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Capturing potential for active mobility: A multi-level survey analysis incorporating associated meanings

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Abstract

Active forms of mobility are important when it comes to tackling environmental challenges, improving the quality of human health and reducing road-traffic congestion and overcrowding in public transportation. Measures such as an enhancement of infrastructure or promotion through campaigns are regularly informed by mobility surveys which cover demographic data, mobility patterns, access to and usage of different modes of transport. To capture potential for active mobility, meanings associated with different modes of transport are presented to identify target groups for tailored campaigns promoting active mobility. By combining those associations with stated preferences more detailed insights into behavioural motivations are gained. The method is instantiated using survey-data from the 11th district of Vienna, Austria, to provide guidance to future survey based mobility studies.

Keywords: Active Mobility (Cycling / Walking); Survey Analysis; Associations.

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1. Current state of the art of mobility surveys

Active forms of mobility such as walking and cycling offer various advantages for cities and regions such as helping with environmental challenges (Lähteenoja et al. 2006, Randelhoff 2015), improving the quality of human health (WHO n.d.), as well as reducing road-traffic congestion (FLOW Project 2017) and overcrowding in public transport (The Telegraph 2016). The recent H2020 project "FLOW" once more revealed the positive impact of walking and cycling on urban congestion and everyday life of citizens by analysing outcomes of transport measures in different cities. Even though the evaluation of these measures did show that the introduction of walking and cycling does not cause congestion but rather reduces it, the survey outcome is somehow limited. What is currently missing when determining potential of active mobility from surveys is estimating the effect of different support measures for active mobility amongst different groups of the population, even though this would support the shift towards such mobility which is politically desired.

Fostering active mobility is an essential part of the EU Commission's 2011 White Paper on Transport (European Commission 2011) and thus encouraged on the national level, e.g. via the Austrian policy paper on transport (bmvit 2012). To collect information on current mobility behaviour and to prepare infrastructural measures as well as campaigns promoting certain modes of locomotion mobility surveys are used. These surveys cover demographic data, mobility patterns, access to and usage of different modes of transport. The information collection concentrates on the current behaviour rather than the willingness to use alternative transport modes. However, the introduction of new mobility options requires more than just visibility to encourage usage. The behavioural model of Fietkau and Kessel (1981) explains behaviour as a combination of influencing factors in which the knowledge transfer is determined as an indeed necessary but often not decisive component for behavioural change (Schlaffer et al. 2002). Attractive behavioural offers and incentives are therefore essential. In order to create them, extensive knowledge of the needs, desires and preferences of the target group is required.

Several approaches exist to analyse attitudes of different groups towards mobility options. Haufe et al. (2016) use Sinus Milieus (see INTEGRAL (2015)) to find information types in the Austrian population to define information strategies to encourage active mobility. Molin et al. (2016) apply a latent class cluster approach to study multimodal travel groups and their attitudes. Both approaches have in common, that they are based on a number of complicated questions as well as complex statistical methodologies.

In this paper a more basic approach is presented that can lead to a thorough understanding of people's views of different travel modes in order to enable the development of communication approaches without the need of extensive surveys or complex statistical methodologies. A first approach was presented in Beirão and Cabral (2007) where attitudes of people towards different modes of transport were included in a survey. However, the analysis is relatively basic and does not offer additional insights past the standard descriptive statistics of the answers.

The approach in this paper is based on methodologies from neuromarketing used to capture underlying needs and desires, called "limbic map" (Häusel 2011). The "limbic map" approach pictures an emotional map by representing motives, values and desires as such and in relation to each other. It is used to state motive and value structures of brands and products clearly. We decided to use an approach inspired by the neuromarketing tool. Therefore, the components of the "limbic map" were transferred in a mobility context to use them innovatively. As a result, meanings associated with different modes of transport are part of a mobility survey in order to capture the participants' perception of different modes. This information combined with the willingness to change behaviour is the basis for encouraging the use of certain modes of transport through tailored campaigns addressing the benefits and putting any reservations into perspective.

To get an even deeper insight into what motivates mobility behaviour, the survey combines associated meanings and a question on willingness to change with stated preference questions. Stated preference methods are rooted in the marketing research of the early 1970s and are prevalent in assessing travel behaviour starting in the late 1970s/early 1980s (Kroes and Sheldon 1988). They are an alternative to revealed preference questions and offer the chance to question people about their reactions to hypothetical scenarios. Through combining the associated meanings, the willingness to change and stated preferences, information on various aspects of mobility behaviour capturing potential for active mobility from different angles is gained.

