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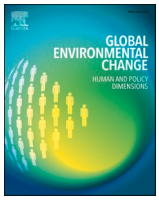

# Why do cars get a free ride? The social-ecological roots of motonormativity

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ABSTRACT

Motonormativity is a shared bias whereby people judge motorised mobility differently to other comparable topics. This works against societies addressing climate and public health crises effectively. A social-ecological explanation has been suggested for the phenomenon, in which motonormativity is shaped by people's environments, but this has not been tested. Here we used a large international sample (N = 2035) and novel within-participants testing to show, for the first time, at least two environmental pathways linked to judgement biases: one related to people's social surroundings and linked with their explicit views on transport, and a separate, more implicit pathway related to higher-level structural influences such as nationality, and living in rural areas. Additionally, respondents dramatically underestimated public support for non-motorised transport relative to their own, a pluralistic ignorance effect likely reflecting another facet of motonormativity. The social-ecological explanation, with its nested environmental influences, helps explain the 'stickiness' of automobility, and implies change will be most likely when multiple facets of a person's social, physical and cultural surroundings align in supporting non-motorised mobility.

## 1. Introduction

Societies around the world struggle with the consequences of over-reliance on private motoring, which is significantly contributing to climate change through emissions (Kazancoglu et al., 2021), local air pollution through (ultra) fine particles (Oliver et al., 2024), road violence through injuries (Miner et al., 2024), urban heat through paved surfaces (Brandsma et al., 2024), noise pollution (Welch et al., 2023), social exclusion (Lucas, 2012) and a large number of related physical and mental health problems (Nieuwenhuijsen & Khreis, 2016).

Walker, Tapp and Davis (2023) suggested that slow progress in addressing these challenges is linked to shared biases that prevent people and institutions from judging motorised transport objectively and dispassionately – a phenomenon they labelled motonormativity. Their suggestion is that motorised mobility is widely and implicitly seen as both normal and proper, so its needs become automatically centred in policy, discourses, decisions and behaviour, potentially within a self-reinforcing cycle. They experimentally demonstrated people's tendency to use different norms and moral standards in judgements of comparable motoring and non-motoring situations using a large representative sample of United Kingdom residents, showing, for example, that while most people think the police should act when an unattended 'car' is stolen, far fewer think the police should act when unattended 'belongings' are stolen. The phenomenon was rapidly replicated in the UK by Frost and Hobbs (2024) and in the United States of America by Goddard (2024). A potentially important finding in these studies is that people who did not themselves rely on motorised mobility tended to show similar pro-motoring biases to people who were regular drivers.

To explain how these biases are shaped, such that they seem to be shared even by non-drivers, Walker et al. (2023) proposed a social-ecological framework (Fig. 1). This suggests that a person's ideas about what behaviours are normal and proper are shaped throughout their life by their social, physical and cultural environments. These potentially mutually reinforcing environments include (1) the micro system of intimate social relationships, in which certain behaviours are modelled and approved by important others; (2) the meso system, where everyday observations of other people tells us what actions are 'normal' in wider society; (3) the exo system, in which behaviours are facilitated or hindered by our physical and legal environments; and (4) the macro system of culture, in which media, news and discourses send messages about which behaviours are and are not valued by society.

Comparable social-ecological frameworks have been employed in child development (Bronfenbrenner, 1974), public health (Egger & Swinburn, 1997; Giles-Corti & Donovan, 2002) and psychology (van den

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Broek et al., 2019) to show people's environments can be key drivers of perceptions and behaviour. Walker et al. argued that in many societies, the various environmental influences in Fig. 1 tend to push in the same direction, reinforcing the message that private motorised mobility is normal, proper and desirable, and that its harms are both inevitable and unimportant. Walker et al. suggested that this repeated lifelong messaging in support of private motorised mobility, from multiple mutually reinforcing layers of the environment, is what leads people automatically to apply different moral and ethical standards to motoring than to other topics. These standards might in turn further solidify by shaping those environments, especially through institutional action.

Here we provide the first test of whether motonormative judgement biases can be explained by such social-ecological environmental influences. To include a range of physical and cultural environments we sampled from the United Kingdom and the United States of America, both of which were used in past motonormativity studies, and added participants from The Netherlands. It was an open question whether motonormative biases would be weaker here (thanks to a greater tradition of non-motorised mobility feeding into cultural norms and infrastructure – Pucher & Buehler, 2008) or stronger (The Netherlands has heterogeneous cycling levels across municipalities [Harms et al., 2014] and we note static levels of non-car travel in recent decades while the number of cars per capita kept growing to a higher level than in the UK).

