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Cycle Commuting and Perceptions of Barriers: Stages of Change, Gender and Occupation

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Structured Abstract:

Purpose - The aim of this study was to investigate perceptions of cycle commuting barriers in relation to stage of change, gender and occupational role. Stage of change is a key construct of the transtheoretical model of behaviour change that defines behavioural readiness (intentions and actions) into five distinct categories.

Design/methodology/approach - A cross-sectional online questionnaire was completed by staff and PhD students (n=831) based in cycle-friendly buildings in a large UK university. The questionnaire included questions relating to demographics, stages of behaviour change

and 18 potential barriers. Data were analysed using t-tests, one-way ANOVAs and two-way ANOVAs.
Findings - Overall, environmental factors were perceived as the biggest barriers to cycle commuting. However, perceptions of cycle commuting barriers significantly differed between stages of change, genders and occupational roles. Precontemplators, females and support staff commonly perceived greater barriers to cycle commuting compared to maintainers, males and academic staff.
Practical implications - The results indicate that tailored individual-level behaviour change interventions focusing on reducing perceptions of barriers that take into account stage of change, gender and occupational differences may play a role in encouraging people to cycle to work.
Originality/value - The study reveals evidence of a significant subjective element involved in perception formation of some potential barriers associated with cycle commuting. Women not only hold stronger perceptions compared to males of risk-orientated barriers but also of more general barriers associated with cycle commuting. The findings also suggest that occupational roles may influence an individual's perceptions of cycle commuting barriers.

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Cycle commuting and perceptions of barriers in relation to stages of change, gender and occupation

Abstract

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commuting. Women not only hold stronger perceptions compared to males of risk-orientated barriers but also of more general barriers associated with cycle commuting. The findings also suggest that occupational roles may influence an individual's perceptions of cycle commuting barriers.

Introduction

In western countries sedentary living is causing severe health consequences (Sallis and Owen, 1999). Over-reliance on motorised transport means that people walk and cycle less than in the past. Cycle commuting is recognised as a favourable activity because it provides an opportunity for regular physical activity within the working population (Vuori *et al*., 1994). While national UK policies and provisions for cycling lag somewhat behind other European countries such as the Netherlands, Germany and Denmark (Pucher and Buehler, 2008), in the UK cycling for transport is increasingly being promoted as a healthy behaviour. The promotion of utilitarian cycling is important not only for the health benefits it can bring but also for the positive consequences that increases in cycle use can have on neighbourhoods, reducing congestion and protecting the environment (Department for Transport, 2004).

Despite the individual and societal benefits of cycling, only a small section of the British population cycle commutes. In the UK only around 2% of trips are made by bicycle (Department for Transport, 2008). A key barrier to cycling is the perception of danger on the roads (Cavill and Davis, 2007). While cycle commuting does pose some actual risks, even with current road conditions in the UK, the risks associated with cycling from accidents and air pollution are understood to be outweighed seven fold by

the health benefits incurred (de Hartog, *et al*., 2010). There are other commonly cited factors that deter people from choosing to cycle for transport such as: lack of time; distance; bad weather; and lack of workplace and en route facilities (Unwin, 1992; Ryley, 2006; Wardman *et al*., 1997; Bergstrom and Magnusson, 2003; Dickinson *et al*., 2003; Shannon *et al*., 2006; Parkin *et al*., 2007). Perceptions of social identity related to cycling may also pose as a deterrent in some instances (Gatersleben and Haddad, 2010). Regardless of whether perceived barriers are objective or subjective, there is a strong inverse correlation between perceived barriers and exercise participation (Sallis and Owen, 1999). Perceived barriers have a strong influence on physical activity (Bauman *et al*., 2002; Trost *et al*., 2002).

Theoretically, the concept of barriers or 'costs' is embedded in psychologically-orientated behaviour change theories such as: the transtheoretical model of behaviour change (Prochaska and DiClemente, 1982); the theory of planned behaviour (Ajzen, 1985); and the health belief model (Becker *et al*., 1977). These theories propose that decreasing perceptions of barriers associated with a specific behaviour assists in changing individual's attitudes, beliefs and intentions towards carrying out that behaviour change. The weighing up of barriers and benefits, termed 'decisional balance', is a central concept of the transtheoretical model of behaviour change, although it was originally proposed by Janis and Mann (1977). According to Janis and Mann (1977), decision-making comprises the process of conflict resolution and avoidance behaviours. The way that an individual appraises and copes with the decision to change a particular behaviour leads to defective or effective information processing and decision-making. The assumptions underlying the

decisional balance construct highlight the role that cognitions play in the decision making process.

In line with psychological theory, studies that have compared groups of cyclists and non-cyclists or stages of change categories (see figure 1) to examine cycling behaviour have found that non-cyclists hold greater perceptions of barriers to cycling than regular cyclists (Crawford *et al*., 2001; Stinson and Bhat, 2004; Shannon *et al*., 2006; Gatersleben and Appleton, 2007; de Geus *et al*., 2008; Titze *et al*., 2008). Shannon *et al*. (2006) examined active commuting within an Australian university setting and reported that reducing both subjective and objective perceptions of barriers is likely to be more important than promoting the benefits of walking and cycling. While perceived barriers associated with cycling behaviour appear to play an important role in the decision making process, no studies to date have solely focussed on investigating individuals' perceptions of barriers to cycle commuting. Rather, previous studies have analysed various barriers as part of a larger framework of attitudinal and/or environmental correlates. Carrying out a study that specifically explores perceptions of cycle commuting barriers in some detail will help to inform individual-level behaviour change interventions aimed to increase cycle commuting behaviour.