2. Survey and analysis methodology

Point of departure is the conventional mobility survey covering questions on demographic data, current mobility patterns, access and usage of different modes of transport. Since the conventional mobility survey does not

answer how the potential for active mobility options can be captured, we decided to address this shortcoming by using the following four step approach: (1) Find a suitable use case, (2) Add additional survey items, (3) Group people according to their current usage of transport modes, (4) Analyse the results for different groups as well as in their entirety.

2.1. *Use case*

Our approach builds on survey-data from the 11th district of Vienna, Austria[2]. The selected area in the northwest of the district is well integrated in the Viennese public transport and road network. The survey is part of the H2020 project "SMARTER TOGETHER" which aims to achieve CO_2 savings through projects in the fields energy, renovation and mobility. In the area of mobility projects, it concentrates on the introduction of electric mobility sharing offers within the district, information on smart use of mobility options as well as local mobility consultancy. The promotion of active mobility is part of the project and therefore supported by the stakeholders which agreed on a mobility survey performed in this area to capture the potential.

Within the 1.5 km^2 study area, one percent of the population (N=21,300; n=241) participated in the mobility survey. The participants were recruited via various channels covering mail, online marketing, promotion in the local mall and the adult education centre and project events. This resulted in a hybrid-sample (59% online; 41% face-to-face) and ensured the participation of different groups of people. A first analysis on the potential for low emission mobility is described in Markvica et al. (2017).

2.2. *Additional survey items*

Our methodology offers a representation of current mobility behaviour based on conventional mobility surveys complemented by additional survey items on willingness to change towards active mobility, associated meanings of walking and cycling and stated preferences. While the use case presented is centred around active mobility, it can be applied to all modes of transportation.

The questions used in the mobility survey targeting the mentioned aspects of mobility behaviour are:

- *If I could choose, I would move as follows … (willingness to change towards active mobility)*
- *I associate with walking/cycling … (associated meanings with walking and cycling)*
- *You want to go to [case description]. Which alternative would you choose? (stated preference)*

For the first question on the willingness to change different modes of transport were named. The survey participants then had to reveal whether they would use modes of locomotion more, the same or less if they had the choice, e.g. if travel distances and infrastructure were appropriate. The second question assessed what meanings are associated by the participants to bike use and walking with the options being: safety, privacy, self-determination, low income, independence, leisure, environmental, reliability, comfort, laziness, necessity, my lifestyle, save money, high income, desirable luxury, unnecessary luxury, habit, save time, normal. Every characteristic of the list could be evaluated by stating if the characteristic "applies", "neither nor" or "does not apply" for this specific mode.

Stated preferences were covered by providing three mobility scenarios. Each scenario described a specific trip which should be made under certain circumstances. Since the survey was not targeted at commuters, it was decided to not include work trip questions, even though these are very important to the modal split. However, since all people have a familiarity with the chosen scenarios of leisure and shopping trips to well-known locations, these questions seemed more appropriate for this particular survey.

- *On a Saturday, you go to the SCS (Shopping City Süd). Which alternative would you choose?*
- *You have plans with friends at a recreational area. Which alternative would you choose?*
- *You want to buy some food (no big purchases) and have to get to a supermarket in your area. Which alternative would you choose?*

For each trip, three alternatives were stated giving details on the used transport mode, travel time, resulting CO_2 emissions and associated costs. The assignment of the various alternatives (i.e. response options) was randomized in order to introduce more variance in the variables to ensure a better estimation of the mode choice model.