## 2. Method

### 2.1. Design

This study used a structural equation modelling approach to look for associations between a range of environmental indicators and motonormative judgement biases (as the main outcome variable) and explicit pro-car attitudinal biases (as a potential pathway variable). The study used a repeated-measures design in which all participants answered all questions. This is a development from previous studies in this area (Frost & Hobbs, 2024; Goddard, 2024; Walker et al., 2023), which used designs where people judged only car-related situations or only non-car situations. The move to a repeated-measures approach provides the ability to model the causes of biases at an individual level.

### 2.2. Participants

2407 people completed the survey. Participants who finished in less than 120 s were removed (n = 45), as these potentially represented people not paying attention. An error with the survey setup meant that 268 early respondents did not see the full set of questions in Table 2 and these people were also removed from the sample, as were people who had left the survey without answering all the questions (n = 59). These steps left us with a final sample of 2035 complete cases for analysis. Demographic information about the sample is given in Table 1.

### 2.3. Materials

The main part of the study had participants rate their agreement with a set of statements that fell into three groups: (1) a pair of statements assessing the respondents' personal support for car travel and non-car travel; (2) statements measuring perceptions of how strongly car travel and non-car travel are supported by (a) close social networks (the micro system in Fig. 1), (b) other observed people (the meso system), (c) the built environment and government policy (the exo system); and (3) five pairs of statements to assess motonormativity. The questions are shown in Table 2. These items were designed to work as opposing pairs, such that the rating of one could be subtracted from the rating of the other to produce a meaningful difference score.

**Table 1**
Demographic information from 2035 participants.

| | Netherlands (N = 660) | UK (N = 685) | USA (N = 690) |
|---|---|---|---|
| Mean age (SD) | 31 (9.4) | 42 (13.2) | 36 (11.9) |
| Median age (range) | 29 (18–75) | 39 (18–82) | 33 (18–74) |
| Gender | Female 47 %<br>Male 52 %<br>Other 1 % | Female 48 %<br>Male 51 %<br>Other 1 % | Female 49 %<br>Male 49 %<br>Other 3 % |
| Location | City centre 27 %<br>City outskirts/ suburbs 53 %<br>Rural/village 19 % | City centre 12 %<br>City outskirts/ suburbs 63 %<br>Rural/village 25 % | City centre 24 %<br>City outskirts/ suburbs 63 %<br>Rural/village 12 % |

Note: percentages might not sum to exactly 100% owing to rounding.

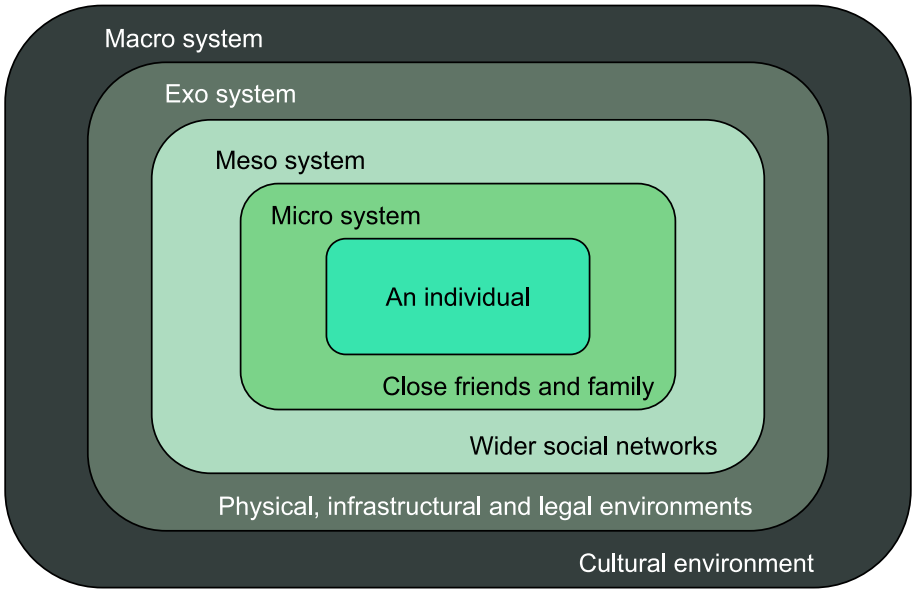


**Fig. 1.** A social-ecological framework within which an individual's perceptions of normality and propriety are shaped by a range of environmental influences from the very proximate micro system to the more distant – but more all-encompassing – macro system.