[Insert Figure 1]

The present study aimed to investigate perceptions of a range of potential barriers associated with cycle commuting and to determine how perceptions differed between individuals at various stages of change. Additionally, the study also investigated

perceptions of barriers in relation to gender and occupation (as an indicator linked to income). The investigation was carried out in a workplace that provided a good standard of cycle facilities for employees. This was done in order to explore perceived barriers amongst a population in which some of the environmental/organisational barriers to cycling had been reduced.

Methods

Design and Procedure

A cross-sectional design was employed and data was collected at a single time point using an on-line questionnaire (Bristol On-line Survey). The questionnaire was piloted for face validity with 15 individuals and minor adaptations were made prior to use. The on-line questionnaire was embedded in an email that invited people to take part in the study and was distributed by departmental administrators via the internal email system to a sub-section of employees and PhD students within a large university setting. Prior to dissemination, permission to distribute the questionnaire was gained by the Human Resources Department. Two reminder emails were sent out in the following month after the questionnaire was disseminated in an attempt to maximise the response rate. On-line questionnaires are a valid method of data collection and due to their impersonal nature may be less prone to effects of socially desirable responses (Gray, 2004). However, it should be acknowledged that non-computer users within the organisation did not have the opportunity to participate in the study. Ethical approval was obtained by following the appropriate university guidelines.

Participants

For the present study, twenty eight buildings from two of the university campuses were targeted that were classified as cycle friendly in accordance with Cycling Scotland's Cycle Friendly Employer scheme. These worksites provided: showers and changing rooms; storage space; cycle parking facilities; financial incentives for cycling (e.g. mileage allowances and discount schemes); and social support (e.g. promotional events). The questionnaire was sent to approximately 2000 individuals, either employees or PhD students, who ranged from 18 to 70 years old. Overall, 831 people responded to the questionnaire (42%).

Instrument

The questionnaire was adapted from an established measure used previously in active travel research (Crawford *et al*., 2001; Mutrie *et al*., 2002). It consisted of three parts: (i) demographic variables; (ii) current cycle commuting behaviour; and (iii) attitudinal questions relating to potential barriers of cycle commuting. Current cycle commuting behaviour was measured using a stage of change scale (see Figure 1). The stage of change is a key component of the transtheoretical model of behaviour change along with the decisional balance (pros and cons), self-efficacy and processes of change. The model proposes that as an individual progresses through the stages of change they undertake different qualitative processes of change, and as a result their perceptions of pros and cons (decisional balance) and their level of self-efficacy is positively influenced (Prochaska and DiClemente, 1982). While the stages of change component has received some criticism for being somewhat arbitrary (Weinstein *et al*., 1998; West, 2005), it

provides a valuable grouping aid (Armitage, 2009) and can help to identify how interventions can effectively target individuals who are at different stages of behavioural readiness. From the pilot work it was found that seasonal cyclists could not easily be categorised within the stages of change model therefore an extra statement was added to the scale stating "I am a seasonal cyclist" to accommodate those who were only cycling to work part of the year. Potential barriers were assessed using 18 common deterring factors (listed in Tables 2, 3 and 4) using a five point Likert scale (1 = 'not discouraging', 2 = 'slightly discouraging', 3 = 'moderately discouraging', 4 = 'very discouraging', 5 = 'stops me from cycling').

Statistical Analyses

Statistical analyses were carried out using the software package SPSS Statistics 17. Initially, percentages were used to provide an overview of each stage of change in relation to gender, age, occupational role and distance between work and home (see Table 1). For the inferential statistics, the independent variables were stage of change (five levels), gender and occupation. It was decided that seasonal cycle commuters, who only cycled for part of the year, would be excluded from the main analysis. This was done to conform to the established stage of change measure used in this study and the TTM theory from which the stage of change construct is a component, as neither explicitly acknowledges seasonal variations in physical activity. The dependent variables were the 18 potential barriers (see Tables 2, 3 and 4).

One-way ANOVAs were carried out to analyse whether perceptions of each of the barriers significantly differed between stages of change (see Table 2) and between occupational roles (see Table 4). Where significant results were found, post hoc Tukey tests were run to identify differences in perceived barriers between individual stages and occupations. Independent t-tests were used to determine whether there were any significant differences in perceptions of barriers between genders (see Table 3). Finally, two-way ANOVAs were carried out to find out if there were any significant interactions between stages of change, gender and occupation with regard to perceptions of barriers. In instances where data violated homogeneity of variance, the appropriate alternative t-test scores were used and for ANOVAs, Brown-Forsyth test scores were used along with Games-Howell post hoc tests.

Results

Demographics

Table 1 shows gender, age, occupation and distance variables in relation to stages of change. In terms of stages of change for cycle commuting behaviour there were 52% pre-contemplators, 9% contemplators, 4% preparers, 3% actors, 26% maintainers and an additional category was added to capture seasonal cyclists (6%). The participants comprised 54% men and 46% women. A chi-square analysis revealed a significant association between gender and stage of change (Chi-square = 25.2, df = 5, $p < 0.001$). This association reflects the tendency for females to be categorised earlier in the stages of change (i.e. less likely to be active cycle commuters) than men.

