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ANALYSING THE PERCEPTIONS OF PEDESTRIANS AND DRIVERS TO SHARED SPACE

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Abstract

Shared space is an approach to improving streets and places where both pedestrians and vehicles are present, with layouts related more to the pedestrian scale and with features encouraging drivers to assume priority having been reduced or removed. It creates a more pedestrian-friendly environment than conventional street layouts, which are based on greater segregation between pedestrians and vehicles, while at the same time introducing uncertainty, which makes drivers engage more fully with their surroundings, leading to lower vehicle speeds and improved safety. This paper investigates the importance of certain person-, context- and design-specific factors affecting the perceptions of pedestrians and drivers to shared space. Using two web-based stated-preference surveys, two sets of responses are collected from pedestrians and drivers, who are presented with different combinations of binary factors forming scenarios. Regression analysis is carried out with logit models for each survey. The results suggest that pedestrians feel most comfortable in shared space under conditions which ensure their presence is clear to other road users – these conditions include low vehicular traffic, high pedestrian traffic, good lighting and pedestrian-only facilities. Conversely, the presence of many pedestrians and, in particular, children and elderly, makes drivers feel uneasy and, therefore, enhances their alertness.

Keywords: shared space, pedestrians, drivers, behaviour, perceptions; street design.

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1 Introduction

Shared space has been defined as "a street or place designed to improve pedestrian movement and comfort by reducing the dominance of motor vehicles and enabling all users to share the space rather than follow the clearly defined rules implied by more conventional designs" (Reid, Kocak, & Hunt, 2009; UK Department for Transport, 2011). In general, such schemes make clear to pedestrians where they might or might not encounter vehicles (the latter is sometimes called "safe zone"), and make clear to drivers who engage more with their surroundings, the possible presence of pedestrians.

Shared space schemes are part of a continuing trend over many years to a more integrated approach to streetscape design – a scale related more to pedestrian movement and lower vehicle speeds, with consequential safety and quality of life benefits – and help assert the function of streets as places for people to use and enjoy. This contrasts the traditional car-oriented approach to street design, which is based on greater segregation of pedestrians and vehicles (Buchanan et al., 1963) to ensure unobstructed traffic flows. The term "shared space" is used to cover a range of treatments, from the removal of guardrails and the introduction of "informal" (uncontrolled) pedestrian crossing facilities in a traditional "kerbed" street layout, through to layouts with a single surface and little or no delineation between pedestrian and vehicle areas (Hamilton-Baillie, 2004a; 2004b; 2005; 2008b; 2008a). The traditional mews streets in London are an example of the latter. In some places (e.g. Drachten in the North of the Netherlands) delineation has been completely or partially removed at particular junctions (although not on the approaches to the junctions), together with the removal of signal control, and it has been found that accidents have been reduced and traffic efficiency improved (Hamilton-Baillie, 2008a).

Naturally, the question that arises is what makes a successful shared space design. An important consideration is that the success of shared space is heavily dependent on the comfort and confidence of pedestrians to move around it and as such, a successful scheme is one that will achieve this. On the other hand, the success of shared space is also dependent on the enhanced alertness of vehicle drivers as to their priority (Adams, 1995). As can be realised, the two objectives (raising the confidence of pedestrians and enhancing the alertness of drivers) are interdependent and a successful shared space design is one that achieves both. If pedestrians do not feel they can safely move around the street space, it is very likely that they will end up walking on the margins of the street, thus creating channels for vehicle movement which would be equivalent to segregation, or that they will avoid the street altogether. Also, if drivers are led to regard the street as their own exclusive territory and feel overconfident driving around it, it is again very likely that they will dominate the space, thus forcing segregation. Such designs would clearly have failed to meet their objectives. It is thus important to understand which factors affect the pedestrians' and drivers' perception towards shared space and to gain a measure of the magnitude of each factor's effect.

This paper considers the perception of pedestrians and drivers separately, with respect to a number of person-, context- and design-specific factors. For pedestrians the perception is expressed as the comfort in sharing space with vehicles, while for drivers it is formulated as their stated willingness to share space with pedestrians. The work described has been conducted as part of a traffic monitoring programme of the Exhibition Road project, comprising the conversion of the layout of the Exhibition Road site in London's South Kensington area from a dual carriageway to a shared space street (Figure 1). Other activities conducted within the framework of the monitoring programme include pedestrian experience surveys at specific sites, behavioural studies and traffic conflicts analyses (Kaparias et al., 2010).

[Figure 1 here]

The paper is structured as follows: Section 2 presents the background of the work described, whose aim has been to identify the various factors which affect the pedestrians' comfort and the drivers' willingness to share space with pedestrians. Section 3 outlines the approach used to design the surveys conducted, their distribution and the results obtained. Section 4 describes the analysis carried out and presents the resulting models, while Section 5 concludes the paper and identifies areas of future research.

2 Background on shared space and road user behaviour

Previous studies on shared space have generally not looked at the overall perception of pedestrians and drivers towards shared space, but have instead mostly dealt with investigating the perceptions of existing shared space schemes by road users. Concentrating almost exclusively on pedestrians, such studies have identified that the confidence of pedestrians is central to the success of shared space schemes.

Namely, having performed surveys on specific shared space sites in the Netherlands and Germany, Gerlach, Boenke, Leven, & Methorst (2008a; 2008b) recommended that the success of shared space involves reducing the freedom of action of car drivers and increasing that of pedestrians. Reid, Kocak & Hunt (2009) and the UK Department for Transport (2011) provided a more complete explanation, following respective surveys across several sites in the UK. They stated that the full benefits of shared space are likely to be achieved when vehicle speeds are effectively controlled (less than 20 mph – 32 km/h), vehicle flows are low (less than 100 veh/h, though evidence has also shown successful schemes operating with much higher vehicle flows), and there are features in the space that encourage pedestrian activity; they also observed from existing experience that the careful selection of materials, the positioning of street furniture and dimensions can have a significant effect on the success of shared space schemes. It can thus be conjectured, that design elements such as seating, vertical water jets at junctions, central bicycle parking, simple drainage details and monuments may act as cues which encourage interaction and human activity.

From further studies it has been discovered that a certain discomfort towards shared space exists amongst the elderly and disabled road users, as these seem to feel an increased threat from vehicles in such environments. Catering for these groups is important and it has been acknowledged in the literature that they should be included in design consultations from the very start to ensure that their needs are met, in part through such measures as the introduction of creative navigational aids, but also through changes in their perception of safety (Clarke, Monderman, & Hamilton-Baillie, 2006; Hamilton-Baillie, 2008a). Research in this area has concluded that the latter may be achieved by providing lines of tactile surfacing, colour contrasting, street furniture and regularly spaced lampposts, but more importantly through the introduction of so-called "safe space" (or "safe zone" or "comfort space"), as outlined in a report by Ramboll Nyvig (Deichman, Winterberg, & Bredmose, 2008). The inclusion of safe spaces would not prevent motorists, cyclists and pedestrians from sharing the larger part of the street (Reid et al., 2009).

From other related research, many other factors have been found to influence pedestrian behaviour, though their effect on pedestrian comfort in shared space has not been looked at as yet. These include, among others, gender and age (Bernhoft & Carstensen, 2008; Granié, 2007), children and other companions (Rosenbloom, Ben-Eliyahu, & Nemrodov, 2009), and geographical location and local practices (Rosenbloom, Nemrodov, & Barkan, 2004), but also lighting (Simons & Bean, 2001) and weather conditions (Gard & Lundborg, 2000).

While much work has been done to establish the perception of pedestrians towards shared space and incorporate it in design, there is a clear gap in research on the perception of drivers. Even where this has been looked into, the underlying objective has been to explain the perception of pedestrians, such as Gerlach et al. (2008a; 2008b). No work has been carried out on the individual parameters affecting the drivers' comfort.

Nevertheless, the willingness of drivers to share space with pedestrians is an essential constituent of shared space. As the successful operation of shared space requires low traffic flows and speeds, it is important to know which factors could decrease the drivers' confidence or could discourage them to use the street altogether, thus bringing about the desired conditions for the confidence of pedestrians to rise. Potentially relevant factors have been found in general driving behaviour literature, and include, for example, gender and age (Özkan & Lajunen, 2006), familiarity with the road (Martens & Fox, 2007), and country of residence (Golias & Karlaftis, 2001), but also lighting (Mayeur, Bremond, & Bastien, 2010), vehicle size (Harb, Radwan, & Yan, 2007), other passengers on board (Fleiter, Lennon, & Watson, 2010) and overall "complexity" of the environment which would require extra attention from the driver's part (Stinchcombe & Gagnon, 2010).