**Table 2**
Pairs of statements rated by participants to assess attitude to car v non-car travel, motonormativity and perceptions of the socio-ecological environment.

| | | | Statement 1 rating minus Statement 2 rating, Mean (SD) | | | |
|---|---|---|---|---|---|---|
| Measure | Statement 1 (agreement rated 1–7) | Statement 2 (agreement rated 1–7) | Overall | NL | UK | USA |
| Is car travel seen as more important than non-car travel? | I think it is important that people can travel by car | I think it is important that people can travel without using a car | −0.48 (1.87) | −1.12 (1.79) | −0.28 (1.79) | −0.05 (1.86) |
| Micro-system social norms of close contacts | My close friends and family would think it is important that people can travel by car | My close friends and family would think it is important that people can travel without using a car | 0.86 (1.98) | 0.25 (1.79) | 1.00 (1.93) | 1.30 (2.05) |
| Meso-system social norms of other people | People who live in my local area think it is important that people can travel by car | People who live in my local area think it is important that people can travel without using a car | 0.82 (2.07) | 0.10 (1.92) | 0.71 (1.83) | 1.62 (2.15) |
| Exo-system influences of physical infrastructure | My local streets my traveling by car easy | My local streets make it easy to travel without using a car | 0.65 (2.24) | −0.37 (1.96) | 0.44 (1.98) | 1.84 (2.18) |
| Exo-system policy influences | My government supports people who travel by car | My government supports people who travel without using a car | 0.40 (2.21) | 0.10 (2.28) | −0.12 (2.02) | 1.21 (2.10) |
| Motonormativity (1) | People shouldn't smoke in highly populated areas where other people have to breathe the cigarette fumes | People shouldn't drive in highly populated areas where other people have to breathe the car fumes | 2.15 (1.87) | 1.77 (1.73) | 2.25 (1.82) | 2.42 (1.98) |
| Motonormativity (2) | People shouldn't play loud music in highly populated areas where other people have to hear it | People shouldn't drive loud cars in highly populated areas where other people have to hear them | 0.39 (1.60) | 0.41 (1.62) | 0.42 (1.60) | 0.33 (1.57) |
| Motonormativity (3) | There's nothing we can do to stop people dying in traffic | There's nothing we can do to stop people dying of diseases | −0.43 (1.53) | −0.41 (1.48) | −0.53 (1.54) | −0.36 (1.58) |
| Motonormativity (4) | People operating motor vehicles should be responsible for any harm they cause | People operating dangerous machinery should be responsible for any harm they cause | −0.29 (1.30) | −0.33 (1.31) | −0.38 (1.37) | −0.16 (1.21) |
| Motonormativity (5) | We should use tax money from people who don't drive cars to support people who want to drive cars | We should use tax money from people who don't ride bicycles to support people who want to ride bicycles | −0.91 (1.94) | −1.41 (2.08) | −0.63 (1.87) | −0.73 (1.77) |

Two of the pairs of matched items intended to assess motonormativity were taken from past research: the pair of statements comparing exposing people to car fumes v. cigarette fumes, as these produced the strongest contrast in Walker et al. (2023)[1]; and the pair of statements that was identical to that first pair, except referring to loud music instead of fumes (as introduced by Frost & Hobbs, 2024). The remainder of the motonormativity items were created for this study, thereby testing whether the motonormativity phenomenon could be seen with previously untested items. These new statements covered topics that seemed interesting and relevant expansions of the original motonormativity context.

For transparency, we also had two further pairs of motonormativity statements that rated participants' agreement with ideas about parking facilities versus non-car storage. However, including these in the statistical modelling process considerably reduced the indices of model fit (CFI fell from 0.90 to 0.77). Further investigation revealed a mistranslation on the Dutch version, which might explain this. We therefore dropped these two items from the analysis.

### 2.4. Procedure

Participants were recruited using the Prolific platform and were paid £1 UK (or the equivalent in local currency) for completing the survey. This took 5.7 min on average, meaning the effective hourly rate was £10.53. Data collection used an online survey hosted on the Qualtrics platform.

Three versions of the survey were created, one for each country. The UK and USA versions were identical except for a small number of spelling differences; the Netherlands version was translated into Dutch by one of the experimenters. Each version began with a clear instruction that participants should only take part in the study if they lived permanently in the respective country – a necessary step given our interest in how the respondents' everyday environments shaped their perceptions.

Following an active consent process, which redirected participants away from the survey if they did not consent to take part, four questions asked some basic demographic information (age, gender, travel behaviour and residential location [city centre, city outskirts, suburbs, village or rural]). Then followed the statements from Table 2, presented one at a time, in random order for each participant. Each was prefaced by 'How much do you agree or disagree with this statement?'. Participants were unable to move backwards through the statements, meaning they could not change an earlier response after seeing a later question – a precaution to facilitate our showing people two versions of each statement. Participants rated their agreement with each statement on a seven-point scale from 'strongly disagree' to 'strongly agree'.

### 2.5. Data preparation

Demographic descriptions of the final sample are shown in Table 1, where it is apparent that gender balance is comparable across the nations but there are age differences ($F_{2,2032} = 150.0$, MSE = 135.0, $p < 0.001$), with the UK participants the oldest on average and the Netherlands participants the youngest, perhaps representing skews in the user base of the Prolific platform. There are also substantial differences in the self-reported urban–rural locations. Both these variables were accordingly included within the main analysis. Data inspection showed that urban categories meant different things across our nations (e.g., almost no Americans said they lived in a village, but a reasonable number in Europe said they did), so for analysis the category 'village' was subsumed within 'rural' and 'city outskirts' was subsumed within 'suburbs', as shown in Table 1.