Most participants (84%) were between the ages of 18 and 50 years old. The spread between genders was evenly distributed across age except for in the oldest age category (60 - 70 years), comprising 4% of the overall sample, which exhibited a male bias. There was also a relatively even spread of participants across occupational roles: 29% academic staff; 22% support staff; 24% research staff; and 24% PhD students (and 2% other). At each end of the stage of change spectrum, differences between occupational roles were evident (Chi-square = 46.9, df = 12, $p < 0.001$) with more academic staff than support staff in the maintenance stage and vice versa in the precontemplator stage. Although not displayed in Table 1, gender differences between the occupational roles were also evident with a higher percentage of males (21%) than females (8%) reported in academic positions and a higher percentage of females (14%) than males (8%) reported in support staff positions. The majority of the sample (78%) lived within a five mile radius from the worksite.

[Insert Table 1 about here]

Stages of Change

As shown in Table 2, precontemplators, contemplators and preparers reported danger on the roads, bad weather and darkness as the three biggest barriers associated with cycling to work. Actors' and maintainers' perceptions differed slightly. Actors reported danger on the roads, bad weather and natural terrain as the biggest barriers to cycle commuting and maintainers reported danger on the roads, bad weather and manmade terrain as the biggest barriers. Statistically significant differences in perceived barriers (set above $p \leq 0.01$ to protect against type 1 errors) were found for 17 out of the 18 barriers as a function

of stage of change. The most significant stage of change differences related to the perceived barriers of: danger on the roads (F (4, 731) = 48.7, $p < 0.001$); physical effort involved (F (4, 221) = 48.3, $p < 0.001$); and natural terrain (F (4, 225) = 47.8, $p < 0.001$). This reveals that although there was some agreement between each stage about which barriers were the biggest, significant stage differences in the perceived strength of these barriers were found. Post hoc tests demonstrated that precontemplators, most commonly, perceived greater barriers than maintainers. Overall, perceptions of barriers incrementally decreased from precontemplation through to maintenance stage.

[Insert Table 2 about here]

Gender

As shown in table 3, both males and females reported danger on the roads, bad weather and darkness as the biggest barriers related to cycle commuting. However, there were significant gender differences in the strength of perceptions for 13 of the 18 barriers between males and females. The most significant gender differences related to perceived barriers of: darkness (t = 7.3, df = 733, $p < 0.001$); natural terrain (t = 7.2, df = 661, $p < 0.001$); and danger on the roads (t = 6.8, df = 732, $p < 0.001$). This indicates that although there was agreement between men and women about which barriers were the biggest, significant gender differences in the perceived strength of these barriers were found. Where gender differences were identified, females consistently perceived greater barriers than males.

[Insert Table 3 about here]

Occupation

As shown in Table 4, academic, support and research staff reported danger on the roads, bad weather and darkness as the biggest barriers associated with cycling to work. PhD students' and the miscellaneous (other) groups' perceptions differed slightly. PhD students reported danger on the roads, bad weather and natural terrain as the biggest barriers to cycle commuting and the miscellaneous group reported danger on the roads, bad weather and manmade terrain as the biggest barriers. Statistically significant differences in perceived barriers ($p \leq 0.01$) were found for 12 out of the 18 barriers as a function of occupational role. The most significant occupation differences related to perceived barriers of: the expense of buying a bike ($F(4, 700) = 10.6$, $p < 0.001$); darkness ($F(4, 780) = 10.1$, $p < 0.001$); and exhaust fumes ($F(4, 781) = 9.1$, $p < 0.001$). This reveals that while there was some agreement between the occupational groups about which barriers were the biggest, significant differences between occupations were found in the perceived strength of these barriers. Post hoc tests demonstrated that, most commonly, support staff perceived greater barriers than academic staff.

[Insert Table 4 here]

Interactions

Two-way ANOVAs were carried out for each of the 18 dependent variables (potential barriers) to test for interactions between pairings of the independent variables (stage of

change, gender and occupation). There were no significant interactions between stage of change, gender and occupation in relation to the 18 potential barriers examined in this study ($p \leq 0.01$).

Discussion

The present study examined 18 potential barriers associated with cycle commuting in relation to stage of change, gender and occupation to identify any differences in perceptions that may affect an individual's decision to cycle commute. A unique aspect of this study is that cycle-specific barriers have been explored in detail. The results show that, overall, physical environmental factors were perceived as the biggest barriers to cycle commuting. However, many perceptions of barriers associated with cycle commuting significantly differed between the stages of change, and to a lesser degree, between genders and occupational roles.

The biggest barriers to cycle commuting

In this study, the biggest barriers associated with cycle commuting related to aspects of the environment such as: danger on the roads; bad weather; darkness; natural terrain; and manmade terrain. However, significant perceptual differences reported between non-cyclists (precontemplators and contemplators) and experienced regular cyclists (maintainers) indicate that perceptions of these environmental barriers may, in part, be influenced by subjective components such as: attitudes, beliefs, knowledge and experiences. Previous active travel studies found that significant environmental variables were mediated by cognitive variables (Rhodes *et al*., 2006; Lemieux and Godin, 2009). Furthermore, a review of cycle commuting literature similarly concluded that attitudes

play a significant role in cycling behaviour as individuals are likely to base their decision to cycle commute on their subjective perceptions of the situation as opposed to the actual objective situation (Heinen *et al*., 2010).

