A study on Powered Two-Wheeler user perceptions towards street designs with elements of shared space

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Abstract

Inspired by developments in urban planning, the concept of "shared space" has recently emerged as a way of creating a better public realm by facilitating pedestrian movement and lowering vehicle traffic volumes and speeds. Previous research looked at how the behaviour and perceptions of pedestrians, vehicle drivers and pedal cyclists, vary with the introduction of elements of shared space. The aim of this study is to extend this analysis to Powered Two-Wheeler (PTW) riders, who are a road user group that is often overlooked. Data are collected by means of a purpose-developed stated-preference survey, where PTW users are presented with a set of hypothetical scenarios of streets designed with different combinations of elements of shared space and are asked to express their "willingness to share space" with vehicles and pedestrians. The results show that PTW riders appear to treat shared space features more like motorised users rather than non-motorised ones. Indeed, lower willingness to share is expressed when large numbers of pedestrians and static obstacles (such as trees, seating and fountains) are present. On the other hand, PTW riders are more positive towards shared space elements if the design provides ample space and a smooth pavement surface.

Introduction

The concept of shared space has emerged as part of a continuous trend over many years towards a more integrated approach to the design of urban streets. Inspired by advances in urban planning, it revolves around layouts aimed at asserting the function of streets as places rather than as arteries, which involves designing for easier pedestrian movement and lower vehicle speeds (Figure 1). As such, it contrasts the traditional car-oriented approach that drove the design of streets for many decades, which relied upon the segregation of motorised traffic from other road users in order to ensure unobstructed flows [1].

Source: Stilfehler, Wikimedia

Figure 1: Shared space examples: New Road, Brighton, UK (left); 16th Street Mall, Denver, CO, USA (right)

Clarifying the term "shared space", this is used to collectively refer to a set of context-sensitive design treatments, whose aim is to create a more pedestrian-friendly environment, and whose extent of implementation may vary. Such treatments range from "light-touch" solutions, such as the replacement of "formal" zebra or signal-controlled crossing facilities with more "informal" (uncontrolled) pedestrian crossings, to more radically-engineered layouts involving level surfaces in so-called "naked streets", where most, or even all, delineation between pedestrian and vehicle areas is removed. Examples of streets with varying extents of shared space features can be found around the world (e.g. [2-5]).

Shared space has been analysed fairly extensively in recent years, yet the focus has been almost exclusively on pedestrians and vehicle drivers, and to a lesser extent on pedal cyclists. The important group of Powered Two-Wheeler (PTW) users has so far remained largely under-represented, despite the unpredictable stance that its interaction with shared space features may exhibit. Namely, as motorised users, PTW riders (a.k.a. motorcyclists) may wish to maintain high travel speeds and may hence feel uncomfortable riding on streets with elements of shared space. On the other hand, however, as more vulnerable than car drivers, they may favour the "calmer" traffic conditions created by the shared space features. It is therefore important to investigate the perceptions of PTW riders towards shared space, and it is the aim of the present study to identify and quantify the factors that influence these through a stated-preference survey.

Background on PTW rider perceptions

In a study by Mannering and Grodsky [6] it has been identified that motorcycling requires a unique skillset, which includes the ability of high-level physical coordination and balance, that is similar in principle to pedal cycling, but much more demanding in terms of intensity. As such, PTW riders have in the past often been viewed as a small high-risk accepting group, whose primary purpose for riding is to seek excitement [7].

However, this claim has more recently been rebutted, as official statistics have shown that a large proportion of PTWs are used for non-leisure travel. For instance, according to the UK Department for Transport's (DfT) latest statistical release, over half (55%) of all motorcycle trips in England in the 2002-2016 period were carried out for the purpose of commuting and business – significantly higher than the respective proportion for all modes combined (19%) [8]. Indeed, most recent UK annual vehicle licencing statistics show that in 2017 there were as many as 110,000 new motorcycle registrations, which corresponded to almost 4% of all registered vehicles [9]. It can be, hence, concluded that PTW users are not a small minority with peculiar characteristics, but rather a mainstream road user group occupying a non-trivial proportion of the modal share.

An important pitfall of motorcycling, however, is that it is widely considered the least safe transport mode. Road safety statistics, unfortunately, confirm this perception as reality: according to the UK DfT's latest data, in 2017 there were over 18,000 casualties in Great Britain, 349 of which were fatalities. Considering the casualty and fatality rates, these were 6043 and 117 per billion passenger miles, respectively, greatly exceeding the corresponding pedal cyclist and pedestrian rates, and making PTW riders the most vulnerable road user group [10]. Past analysis from other countries has delivered similar findings (e.g. [11]). As a result, much of the previous research on PTW riders has concentrated on the central issue of safety.