[1] As Table 2 shows, the mean difference in rating between these two items here was 2.15 points on the 7-point scale. For interest, we re-analysed data from Walker et al. (2023) where this same question-pair had been used. The mean difference there between the same two items was 1.60. However, that earlier study used a 5-point scale. Multiplying this difference by 7/5 gives a value of 2.24, showing that closely comparable results are seen in the independent-measures design of that earlier study and the repeated-measures design used here. We thank the anonymous reviewer who suggested comparing the same effect across the two studies.

As shown in Table 2, pairs of items were combined to create unified variables, each capturing the difference between two opposed statements to assess perceptions of the micro (friends and family), meso (local people), exo (local streets, government) systems surrounding each respondent, and five facets of motonormativity. Every item had been rated on a 7-point Likert scale, so these new combined scores ranged from −6 to +6.

### 2.6. Modelling

Structural equation modelling was carried out using the R lavaan package (Rosseel, 2012). As shown in Fig. 3, the latent variable of motonormativity was modelled from the five subscales. This was then predicted from the measure of explicit pro-car attitude, which had been created by subtracting each person's support for non-car travel from their support for car travel, as described above. In turn, this measure of explicit attitude, as well as motonormativity, was predicted from two dummy coded nationality variables (with Netherlands as the reference category), from two dummy coded location variables (suburbs and rural, with 'city centre' as the reference category), from age (which had been normalised to have a mean of zero and standard deviation of 1), and from ratings of support for car travel vs non-car travel within the micro, meso and exo systems, created as described above. Gender and travel behaviour were tested during the modelling process but did not have useful predictive ability. As they were not specifically part of the theory we were testing, they were not retained in the model.

### 2.7. Open science

The dataset and analysis scripts used for this study are available from https://osf.io/j8gxy/. These permit the easy replication of the results reported here.

## 3. Results

Table 2 contains simple comparisons of how the pairs of contrasting statements were rated. This shows how respondents in the Netherlands seemed to value non-car travel more than respondents in the UK and, especially, the USA; how the social norms of non-car travel might be more apparent in the Netherlands' meso-system ratings; how all three nations were broadly similar in how they viewed the degree of control society has over deaths from traffic versus deaths from disease; and how people tended to rate their own support for non-car travel higher than other people's.

Fig. 2 shows how respondents' support for car and non-car mobility compares to their perceptions of support from their micro- (family and friends), meso- (other people) and exo-system (infrastructure and government policy) environments. On each scale, the respondent's level of support has had the comparator's perceived level of support subtracted from it. This means positive scores (shown in pink) come from people who rated their own support higher than the comparator's and negative scores (shown in blue) come from respondents who rated their own support lower than the comparator's. The three percentages on each row show the proportion of respondents who felt their support was less than, equal to, or greater than the comparator's support respectively. For example, on the top row, 24 % of UK respondents felt their support for car travel was lower than their friends/family, 51 % felt their support was the same and 25 % felt their support was higher.

For non-car travel specifically, the majority of people thought their level of support was above average. For example, 66 % of USA respondents thought they supported non-car travel more than other local people, and only 8 % felt that other local people were more supportive than they were. Interestingly, participants tended to feel they supported both car *and* non-car travel more than did their governments, particularly in the UK. The extent to which Netherlands infrastructure is perceived to support non-car travel better than UK and USA infrastructure might be visible in the chart's penultimate row, but still, most people in The Netherlands considered their own support for non-car travel to be stronger than infrastructural and, especially, government support.

### 3.1. Testing the social-ecological model

A structural equation model (SEM) predicted motonormativity as a latent construct measured by 5 subscales, each contrasting a motoring judgement with an equivalent non-motoring judgement. This composite


**Fig. 2.** Respondents' support for car and non-car travel compared with perceived support from four social-ecological environmental sources. Positive scores represent people who felt their own support was greater than the comparator's.