[2] http://www.smartertogether.at/mobilitaetsbefragung/

2.3. *Group formation*

To capture the potential of active modes for the study area, we decided on a group formation based on the survey participants' preferences. The group formation was carried out by traffic modes chosen either daily or more than once a week for trips covering car, public transport (PT), cycling and walking. During the classification, it was found that footpaths are not a criterion to differentiate since all people in the survey have walking stages in their daily routes. Hence, walking it is not part of Fig. 1 (reducing the sample to N=223). According to the parameters mentioned, five groups are obtained:

- Car Only (n=36)
- PT Only (n=126)
- Car & PT Only (n=17)
- Car, PT & Bike (n=7)
- Other (n=37)

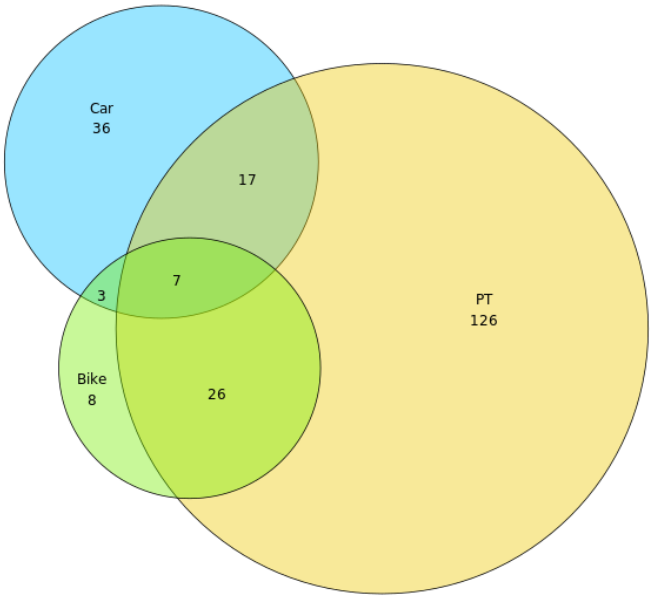


Fig. 1 Group formation according to predominant usage of modes of transport

2.4. *Analysing results*

Meanings associated with different modes of transport are compared between groups, along household-income and age. We highlight specific meanings gaining insights into shared understandings of mobility practices. To represent the complex interrelation within the data, a variety of graphical representations is innovatively used.

The analysis runs in three steps. In the first step, the willingness to change is analysed for the different groups defined in section 2.3. For each of these groups the question what the respondents would like to do more/the same amount/less was analysed to find out the potential of a mode. It was assumed that if people would e.g. like to use a bike more, that there was a high potential to get these respondents to switch at least some of their trips to bike if certain pre-requisites were met. To learn more about what were the most important associations for certain modes three-dimensional histograms were used. The knowledge about the associations can be used to design campaigns to support infrastructure developments. Finally, to understand the groups and their associations better, a graphical representation using bar graphs and scatter plots was used to learn who associated what with certain modes. In this paper, we distinguished within the groups by age and income to learn which group to target when designing mobility campaigns and promoting services, respectively.

3. Results on the willingness to change of mobility groups

Within this sample, two target groups are of particular interest: The first covers frequent car users (14.9 %), the second regular PT users (52.3 %). Literature often focuses on these groups since the former presents a large potential for reduced CO_2 emissions and space consumption, while the latter is of interest due to population

growth challenging the existing transportation network making a further shift towards PT difficult to achieve in the short-run. Approaches mainly try to capture information on the attributes required to become an attractive mode of transport by using qualitative methods (Guiver 2007, Gardner and Abraham 2007, Beirão and Cabral 2007, Jensen 1999) whereas our approach focusses on information gained via quantitative data.

3.1. *Willingness to change towards active mobility*

Results in Fig. 2 show that a majority of respondents have a positive affect towards active mobility. The graphs show the potential of changes towards a mode in green. These are the people in each group who state that they would like to use a certain mode more frequently and hence, are considered a group that would be willing to switch to active modes for certain trips if conditions are right.

Questioning those using the car daily or several times a week, 30.6 % would like to cycle and 27.8% would appreciate to walk more often. A similar tendency could be recognized for the public transport users. Whereas 45.3 % would like to use the bike more often, only 19.1 % would want to walk more frequently. While there are also people who want to cycle and walk less, there is a strong potential to achieve a shift towards a more active lifestyle if the framework conditions like enough bike parking and good cycling facilities are available to enable such a shift.