In summary, it has been concluded that there is a clear gap in research into the design of the layout of shared space streets, which plays a central role in their success. Based on the literature, number of elements potentially affecting pedestrians' comfort and drivers' willingness to share space can be subdivided into two groups: internal elements and external elements. The former include the characteristics and attributes relating to the pedestrian/driver himself/herself, whereas the latter refer to the features relating to the conditions surrounding him/her. These elements are summarised in Table 1.

[Table 1 here]

To determine the degree to which these factors affect the road users' perception to shared space environments, two surveys have been carried out for pedestrians and drivers respectively.

3 Stated-preference survey methodology and results

The survey methodology adopted and the results obtained are outlined here. This includes the survey design procedure, its dissemination and the overall response obtained.

3.1 Survey design

The first step of the survey design included defining the target sample of respondents. As anyone can use a shared space street, the target sample for both surveys involved almost everyone (with a condition applied to the drivers' survey, so as to exclude non-drivers). Hence, it was decided to proceed using web-based surveys, with the intention of obtaining as large samples as possible, bearing in mind though that a good spread of respondents (e.g. of different age groups) was needed in order to be able to identify potential biases in the results. Regarding means of dissemination, these included email, social networking websites and postings on Internet forums.

The actual choice attributes and levels in the context of pedestrians' comfort and drivers' willingness to share needed to be determined before surveying. It was decided that, for the purpose of keeping the analysis manageable, the lists of external attributes given in Table 1 would be refined down to seven attributes for each survey. A bi-level design would be adopted to enable simple and economical screening while at the same time giving most of the information required to go to a multi-level response experiment if one is needed.

In order to identify the seven attributes that would be included in each survey two focus groups were held. The focus groups were identical in their composition: they consisted of three members of staff and three students of Imperial College London each, and were moderated by one of the students. The relevant lists of Table 1 were distributed in advance and participants were asked to rank them according to their importance to them. Participants were then engaged in discussions and reached consensuses as to the final seven external attributes that would be included in each survey. Participants were also asked to discuss and conclude on the definition of the levels of each of the attributes, so that these would be both accurate and clear to the respondents. The final seven attributes of the pedestrians' and drivers' surveys with their corresponding levels, as identified by the focus groups, are given in Tables 2 and 3 respectively.

[Table 2 here]

[Table 3 here]

The main part of the study was carried out in the form of two stated-preference surveys, whereby each respondent was presented with sets of scenarios, i.e. combinations, or sets, of selected attributes (and corresponding levels), to which he/she was asked to make a binary (yes/no) decision on whether he/she would be comfortable moving around as a pedestrian, or whether he/she would be willing to use the street and share the surface with pedestrians as a vehicle driver. Each scenario consisted of all seven attributes in each survey with a specific level for each attribute (Figure 2). The pedestrians' survey also included questions on the respondent's gender, age (under 30, 30-49, over 50), driving, cycling and bus travelling frequencies (less than once a month, at least once a month), on whether he/she used a wheelchair or pushchair, and on whether he/she had heard of the shared space concept before, in order to define his/her characteristics. In the drivers' survey, on the other hand, the respondent's gender, age, driving frequency and previous shared space experience (whether heard of shared space or driven in shared space) was asked for. The country of residence was additionally extracted in both surveys from the IP-address of the respondent's computer.

An introductory description of shared space was provided at the beginning of both surveys to help set the context and respondents were allowed to comment in order to help identify any additional issues relevant to the study. The questions that respondents were asked to state their binary (yes/no) preference to were formulated as follows for the two surveys:

Pedestrians: "*Put yourself in the position of a pedestrian walking around a shared space (i.e. a street where pedestrians, cyclists and motorists mix and share the space together). Would you be comfortable moving around this space if it had the following combination of characteristics?"*
Drivers: *"Would you be willing to drive on the below surface and share the space with pedestrians and cyclists? Please comment on how you would feel in these conditions."*

[Figure 2 here]

An issue that had to be dealt with was the number of questions that the respondent would be presented with, as the seven attributes chosen with two levels each would result in a total of 2^7=128 scenarios in each survey. As it has been suggested that respondents typically become disinterested and restless after about 15 questions (Bennett & Blamey, 2001), a fractional factorial design (i.e. a design consisting of a subset of the possible combinations) was applied in order to reduce the number of scenarios without losing important information in both surveys.

1/8 fractional factorial design was used for both the drivers' and pedestrians' surveys, which resulted in 128/8=16 questions in each. This was done following the method suggested by McLean and Anderson (1984), which involves obtaining the full factorial (all combinations) for the first four most important factors (identified by judgement) and then selecting certain levels for the remaining three factors by simple multiplication of the levels for the initial four factors, so as to confound some main effects' estimates with the estimates of the interaction effects of the initial four factors. For the pedestrians' survey, vehicle traffic, pedestrian traffic, safe zones and surface condition were identified as most important, while for the drivers' survey vehicle traffic, pedestrian density, children and elderly and space size were selected. It should be noted that a resolution IV design was sought in both surveys, i.e. one where no main effects would be confounded with two-factor interactions, but where some main effects would be confounded with three-factor interactions.

The procedure of factorial design used (Tables 4 and 5) was adapted from suggested summary tables in the literature (Box, Hunter, & Hunter, 1978; Montgomery, 2000). As such, the levels chosen for Factor 5 for each scenario were determined by multiplying the levels of Factors 1, 2 and 3; similarly Factor 6 was formed using Factors 2, 3 and 4 and Factor 7 was formed using Factors 1, 3, and 4. An important consideration here is the fact that in the pedestrians' survey '+1' denotes the levels of VT – "low", PT – "low", SZ – "provided", SC – "dry", SF – "provided", TP – "provided" and LL –

"bright". Respectively, in the drivers' survey '+1' denotes the levels of VT – "low", PD – "low", CE – "few", SS – "small", LL – "bright", VS – "small" and SF – "not provided". '-1' denotes the opposite levels in both surveys.

[Table 4 here]

[Table 5 here]

It should also be mentioned that the order in which the scenarios appeared to the respondent was randomised in both surveys in order to reduce the occurrence of biases towards particular factor combinations.

3.2 Results

Considering the response to the pedestrian survey, 920 surveys were started. Answers were included in the analysis if a response to at least one scenario was provided, given that each decision was independent of all other scenarios. As such, the total number of usable responses obtained was 871, corresponding to 12,635 individual scenarios used in the analysis. With respect to the demographics of the sample of the usable responses, 546 of the 871 respondents were male (63%); 632 were under 30 years old (72%), 181 were between 30 and 49 (21%) and 58 were over 50 (7%). Only 5 respondents indicated that they used a wheelchair and 28 that they used a pushchair. 484 respondents, i.e. slightly more than half (55%), stated that they had not heard of the shared space concept prior to the survey. Regarding driving, cycling and bus usage frequency, 493 (57%) pointed out that they drove at least once a month, 369 (42%) indicated that they cycled at least once a month, and 745 (85%) said that they took the bus at least once a month. The vast majority of the respondents (702 – 82%) were UK-based. From the 12,635 completed scenarios, 6,427 (51%) were evaluated as comfortable for pedestrians ("yes" response).

As concerns the response of the drivers' survey, 373 surveys were started. Again, answers were included in the analysis if a response to at least one scenario was provided, given that each decision was independent of all other scenarios. As such, the total number of usable responses obtained was 298, corresponding to 3,720 individual scenarios used in the analysis. With respect to the demographics of the sample of the usable responses, 194 of the 298 respondents were male (65%); 119 were under 30 years old (40%), 130 were between 30 and 49 (44%) and 49 were over 50 (16%). 213 respondents, i.e. the majority (71%), stated that they had heard of the shared space concept prior to the survey, while 132 (44%) stated that they had driven on shared space before. Regarding driving frequency, 119 respondents (40%) pointed out that they drove daily and another 93 (31%) that they drove weekly; 101 (34%) said that they drove less than once a month (occasionally). The majority of the respondents (188 – 63%) were UK-based. Among the 3,720 completed scenarios, drivers stated that they were willing to share the space with pedestrians in 2,010 (54%) ("yes" response).