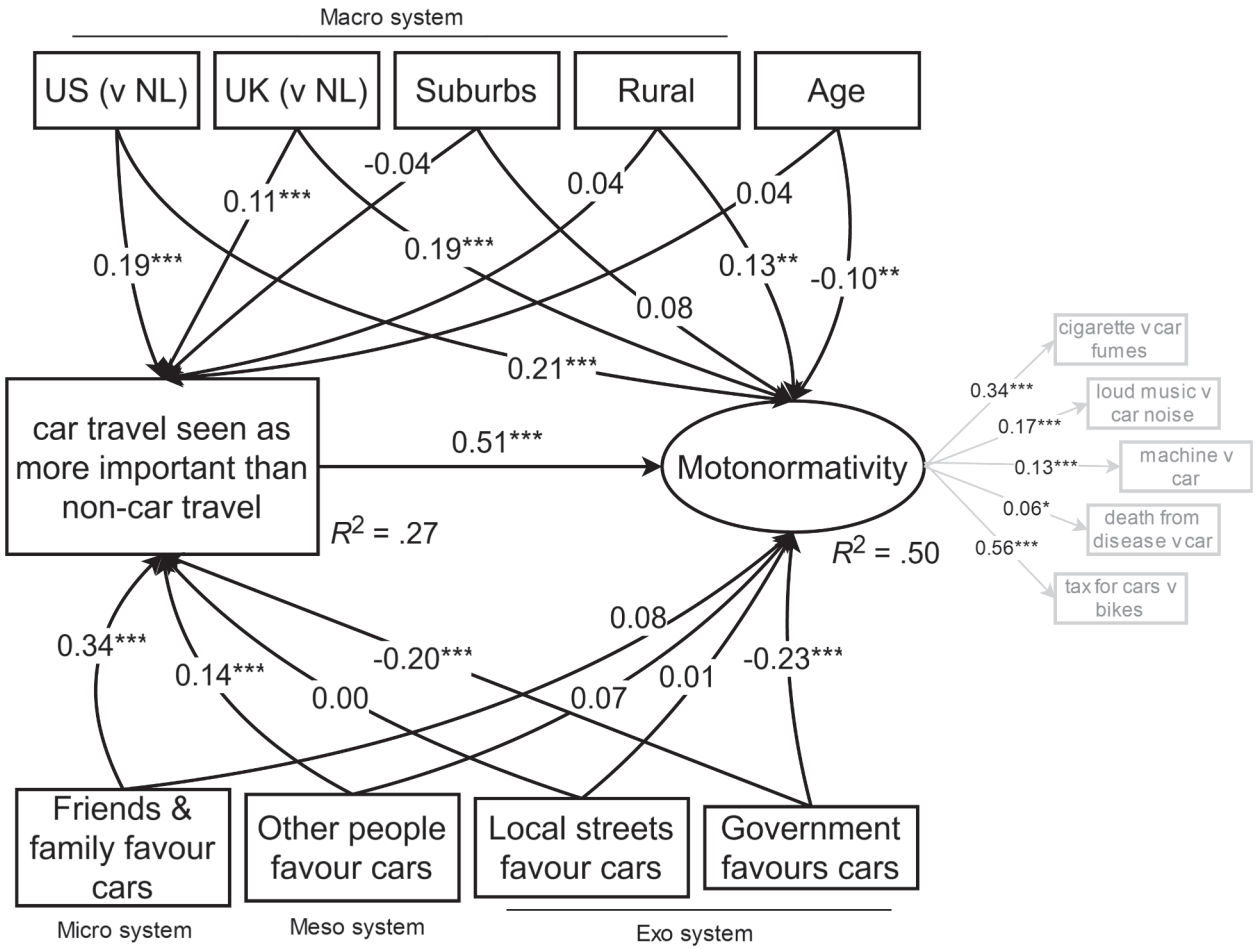


**Fig. 3.** Structural equation model predicting explicit pro-car support and motonormativity from demographic and environmental predictors. Scores on arrows are standardized marginal coefficients. $^{*}p \leq 0.05$, $^{**}p \leq 0.01$, $^{***}p \leq 0.001$.

motonormativity score was predicted from individual support for car travel versus non-car travel. In turn, both these measures were predicted from (1) four measures that assessed how well the socio-ecological environment was seen to support car travel (at micro, meso, and exo levels – shown along the bottom of Fig. 3), (2) normalized age, and (3) dummy variables coding the macro-level influences of respondents' nations and residential locations. The SEM is shown in Fig. 3. This fit the data quite well, with RMSEA = 0.037 (95 % CI 0.031 to 0.043), Standardized Root Mean Square (SRMS) residuals = 0.025, CFI = 0.90, $\chi^2$ (45) = 168.17, $p < 0.001$, $R^2 = 0.50$ for motonormativity and $R^2 = 0.27$ for individual attitudes to car versus non-car travel. Although the five components of motonormativity that were tested here were all significantly related to the latent variable in the SEM, the items were not strongly correlated with one another (Cronbach $\alpha = 0.28$) and we return to this in the Discussion. Nevertheless, the $R^2$ values suggest that the model's prediction of the outcome measures was reasonably good.

As well as showing that the most important predictor of pro-car judgement biases was explicit pro-car attitude (the horizontal arrow), Fig. 3 provides several other insights: (1) explicit pro-car attitude seems to be related particularly to what other people are thought to believe, with separate influences of micro (friends and family), meso (descriptive social norms) and exo (government, but not infrastructure) systems; (2) the relationship between social norms and motonormativity seems to be mostly linked through explicit attitudes to car versus non-car travel; (3) motonormativity is also separately predicted by 'objective' macro-level characteristics of the environment, including living outside The Netherlands, and living rurally; (4) there is a small negative relationship between age and motonormativity, even though explicit views didn't seem to change with age; (5) some of the predictors have separate effects on explicit attitudes and implicit motonormativity – most notably, perceptions of government support for pro-car transport policy had separate negative relationships with both explicit and implicit measures of pro-car bias.