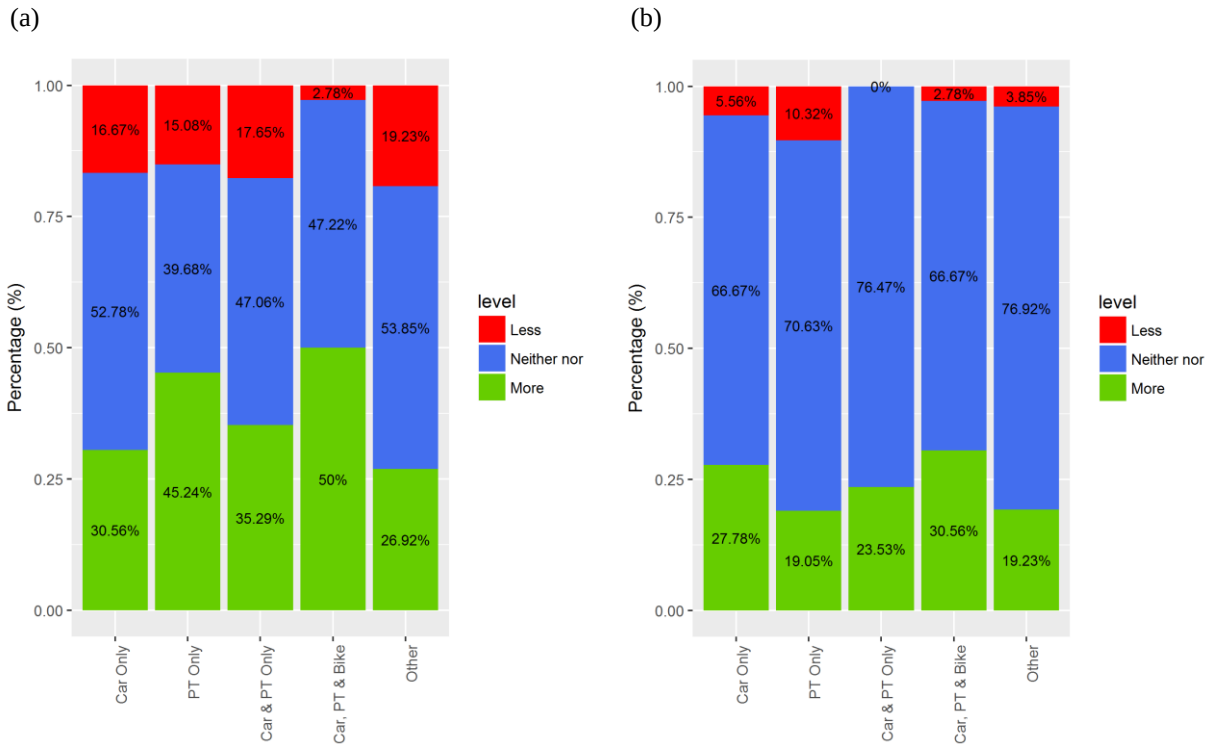
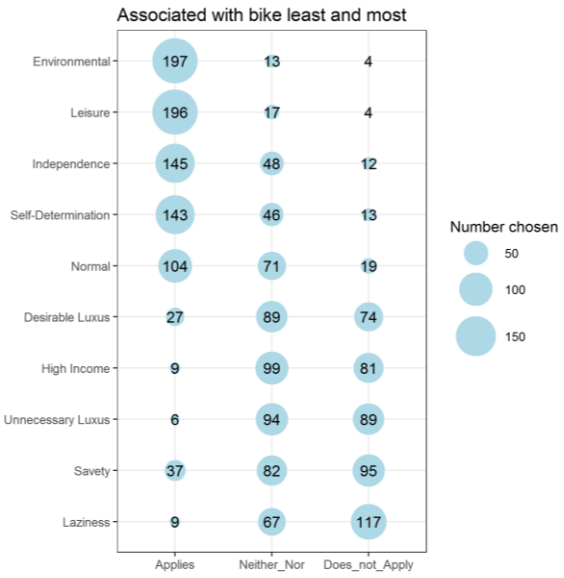


Fig. 2 Graphical representation of the potential for a shift towards a more active lifestyle by willingness to (a) cycle more often and (b) walk more often within the different groups

3.2. *Associated meanings of walking and cycling*

Furthermore, the participants had to reveal their associations with different transport modes. They could choose if they associate different characteristics from a list with cycling and walking on the personal level or not. In Fig. 3 the main associations are presented. The size of the circle represents the percentage of people giving the answer with the number of respondents giving the answer included in the circle. In the figures only the five associations with the mode given most often and least are presented.