4. Analysis and model fitting

In order to interpret the results and fit models to determine how each of the factors investigated influences the pedestrians' comfort and drivers' willingness to share space, binary logistic regression is performed, as this seems to be most suited due to the fact that the information obtained from the surveys is in binary form (only two choice options were available for each scenario: yes and no). The outcome of the pedestrians' model is thus the probability of a pedestrian to feel comfortable moving around a shared space street (COMFORT, yes = 1, no = 0), and of the drivers' model the probability of a driver to be willing to share the space with pedestrians (SHARE, yes = 1 and no = 0). The STATA 10 statistical software package is used to perform binary logistic regression and estimate the coefficients of the resulting logit models for pedestrians and drivers. The analysis is carried out in two stages for each model; the first stage includes the estimation of the coefficients of only the main effects of the attributes considered, in order to quantify their impacts on the pedestrians' perception and the willingness to share of drivers, omitting interactions between them. The second stage then goes on to include two-way interaction terms, with the prospect of identifying significant factor combinations.

4.1 Pedestrians' comfort

The set of attributes of the pedestrians' model includes those relating to each scenario, as well as those relating to the respondent's characteristics. Namely, the scenario-specific (external) attributes are the ones shown in Table 2, i.e. vehicle traffic (VT, low = 0, high = 1), pedestrian traffic (PT, low = 0, high = 1), provision of safe zones (SZ, not provided = 0, provided = 1), surface condition (SC, wet = 0, dry = 1), lighting level (LL, dark = 0, bright = 1), provision of seating facilities (SF, not provided = 0, provided = 1) and provision of trees and plants (TP, not provided = 0, provided = 1). Similarly, the respondent-specific (internal) variables are: gender (GEN, female = 0, male = 1), age (AGE, under 30 years = 1, 30-49 years = 2, over 50 years = 3), using a wheelchair or pushchair (WPC, no = 0, yes = 1), heard of shared space (HEA, no = 0, yes = 1), driving frequency (DRI, less than once a month = 0, at least once a month = 1), cycling frequency (CYC, less than once a month = 0, at least once a month = 1), frequency of taking the bus (BUS, less than once a month = 0, at least once a month = 1) and country of residence (COU, non-UK = 0, UK = 1).

Observing the data input, most of the independent variables (internal and external) are binary, with the exception of the respondent's age, which is categorical. As such, considering the fact that the number of variables coming into the model for each attribute is n-1, n being the number of levels, each attribute will have one variable in the model and the AGE attribute will have two. Hence, the following binary variables are generated: the dependent variable *COMFORT_1* (for COMFORT = 1), and the independent variables *GEN*_1, *AGE*_2, *AGE*_3, *WPC*_1, *HEA*_1, *DRI*_1, *CYC*_1, *BUS*_1, *COU*_1, *VT*_1, *PT*_1, *SZ*_1, *SC*_1, *LL*_1, *TP*_1 and *SF*_1 (for GEN = 1, AGE = 2, AGE = 3, WPC = 1 etc). The model will thus be of the form:

$$ln(1/(1-p_p)) = \beta_0 + \beta_1 \cdot (GEN\_1) + \beta_2 \cdot (AGE\_2) + \beta_3 \cdot (AGE\_3) + \beta_4 \cdot (WPC\_1) + \beta_5 \cdot (HEA\_1) + \beta_6 \cdot (DRI\_1) + \beta_7 \cdot (CYC\_1) + \beta_8 \cdot (BUS\_1) + \beta_9 \cdot (COU\_1) + \beta_{10} \cdot (VT\_1) + \beta_{11} \cdot (PT\_1) + \beta_{12} \cdot (SZ\_1) + \beta_{13} \cdot (SC\_1) + \beta_{14} \cdot (LL\_1) + \beta_{15} \cdot (TP\_1) + \beta_{16} \cdot (SF\_1),$$

where p_p expresses the probability of the pedestrian feeling comfortable moving around in a space shared with vehicles.

The results of the first stage of the analysis, i.e. the binary logistic regression considering only the main effects, are shown in Table 6, which, for the ease of the reader, also contains the descriptions of the variables. From there it can be seen that the model as a whole is statistically significant as the null hypothesis that the model does not estimate the data correctly is rejected ($Prob > chi^2 = 0.00$). Additionally, it can be seen that the model is a good fit, as the null hypothesis that the model does not fit the data accurately is rejected at the 5% level in the Hosmer-Lemeshow test ($Prob > chi^2 = 0.269$).

[Table 6 here]

Looking at the coefficients in Table 6 it can be seen that the intensity of vehicle traffic has a negative effect on the comfort of pedestrians, and so does the age of the respondent and the use of a wheelchair or a pushchair. These effects seem reasonable. Namely, higher vehicle traffic in a street of any kind is usually associated with an increased perception of danger. Given that in shared space pedestrians share the street with vehicles, high vehicle traffic is likely to reinforce this perception, thus decreasing pedestrian comfort. Similarly, older pedestrians feel more threatened by the fact that in shared space vehicles share the street with them, and as such it is logical for their comfort to decrease with increasing age (it is notable that the coefficient of *AGE*_3 is more negative than the one of *AGE*_2, which demonstrates the pattern of reduced comfort with increasing age). Following a similar logic, pedestrians using a wheelchair or a pushchair also feel more threatened by the fact that vehicles share the street with them, which explains their reduced comfort.

Table 6 also shows which attributes have a positive effect of the comfort of pedestrians. Taking internal attributes, men are more likely to feel comfortable in shared space than women; a pedestrian is more likely to feel comfortable if he/she has heard of the concept of shared space before; he/she is also more likely to feel comfortable in a shared space street if he/she is driving, cycling or taking the bus at least once a month, and if his/her country of residence is the UK. Regarding external characteristics, higher pedestrian traffic, the provision of safe zones, dry surface, good lighting, the provision of trees and plants and the provision of seating facilities seem to positively affect the comfort of pedestrians.

Considering the magnitude of the effect of each attribute, vehicle traffic appears most important, followed by the provision of safe zones and lighting level. Among the internal attributes, age and previous knowledge of the shared space concept seem to be most important. However, to extract more reliable conclusions about these factors, one has to also look at the statistical significance of the coefficients. It can be seen that the *p*-values from the significance tests of most coefficients are below 0.05 and are as such statistically significant. Exceptions to this are the use of a wheelchair or pushchair (*WPC*_1) and the driving frequency (*DRI*_1) of the respondent, which are statistically insignificant (this is also confirmed by the large standard errors compared to the actual coefficients). However, this does not necessarily mean that they do not influence the comfort of pedestrians, as they may be coupled with other attributes when interaction terms are added to the model.

Moving onto the second stage of the analysis, binary logistic regression is performed again, this time by additionally considering interactions between the variables. For this, the binary variables for all two-way interactions are generated, i.e. between internal attributes (*GEN*_1**AGE*_2, *GEN*_1**AGE*_3, ...), between external attributes (*VT*_1**PT*_1, *VT*_1**SZ*_1, ...) and between internal and external attributes combined (*GEN*_1**VT*_1, *GEN*_1**PT*_1, ...). This introduces 119 interaction terms in the model, which brings the total number of variables to 135. The model is thus of the same form as the main effects model, with the addition of the interaction terms, i.e. $ln(1/(1-p_p)) = \beta_0 + \beta_1 \cdot (GEN\_1) + ... + \beta_{17} \cdot (GEN\_1*AGE\_2) + \beta_{18} \cdot (GEN\_1*AGE\_3) + ...$

Performing the regression, a number of interaction variables are dropped due to collinearity. These are: “Over 50 years old & Wheelchair/pushchair” (*AGE*_3**WPC*_1), “High vehicle traffic & Bright lighting” (*VT*_1**LL*_1), “High vehicle traffic & Provision of trees/plants” (*VT*_1**TP*_1), “High pedestrian traffic & Provision of safe zones” (*PT*_1**SZ*_1), “High pedestrian traffic & Dry surface condition” (*PT*_1**SC*_1), “High pedestrian traffic & Provision of seating facilities” (*PT*_1**SF*_1), “Provision of safe zones & Dry surface condition” (*SZ*_1**SC*_1), “Provision of safe zones & Bright lighting” (*SZ*_1**LL*_1), “Provision of safe zones & Provision of trees/plants” (*SZ*_1**TP*_1), “Provision of safe zones & Provision of seating facilities” (*SZ*_1**SF*_1), “Dry surface condition &

Bright lighting" (*SC*_1**LL*_1), "Dry surface condition & Provision of trees/plants" (*SC*_1**TP*_1), "Dry surface condition & Provision of seating facilities" (*SC*_1**SF*_1), "Bright lighting & Provision of trees/plants" (*LL*_1**TP*_1) and "Provision of trees/plants & Provision of seating facilities" (*TP*_1**SF*_1). The results of the regression are shown in Table 7, where the explicit names of the variables are again included for the ease of the reader. As can be seen, the model as a whole is again statistically significant as the null hypothesis that the model does not estimate the data accurately is rejected ($Prob > chi^2 = 0.000$). Additionally, the model is a very good fit (and as expected better than in the case of the main effects only, due to the inclusion of the interaction terms) as the null hypothesis that the model does not fit the data accurately is rejected at the 5% level in the Hosmer-Lemeshow test ($Prob > chi^2 = 0.890$).