Qualitative active travel research provides some insight into the underlying cognitive and behavioural processes that may partially explain differences amongst individual's perceptions towards key environmental factors. For instance, Daley *et al*. (2007) and van Bekkum *et al*. (2011) found that people who cycled in urban environments perceived danger on the roads to be less of a barrier to cycling than non-cyclists reported, and discussed strategies they used to effectively deal with traffic such as: being vigilant and alert, clear signalling; making eye contact with other drivers; wearing high visibility clothing; and developing knowledge of alternative cycling routes. Such strategies can be developed through cycle training, which has been found to be effective at increasing people's cycling knowledge, skills and self-confidence (Telfer *et al*., 2006). However, it is commonly understood that environmental changes, such as infrastructure improvement, also need to occur if cycling is to become a feasible form of transportation (e.g. Davis *et al*., 1997; Mutrie *et al*., 2002). An appreciation of the complexity involved in cycle commuting is necessary to effectively promote and sustain this behaviour in the UK context (McKenna and Whatling, 2007). Both community-level interventions that target infrastructure and individual-level behaviour change interventions that target social-cognitions and provide information have been found to moderately increase cycling behaviour (Yang *et al*., 2010). Therefore, while there are individual-level changes that can be encouraged in terms of cognitive and behavioural processes to help to improve people's perceptions of cycle commuting, continuous efforts

need to be made at a policy level to help to create conducive environments, which can support individuals in changing their behaviour (Institute for Government and Cabinet Office, 2010).

Stage of change differences

In this study, perceptions of barriers incrementally decreased from precontemplation through to maintenance stage. In relation to stage of change, significant differences in perceptions of barriers were reported for 17 out of the 18 potential barriers investigated. This trend is in accordance with previous studies (Shannon *et al*., 2006; Gatersleben and Appleton, 2007) and lends support to the transtheoretical model of behaviour change. A review of attitudes relating to travel behaviour indicated interventions that use stage-tailored strategies are likely to be more effective than universal strategies that do not segment the population into sub-groups (Anable *et al*., 2006). The results from the present study provide information about the kinds of individual-level practices that might be best suited to reducing perceptions of barriers for each specific stage.

Precontemplators reported significantly greater perceptions of barriers compared to maintainers for 16 out of the 18 potential barriers associated with cycle commuting. In the early stages of behaviour change individuals often cannot see beyond the difficult aspects of changing their behaviour (Bull, 2001). Some of these perceptions may relate to objective barriers such as living a greater distance from work (Shannon *et al*., 2006; Parkin *et al*., 2007). However, other perceptions of barriers, for example: danger on the roads; bad weather; darkness; manmade and natural terrain; exhaust fumes; carrying belongings; and physical effort may involve a subjective element that is amenable to

change through individual-level behaviour change intervention. To target individuals in the precontemplation stage, the use of media, leaflet and poster campaigns, which help to raise problem awareness (e.g. in terms of problems related to motorised forms of transport) has previously been recommended (Biddle and Mutrie, 2001). Further, it has been found that many non-cyclists do not identify with cycling and that cultural changes regarding the image of cycling are needed to encourage non-cyclists to start cycling (Gatersleben and Appleton 2007; Gatersleben and Haddad, 2010). The present findings indicate that precontemplators perceive a large number of diverse barriers to cycling. Therefore, even at this early stage in behavioural readiness, informational messages that help to reduce perceptions of some key barriers may facilitate stage progression. For example, raising awareness to existing resources such as community-level cycling provision, cycle training and workplace cycle discount schemes may help to reduce perceptions of some barriers. All participants worked in cycle friendly sites, providing showers and bike storage, but precontemplators perceived showering and changing facilities as more of a barrier to cycling than maintainers, suggesting that precontemplators may not be well informed about such facilities. Therefore, workplaces should ensure that their cycling facilities are widely communicated to all staff in order to dispel inaccurate perceptions.

Contemplators also voiced a number of concerns but not as many or as strongly as precontemplators. Contemplators held significantly greater perceptions of barriers than the maintainers for eight out of the 18 potential barriers investigated: danger on the roads, bad weather; darkness; natural terrain, storage at home, physical effort involved; and the expense of buying a bike. Contemplators may be a prime target stage for interventions as

a review by Ogilvie *et al*. (2004) found evidence that behaviour change programmes targeting motivated sub-groups are effective at changing travel choices (Ogilvie *et al.*, 2004). For people who are considering cycle commuting as an option, carrying out a personal assessment of barriers and receiving practical advice and support to overcome some of these may be helpful (Marcus and Forsyth, 2003). This kind of exercise could be facilitated in a workplace setting or online. Contemplators, like preparers, held strong concerns about the dangers of cycling on roads but as they are more willing to cycle, providing cycle training opportunities may be well received. Both contemplators and precontemplators showed a heightened concern to barriers relating to the physicality of cycling such as the physical effort involved and the nature of the terrain (hilliness). This finding is congruent with previous cycling research within an Austrian student population, which found that non-cyclists were more deterred by the physical effort involved in cycling than cyclists (Titze *et al*., 2007). At this stage, providing taster sessions, as recommended by Biddle and Mutrie (2001), may help individuals who are contemplating cycle commuting to overcome some of the concerns relating to the physicality of cycling. Rose and Manrfurt (2007) assessed the impact of a 'Ride to Work Day' and found that 27% of first time riders participating in the event were still cycling five months after the event.

Preparers held more positive perceptions than contemplators and precontemplators. As preparers are already infrequently cycle commuting, it is likely that there will be very specific barriers holding them back from regularly cycling to work. Only three out of the 18 potential barriers were viewed as significantly greater barriers compared to maintainers. These were: bad weather; darkness; and carrying belongings.

Seeking out advice and strategies from experienced cyclists about how to deal with or overcome such barriers may help those in the preparation stage to progress to regular cycle commuters. As discussed by van Bekkum *et al*., (2011), regular cycle commuters appear to use effective coping strategies to overcome barriers such as carrying belongings by using pannier bags. Informal social support networks may be helpful for individuals in the preparation stage (Marcus and Forsyth, 2003) as they would facilitate knowledge exchange between experienced and less experienced cyclists. Supportive social networks could be developed in workplaces by setting up bicycle user groups and running promotional events.