Table 3 shows the direct, indirect and total effects of the SEM predictors on motonormativity. There are predictors in Table 3 that have (a) significant total effects almost entirely carried by the indirect effect via pro-car attitudes (friends/family), (b) significant total effects but non-significant indirect effects (rurality, age), and (c) significant total effects and substantially reduced indirect effects compared to the total

**Table 3**
Standardized coefficients (*p*-values) from the Structural Equation Model for direct, indirect and total effects of predictors on motonormativity.

| Predictor | Direct effect | Indirect effect | Total effect |
|---|---|---|---|
| Macro: US residence (v NL) | 0.21 (< 0.001) | 0.10 (< 0.001) | 0.31 (< 0.001) |
| Macro: UK residence (v NL) | 0.19 (< 0.001) | 0.06 (< 0.001) | 0.25 (< 0.001) |
| Macro: Suburbs (v city) | 0.08 (0.06) | −0.02 (0.16) | 0.06 (0.15) |
| Macro: Rural (v city) | 0.13 (0.003) | 0.02 (0.17) | 0.15 (0.001) |
| Exo: Local streets | 0.01 (0.81) | 0.00 (0.93) | 0.01 (0.84) |
| Exo: Government | −0.23 (< 0.001) | −0.10 (< 0.001) | −0.33 (< 0.001) |
| Meso: Other people's attitude | 0.07 (0.09) | 0.07 (< 0.001) | 0.14 (0.001) |
| Micro: Friend/family attitude | 0.08 (0.06) | 0.17 (< 0.001) | 0.25 (< 0.001) |
| Age | −0.10 (0.007) | 0.02 (0.07) | −0.08 (0.04) |

effect (e.g., government policy). This pattern clearly supports the idea that motonormativity is influenced by multiple aspects of a person's environment through at least two pathways: one direct, and another indirect. The indirect pathway sees motonormativity linked to aspects of the social-ecological environment via explicit attitudes to whether car travel is more important than non-car travel.

The SEM process calculated each person's motonormativity level as a latent variable measured in standardized units. The distribution of these scores is shown in Fig. 4. Mean scores were: Netherlands = -0.07 (SD 0.43), UK = 0.34 (SD 0.42), USA = 0.36 (SD 0.40). These scores were significantly different from one another ($F_{2,2032} = 227.4$, MSE = 0.17, $p < 0.001$). Holm-Bonferroni-corrected pairwise *t*-tests showed that the Netherlands' mean motonormativity score was significantly lower than the other two countries (both $p < 0.001$) whereas the UK and USA did not differ significantly ($p = 0.55$).

## 4. Discussion

This study (1) replicated the phenomenon of motonormativity, whereby people sometimes apply different standards to judgements about motoring than to judgements about other topics; (2) compared these biases across three nations with overlaps and differences in their cultures and transport infrastructures, finding lower levels in the Netherlands; (3) for the first time looked at motonormativity at the level of the individual, using repeated-measures analysis; and (4) provided the first test of whether the motonormativity phenomenon is related to a person's perceived social, physical and cultural environments, thereby evaluating a social-ecological explanation for the origin and maintenance of these biases. Our analysis suggests that a person's tendency to show judgement biases favouring motoring involves at least two pathways: one related to explicit views on the primacy of car travel over non-car travel, which in turn is related to people's local – especially social – environments, and a separate pathway in which motonormativity is associated with 'objective' macro-level factors like nationality and living in rural areas, and so likely represents cultural and/or infrastructural influences.

This study also showed that many participants believed their own attitudes to transport were substantially different to other people's. This might align with the phenomenon of *pluralistic ignorance* (Prentice & Miller, 1996), in which a majority of people wrongly believe that the social consensus is different to their own ideas, and that they are in a minority. Here, most of our respondents tended to assume that other people held different views to themselves – especially when asked about non-car travel, where respondents quite consistently assumed they were more supportive than they believed other people to be (e.g., 66 % of USA respondents thought they supported non-car travel more than other local people, and only 8 % felt other people were more supportive than they were). While our sample was not necessarily fully representative of the three nations, we note that these findings align with data from BikeIsBest (2020), who did use a nationally representative UK sample and who showed a comparable pluralistic ignorance effect whereby people systematically underestimated popular support for more cycle travel. This is all potentially relevant to policymakers who might find it difficult achieving public support for changes to road systems: it is possible public support for changes to road systems becomes 'hidden' because people tend incorrectly to assume that their (majority) desire for change represents an unpopular minority view. As a result of this misperception, people wanting change might not express this publicly, prompting people opposed to change to believe that they represent a majority and thereby claiming (and getting) full attention in public debate. If this reasoning is correct, policymakers in future might seek ways to make hidden voices public. For example, what we often see in heavily debated policies to lower car dependency is a call for a referendum. But where that does happen, it can further strengthen this dynamic, with a low turn-out where a majority does not vote – quite plausibly because they think their view is a minority view. Instead, given the findings presented here, when policymakers need properly to understand public perceptions on topics that are likely to be affected by motonormativity and its concomitant pluralistic ignorance effect, methods such as representative polling, or participatory value evaluation (PVE), might be better for providing a broader understanding of the variety of opinions throughout society (Mouter, 2021).