As the main effects have been considered in the first stage of the analysis (the first 16 variables on Table 7 are the residuals of the interaction effects and can thus not be re-analysed as main effects), this stage is concerned with the interaction effects, and more specifically with the identification of significant combined effects on the pedestrians' comfort. Taking, again, a level of significance of 5% (0.05), 24 of the total 119 interaction effects are found to be statistically significant (with the remaining ones omitted from Table 7). These are interpreted next.

[Table 7 here]

Starting from the interactions involving the pedestrian's gender, the variables *GEN*_1**COU*_1, *GEN*_1**SZ*_1 and *GEN*_1**LL*_1 are significant and have negative coefficients. These suggest that the combinations of a pedestrian being male and UK-based, of a pedestrian being male and of a safe zone being provided, and of a pedestrian being male and of good lighting being available, reduce the total effect of these factors, which implies that the comfort of female pedestrians increases with the provision of a safe zone and of good lighting levels more than for male pedestrians. Such a result seems plausible.

The next significant interaction variables considered are the ones involving the pedestrian's age. Taking the ones involving middle-aged pedestrians (30-49 years old), these are *AGE*_2**HEA*_1, *AGE*_2**BUS*_1, *AGE*_2**COU*_1 and *AGE*_2**VT*_1, with the former three having positive coefficients and the latter having a negative one. This means that the combined effects of a pedestrian being middle-aged and having heard of shared space, being middle-aged and taking the bus at least once a month and being middle-aged and UK-based increase the comfort in a shared space environment; on the other hand, the comfort of middle-aged pedestrians decreases with the presence of high vehicle traffic more than it does for younger pedestrians.

Considering the interactions involving older pedestrians (over 50 years old), the variables AGE_3*DRI_1, AGE_3*CYC_1 and AGE_3*COU_1 have positive significant coefficients, whereas AGE_3*SZ_1 has a negative one. The interpretation of this is that the comfort of older pedestrians in shared space seems to be higher if they drive or cycle at least once a month, or if they are UK-based. While the latter is not an obvious conclusion, the former two seem sensible as older pedestrians who drive or cycle regularly demonstrate greater mobility and would hence be likely to feel more comfortable in shared space than less mobile ones. Considering the combined effect of a pedestrian being old and a safe zone being provided, the negative coefficient points to the fact that the provision of a safe zone may influence the shared space comfort of younger and middle-aged pedestrians more than that of older pedestrians.

Assessing the interactions involving pedestrians using a wheelchair or a pushchair, the factors WPC_1*BUS_1 and WPC_1*COU_1 have negative significant coefficients. This means that the shared space comfort of wheelchair and pushchair users who take the bus at least once a month or who are UK-based seems to be reduced. This is in line with the positive coefficient of the residual variable WPC_1, as wheelchair and pushchair users would be expected to at least be neutral with respect to shared space (as shown in the main effects), if not feel less comfortable. On the other hand, the combined effect of a pedestrian having heard of shared space and the existence of many pedestrians (HEA_1*PT_1) appears to have an enhancing effect on the comfort, presumably due to the fact that the presence of pedestrians asserts the concept of shared space to the respondent who is already familiar with it.

Investigating the interactions involving pedestrians' mobility habits (driving, cycling and taking the bus regularly), the variables DRI_1*BUS_1, DRI_1*COU_1, DRI_1*SZ_1, CYC_1*COU_1 and BUS_1*VT_1 have significant effects, all of them negative. The first three may be indicating a potential bias in the model, introduced by respondents driving regularly and hence assessing their comfort on shared space as drivers rather than as pedestrians. The fourth variable, however, may suggest that UK-based respondents who cycle regularly dislike the idea of sharing space with vehicles as pedestrians, since they are aware of the dangers they are exposed to as cyclists, especially considering the UK driving style and the relatively small availability of dedicated cycling infrastructure. In a similar way, the fifth variable may point to the fact that frequent bus travellers also dislike sharing space with vehicles, as they are most likely "experienced" pedestrians coming into contact with motorised traffic fairly often.

The negative coefficient of the interaction variable COU_1*SZ_1 implies that the combined effect of a pedestrian being UK-based and of a safe zone being provided decreases the comfort. This may be indicating that UK-based pedestrians may feel less certain about the success of operation of a safe zone in shared space due to the fact that they are not familiar with such a concept so far and do not understand how this can be imposed in a shared space environment.

Interesting conclusions can be drawn from the last four significant interaction variables, which involve purely external combinations of effects. Taking VT_1*PT_1 and VT_1*SZ_1, it is suggested that the comfort of pedestrians in shared space streets with many vehicles increases with the existence of many pedestrians and with the provision of a safe zone (positive coefficients). Both of these seem plausible, as the high pedestrian volume should ensure the comfort of pedestrians in the street, thus dominating the high vehicle traffic volumes, and as the provision of a safe zone would offer a "refuge" to the pedestrians in case they feel threatened by the large number of vehicles.

Finally, considering the significant interactions of high pedestrian traffic and the provision of trees and plants (PT_1*TP_1), and of good lighting levels and seating facilities (LL_1*SF_1), the former appears to be negative while the latter is positive. The seemingly decreasing effect of the former may be attributed to the fact that the presence of many pedestrians and of trees and plants may result in the space being too crowded, thus not enabling pedestrians to walk freely. The seemingly boosting effect of good lighting levels and seating facilities on the pedestrians' comfort in the street, on the other hand, may suggest that these are features encouraging pedestrians to dwell longer in the street, by making it a more pleasant place and as a result increasing their comfort.

In summary, a number of internal (respondent-specific) and external (scenario-specific) attributes, as initially selected from Table 1, are found to have statistically significant effects (positive or negative) on the comfort of pedestrians in sharing space with vehicles. Many of the findings are along the lines of what would be expected based on the literature review of Section 2 and the author's judgement: attributes such as vehicle traffic, pedestrian traffic, provision of safe zones, lighting level, age and travel (driving/cycling/bus) frequency impact the pedestrian experience in general and it seems sensible that they would also affect the comfort in shared space. The significant effects of a number of factor combinations, such as gender and lighting level, and age and safe zones, are also as expected. On the other hand, there are some unexpected findings, such as the significant positive main effects of being UK-based and of being male, and of several interactions, such as the positive combined effects of being middle-aged and taking the bus once a month, and of being over 50 and UK-based. Explanations for the occurrence of these findings may be found in sociology literature, which, however, is beyond the scope of this study.

4.2 Drivers' willingness to share

Similarly to the pedestrians' model, the set of attributes for the drivers' model includes the external attributes shown in Table 3 (i.e. vehicle traffic (VT, low = 0, high = 1), pedestrian density (PD, low =

0, high = 1), children and elderly (CE, few = 0, many = 1), space size (SS, small = 0, big = 1), lighting level (LL, not bright = 0, bright = 1), vehicle size (VS, small = 0, big =1) and provision of street furniture (SF, not provided = 0, provided = 1)) and the following internal variables: gender (GEN, female = 0, male = 1), age (AGE, under 30 years = 1, 30-49 years = 2, over 50 years = 3), driving frequency (DRI, daily = 1, once a week = 2, occasionally = 3), heard of shared space (HSS, no = 0, yes = 1), driven in shared space (DSS, no = 0, yes = 1) and country of residence (COU, non-UK = 0, UK = 1).