The results for actors and maintainers reveal that although individuals in both of these groups are regularly cycling to work, actors, who only started regularly cycle commuting in the last 6 months, were significantly more deterred by two out of the 18 potential barriers than maintainers. Similarly to the profile of preparers, actors were found to be more concerned about bad weather and carrying belongings than maintainers. This suggests that for individuals who have only recently started cycling there are still some practical challenges that could be addressed. It is, therefore, important that individuals in the action stage of cycle commuting continue to receive support to help them maintain their behaviour. In line with the suggestion for preparers made earlier, individuals in the action stage may also benefit from social support and accessing knowledge from experienced cyclists regarding effective coping strategies and practices.

Gender differences

Within the present study more men than women were found to cycle commute, which is a commonly reported finding (Unwin, 1992; Troped *et al*., 2001; Dickinson *et al*., 2003; Department for Transport, 2007; Garrard *et al*., 2008). This gender imbalance appears to be pronounced in countries where the uptake of cycling for transport is low, such as the UK, but is not present in some European countries where rates of utilitarian cycling are higher, such as Denmark, the Netherlands and Germany (Garrard, 2003). Women perceived 13 out of the 18 barriers associated with cycle commuting to be significantly greater than males. In accordance with this study, it has previously been documented that women perceive danger on the roads to be a greater barrier to cycling than men (Krizek *et al*., 2005; Department for Transport, 2007; Davies *et al*., 1997; Tilahun *et al*., 2007), which is likely to stem from established gender differences in risk taking (Byrnes *et al*., 1999).

To date, few studies have explored women's perceptions of barriers to cycle commuting in great detail (Garrard *et al*., 2006; Steinbach *et al*., In press). In the present study, women were found to hold more negative perceptions of barriers such as: bad weather; natural terrain; distance to work; carrying belongings; storage at home; the school run; physical effort involved; the expense of buying a bike; and wearing casual clothing. Issues such as the school run and carrying belongings are likely to pose objective barriers to cycling for women as they have more complex trips, such as juggling childcare responsibilities and shopping (Pooley and Turnbull, 2000; Dickinson *et al*., 2003). Women were also found to view the expense of buying a bike more of a barrier than males. According to Dickinson *et al*. (2003), women were less likely to own a bike or have access to a bike than men, which could help explain this finding. Women's

heightened concerns about: physical effort involved in cycling; natural terrain (hilliness); and wearing casual clothing, are perhaps in part explained by culturally ingrained gender stereotyping and norms. Horton (2007) proposes that cycling is a gendered activity and that people may be discouraged to take it up not only because of fears related to cycling in traffic but because of fear linked to: the physicality of cycling; aggression from strangers; and the embarrassment of having one's body on display. Similarly, a recent UK-based qualitative study found that specific barriers to cycling reported by women stemmed from 'the gendered travelling body', referring to the publicly visible act of cycling, which contradicts more orthodox female identities (Steinbach *et al*., In press).

Encouraging women to cycle is likely to involve providing many layers of support. On an individual level, providing educational training in terms of cycle maintenance classes and cycle training courses that encourage female cyclists to be more assertive and capable may help women to feel empowered and diminish barriers that may be heightened due to cultural gender differences. Additionally, providing cycle maintenance and training classes that are female only may help to lessen women's initial feelings of embarrassment and vulnerability towards cycle commuting. On an organisational level, employers could help to encourage women to cycle by: changing policy and practice around expected dress codes; providing necessary facilities for maintaining one's appearance; and allowing women flexibility in their work patterns to cater for child-care. Infrastructure improvements for cycling are also likely to encourage more female cyclists (Garrard, 2003). Daley *et al*. (2007) found that females were attracted to cycling, as it is a low impact form of exercise; indicating that if the necessary support is in place, cycle commuting would be appealing to women.

Occupation differences

In relation to occupation, significant differences in perceptions were reported for 12 out of 18 potential barriers to cycle commuting. These findings indicate a common trend that support staff (primarily consisting of administrators and secretaries) perceived greater barriers than academic staff for 11 out of the 18 listed barriers. This suggests that occupational position and associated factors such as: income; level of education; social identity; work culture; and dress code, may play an independent role in an individual's perceptions of barriers to cycling. There are no previous findings available regarding differing job roles and cycling. Results regarding cycle use, income and education are mixed. Higher income has been linked to less cycle use (Badland and Schofield, 2006; Pucher *et al*., 1999; Winters, *et al*., 2007), but other studies have found little variation in relation to income and cycling for transport (Pucher and Renne, 2003; Scottish Executive, 2009; Tin Tin *et al*., 2009). Some research has found higher education is linked to higher cycle use (de Geus *et al*., 2008; Plaut, 2005), whereas other studies have found the contrary: that lower education is associated with higher cycle use (Badland and Schofield, 2006; Winters, *et al*., 2007).

Two potential barriers that involve a financial element (expense of buying a bike and lack of waterproof clothing) were perceived as greater barriers by support staff, research staff and PhD students in comparison to academics. A possible explanation is that buying a bike and the necessary clothing and equipment (which can be a considerable financial output) may pose more of a barrier to those who are earning less than an academic's wage. Alternatively, it could simply be that more lecturing staff already own a bicycle. These findings suggest that when developing interventions to

promote cycle commuting, specific characteristics relating to occupational roles such as: income; level of education; social identity; work culture; and dress code may also need to be taken into account. Attention should be paid to providing financial support and resources (such as bicycle loan schemes and discount schemes) for people who are on lower incomes.