(a)



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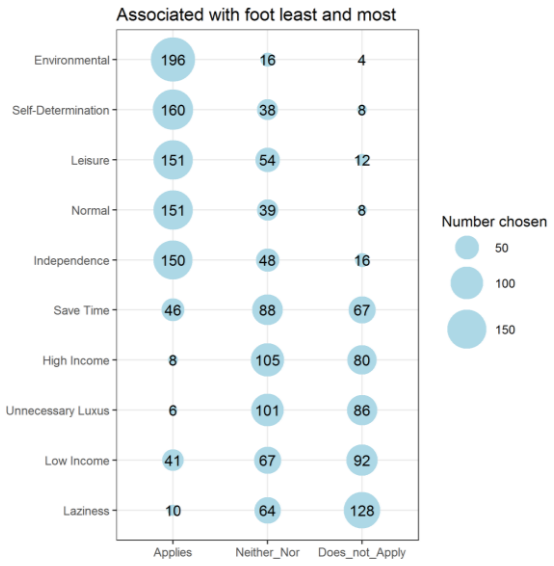


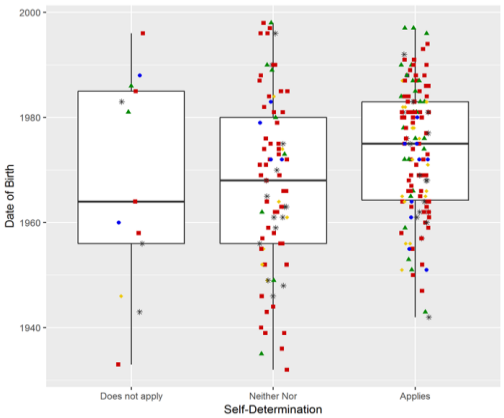
Fig. 3 Prevalent associations with (a) cycling and (b) walking

In both cases, for cycling and walking, the associations concentrated on the environmental as well as leisure aspect followed by self-determination and independence. Both means of locomotion are hardly associated with high income or laziness, which is indicated in Fig. 3, which leaves ample room for interpretation from a social structure point of view.

The following figures (Fig. 4 – Fig. 6) contain different elements and can be applied to cross-examine different attributes like age or income and meanings and group information. First a boxplot of the attributes is presented for each of the three answers of the association. This gives us the median age / income of the respondents associating something with the mode. To check that there is no underlying modal dependence, the group of each respondent is presented in the plots by a coloured dot giving their age / income, their answer to the association question as well as the group they belong to. Some examples relevant to cycling are presented below:

Even though cycling is still widely associated with leisure activities by younger respondents, Fig. 4 shows that on average, they also have a much stronger link to lifestyle, self-determination, independence and time-savings than other age groups.

(a)



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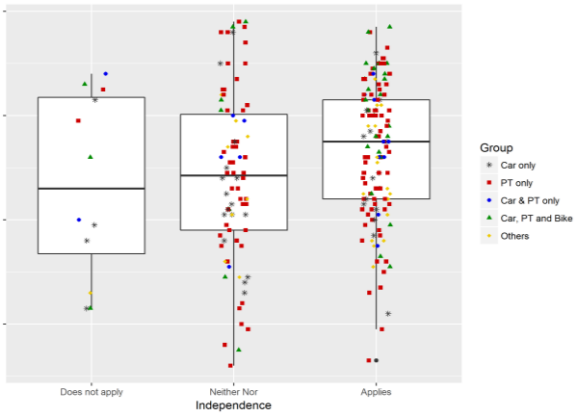