Again, most of the independent variables (internal and external) are binary, with the exception of the respondent's age and driving frequency, which are categorical. As such, each attribute will have one variable in the model, and the AGE and DRI attributes will have two each. The following binary variables are hence generated: the dependent variable *SHARE_1* (for SHARE = 1), and the independent variables *GEN*_1, *AGE*_2, *AGE*_3, *DRI*_2, *DRI*_3, *HSS*_1, *DSS*_1, *COU*_1, *VT*_1, *PD*_1, *CE*_1, *SS*_1, *LL*_1, *VS*_1 and *SF*_1 (for GEN = 1, AGE = 2, AGE = 3, DRI = 2, DRI = 3, HSS = 1 etc). The model is thus of the form:

$$ln(1/(1-p_d)) = \beta_0 + \beta_1 \cdot (GEN\_1) + \beta_2 \cdot (AGE\_2) + \beta_3 \cdot (AGE\_3) + \beta_4 \cdot (DRI\_2) + \beta_5 \cdot (DRI\_3) + \beta_6 \cdot (HSS\_1) + \beta_7 \cdot (DSS\_1) + \beta_8 \cdot (COU\_1) + \beta_9 \cdot (VT\_1) + \beta_{10} \cdot (PD\_1) + \beta_{11} \cdot (CE\_1) + \beta_{12} \cdot (SS\_1) + \beta_{13} \cdot (LL\_1) + \beta_{14} \cdot (VS\_1) + \beta_{15} \cdot (SF\_1),$$

where p_d expresses the probability of the driver willing to share space with pedestrians.

The results of the first stage of the analysis, i.e. the binary logistic regression considering only the main effects, are shown in Table 8. From there it can be seen that the model as a whole is statistically significant ($Prob > chi^2 = 0.000$). Additionally, it can be seen from the Hosmer-Lemeshow test that the model is an adequately good fit ($Prob > chi^2 = 0.084$).

[Table 8 here]

Looking at the coefficients in Table 8, it can be seen that high vehicle traffic, high pedestrian density, many children and elderly, driving a big vehicle and the provision of street furniture all have negative effects on the willingness of drivers to share space with pedestrians. These seem fairly reasonable; namely, high vehicle traffic can be frustrating for drivers and is therefore undesirable; high pedestrian density is also undesirable, as a large number of pedestrians can severely obstruct traffic; the presence of many children and elderly means that the pedestrians are more vulnerable and drivers would naturally feel more distressed; driving a large vehicle can also make a driver feel more uneasy in shared space compared to a small vehicle; and street furniture introduces further obstructions for vehicles and is generally unwanted.

Table 8 also shows which attributes have positive effects on the willingness of drivers to share space. More specifically, male drivers seem more willing to share than female ones, and the willingness appears to be positively affected by previous experience with shared space (whether heard or driven). Also, UK drivers seem to be more willing to share the space than non-UK ones, possibly because of the publicity that shared space has received in the UK compared to other countries. The willingness to share of drivers is also positively affected by the size of the space being large and by good lighting.

Considering the magnitude of the effect of each attribute, the most important external element seems to be the presence of children and elderly, followed by pedestrian density and lighting level. As concerns internal attributes, having heard of shared space appears most important. With respect to statistical significance, it can be seen that the *p*-values from the significance tests of most coefficients are below 0.05 and are as such statistically significant. Exceptions are the variables relating to age and driving frequency (i.e. *AGE*_2, *AGE*_3, *DRI*_2 and *DRI*_3), which are all insignificant. However, this does not necessarily mean that they do not influence the willingness to share of drivers, as they may be coupled with other attributes when interaction terms are added to the model. An interesting observation is also the fact that the constant term of the model is insignificant; this indicates that drivers appear to be indifferent to sharing space when all parameters are set to their "zero" levels.

Moving onto the second stage of the analysis, binary logistic regression is performed again, this time by additionally considering interactions between the variables. For this, the binary variables for all two-way interactions are generated, thus introducing 103 interaction terms in the model, which brings the total number of variables to 118. The model thus becomes: $ln(1/(1-p_d)) = \beta_0 + \beta_1 \cdot (GEN\_1) + ... + \beta_{16} \cdot (GEN\_1*AGE\_2) + \beta_{17} \cdot (GEN\_1*AGE\_3) + ….$

Performing the regression, a number of interaction variables are again dropped due to collinearity. These are: "High vehicle traffic & High pedestrian density" (*VT*_1**PD*_1), "High vehicle traffic & Big shared space" (*VT*_1**SS*_1), "High vehicle traffic & Bright lighting" (*VT*_1**LL*_1), "High vehicle traffic & Big vehicle" (*VT*_1**VS*_1), "High vehicle traffic & Street furniture" (*VT*_1**SF*_1), "High pedestrian density & Bright lighting" (*PD*_1**LL*_1), "Many children/elderly & Big shared space" (*CE*_1**SS*_1), "Many children/elderly & Bright lighting" (*CE*_1**LL*_1), "Many children/elderly & Big vehicle" (*CE*_1**VS*_1), "Big shared space & Big vehicle" (*SS*_1**VS*_1), "Big shared space & Street furniture" (*SS*_1**SF*_1), "Bright lighting & Big vehicle" (*LL*_1**VS*_1) and "Bright lighting & Street furniture" (*LL*_1**SF*_1). The results of the regression are shown in Table 9. As can be seen, the model as a whole is again statistically significant (*Prob* > chi^2 = 0.000) and a fairly good fit, as the null hypothesis that the model does not fit the data accurately is rejected at the 5% level in the Hosmer-Lemeshow test (*Prob* > chi^2 = 0.161).

[Table 9 here]

As the main effects were considered in the first stage of the analysis, this stage is concerned with the identification of significant combined effects on the drivers' willingness to share space. One issue that should be noted, however, is the fact that the interaction effects are used in comparison to the residuals, and as some residuals are large, a number of interaction effects may appear as having the opposite effect when they are in fact only reducing the main effect. This is the case for some of the interactions involving the "Driving weekly" (*DRI*_2), "High pedestrian density" (*PD*_1), "Many children/elderly" (*CE*_1) and "Street furniture" (*SF*_1) attributes.

Taking, again, a level of significance of 5% (0.05), 25 of the total 103 interaction effects are found to be statistically significant (with the remaining ones omitted from Table 9) and are interpreted next. Starting from the interactions involving the driver's gender, the variables *GEN*_1**AGE*_2, *GEN*_1**AGE*_3, *GEN*_1**DRI*_3, *GEN*_1**COU*_1 and *GEN*_1**VS*_1 are significant and have positive coefficients. Considering the first two, these indicate that the willingness of male drivers to share the space with pedestrians increases with increasing age; in other words, while age on its own was found insignificant, it appears that it plays an important role when male drivers are looked at, compared to female drivers. What can be deduced from this is that among drivers of the same age group, men are more likely to be willing to share space with pedestrians than women, with this effect becoming stronger with increasing age. As concerns the other three variables, the positive coefficients indicate that among occasional drivers (once a month or less) men are more likely to be willing to share space than women, that UK-based male drivers are more willing than UK-based female ones, and that male drivers of large vehicles are more willing to share the space with pedestrians than female large vehicle drivers.

Moving onto the interactions involving the driver's age, it appears once more that this is an important parameter, as it figures in several significant interaction terms of the model, despite being insignificant in the main effects model. Eight interaction terms involving age are significant. Considering the first two together (*AGE*_2**DRI*_2 and *AGE*_3**DRI*_2), it is found that among "weekly" drivers the willingness to share space decreases with increasing age. A similar trend is observed when looking at the third and fourth variable together (*AGE*_2**DSS*_1 and *AGE*_3**DSS*_1), which reflect the decreasing willingness with increasing age among drivers that have driven in shared space before. Conversely, looking at the interaction of age with the presence of children and elderly (*AGE*_2**CE*_1 and AGE_3*CE_1), the willingness to share seems to be increasing with increasing driver's age. Similar observations can be made in the positive coefficient of AGE_3*PD_1, and in the negative coefficient of AGE_3*VT_1; these show that older drivers are more willing to share at high pedestrian density but less willing at high vehicle traffic. A possible explanation for this could be that older drivers prefer to drive slower, and as the presence of pedestrians and especially children and elderly requires them to do so, this increases their willingness to share space; on the other hand, the presence of vehicle traffic makes them feel more frustrated and is therefore undesirable by them.

Assessing the interactions including the driving frequency, the variables DRI_2*HSS_1, DRI_2*DSS_1, DRI_3*DSS_1, DRI_2*COU_1 and DRI_3*CE_1 are significant, with the first and the last ones having positive and the remaining three having negative effects. Considering the first term, it appears that the combination of being a "weekly" driver and of having heard of shared space before positively affects the willingness to share space. However, it is interesting to note, from the second and third terms, that non-daily drivers are less likely to be willing to share if they have driven in shared space before. "Weekly" drivers also seem to be less likely to share the space if they are UK-based, while the last term implies that occasional drivers are more likely to be willing to share if there are many children and elderly around. A possible explanation for the last finding is that less frequent drivers, similarly to older drivers, would prefer driving slowly and being more attentive, and that the presence of children and elderly would enable them to do so more easily.