Limitations

There were a number of limitations within this study. Firstly, data was collected via a self-report method with no objective measures in place. The response rate (42%) was good for a survey of this nature. However, the achieved sample may not be completely representative of all the University staff. For example, although the profile of male and female staff does reflect the gender bias in staff roles it may not be fully representative of gender ratios of the University's staff as a whole. Furthermore, the category of 'support staff' was broader than the other occupational categories and may have potentially included a small number of relatively high earning administrative managers. This study was carried out in a workplace providing adequate cycle facilities; therefore some findings would not apply to workplaces that do not provide suitable cycle provision for employees. It is also acknowledged that cycle environments vary between places and cultures so findings from this study, regarding environmental barriers, which confirm other research evidence (e.g. Crawford *et al*., 2001; Daley *et al*., 2007), should be interpreted in context. Further research in different work-settings is required to establish whether the barriers to cycle commuting revealed in this population are generalisable to staff working in other occupational settings.

Conclusion

This study has revealed that, overall, environmental factors were perceived as the biggest barriers to cycle commuting. However, significant differences in perceptions of barriers were found as a function of stage of change, gender and occupation. Individuals at earlier stages of change perceive greater barriers to cycle commuting than regular cyclists. Furthermore, women and support staff commonly perceive relatively greater barriers than men and academic staff. Individual-level behaviour change interventions aiming to promote cycle commuting that focus on reducing perceptions of barriers should take into account stage of change, gender and occupational characteristics in order to enhance effectiveness and facilitate behaviour change.

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Figure 1: Descriptions of stage of change categories in relation to cycle commuting based on the TTM from Mutrie *et al*. (2002)

Stage	Description
Precontemplator	No intention to start cycle commuting in the next six months
Contemplator	Thinking about starting to cycle commute in the next six months
Preparer	Infrequently cycle commuting (no more than once a week)
Actor	Started regularly cycle commuting in the last six months
Maintainer	Has been regularly cycle commuting for at least six months

Table 1: Demographic variables displayed by stage of cycle commuting behaviour

Demographic variables	PC	C	P	A	M	S	Total
Behaviour	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)
Stage	51.1% (433)	9.1% (76)	3.7% (31)	2.5% (21)	26.5% (220)	6.0% (50)	100% (831)
Gender							
Male	25%(208)	4.2% (35)	1.9% (16)	1.3% (11)	17.9% (149)	3.5% (29)	53.9% (448)
Female	27.1% (225)	4.9% (41)	1.8% (15)	1.2% (10)	8.5% (71)	2.5% (21)	46.1% (383)
Age							
18-30 years	16.5% (137)	2.9% (24)	1.4% (12)	1.7% (14)	9.6% (80)	1.6% (13)	33.7% (280)
31-40 years	17.2% (143)	3.2% (27)	1.0% (8)	0.7% (6)	7.1% (59)	2.5% (21)	31.8% (264)
41-50 years	9.1% (76)	1.4% (12)	1.3% (11)	0.1% (1)	5.8% (48)	0.8% (7)	18.7% (155)
51-60 years	7.2% (60)	1.4% (12)	0.0% (0)	0.0% (0)	3.4% (28)	0.7% (6)	12.8% (106)
61-70 years	2.0% (17)	0.1% (1)	0.0% (0)	0.0% (0)	0.6% (5)	0.4% (3)	3.1% (26)
Occupation							
Academic	13.2% (110)	2.4% (20)	1.3% (11)	0.0% (0)	9.9% (82)	2.5% (21)	29.4% (244)
Research staff	11.4% (95)	2.8% (23)	0.6% (5)	1.2% (10)	6.3% (52)	1.4% (12)	23.7% (197)
PhD students	11.9% (99)	1..7% (14)	1.2% (10)	1.0% (8)	6.7% (56)	1.2% (10)	23.7% (197)
Support staff	14.7% (122)	2.2% (18)	0.5% (4)	0.2% (2)	3.1% (26)	0.8% (7)	21.5% (179)
Other	0.8% (7)	0.1% (1)	0.1% (1)	0.1% (1)	0.5% (4)	0.0% (0)	1.7% (14)
Distance (one way)							
0-1 mile	9.9% (82)	1.3% (11)	1.1% (9)	0.4% (3)	3.2% (27)	0.7% (6)	16.6% (138)
1-2 miles	14% (116)	2.9% (24)	0.7% (6)	1.1% (9)	10.3% (86)	2.3% (19)	31.3% (260)
2-5 miles	12.5% (104)	4.0% (33)	1.4% (12)	1.0% (8)	9.0% (75)	2.2% (18)	30.1% (250)
5-10 miles	5.8% (48)	0.6% (5)	0.4% (3)	0.0% (0)	1.7% (14)	0.2% (2)	8.7% (72)
10miles +	10.0% (83)	0.4% (3)	0.1% (1)	0.1% (1)	2.2% (18)	0.6% (5)	13.4% (111)

Note. PC = precontemplators, C = contemplators, P = preparers, A = actors, M = maintainers, S = seasonal

Table 2: One-way ANOVA results for perceptions of barriers between stages of change

