Towards using Segmentation-based Techniques to Personalize Mobility Behavior Interventions

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Abstract This paper describes our initial work towards a segmentation-based approach to personalized digital behavior change interventions in the domain of sustainable, multi-modal urban transport. Segmentation is a key concept in market research, and within the transport domain Anable has argued that there are segments of travelers that are relatively homogenous in terms of their mobility attitudes and behaviors. We describe an approach aimed at tailoring behavior change notifications by using segmentation-based techniques for user profiling. We report results from a Mechanical Turk study in which we obtained a crowd-sourced categorization of motivational messages. This is a first step towards understanding how to better deliver persuasive messages to relevant users profiles and situational contexts in the urban mobility domain. We conclude by discussing future steps of our work that should inform the deployment of persuasion profiling techniques to achieve sustainable mobility goals.

1 Introduction and Related Work

We are investigating how to maximize the persuasion potential for nudging citizens towards more sustainable transport choices via an urban mobility platform based on mobile and web interfaces. In our earlier work, we discussed how behavior change theories can be integrated into a sustainable urban mobility platform (Forbes et al. 2012). Building on the theories and techniques of Michie et al (2008, 2009, 2011), we were also inspired by the segmentation work of Anable (2006). In this paper, we aim to combine the profiling tools of Anable's segmentation analysis with digital intervention techniques to deploy *targeted* digital interventions that prompt people to use more sustainable transport modes. The SUPERHUB project (http://superhub-project.eu) aims to do this by a combination of: i) prompting intention formation, ii) setting and reviewing specific goals; iii) providing monitoring, feedback, and rewards; iv) supporting (social) comparison; v) aiding decision-making.

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To improve behavior change interventions for urban mobility, our recent research has identified a considerable potential in exploring and experimenting with the following techniques:

- Just-in-time prompts and notifications. Participants are prompted at appropriate times to change their behavior, for example to provide a lift or use public transport.
- Notifications or prompts are personalized according to user characteristics and context. Notifications to encourage behavior change are sent by taking into account domain-relevant user profiles and activities in order to raise their effectiveness in terms of user acceptance and persuasion.

Previous work suggests that personalized or tailored messages are more useful than generic ones in promoting behavior change (e.g., Masthoff et al, 2013). Noar et al (2007) provides a Meta-analytic review of tailored Health Behavior Change interventions and provides evidence for the effectiveness of tailoring. Tailored messages may be especially useful when emotional arousal facilitates behavior change interventions (Rimer & Kreuter, 2006, Lang 2006). Research has shown that users show significant individual differences in their response to influence attempts (Cacioppo et al. 1986; Cialdini et al. 1995; Guadagno et al. 2001; Kaptein et al. 2009). This suggests that using persuasion profiles (estimates of an individual user's susceptibility to different influencing strategies) to adapt persuasive systems should be considered (Kaptein & Eckles, 2010).

In this paper, we discuss how a segmentation-based approach can be used, where motivational messages are tailored to Anable's traveler segments. We also present the results of an initial study to select and categorize motivational messages. We finish by describing how this work will be extended to obtain an effective algorithm for selecting motivational messages based on the traveler segment a user belongs to.

2 A segmentation-based approach

The preliminary user research undertaken by large scale questionnaires and numerous focus groups early in our project found that different people have very different concerns regarding their travel choices. Some people are committed to the environment and will do what they can to reduce their carbon footprint. Others are less concerned and it will take a lot more persuading than simply showing CO_2 comparisons for them to make more sustainable travel choices.

Anable (2005) stated that travel research methodology and policy interventions often overlook how the combination of instrumental, situational and psychological factors affects travel choice and differs for distinct groups of people. Understanding what will motivate people to change their behavior is a key element of any successful intervention. For example, visualizing the amount of CO_2 produced over a year may work for some, whereas for others finding out the amount of money they could save by taking the bus rather than driving may be more motivating. Different people will respond more or less to different cues and this represents a major research challenge

in understanding how to develop effective persuasive interventions for everyone, not just those already concerned about the environment.

Table 1. Segmentation of people based on mobility attitudes, from Anable (2010).

Segment title	Segment description
Devoted Drivers	Think successful people drive, have no intention to reduce car use. They are not keen on using public transport (stressful) or cycling, find walking slow and don't not care about fitness or the environment.
Image Improvers	Like driving and don't want to cut down car use, They are not keen on using public transport but think cycling is a good way to keep fit. They have moderate environmental awareness and would like to increase the amount they walk and cycle.
Malcontented Motorists	Drive but don't really like driving, they are keen to drive less but still prefer the car to cycling, they also see problems with public transport. They have a small level of environmental consciousness. Large proportion of women drivers.
Active Aspirers	Would like to cut down on car use and agree that the bus can be quicker, but still see problems with using public transport. See themselves as cyclists and also regard walking as healthy. Have a high moral obligation to the environment and are highly motivated to use active modes of transport.
Practical Travelers	Only use the car when necessary and believe cars reduce quality of life. Enjoy cycling and will walk when it is more practical than cycling. See local pollution and congestion as is-sues but are not motivated by climate change. Have no intention of reducing car use or increasing Public Transport use.
Car Contemplators	See cars as status symbols and believe car use should be unrestricted. Would rather use the bus than cycle but see lots of problems with using public transport. Have a neutral attitude to the environment and are not motivated by fitness. Tend to be younger with the highest proportion of students.
Public Transport Dependents	Do not like driving but think people should be allowed to use cars and would prefer to travel more by car.
Car Free Choosers	Do not like driving and think that cars lead to unhealthy lifestyles. Believe car use should be reduced and find no issues with public transport. See cycling and walking as beneficial and are keen to use active modes of transport.