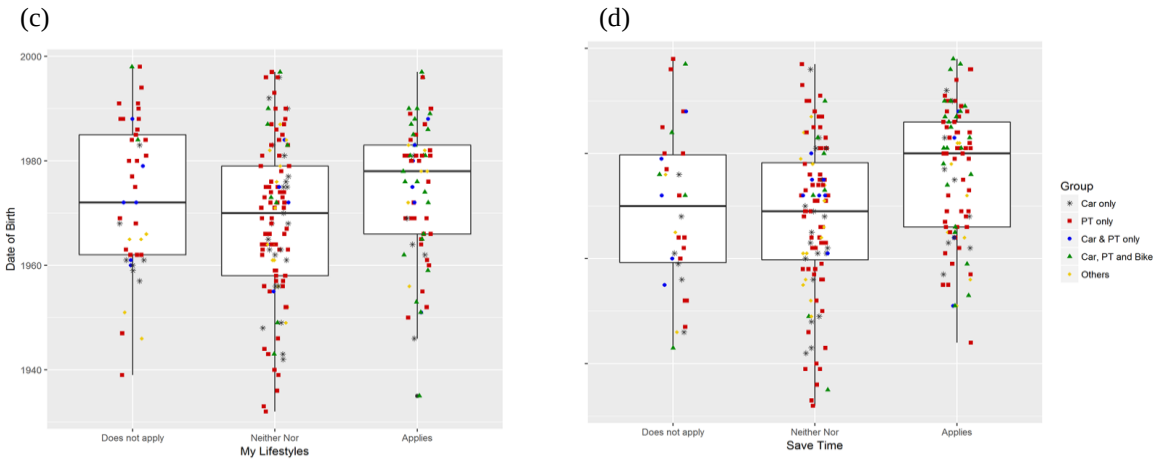

Fig. 4 Influence of age on bike image regarding (a) self-determination, (b) independence, (c) lifestyle and (d) time saving

In addition, the average age of people regarding cycling as safe is much lower than that of people regarding it as not safe (see Fig. 5). Overall, one can see that the image of cycling changes with age. Where younger people have a more positive image of cycling than their older counterparts. Looking at the distribution of the different groups in the graphs, it seems like the current mode choice behaviour does not have a large influence on the association with different modes. The distribution of groups among the different associations shows that current mode choice behaviour is not clearly correlated with the answers to the associations.

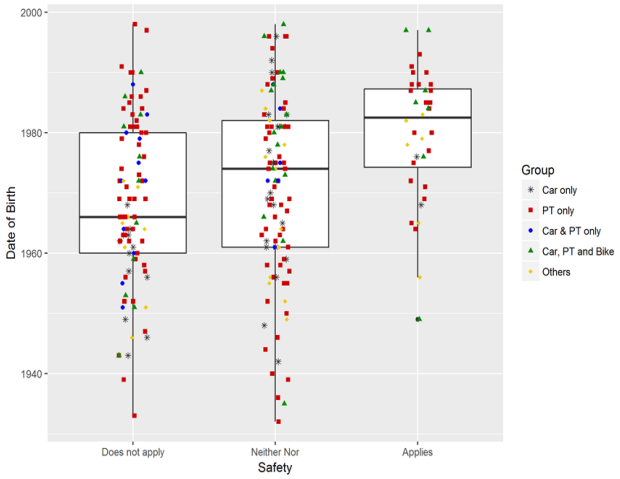

Fig. 5 Influence of age on bike image regarding safety

Fig. 6 shows that on average cycling is associated more as low income transport mode by those who have little money at their disposal. Prestige is therefore not the main reason for (non-)usage. People with less budget connect cycling somewhat more with money saving.