With respect to the country of residence, two interaction terms are significant: DSS_1*COU_1 and COU_1*PD_1. The former represents the combined effect of having previously driven in shared space and being UK-based, which is positive. This can be attributed to the fact that in the UK many shared space schemes have been implemented and therefore drivers are more likely to have gotten used to driving in such environments. The latter term expresses the combined effect of being UK-based and driving through an area of high pedestrian density, which is negative, meaning that UK drivers are less likely to be willing to share if there are many pedestrians around. An explanation for this could be sought in pedestrians' and drivers' behavioural studies, showing how these road users behave in the UK and in other countries.

Interesting conclusions can be drawn from the last five significant interaction variables, which involve purely external attributes. Namely, the PD_1*CE_1 variable has a positive coefficient, which indicates that while high pedestrian density and the presence of many children and elderly have strongly negative effects themselves, their combination reduces the total negative effect. An explanation may be given by the fact that the many children and elderly may be "protected" by the high pedestrian density, making drivers more confident, as opposed to a low-pedestrian-density situation, where they would be exposed to a greater threat from traffic. On the other hand, the combined effect of high pedestrian density and the shared space area being big (*PD*_1**SS*_1) is negative; this can be attributed to the drivers' confidence being reduced due to the even larger number of pedestrians present in the street (a large area with high pedestrian density implies even more pedestrians).

The combined effect of high pedestrian density and provision of street furniture (*PD*_1**SF*_1) is strongly positive, which means that the total negative effect of *PD*_1 and *SF*_1 is reduced. This implies that drivers are more willing to share the space with larger numbers of pedestrians if street furniture is present, as this will in theory protect the pedestrians from traffic, thus making drivers more confident. A further positive combined effect that can also be attributed to that explanation is that of the presence of many children and elderly and of street furniture (*CE*_1**SF*_1). Finally, the combined effect of the space being large and good lighting being available (*SS*_1**LL*_1) is also strongly positive. This seems plausible, as good lighting and a large space offers drivers better driving conditions.

In summary, a number of internal and external attributes, as initially selected from Table 1, appear to have statistically significant effects on the willingness of drivers to share space with pedestrians. Many of the findings are along the lines of what would be expected based on the literature review of Section 2 and the authors' judgement: attributes such as vehicle traffic, pedestrian density, presence of children and elderly, vehicle size, street furniture, gender and previous experience with shared space influence the driving comfort in general and shared space would not be an exception. The effects of some factor combinations, especially the ones involving age, are also as expected. On the other hand, the findings that age is only significant when coupled with other attributes, and that drivers are indifferent as to their willingness to share space if all attributes are set to zero, are unexpected findings. While it would be an interesting topic, investigating the occurrence of these findings is beyond the scope of this study.

5 Conclusions

This paper examined the effect of different parameters on the pedestrians' comfort and the drivers' willingness to share space with pedestrians in shared space schemes, which are increasingly being introduced around the world as an alternative to traditional segregated street design. The study was carried out with the help of two online surveys, which presented the respondents with different combinations of shared space features and in which they were asked to state whether they, as a pedestrian would feel comfortable moving around, or as a driver would be willing to share the space with other road users, respectively. The data collected in both surveys was complemented by respondent-specific attributes. To draw conclusions, binary logistic regression models were fitted to the data, including both main and interaction effects. The results showed that for pedestrians, vehicle traffic, provision of safe zones and lighting level were most important among the external (scenario-specific) attributes, while age and gender were dominant among internal (respondent-specific) attributes. For drivers, on the other hand, the presence/absence of children and elderly, pedestrian density and lighting level were most important among the external variables, while previous knowledge of shared space and country of residence (only with respect to UK- or non-UK based respondents, more research is required to investigate the non-UK group) were dominant among the internal attributes. A number of interaction effects also seemed to play an important role both for pedestrians and for drivers.

The present study represents a first step towards understanding the perception of pedestrians and drivers with respect to shared space. Naturally, the results have implications on policy, in particular as to the design and implementation of shared space schemes and the features required to ensure their successful operation. For example, an important policy-related finding is that the provision of a safe zone increases the comfort of pedestrians to move around the space and strengthens their confidence. The inclusion of a safe zone can thus be given as a recommendation to designers, since its provision is very likely to contribute to the successful operation of a shared space scheme. On the other hand, the presence of many pedestrians, and in particular children and elderly, decreases the willingness to share of drivers, whilst at the same time increasing the comfort of pedestrians. This is a valuable finding for planners, who may wish to ensure the enhanced alertness of drivers in a space through their reduced willingness to share so as to boost the confidence of pedestrians.

While the present study has thrown some light into the under-explored topic of pedestrians' and drivers' perception to shared space, research in this direction continues. Further work will concentrate on extending this study to other road users (such as cyclists) in order to define the attributes that affect their perception of shared space. Coupled with on-going road user behaviour monitoring work, useful conclusions are expected to be drawn as more shared space schemes are introduced and road users gain experience with them. Perception surveys will also be carried out on specific case studies. Finally, future research will also focus on more vulnerable road user groups (such as the blind and partially-sighted) to establish their needs and ensure their inclusion in shared space.

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References

Adams, J. (1995). *Risk*. London: UCL Press.

Bennett, J. & Blamey, R. (2001). *The choice modelling approach to environmental valuation*. Cheltenham, UK: Edward Elgar Publishing.

Bernhoft, I. M. & Carstensen, G. (2008). Preferences and behaviour of pedestrians and cyclists by age and gender. *Transportation Research F, 11,* 83-95.

Box, G. E. P., Hunter, W. G., & Hunter, J. S. (1978). *Statistics for experimenters: An introduction to design, data analysis, and model building*. (1st ed.) New York, USA: Wiley and Sons.

Buchanan, C., Cooper, G. H. C., MacEwen, A., Crompton, D. H., Crow, G., Michell, G. et al. (1963). *Traffic in towns*. HMSO.

Clarke, E., Monderman, H., & Hamilton-Baillie, B. (2006). The evolution of shared space. *Traffic Engineering and Control, 47,* 290-292.

Deichman, J., Winterberg, B., & Bredmose, A. (2008). *Shared space - safe space*.

Fleiter, J. J., Lennon, A., & Watson, B. (2010). How do other people influence your driving speed? Exploring the 'who' and the 'how' of social influences on speeding from a qualitative perspective. *Transportation Research F, 13,* 49-62.

Gard, G. & Lundborg, G. (2000). Pedestrians on slippery surfaces during winter--methods to describe the problems and practical tests of anti-skid devices. *Accident Analysis & Prevention, 32,* 455-460.

Gerlach, J., Boenke, D., Leven, J., & Methorst, R. (2008a). Sinn und Unsinn von Shared Space - Zur Versachlichung einer populären Gestaltungstheorie; Teil 1. *Strassenverkehrstechnik, 2/2008,* 61-65.

Gerlach, J., Boenke, D., Leven, J., & Methorst, R. (2008b). Sinn und Unsinn von Shared Space - Zur Versachlichung einer populären Gestaltungstheorie; Teil 2. *Strassenverkehrstechnik, 3/2008,* 140-149.

Golias, I. & Karlaftis, M. G. (2001). An international comparative study of self-reported driver behavior. *Transportation Research F, 4,* 243-256.

Granié, M. A. (2007). Gender differences in preschool children's declared and behavioral compliance with pedestrian rules. *Transportation Research F, 10,* 371-382.

Hamilton-Baillie, B. (2004a). A street revolution. *Green Places, June 2004,* 20-23.

Hamilton-Baillie, B. (2004b). Urban design: Why don't we do it in the road. *Journal of Urban Technology, 11,* 43-62.

Hamilton-Baillie, B. (2008a). Shared space: Reconciling people, places and traffic. *Built Environment, 34,* 161-181.

Hamilton-Baillie, B. (2008b). Towards shared space. *Urban Design International, 13,* 130-138.

Hamilton-Baillie, B. & Jones, P. (2005). Improving traffic behaviour and safety through urban design. *Proceedings of the Institution of Civil Engineers - Civil Engineering, 158,* 39-47.

Harb, R., Radwan, E., & Yan, X. (2007). Larger size vehicles (LSVs) contribution to red light running, based on a driving simulator experiment. *Transportation Research F, 10,* 229-241.

Kaparias, I., Bell, M. G. H., Greensted, J., Cheng, S., Miri, A., Taylor, C. et al. (2010). Development and implementation of a vehicle-pedestrian conflicts analysis method: Adaptation of a vehicle-vehicle technique. *Transportation Research Record, 2198,* 75-82.

