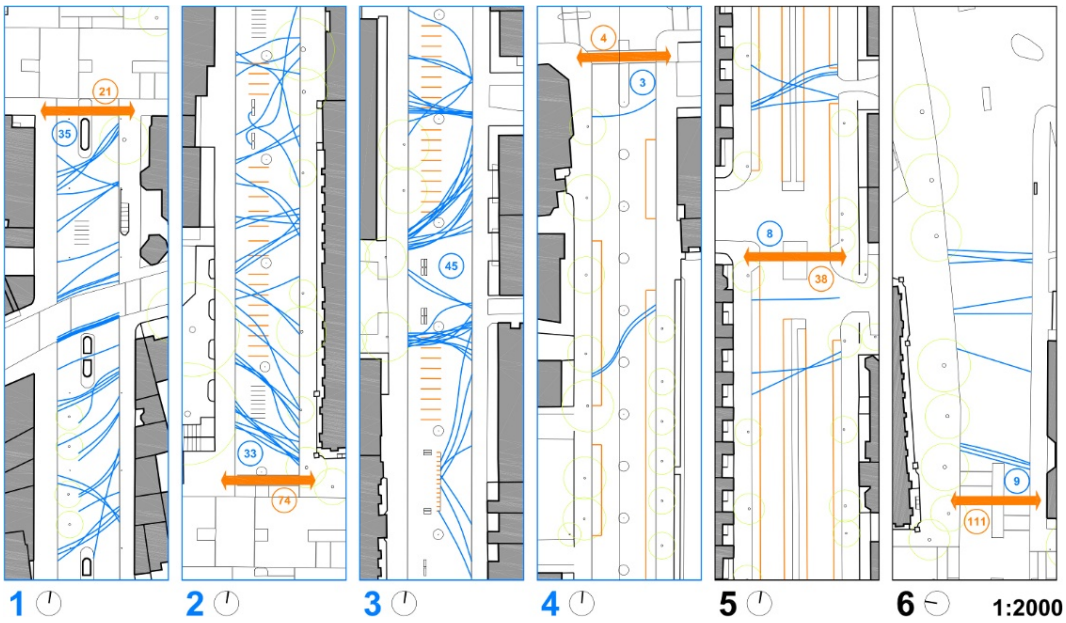

Figure 14. Pedestrians crossing the street during the busiest registered 5-minute interval. Shared space: (1) Exhibition Rd–South, (2) Exhibition Rd–Museum, (3) Exhibition Rd-University, (4) Exhibition Rd–North; Conventional layouts: (5) Queen's Gate–University, (6) Cromwell Rd–Museum.

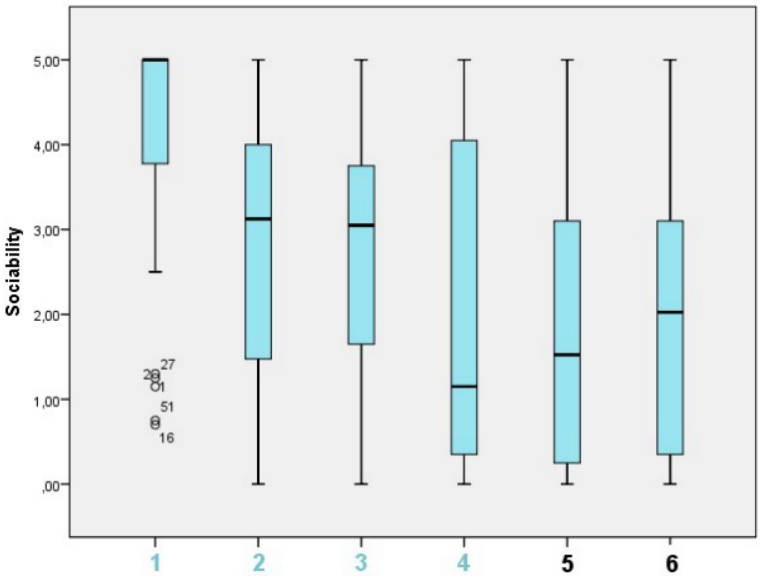

Figure 15. "In a scale from 0 to 5, to what extent do you agree this is a place where you'd stop and socialise?" Boxplot of the scores from 0 (completely disagree) to 5 (completely agree) given by pedestrians at each of the six study areas. Shared space: (1) Exhibition Rd–South, (2) Exhibition Rd–Museum, (3) Exhibition Rd–University, (4) Exhibition Rd–North; Conventional: (5) Queen's Gate–University; (6) Cromwell Rd–Museum.