Potential Barriers	PC mean (SD)	C mean (SD)	P mean (SD)	A mean (SD)	M mean (SD)	df	F	*p*	Post hoc
Danger on the roads	4.03 (1.21)	3.42 (1.28)	3.00 (1.36)	3.14 (1.01)	2.63 (1.18)	4, 731	48.658**	<0.001	PC vs C PC vs P PC vs A PC vs M C vs M
Bad weather	3.21 (1.26)	3.12 (1.15)	3.68 (1.11)	3.38 (1.02)	2.33 (1.06)	4, 198	26.811²****	<0.001	PC vs M C vs M P vs M A vs M
Darkness	2.95 (1.37)	2.54 (1.16)	2.90 (1.27)	2.19 (0.93)	1.71 (0.91)	4, 184	43.552²**	<0.001	PC vs A PC vs M C vs M P vs M
Manmade terrain (poor roads)	2.59 (1.40)	2.01 (1.09)	2.23 (1.31)	2.14 (1.15)	1.97 (1.03)	4, 166	11.047²**	<0.001	PC vs M PC vs C
Natural terrain (hilliness)	2.80 (1.44)	2.42 (1.33)	1.94 (0.96)	2.29 (0.90)	1.54 (0.77)	4, 225	47.848²**	<0.001	PC vs P PC vs M C vs M
Exhaust fumes	2.71 (1.33)	2.08 (1.03)	1.83 (1.15)	1.76 (0.62)	1.78 (0.91)	4, 205	35.474²**	<0.001	PC vs C PC vs P PC vs A PC vs M
Distance from work	2.67 (1.73)	1.63 (1.07)	1.76 (1.06)	1.86 (1.19)	1.66 (0.96)	4, 192	33.482²**	<0.001	PC vs C PC vs P PC vs M
Carrying belongings	2.34 (1.35)	1.90 (1.06)	2.33 (1.27)	2.55 (1.10)	1.60 (0.80)	4, 146	17.177²**	<0.001	PC vs C PC vs M P vs M A vs M
Storage at home	2.36 (1.48)	2.35 (1.40)	1.61 (0.98)	1.89 (0.99)	1.47 (0.77)	4, 165	21.114²**	<0.001	PC vs M C vs M
School run	2.28 (1.76)	1.85 (1.41)	2.47 (1.88)	1.60 (1.35)	1.36 (0.82)	4, 60	6.520²**	<0.001	PC vs M
Time taken to cycle	2.46 (1.62)	1.77 (1.18)	1.50 (0.86)	1.81 (1.03)	1.26 (0.68)	4, 214	46.955²**	<0.001	PC vs C PC vs P PC vs M C vs M
Changing and showering facilities	1.91 (1.25)	1.89 (1.19)	1.81 (1.08)	1.68 (1.16)	1.46 (0.86)	4, 130	5.242²*	0.001	PC vs M
Physical effort involved	2.13 (1.30)	1.62 (0.97)	1.55 (0.85)	1.43 (0.68)	1.15 (0.39)	4, 221	48.340²**	<0.001	PC vs C PC vs P PC vs A PC vs M C vs M
Storage at work	1.75 (1.09)	1.75 (1.09)	1.71 (1.10)	1.94 (1.14)	1.50 (0.93)	4, 635	2.093	0.080	
Expense of buying a bike	1.97 (1.24)	2.20 (1.35)	1.00 (0.00)	1.60 (0.88)	1.23 (0.59)	4, 662	20.627²**	<0.001	PC vs P PC vs M C vs P C vs M
Casual clothing	1.77 (1.19)	1.57 (0.92)	1.75 (1.00)	1.70 (0.92)	1.27 (0.59)	4, 148	9.611²**	<0.001	PC vs M
Health problems	1.65 (1.26)	1.16 (0.71)	1.37 (1.01)	1.50 (0.94)	1.38 (0.89)	4, 107	4.092²*	0.004	PC vs C
Lack of waterproof clothing	1.60 (1.00)	1.59 (0.98)	1.36 (0.91)	1.63 (0.83)	1.29 (0.63)	4, 148	4.011²*	0.004	PC vs M

Note. PC = precontemplators, C = contemplators, P = preparers, A = actors, M = maintainers, df = degrees of freedom, F = ANOVA score, p = significance level, * ≤ 0.01, ** ≤ 0.001, Post hoc = Tukey or Games-Howell test with a significance value set at $p \leq 0.05$, ² = Levene's test for homogeneity of variance has been violated ($p = \leq 0.05$) so the Brown-Forsythe test (adjusted F and residual degrees of freedom) has been used instead.

Table 3: t-test results for perceptions of barriers between males and females

Potential barriers	Female mean (SD)	Male mean (SD)	df	T	*p*
Danger on the roads	3.82 (1.23)	3.18 (1.38)	732	6.759[a]**	<0.001
Bad weather	3.21 (1.21)	2.80 (1.24)	739	4.608**	<0.001
Darkness	2.90 (1.33)	2.24 (1.25)	733	7.299**	<0.001
Manmade terrain (poor road surfaces)	2.54 (1.29)	2.14 (1.24)	723	4.265**	<0.001
Natural terrain (hilliness)	2.69 (1.38)	2.00 (1.19)	661	7.224[a]**	<0.001
Exhaust fumes	2.56 (1.29)	2.10 (1.16)	690	4.752[a]**	<0.001
Distance from work	2.34 (1.58)	2.06 (1.42)	695	2.501[a]**	<0.001
Carrying belongings	2.29 (1.26)	1.89 (1.13)	678	4.422[a]**	<0.001
Storage at home	2.25 (1.47)	1.89 (1.18)	549	3.106[a]*	0.002
School run	2.48 (1.80)	1.66 (1.29)	270	4.979[a]**	<0.001
Time taken to cycle	2.08 (1.42)	1.90 (1.40)	728	1.723	0.085
Changing and showering facilities	1.81 (1.18)	1.77 (1.14)	630	0.640	0.522
Physical effort involved	1.96 (1.21)	1.55 (0.99)	654	5.263[a]**	<0.001
Storage at work	1.72 (1.08)	1.71 (1.09)	638	0.070	0.944
Expense of buying a bike	1.85 (1.20)	1.61 (1.04)	581	2.621[a]*	0.009
Casual clothing	1.84 (1.16)	1.41 (0.83)	543	5.431[a]**	<0.001
Health problems	1.63 (1.23)	1.43 (1.00)	447	1.948[a]	0.052
Lack of waterproof clothing	1.59 (1.02)	1.44 (0.81)	554	1.903[a]	0.058