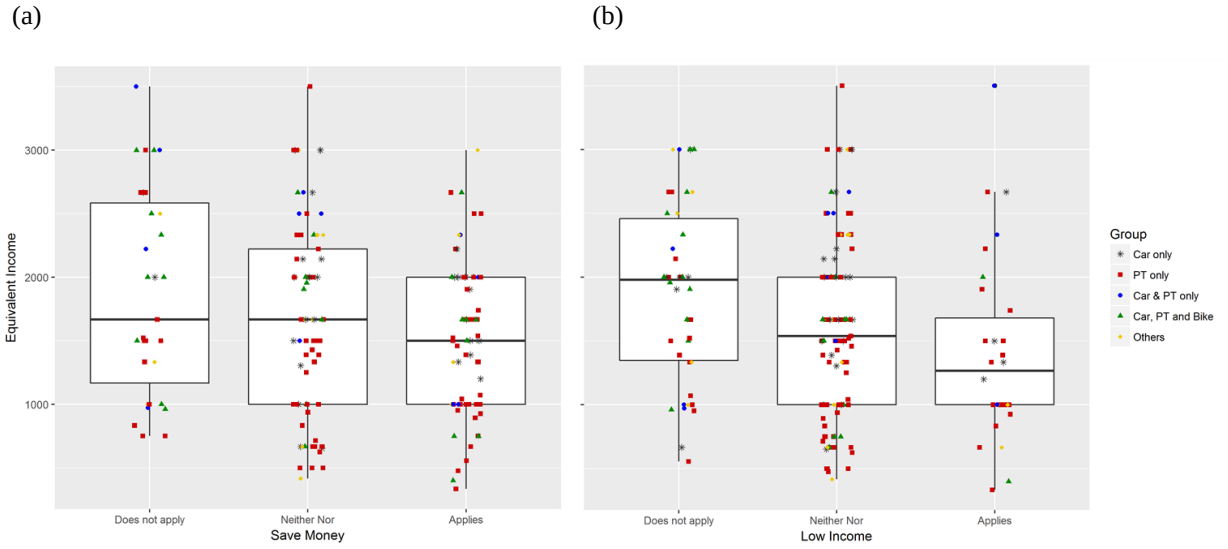

Fig. 6 Influence of budget on bike image regarding (a) money saving and (b) low income

Walking is associated with low income by those with very restricted budget (see Fig. 7). People with higher incomes are less likely to connect walking to the available budget of a person.

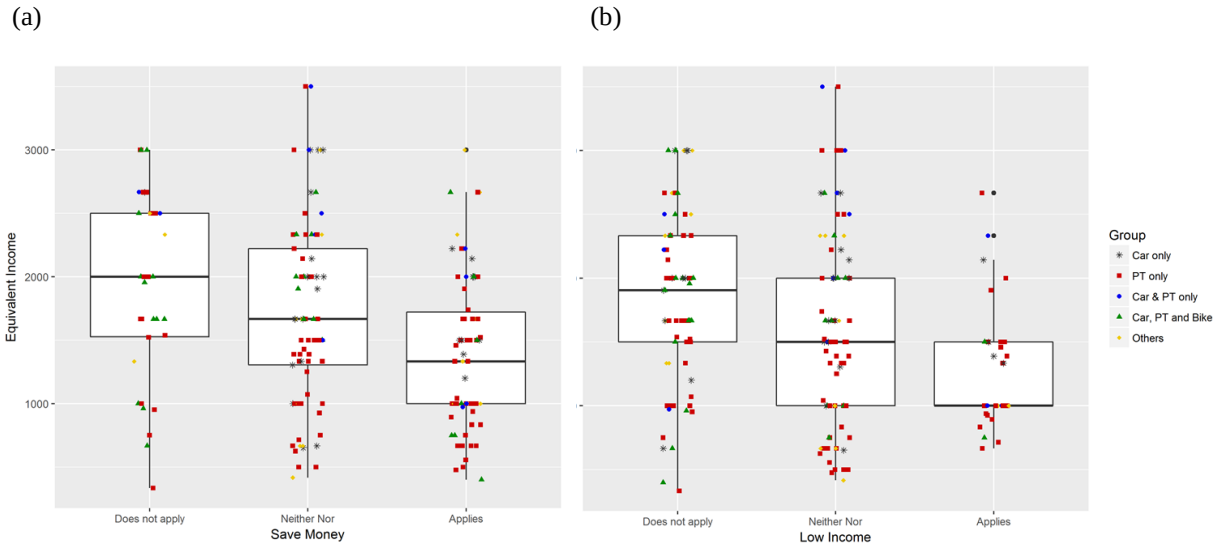

Fig. 7 Influence of budget on walking image regarding (a) money saving and (b) low income

3.3. *Stated preference*

As the final part of the multi-level survey analysis a small stated preference survey was performed to estimate mode-choice models. The choice models can be used for a more detailed examination of different relationships between factors influencing the mode choice of active modes. As an example, in this survey the connection of income and costs of transportation was tested for different electric sharing options including electric bike sharing. Due to the length of the survey only three stated preference questions presented in section 2.3 were added, limiting the scope of the mode choice model.

For the model with parameters in Table 1. For that model, people were combined in classes by income and a cost parameter was estimated for each class together with travel time parameters for the different modes.

Tab 1. Parameters of a simple mode choice model showing the cost sensitivity dependent on the income class where class 1 is low income and class 4 is the class with highest income.