Findings from several decades of studies on PTW crashes have identified a number of factors that contribute to this overall poor safety record. Both the seminal "Hurt" [12] and "MAIDS" [13] reports in the US and the EU respectively found that a substantial proportion of the crashes are caused by the often dangerous riding behaviour of the motorcyclists, which may include speeding and violating right of way. Other research demonstrated that a cause of crashes involving PTWs lies in the situational awareness of drivers and riders [14-15], and specifically in the absence of mutual awareness [16]. Indeed, it has been found that, perhaps paradoxically, both drivers and PTW riders may often overlook objects and events occurring close to them and in the central foreground, as more distant objects could catch and hold their views instead [17]. This phenomenon has been termed "inattentional blindness" [18], and the extent to which it occurs is variable, with the orientation, speed, size and shape of the objects in question playing an important part [19], along with conspicuity [20] and expectation [21].

The past research on motorcyclist safety reveals useful behavioural traits of PTW users, which can inform the investigation of their perceptions towards shared space. From the review of the research, a number of factors potentially affecting PTW rider comfort and confidence can be identified and categorised into two groups: internal elements and external elements. The former include the characteristics and attributes relating to the rider himself/herself, whereas the latter refer to the features relating to the surrounding conditions. A number of potential elements are listed in Table 1.

Table 1: Elements potentially affecting PTW comfort and confidence

Internal elements	External elements
Gender	Volume of vehicle traffic
Age	Pedestrian density
Riding frequency	Pedestrian types (children, elderly, disabled etc.)
Motorcycle type	Surface condition (wet/dry)
Trip characteristics (purpose, length etc.)	Paving materials and colour
	Lighting level
	Presence of obstacles
	Street space size (length and width)
	Presence of other motorcycles
	Traffic regulations
	Presence of pedal cyclists
	Parked vehicles
	Land uses

Survey design

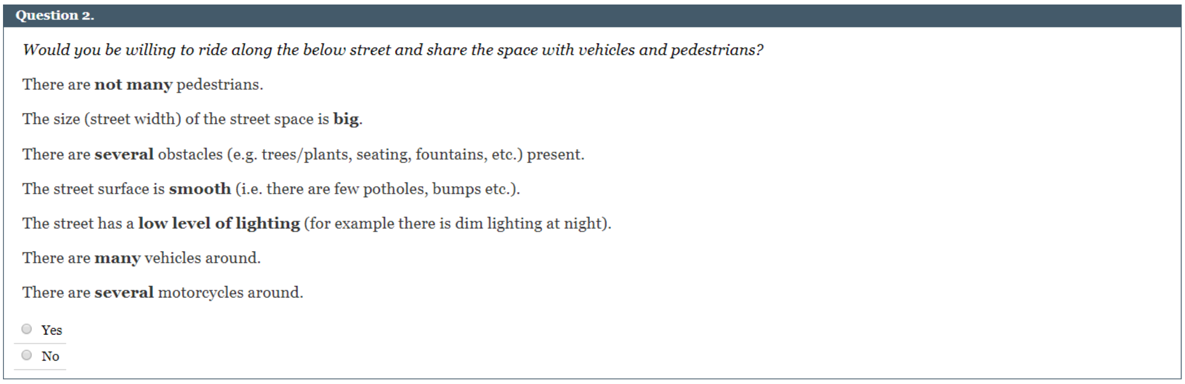
The target sample of the study includes all motorcyclists of all age groups and experience levels, given that they can all use a street with elements of shared space. Given the breadth of the target group, hence, the data collection has been conducted through a web-based survey in order to get as diverse a sample as possible. Regarding dissemination, the survey has been setup using the University of Southampton's "iSurvey" tool (https://www.isurvey.soton.ac.uk) and has been circulated to potential respondents through email lists and word of mouth.

The actual choice attributes and levels in the context of PTW users' willingness to share space need to be determined before surveying. As a result of a focus group consisting of staff and students from the University of Southampton, the list of external attributes given in Table 1 has been refined down to seven bi-level attributes included in the final survey. The attributes chosen and their corresponding levels are presented in Table 2.

Table 2: Attributes and levels

Attribute	Description	Level
Pedestrians (PD)	The number of pedestrians in the street	Many / Not
Space Size (SS)	The size (length and width) of the street space	Big / Small
Obstacles (OB)	Presence of obstacles (trees/plants, seating facilities, etc.)	Several / Few
Surface Condition (SC)	The condition of the street surface (due to potholes, bumps, ...)	Smooth / Rough
Lighting Level (LL)	The level of lighting provided (e.g. day- or night-time)	Good / Low
Vehicles (VT)	The number of vehicles in the street	Many / Not many
Motorcycles (MT)	Presence of other motorcycles in the street	Several / Few

The main part of the study is carried out in the form of a stated-preference survey, whereby each respondent is presented with a set of scenarios, i.e. combinations of selected attributes (and corresponding levels), to which he/she is asked to make a decision on whether he/she, as a rider on their motorcycle, would be willing to ride their motorcycle along the street and share the space with other road users. Each scenario consists of all seven attributes with a specific level for each attribute (Figure 2). The survey also includes questions on the respondent's age, gender, riding frequency, and motorcycle type, in order to define his/her characteristics. An introductory description of the concept shared space is also provided at the beginning of the survey to help set the context.