The social-ecological explanation of motonormativity, with its multiple, potentially aligned influences (Walker et al., 2023), implies that biases (and, likely, behaviour) will tend to be 'sticky', resisting change unless multiple facets of a person's environment support this – a suggestion that aligns with, and might help explain, the conclusion of the most recent systematic review of active travel interventions (Roaf et al., 2024), which pointed to the importance of infrastructural change. Those seeking to shift mobility judgements and actions might usefully focus their efforts away from individual behaviour change and towards modifying structural enablers at the outer macro- and *exo*-system layers shown in Fig. 1, as these necessarily affect multiple environmental influences for multiple people – perhaps even synergistically shaping micro and meso social norms in the process. This 'outward-in' approach is congruent with recent work on how infrastructural enablers can shape

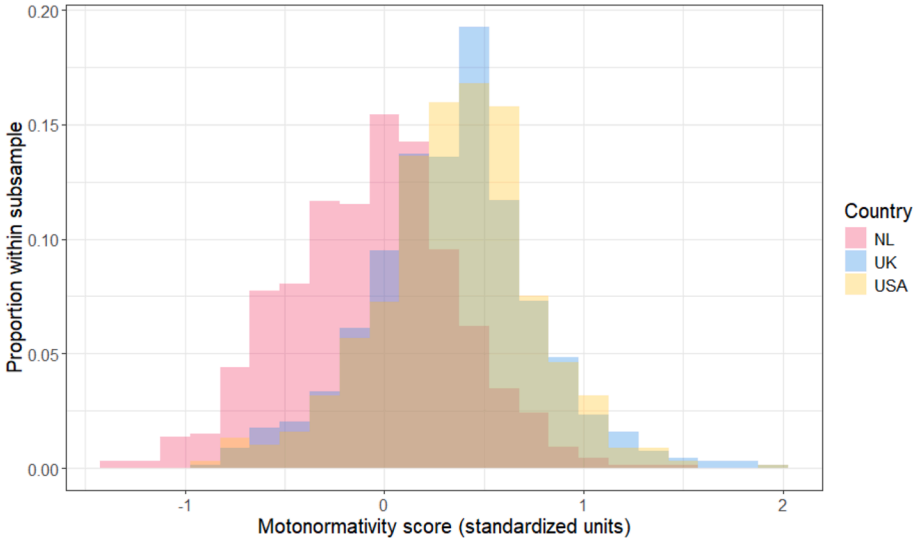


**Fig. 4.** Distribution of motonormativity scores (in standard deviation units) by country.

behaviour which, in turn, shapes attitudes (Rahman & Sciara, 2022; van Wee et al., 2019). It not only sidesteps problems with asking individuals to act in ways their surroundings do not support – a concern with many traditional behaviour change approaches – but might even have benefits for policy acceptance amongst the public (de Groot & Schuitema, 2012; Diepeveen et al., 2013; Grelle & Hofmann, 2023).

Meaningful and pragmatic approaches to addressing motonormativity at the macro level might include action to alter the taken-for-granted language, narratives and norms around motoring. A first route here is explicitly to recognise the agency of people causing harm and the non-inevitability of their doing so (Laker, 2021; Te Brömmelstroet, 2020, 2024; Te Brömmelstroet et al., 2022). From here, one could formally signal that because private motoring always imposes harms onto others, however useful it is to the person driving, it is reasonable to expect a responsible member of society to minimise these harms as much as possible. A second route could avoid the current 'stickiness' of motonormativity by activating different norm sets. For example, where it is suspected that motonormativity might distort perceptions of a policy, people might be reminded of outcomes that they value (e.g., improving the mental or physical health of children) and the discussion focused around the policy's ability to delivery these outcomes. This could avoid the discussion becoming fixated on specifics of changing traffic, which after all is only an intermediate step towards these wider goals, and might help unlock currently 'hidden' support for non-car mobility or car-reduction schemes.