Martens, M. H. & Fox, M. (2007). Does road familiarity change eye fixations? A comparison between watching a video and real driving. *Transportation Research F, 10,* 33-47.

Mayeur, A., Bremond, R., & Bastien, J. M. C. (2010). The effect of the driving activity on target detection as a function of the visibility level: Implications for road lighting. *Transportation Research F, 13,* 115-128.

McLean, R. & Anderson, V. (1984). *Applied factorial and fractional designs*. New York, USA: Marcel Dekker Inc .

Montgomery, D. (2000). *Design and analysis of experiments*. (5th ed.) New York, USA: Wiley and Sons.

Özkan, T. & Lajunen, T. (2006). What causes the differences in driving between young men and women? The effects of gender roles and sex on young drivers' driving behaviour and self-assessment of skills. *Transportation Research F, 9,* 269-277.

Reid, S., Kocak, N., & Hunt, L. (2009). *DfT shared space project - Stage 1: Appraisal of shared space* (Rep. No. C3783100).

Rosenbloom, T., Ben-Eliyahu, A., & Nemrodov, D. (2009). Children's crossing behavior with an accompanying adult. *Safety Science, 46,* 1248-1254.

Rosenbloom, T., Nemrodov, D., & Barkan, H. (2004). For heaven's sake follow the rules: pedestrians' behavior in an ultra-orthodox and a non-orthodox city. *Transportation Research F, 7,* 395-404.

Simons, R. H. & Bean, A. R. (2001). Residential road lighting. In *Lighting Engineering* (pp. 389-401). Oxford: Architectural Press.

Stinchcombe, A. & Gagnon, S. (2010). Driving in dangerous territory: Complexity and road-characteristics influence attentional demand. *Transportation Research F, In press*.

UK Department for Transport (2011). *Local Transport Note 1/11 - Shared space*.

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Table 1

Pedestrians	Drivers
Internal elements:	Internal elements:
Gender	Gender
Age	Age
Disability (e.g. blind, wheel chair)	Driving frequency
Country of residence	Knowledge of shared space
Companions (e.g. children)	Driving frequency
Items being carried (e.g. luggage, push chair)	Country of residence
Usual mode of travel (e.g. car, bicycle, bus)	
External elements:	External elements:
Vehicle traffic conditions	Vehicle traffic conditions
Pedestrian density	Pedestrian density
Pedestrian-specific facilities (e.g. seating)	Pedestrian types (children, elderly etc.)
Street furniture	Weather and surface conditions
Safe zones	Paving materials and colour
Lighting level	Lighting level
Weather and surface conditions	Street furniture
Provision of landscaping (i.e. trees and plants)	Vehicle size
	Passengers on board
	Trip characteristics (purpose, length etc.)

Table 2

Attribute	Description	Level
Vehicle traffic (VT)	The intensity of vehicle traffic	High Low
Pedestrian traffic (PT)	The intensity of pedestrian traffic	High Low
Safe zones (SZ)	The availability of safe zones	Not provided Provided
Surface condition (SC)	The street surface condition in terms of moisture	Wet Dry
Lighting level (LL)	The level of lighting provided	Dark Bright
Trees or plants (TP)	The availability of trees or plants	Not provided Provided
Seating facilities (SF)	The availability of seating facilities	Not Provided Provided

Table 3

Attribute	Description	Level
Vehicle traffic (VT)	The intensity of vehicle traffic	High Low
Pedestrian density (PD)	The density of pedestrian traffic	High Low
Children and elderly (CE)	The amount of children and elderly pedestrians	Many Few
Space size (SS)	The size (length and width) of the shared space street	Big Small
Lighting level (LL)	The level of lighting provided	Bright Not bright
Vehicle size (VS)	The size of the vehicle being driven	Big Small
Street furniture (SF)	The availability of street furniture (trees, seating etc.)	Provided Not provided

Table 4

Factor	1	2	3	4	5	6	7
Label	Vehicle Traffic	Pedestrian Traffic	Surface Condition	Safe Zones	Seating Facilities	Trees or Plants	Lighting Level
Definition	1	2	3	4	1*2*3	2*3*4	1*3*4
Scenario 1	-1	-1	-1	-1	-1	-1	-1
Scenario 2	+1	-1	-1	-1	+1	-1	+1
Scenario 3	-1	+1	-1	-1	+1	+1	-1
Scenario 4	+1	+1	-1	-1	-1	+1	+1
Scenario 5	-1	-1	+1	-1	+1	+1	+1
Scenario 6	+1	-1	+1	-1	-1	+1	-1
Scenario 7	-1	+1	+1	-1	-1	-1	+1
Scenario 8	+1	+1	+1	-1	+1	-1	-1
Scenario 9	-1	-1	-1	+1	-1	+1	+1
Scenario 10	+1	-1	-1	+1	+1	+1	-1
Scenario 11	-1	+1	-1	+1	+1	-1	+1
Scenario 12	+1	+1	-1	+1	-1	-1	-1
Scenario 13	-1	-1	+1	+1	+1	-1	-1
Scenario 14	+1	-1	+1	+1	-1	-1	+1
Scenario 15	-1	+1	+1	+1	-1	+1	-1
Scenario 16	+1	+1	+1	+1	+1	+1	+1

Table 5

Factor	1	2	3	4	5	6	7
Label	Vehicle Traffic	Pedestrian Density	Children & Elderly	Space Size	Lighting Level	Vehicle Size	Street Furniture
Definition	1	2	3	4	1*2*3	2*3*4	1*3*4
Scenario 1	+1	-1	+1	+1	-1	-1	+1
Scenario 2	+1	-1	+1	-1	-1	+1	-1
Scenario 3	+1	-1	-1	+1	+1	+1	-1
Scenario 4	+1	-1	-1	-1	+1	-1	+1
Scenario 5	+1	+1	+1	+1	+1	+1	+1
Scenario 6	+1	+1	+1	-1	+1	-1	-1
Scenario 7	+1	+1	-1	+1	-1	-1	-1
Scenario 8	+1	+1	-1	-1	-1	+1	+1
Scenario 9	-1	-1	+1	+1	+1	-1	-1
Scenario 10	-1	-1	+1	-1	+1	+1	+1
Scenario 11	-1	-1	-1	+1	-1	+1	+1
Scenario 12	-1	-1	-1	-1	-1	-1	-1
Scenario 13	-1	+1	+1	+1	-1	+1	-1
Scenario 14	-1	+1	+1	-1	-1	-1	+1
Scenario 15	-1	+1	-1	+1	+1	-1	+1
Scenario 16	-1	+1	-1	-1	+1	+1	-1

Table 6

Attribute	Variable	Coef (β)	Std err	P > |z|
Male	*GEN_1*	0.29	0.04	.000
30-49 years old	*AGE_2*	-0.12	0.05	.025
Over 50 years old	*AGE_3*	-0.57	0.09	.000
Wheelchair/pushchair	*WPC_1*	-0.04	0.11	.727
Heard of shared space	*HEA_1*	0.57	0.04	.000
Driving monthly	*DRI_1*	0.07	0.04	.098
Cycling monthly	*CYC_1*	0.09	0.04	.039
Taking the bus monthly	*BUS_1*	0.26	0.06	.000
UK resident	*COU_1*	0.20	0.05	.000
High vehicle traffic	*VT_1*	-1.62	0.04	.000
High pedestrian traffic	*PT_1*	0.43	0.04	.000
Provision of safe zones	*SZ_1*	1.08	0.04	.000
Dry surface condition	*SC_1*	0.38	0.04	.000
Bright lighting	*LL_1*	0.68	0.04	.000
Provision of trees and plants	*TP_1*	0.36	0.04	.000
Provision of seating facilities	*SF_1*	0.27	0.04	.000
Constant		-1.57	0.10	.000

Note: Number of observations = 12,365; chi^2 = 2963.11; $Prob > chi^2$ = .000; $Pseudo\text{-}R^2$ = .169
Hosmer-Lemeshow goodness-of-fit test: chi^2 = 9.94; $Prob > chi^2$ = .269