Question 2.

Would you be willing to ride along the below street and share the space with vehicles and pedestrians?

There are **not many** pedestrians.

The size (street width) of the street space is **big**.

There are **several** obstacles (e.g. trees/plants, seating, fountains, etc.) present.

The street surface is **smooth** (i.e. there are few potholes, bumps etc.).

The street has a **low level of lighting** (for example there is dim lighting at night).

There are **many** vehicles around.

There are **several** motorcycles around.

Yes

No

Figure 2: An example scenario

An issue that needs to be dealt with is 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 line with previous relevant work on the topic [22], a fractional factorial design is applied in order to reduce the number of scenarios without losing important information. For the survey on the PTW users' willingness to share space, a 1/16 fractional factorial design is used, which results in 128 / 16 = 8 questions. This is done following the method described in [23], which involves obtaining the full factorial (all combinations) for the first three most important factors (identified by the focus group) and then selecting certain levels for the remaining four factors by simple multiplication of the levels for the initial three factors, so as to confound some main effects' estimates with the estimates of the interaction effects of the initial three factors. The following three factors have been identified by the focus group as most important: pedestrian density, space size, and obstacles. It should be noted that a Resolution III design has been sought, i.e. one where main effects are not confounded with each other and can be estimated adequately reliably.

Table 3: The set of eight scenarios used in the survey in binary format

Factor	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Label	**PD**	**SS**	**OB**	**SC**	**LL**	**VT**	**MT**
Definition	***1***	***2***	***3***	***1*2***	***1*3***	***2*3***	***1*2*3***
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

Analysis methodology

Binary logistic regression is performed in order to interpret the responses obtained and fit a model to determine how each of the factors affects the PTW users' willingness to share space. The outcome of the model is the probability of a PTW rider willing to share the space with vehicles and pedestrians (SHARE, yes = 1, no = 0). The set of model attributes 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 1, i.e. pedestrians (PD, not many = 0, many = 1), space size (SS, small = 0, big = 1), obstacles (OB, few = 0, several = 1), surface condition (SC, rough = 0, smooth = 1), lighting level (LL, low = 0, good = 1), vehicles (VT, not many = 0, many = 1) and motorcycles (MT, few = 0, several = 1). Similarly, the respondent-specific (internal) variables are: gender (GEN, female = 0, male = 1), age (AGE, under 30 years = 0, 30-49 years = 1, over 50 years = 2), riding frequency (FRQ, occasionally = 0, frequently = 1) and motorcycle type (MTP, small = 0, big = 1).

The SPSS 25 statistical software package is used to perform the binary logistic regression and estimate the coefficients of the resulting logit model. 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 should be 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 *SHARE_1* (for SHARE = 1), and the independent variables *GEN_1*, *AGE_1*, *AGE_2*, *FRQ_1*, *MTP_1*, *PD_1*, *SS_1*, *OB_1*, *SC_1*, *LL_1*, *VT_1* and *MT_1* (for GEN = 1, AGE = 2, AGE = 3, FRQ = 1, MTP = 1, PD = 1, etc.). The model is thus of the form:

$$ln(1/(1-p)) = \beta_0 + \beta_1 \cdot (GEN\_1) + \beta_2 \cdot (AGE\_1) + \beta_3 \cdot (AGE\_2) + \beta_4 \cdot (FRQ\_1) + \beta_5 \cdot (MTP\_1) + \beta_6 \cdot (PD\_1) + \beta_7 \cdot (SS\_1) + \beta_8 \cdot (OB\_1) + \beta_9 \cdot (SC\_1) + \beta_{10} \cdot (LL\_1) + \beta_{11} \cdot (VT\_1) + \beta_{12} \cdot (MT\_1)$$

where p expresses the probability of the PTW rider willing to share space with vehicles and pedestrians.