At the exo level, as well as highlighting 'hidden' support for change, those seeking to change streets might, in light of our findings, avoid an all-or-nothing proposition that activates motonormativity. A specific strategy that might help overcome societal resistance or fear of change is honest experimentation. Norms can be challenged through actual embodied experiences of change in a context where tension is limited, and collective learning can take place. For transport, street experiments are intentional, temporary changes of street use, regulation and/or form, aimed at exploring systemic change in urban mobility (Bertolini, 2020; VanHoose et al., 2023) and offer a tangible, realistic mechanism to begin action for change.

Finally, future policymakers might also usefully note our interesting and unexpected finding that there are separate negative relationships between perceptions of government travel policy and (1) explicit views on the importance of car versus non-car travel and (2) motonormativity. Fig. 2 also shows a pervasive effect, across all three nations, but particularly the UK, whereby people felt their own views were out of line with government policy *whatever this was*: government was seen as simultaneously less supportive than respondents for driving and for not driving. This might suggest that governments are not trusted on travel policy, whatever they say about it. It is plausible that this is linked to governments historically failing to take a sufficiently clear stance on the value of non-car mobility and the harms of motorised mobility (see Xiao et al., 2022, for a review). Either way, the paradox we have identified here provides an insight that could usefully feed into future policy communications strategies.

## 5. Limitations

The relationships we measured between personal pro-car attitudes and people's social environments likely arise because social relationships shape people's attitudes, but in the absence of longitudinal or experimental data it remains possible that the relationships we saw arose because, when we asked about the views of other people, our respondents made the assumption that these views must align with their own, representing a false consensus effect (Marks & Miller, 1987; Ross et al., 1977). However, the suggestion that respondents assumed other people's views must align with their own is not compatible with the signs of a pluralistic ignorance effect seen in Fig. 2. It is notable how the pluralistic ignorance effect arose most clearly for non-car travel, which is not a normative behaviour in these societies, and might even be seen as a progressive stance.

People's attitudes to car versus non-car travel were assessed by subtracting their explicit agreement with the statement 'I think it is important that people can travel without using a car' from their agreement with the statement 'I think it is important that people can travel by car'. This approach is simple – it is effectively just combining two Likert scales to create a clear unified score with a greater range – and our measure of pro-car attitude was predicted reasonably well in our model, suggesting that it had some validity. At the same time, we appreciate that there could have been advantages from measuring pro-car attitudes in a multidimensional way, as with the multiple pairs of statements used to measure motonormativity. Speaking of which, we note that these five pairs of statements were chosen somewhat arbitrarily, based on comparisons that we thought should be interesting, and where we saw potential for double standards to show themselves. In the structural equation model, some of the subscales loaded more highly onto the latent measure of motonormativity than others, as shown in Fig. 3. We did a sensitivity analysis by removing each of the five subscales from the SEM, and in no case did this qualitatively change the findings of the study, but given the loadings, and the low Cronbach alpha reported earlier, it is likely that a better set of motonormativity measures could have been found, and we do not claim to have used the ideal set of items here. At the same time, it could be argued that any weaknesses in measuring motonormativity effectively strengthen our conclusions: we found substantial effects ($R^2 = 0.50$) even with what might be an imperfect measure of the outcome variable. It is likely the findings would only have become clearer with a better set of measures assessing motonormativity.

Finally, our recruitment method did not provide representative samples of the population in each country. However, we were not attempting to compare the proportion of people in each nation endorsing a particular perspective, as with an international opinion poll. Rather, because we were looking at how social, policy, infrastructural and cultural environments influence judgements at an individual level, we sampled from multiple countries primarily as a way of increasing the heterogeneity in our participants' environments. We wanted only moderate heterogeneity, however, as testing three entirely distinct subgroups of respondents would have limited our ability to test a social-ecological model. This is why we compared three relatively similar Western nations rather than one of these countries and, say, India or China. Extending to a broader range of nations would now be a useful next step.

## 6. Conclusions

Motonormativity leads people to use different standards when judging motor transport than when judging other topics, and this might prevent people and institutions making rational decisions about motoring and its various harms. Using a large international sample we provided evidence, for the first time, that this tendency is related to multiple facets of people's social, physical and cultural environments, as predicted by a social-ecological framework. Our study also showed a widespread tendency for respondents to believe they were more supportive than their governments for both car travel and non-car travel: a superficially paradoxical finding that likely raises questions of how much governments are trusted on transport policy. Finally there was a pluralistic ignorance effect, where most people in our study felt they supported non-car mobility more than other people. This lack of awareness of what other people think about non-car mobility might help explain public resistance to attempts to promote it. Based on the findings here, we offered several suggestions for policymakers to help them overcome motonormative biases and pluralistic ignorance effects when enacting future transport policies.

## 7. Author note

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## CRediT authorship contribution statement

**Ian Walker:** Writing – review & editing, Writing – original draft, Visualization, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Marco te Brömmelstroet:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Funding acquisition, Conceptualization.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Data availability

Our data and code are publicly available and this is explained and linked in the paper

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