Note. df = degrees of freedom, t = t-test score, *p* = significance level, d = Cohen's d (effect size),
[a] = Levene's test for homogeneity of variance has been violated ($p = \leq 0.05$) * ≤ 0.01, ** ≤ 0.001.

Table 4: One-way ANOVA results for perceptions of barriers between occupational roles

Potential barriers	Academic mean (SD)	Support mean (SD)	Research mean (SD)	PhD mean (SD)	Other mean (SD)	df	F	*p*	Post hoc
Danger on the roads	3.39 (1.33)	3.84 (1.40)	3.37 (1.32)	3.34 (1.33)	3.43 (1.45)	4, 781	3.991*	0.003	S vs A S vs R S vs PhD
Bad weather	2.74 (1.17)	3.26 (1.33)	3.07 (1.23)	2.95 (1.24)	3.00 (1.11)	4, 786	4.572**	0.001	S vs A
Darkness	2.49 (1.24)	3.07 (1.50)	2.40 (1.26)	2.26 (1.22)	2.43 (1.16)	4, 780	10.067[a]**	<0.001	S vs A S vs R S vs PhD
Manmade terrain (poor roads)	2.22 (1.20)	2.74 (1.43)	2.22 (1.18)	2.19 (1.27)	2.15 (1.21)	4, 769	5.649[a]**	<0.001	S vs A S vs R S vs PhD
Natural terrain (hilliness)	2.11 (1.24)	2.76 (1.54)	2.19 (1.25)	2.29 (1.23)	2.43 (1.60)	4, 771	5.813[a]**	<0.001	S vs A S vs R S vs PhD
Exhaust fumes	2.14 (1.10)	2.82 (1.51)	2.24 (1.01)	2.14 (1.18)	2.21 (1.31)	4, 781	9.055[a]**	<0.001	S vs A S vs R S vs PhD
Distance from work	2.01 (1.36)	2.57 (1.72)	2.18 (1.47)	2.02 (1.39)	2.79 (1.85)	4, 788	4.197[a]*	0.003	S vs A S vs R
Carrying belongings	2.01 (1.13)	2.22 (1.30)	2.10 (1.18)	1.98 (1.21)	2.50 (1.61)	4, 772	1.288[a]	0.280	
Storage at home	1.77 (1.12)	2.10 (150)	2.24 (1.39)	2.15 (1.31)	2.00 (1.35)	4, 686	3.307[a]	0.012	
School run	2.12 (1.57)	2.37 (1.84)	1.82 (1.45)	1.43 (1.11)	1.88 (1.46)	4, 372	3.974[a]*	0.005	S vs PhD
Time taken to cycle	1.87 (1.32)	2.55 (1.68)	1.89 (1.27)	1.66 (1.18)	2.50 (1.95)	4, 721	8.531[a]**	<0.001	S vs A S vs R S vs PhD
Changing and showering facilities	1.61 (1.00)	1.93 (1.34)	1.75 (1.09)	1.87 (1.22)	2.15 (1.41)	4, 669	1.999[a]	0.100	
Physical effort involved	1.55 (0.93)	2.08 (1.30)	1.72 (1.14)	1.66 (1.01)	2.14 (1.61)	4, 782	4.982[a]*	0.001	S vs A S vs R S vs PhD
Storage at work	1.65 (1.01)	1.71 (1.15)	1.80 (1.15)	1.73 (1.01)	1.42 (0.70)	4, 676	0.667[a]	0.615	
Expense of buying a bike	1.36 (0.75)	1.84 (1.24)	1.76 (1.12)	2.04 (1.27)	1.38 (0.87)	4, 700	10.581[a]**	<0.001	S vs A R vs A PhD vs A
Casual clothing	1.53 (0.87)	1.77 (1.23)	1.59 (1.05)	1.53 (0.92)	1.64 (1.08)	4, 731	1.461[a]	0.217	
Health problems	1.33 (0.87)	1.75 (1.30)	1.46 (1.07)	1.56 (1.15)	2.30 (1.70)	4, 539	2.897[a]	0.032	
Lack of waterproof clothing	1.27 (0.60)	1.66 (1.01)	1.59 (0.99)	1.62 (0.99)	1.36 (0.67)	4, 671	5.812 [a]**	<0.001	S vs A R vs A PhD vs A

Note. df = degrees of freedom, F = ANOVA score, p = significance level, * ≤ 0.01, ** ≤ 0.001, Post hoc = Tukey or Games-Howell test with a significance value set at $p \leq 0.05$, [a] = Levene's test for homogeneity of variance has been violated ($p = \leq 0.05$) so the Brown-Forsythe test (adjusted F and residual degrees of freedom) has been used instead, S = support staff, A = academic staff, R = research staff, and PhD = PhD student.