Results

A medium-sized sample of 39 usable responses has been obtained. These correspond to a set of 264 individual scenarios used in the analysis (2 respondents have not provided answers to all scenarios), out of which 126 (48%) have been 'Yes' responses. With respect to the demographics of the sample of the usable responses:

- 27 of the 39 respondents are male, while 12 are female.
- 14 respondents are under 30 years old, 16 are between 30 and 49 and 9 are over 50.
- 27 respondents identify as frequent riders, i.e. riding a motorcycle at least once a week, while 12 are infrequent riders, i.e. riding up to once a month.
- 29 respondents ride a big motorcycle (i.e. cruiser, sport bike or touring bike), while 10 ride a smaller one (i.e. scooter/moped).

The results of the binary logistic regression are shown in Table 4. Considering the coefficients, it can be first observed that the constant term of the model is not statistically significant at the 0.05 level (since the "significance" value is greater than 0.05). This indicates that PTW users appear to be indifferent to sharing space with pedestrians and vehicles as a starting position and suggests that, according to the survey carried out, they do not have any initial favourable view or preoccupation towards the concept of shared space. Instead, it is the individual features and circumstances that "swing" a PTW user's opinion towards either position.

Table 4: Results of binary logistic regression for PTW riders' willingness to share space

Attribute	Variable	Coefficient (β)	Standard error	Significance
Male	*GEN_1*	0.136	0.388	.726
30-49 years old	*AGE_1*	-0.164	0.353	.642
Over 50 years old	*AGE_2*	-0.841	0.452	.063
Riding frequently	*FRQ_1*	0.596	0.344	.084
Big motorcycle	*MTP_1*	1.836	0.474	.000
Many pedestrians	*PD_1*	-1.990	0.497	.000
Big street space	*SS_1*	1.382	0.378	.000
Several obstacles	*OB_1*	-1.042	0.503	.038
Smooth surface condition	*SC_1*	0.857	0.387	.027
Good lighting level	*LL_1*	0.697	0.492	.156
Many vehicles	*VT_1*	-0.089	0.372	.812
Several motorcycles	*MT_1*		*dropped due to collinearity*	
Constant		-1.376	.771	.074

Number of observations = 264; chi^2 = 98.565; Sig. = .000; Pseudo-R^2 (Nagelkerke) = 0.416

Looking at the coefficients of the scenario-specific variables, it can be seen that high numbers of pedestrians and the presence of several obstacles have negative statistically significant effects on the willingness of motorcyclists to share space with pedestrians and other vehicles. On the other hand, riding through a big street space (in terms of length and width), or on a street that has a smooth surface, both have positive statistically significant effects. These all seem fairly reasonable. Namely, the presence of obstacles (e.g. trees, seating, fountains etc.) can severely obstruct the path of PTWs and may contribute to a negative riding experience; if, additionally, these obstacles are moving (i.e. pedestrians), then PTW riders would naturally feel more uncomfortable, as they would need to devote extra caution to their surroundings. On the other hand, a big space and a smooth street surface (with fewer potholes, bumps etc.) may enhance the riding experience and compensate for any potential discomfort caused by elements of shared space.

Considering the coefficients of the respondent-specific attributes, it can be observed that the variable relating to riding a big motorcycle type has a positive statistically significant coefficient. While unexpected, this finding is reasonable, as it points to the conclusion that, under the condition of increased interaction with other road users, riding a large motorcycle asserts the presence of the rider in the street and makes them feel more confident and comfortable than they would be if they were riding a smaller motorcycle.

Finally, it is noted that a number of model variables do not have statistically significant coefficients. This, however, does not necessarily mean that they do not influence the willingness to share of PTW users, as they may be confounded with other attributes when two-way and three-way interaction terms are added to the model. To investigate these, however, a minimum Resolution IV fractional factorial design would have been required, which would have increased the number of questions of the survey to impractical levels and would have, hence, limited the response rate. Alternative ways could be considered in this case, but such analysis lies beyond the scope of this study.

Concluding remarks

All in all, it appears that the perception of PTW riders towards shared space is closer to that of vehicle drivers rather than to that of pedestrians or pedal cyclists. Indeed, the results suggest that motorcyclists behave more like motorised users and less like vulnerable ones, as they mostly favour having relatively unobstructed passage through a road on a motorcycle that best asserts their presence and are not attracted by the "calmer" traffic conditions. Providing ample space and a smooth surface is likely to be the most effective way of achieving their integration in streets with elements of shared space.

While the present study has thrown some light into the under-explored topic of PTW user perceptions towards street designs with elements of shared space, research in this direction continues. It is important to complement the study with behavioural observations from real-world streets designed with elements of shared space so as to be able to confirm the findings and further investigate how motorcyclist behaviour and perceptions vary with different combinations and extents of shared space features. In particular, it would be interesting to introduce a cultural dimension to the analysis and investigate how the behaviour and perceptions may change between different cities and countries. This will form a solid basis towards the overall goal of ensuring that the needs and particularities of all road users, including PTW riders, are fully addressed in new designs.

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