Table 7

Attribute	Variable	Coef (β)	Std err	P > |z|
Male	*GEN_1*	1.21	0.22	.000
30-49 years old	*AGE_2*	-0.95	0.28	.001
Over 50 years old	*AGE_3*	-2.88	0.57	.000
Wheelchair/pushchair	*WPC_1*	1.06	0.49	.033
Heard of shared space	*HEA_1*	0.38	0.22	.090
Driving monthly	*DRI_1*	0.93	0.23	.000
Cycling monthly	*CYC_1*	0.27	0.22	.213
Taking the bus monthly	*BUS_1*	0.51	0.26	.052
UK resident	*COU_1*	1.12	0.25	.000
High vehicle traffic	*VT_1*	-1.80	0.21	.000
High pedestrian traffic	*PT_1*	0.35	0.19	.064
Provision of safe zones	*SZ_1*	1.38	0.19	.000
Dry surface condition	*SC_1*	0.57	0.19	.002
Bright lighting	*LL_1*	1.01	0.19	.000
Provision of trees/plants	*TP_1*	0.65	0.19	.001
Provision of seating facilities	*SF_1*	0.27	0.19	.147
Male & UK resident	*GEN_1*COU_1*	-0.30	0.12	.015
Male & Provision of safe zones	*GEN_1*SZ_1*	-0.38	0.09	.000
Male & Bright lighting	*GEN_1*LL_1*	-0.19	0.09	.038
30-49 years old & Heard of shared space	*AGE_2*HEA_1*	0.38	0.12	.001
Over 50 years old & Driving monthly	*AGE_3*DRI_1*	0.78	0.32	.014
Over 50 years old & Cycling monthly	*AGE_3*CYC_1*	0.46	0.20	.022
30-49 years old & Taking the bus monthly	*AGE_2*BUS_1*	0.30	0.15	.047
30-49 years old & UK resident	*AGE_2*COU_1*	0.47	0.14	.001
Over 50 years old & UK resident	*AGE_3*COU_1*	1.54	0.24	.000
30-49 years old & High vehicle traffic	*AGE_2*VT_1*	-0.39	0.12	.001
Over 50 years old & Provision of safe zones	*AGE_3*SZ_1*	-0.41	0.18	.026
Wheelchair/pushchair & Taking the bus monthly	*WPC_1*BUS_1*	-0.92	0.27	.001
Wheelchair/pushchair & UK resident	*WPC_1*COU_1*	-0.70	0.27	.009
Heard of shared space & High pedestrian traffic	*HEA_1*PT_1*	0.22	0.09	.014
Driving monthly & Taking the bus monthly	*DRI_1*BUS_1*	-0.33	0.14	.020
Driving monthly & UK resident	*DRI_1*COU_1*	-0.37	0.13	.004
Driving monthly & Provision of safe zones	*DRI_1*SZ_1*	-0.18	0.09	.046
Cycling monthly & UK resident	*CYC_1*COU_1*	-0.33	0.12	.008
Taking the bus monthly & High vehicle traffic	*BUS_1*VT_1*	-0.32	0.12	.008
UK resident & Provision of safe zones	*COU_1*SZ_1*	-0.23	0.12	.048
High vehicle traffic & High pedestrian traffic	*VT_1*PT_1*	0.34	0.09	.000
High vehicle traffic & Provision of safe zones	*VT_1*SZ_1*	0.40	0.09	.000
High pedestrian traffic & Provision of trees/plants	*PT_1*TP_1*	-0.21	0.09	.014
Bright lighting & Provision of seating facilities	*LL_1*SF_1*	0.24	0.09	.005
Constant		-2.82	0.35	.000

Note: Number of observations = 12,365; chi^2 = 3260.70; $Prob > chi^2$ = .000; $Pseudo\text{-}R^2$ = .186
Hosmer-Lemeshow goodness-of-fit test: chi^2 = 3.62; $Prob > chi^2$ = .890

Table 8

Attribute	Variable	Coef (*β*)	Std err	P > |z|
Male	*GEN_1*	0.23	0.08	.003
30-49 years old	*AGE_2*	0.08	0.08	.343
Over 50 years old	*AGE_3*	0.09	0.11	.439
Driving weekly	*DRI_2*	-0.12	0.09	.170
Driving occasionally	*DRI_3*	0.01	0.09	.913
Heard of shared space	*HSS_1*	0.57	0.09	.000
Driven in shared space	*DSS_1*	0.15	0.08	.046
UK resident	*COU_1*	0.32	0.08	.000
High vehicle traffic	*VT_1*	-0.34	0.07	.000
High pedestrian density	*PD_1*	-0.71	0.07	.000
Many children/elderly	*CE_1*	-1.10	0.07	.000
Big shared space	*SS_1*	0.35	0.07	.000
Bright ligting	*LL_1*	0.58	0.08	.000
Big vehicle	*VS_1*	-0.34	0.07	.000
Street furniture	*SF_1*	-0.15	0.07	.037
Constant		0.24	0.14	.103

Note: Number of observations = 3,720; chi^2 = 598.37; $Prob > chi^2$ = .000; $Pseudo\text{-}R^2$ = .117
Hosmer-Lemeshow goodness-of-fit test: chi^2 = 13.92; $Prob > chi^2$ = .084

Table 9

Attribute	Variable	Coef (*β*)	Std err	P > |z|
Male	*GEN*_1	-0.71	0.34	.034
30-49 years old	*AGE*_2	-0.52	0.35	.140
Over 50 years old	*AGE*_3	-0.70	0.49	.155
Driving weekly	*DRI*_2	1.62	0.39	.000
Driving occasionally	*DRI*_3	-0.22	0.38	.570
Heard of shared space	*HSS*_1	-0.18	0.37	.630
Driven in shared space	*DSS*_1	0.45	0.34	.182
UK resident	*COU*_1	0.11	0.34	.752
High vehicle traffic	*VT*_1	-0.76	0.25	.002
High pedestrian density	*PD*_1	-2.54	0.55	.000
Many children/elderly	*CE*_1	-3.07	0.32	.000
Big shared space	*SS*_1	-0.21	0.45	.646
Bright ligting	*LL*_1	-0.77	0.67	.247
Big vehicle	*VS*_1	-1.09	0.34	.001
Street furniture	*SF*_1	-1.53	0.60	.011
Male & 30-49 years old	*GEN*_1**AGE*_2	1.03	0.20	.000
Male & Over 50 years old	*GEN*_1**AGE*_3	1.60	0.30	.000
Male & Driving occasionally	*GEN*_1**DRI*_3	0.76	0.23	.001
Male & UK resident	*GEN*_1**COU*_1	0.50	0.20	.012
Male & Big vehicle	*GEN*_1**VS*_1	0.36	0.17	.031
30-49 years old & Driving weekly	*AGE*_2**DRI*_2	-1.17	0.25	.000
Over 50 years old & Driving weekly	*AGE*_3**DRI*_2	-1.55	0.30	.000
30-49 years old & Driven in shared space	*AGE*_2**DSS*_1	-0.50	0.20	.014
Over 50 years old & Driven in shared space	*AGE*_3**DSS*_1	-0.75	0.26	.004
Over 50 years old & High vehicle traffic	*AGE*_3**VT*_1	-0.60	0.24	.013
Over 50 years old & High pedestrian density	*AGE*_3**PD*_1	0.50	0.25	.046
30-49 years old & Many children/elderly	*AGE*_2**CE*_1	0.46	0.18	.013
Over 50 years old & Many children/elderly	*AGE*_3**CE*_1	0.72	0.24	.003
Driving weekly & Heard of shared space	*DRI*_2**HSS*_1	1.32	0.26	.000
Driving weekly & Driven in shared space	*DRI*_2**DSS*_1	-0.95	0.20	.000
Driving occasionally & Driven in shared space	*DRI*_3**DSS*_1	-0.65	0.22	.003
Driving weekly & UK resident	*DRI*_2**COU*_1	-2.03	0.24	.000
Driving occasionally & Many children/elderly	*DRI*_3**CE*_1	0.40	0.20	.050
Driven in shared space & UK resident	*DSS*_1**COU*_1	0.58	0.19	.003
UK resident & High pedestrian density	*COU*_1**PD*_1	-0.37	0.18	.033
High pedestrian density & Many children/elderly	*PD*_1**CE*_1	1.45	0.22	.000
High pedestrian density & Big shared space	*PD*_1**SS*_1	-0.51	0.23	.028
High pedestrian density & Street furniture	*PD*_1**SF*_1	2.46	0.95	.010
Many children/elderly & Street furniture	*CE*_1**SF*_1	0.41	0.21	.046
Big shared space & Bright lighting	*SS*_1**LL*_1	2.80	1.11	.012
Constant		2.79	0.70	.000

Note: Number of observations = 3,720; chi^2 = 980.83; $Prob > chi^2$ = .000; $Pseudo\text{-}R^2$ = .191
Hosmer-Lemeshow goodness-of-fit test: chi^2 = 11.80; $Prob > chi^2$ = .161

Figure 1
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Figure 2
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