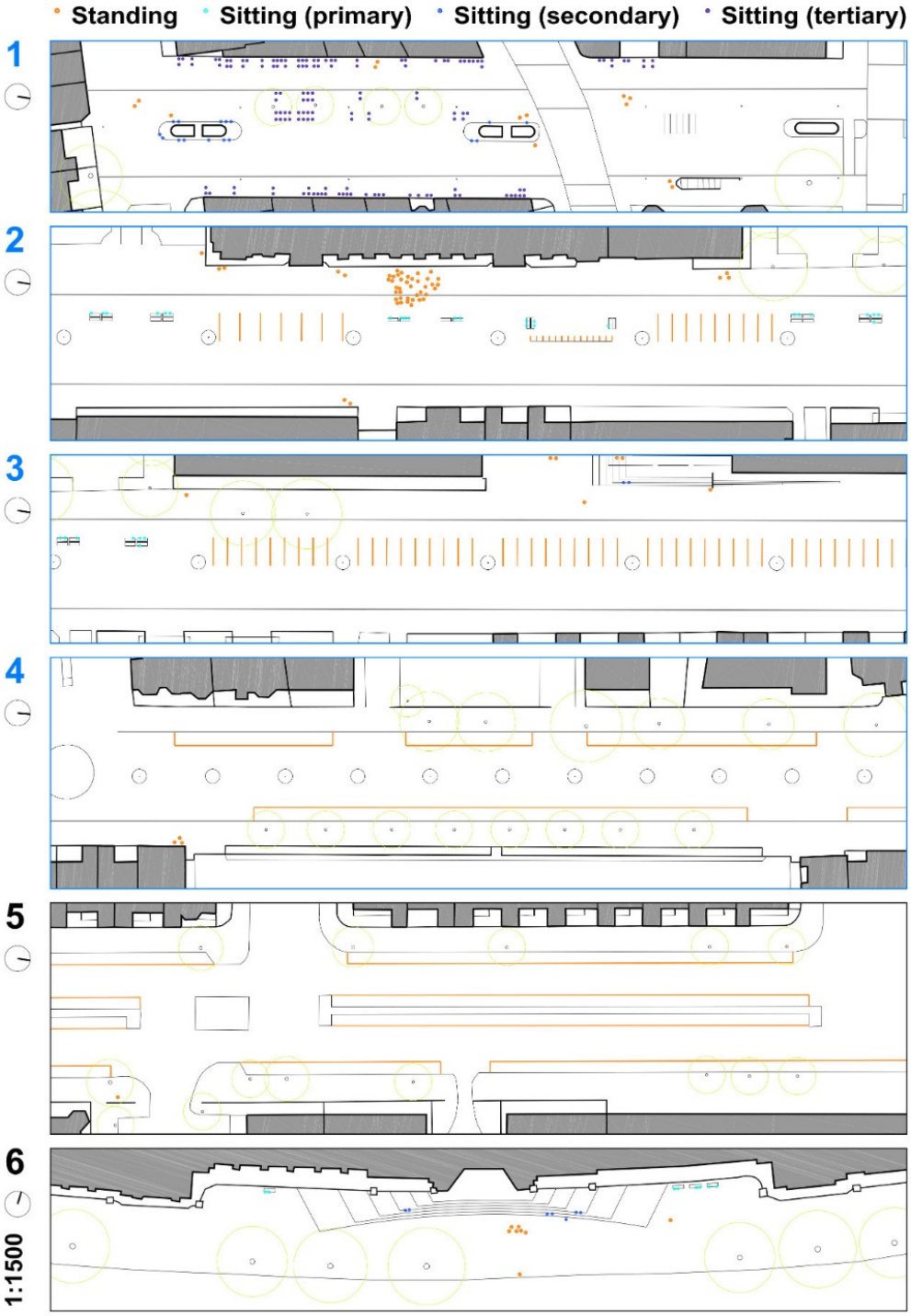

Figure 16. Maximum registered stationary activity: people standing (orange), sitting-primary (light blue), sitting-secondary (dark blue), and sitting-tertiary (deep purple). Shared space: (1) Exhibition Rd–South, (2) Exhibition Rd–Museum, (3) Exhibition Rd-University, (4) Exhibition Rd–North; Conventional: (5) Queen's Gate–University; (6) Cromwell Rd–Museum.