Parameter	**Estimate**	**Std. Error (t-value)**
tt E-Bike	-0.274	0.039 (-7.113)
tt Walking	-0.355	0.078 (-4.533)
tt Bike	-0.356	0.068 (-5.223)
tt Car	-0.099	0.030 (-3.338)
nr of used modes	-0.945	0.480 (-1.970)
cost:income_class 1	-1.226	0.371 (-3.308)
cost:income_class 2	-1.446	0.368 (-3.931)
cost:income_class 3	-1.383	0.367 (-3.769)
cost:income_class 4	-1.546	0.371 (-4.168)

One can see that cost sensitivity is related to income but not in the way expected. People with lowest incomes are actually least cost sensitive while people with high incomes are most cost sensitive. Combining this with the knowledge from the associations this suggests that while people with high incomes use cheaper travel options like cycling and walking this is not for reasons of saving money.

4. Summary of results for active modes

Adding associations and stated preference questions to conventional surveys, offers the opportunity to capture the willingness to change towards other modes of transport. It also allows capturing the image of modes of transport by tying together data on attitudes and values with current mobility patterns and demographics. In particular a multi-level survey approach was applied that offers the chance to use a simple question about desired mobility behaviour to estimate the potential of active mobility. In the next level, the associations of respondents with different modes is learned to get a better understanding of how different modes are seen and can be used to find ways to address different groups of people with different strategies when trying to increase usage of that mode. The last level is a mode choice model based on several stated preference questions which can be applied to relate different influencing factors like costs and travel times and learn about connections of these influencing factors. This multi-level approach and its interpretation was applied to learn about active mobility in a well-connected area of Vienna, Austria. In the following we present two examples of how the analysis can be interpreted and applied for the design of campaigns for the two active modes of cycling and walking. While they can be used as a guideline of how to apply the presented methodology for campaign design they are only meant as examples and were not tested further in the field.

4.1. *Interpretation for Walking*

While people already use walking in their daily routine there is still some potential for a small increase of it. Walking is perceived as environmental friendly, self-determined, conventional, spare time, independent mobility option. Since it is hardly associated with unnecessary luxury, high income and laziness the attitude towards walking is rather positive. The result that around 25% of respondents would like to walk more also supports the finding that through targeted campaigns together with the improvement of infrastructure, environment and connectivity of areas to public transport offer the opportunity to increase the modal share of walking. To increase the share of walking it might be a strategy to highlight these positive associations with walking in campaigns. Looking at Fig. 7 such campaigns could target the image of especially people with low income that walking stigmatises them as poor and trying to change the image towards health improvements that is prevalent in groups with higher income.

4.2. *Interpretation for Cycling*

A large share of people in the study area would like to cycle more. In particular people who are heavy public transport users would like to integrate cycling into their daily routines. Prestige was found not to be the main reason for (non-)usage since cycling associated significantly more with low income by those having little money on their disposal. Younger respondents are more likely to associate positive meanings with cycling as a transport mode. Even though cycling is still widely associated with leisure activities by younger respondents, they also much stronger link it to lifestyle, self-determination, independence and time saving. Furthermore, younger

respondents regard cycling as safer when compared to other age groups. Age therefore has a higher impact on the image towards cycling than assumed indicating potential for active mobility among them.

As an example of an integrated program to support cycling amongst older people based on the results from Fig. 4 - 5, addressing their safety concerns that seem to hinder increased bike usage in this group (while this seems to be less of an issue for younger people) could be a promising path. Programs could be developed that help people to overcome these fears for example through specifically designed cycling courses for the elderly that are supported by a PR campaign that highlights the health advantages versus the adverse dangers of cycling changing the image of cycling towards a safe and healthy way of transportation. Campaigns like the one suggested above could form an important addition to the improvement of cycling infrastructure when promoting cycling in a city.

5. Conclusions and Outlook

Adding the new survey items creates the possibility to design more targeted PR campaigns or develop strategies and initiatives that fit better to a target group and hence have a better chance of succeeding. The methodologies in this paper are meant as a guideline to using extended surveys to extract meanings of mode usage amongst different groups that can be applied for the design of these campaigns. As an example of how to apply the new methodology, an analysis of the associations of respondents from Vienna was presented here. It shows that there is potential for changing the modal splits for walking and cycling. Furthermore, examples of how to interpret these associations in designing campaigns for active mobility are presented for both modes.

In future work, it remains to show how campaigns designed with the methodology do perform compared to less targeted campaigns when promoting walking and cycling. Furthermore, it would be interesting to see if there is a connection between the health benefits of cycling and walking and higher incomes. Such a connection could be used to design campaigns targeted at these but also less prosperous groups when designing campaigns for the promotion of cycling.

Acknowledgements

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