To enable a more tailored approach, we are considering the different types of 'traveler profile' proposed by the 'Segment' methodology developed by Anable (2010) which deploys a version of psychological theory of attitude-behavior relations (Theory Planned Behavior – TPB) to score travelers on specific attitude statements. Anable (2010) proposes eight distinct attitudinal segments, as shown in Table 1. The population segments are distinguished by their attachment to the car, self-identification with alternative travel modes and motivations for fitness and environ-

mental protection. A series of so-called 'golden questions'[5] were developed (answered via a Likert scale of 1-5, 1 being strongly disagree or very unlikely, 5 being strongly agree or very likely) to assign travelers to these segments. Example questions are: "I am not the kind of person who rides a bicycle", "I feel I should walk more to keep fit", and "I feel a moral obligation to reduce carbon emissions". The SEGMENT project has shown that these segments are common and workable across Europe. The proportions of the segments vary from country to country in relation to the value people put on status, cost, time, environment, social norms etc.

3 Validation of motivational messages

This section describes our approach to categorize and validate motivational messages for use in personalized behavior change interventions. We are currently carrying out experimentation by utilizing Amazon's Mechanical Turk (MT) to gather crowd sourced intelligence about which kinds of message would be best suited to motivate Anable's defined traveler profiles. Initially we produced and selected a wide range of messages including quotations that we thought could motivate sustainable travel behavior in our users. This first MT study shows how we validated the messages to be used in each of the motivational categories shown in Table 2. We adopted the approach used in Dennis et al (2013), who investigated the categorization of emotional support statements.

3.1 Participants

Participants were recruited from Amazon's Mechanical Turk service (MT, 2013), a crowd-sourcing tool. Participants (called workers) complete small tasks (called HITs) made available by requesters and are paid a small sum for completing the task successfully. For this validation experiment (HIT), participants had to be based in the US and have an acceptance rate of 90% (meaning that 90% of the work they do is accepted by other requesters as good quality) and were paid $0.70. We used a Cloze Test (Taylor, 1953) for English fluency due to the language based nature of the study. Workers who failed the test were excluded. 30 participants completed the experiment and were 27% male. 24% of participants were 18-25, 43% were 26-40 and 33% were 41-65. The average time taken to complete the experiment was around 11 minutes.

[5] For further information on the golden questions and to access the segmentation tool, see www.segmentproject.eu/segmentationquiz .

3.2 Procedure

Participants were introduced to the categories and their definitions (as described in Table 2). Next, they were shown a message and asked to place it into one of the categories (still seeing the definitions), as shown in Figure 2. This was repeated for each of the 74 messages. Participants were advised that there were no right or wrong answers and that it was their opinion that counted.

Table 2. Message categories

Message category	Description
Change is possible (CP)	Aims to tell you that you can positively impact the environment
Sustainability self-reflection (SS)	Aims to make you reflect on the importance of behaving in a sustainable way
Social comparison (SC)	Aims to make you reflect on how sustainably your travel behavior is compared to that of others
Benefits walking (BW)	Aims to highlight one or more benefits of walking
Benefits cycling (BC)	Aims to highlight one or more benefits of cycling
Benefits public transport (BPT)	Aims to highlight one or more benefits of using public transport
Drawbacks driving (DD)	Aims to highlight one or more negative aspects of driving
Advice on sustainable travel (AD)	Aims to provide advice on how to travel more sustainably
Other	Does not match any of the other categories

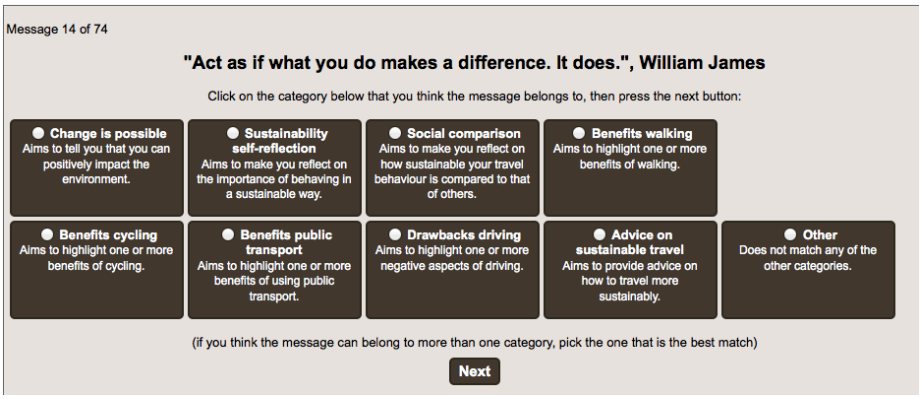

Fig. 2. Example of how messages were presented to participants during the MT study.

3.3 Validation Measure

We use Free-Marginal Kappa (Randolph, 2005), as a metric for establishing how well

categorized our messages were. The kappa value describes agreement amongst raters, with 1 indicating unanimous agreement, 0.7 excellent and 0.4 moderate agreement. To be reliably categorized, the kappa score for the message had to be ≥ 0.4.

3.4 Results

Table 3 shows the messages with kappa ≥ 0.4. To decide on which messages to put forward to the next phase and potentially use as motivational messages during our next project trial, we selected those that had the highest kappa values and that had at least a kappa ≥ 0.4 (so, had an adequate level of agreement between the participants).

Table 3. Messages with adequate inter participant agreement (kappa ≥ 0.4).

Category	Message	Kappa
AD	Did you know that if you use the SUPERHUB Journey Planner for your regular journeys, you will get warnings about disruptions?	0.42
	Are you searching for a ride share but don't trust the services offered on the web? SUPERHUB is secure and safe, and all the riders profiles are verified and classified according to the rating provided by other members of the community.	0.41
CP	"You must be the change you wish to see in the world" Mahatma Gandhi	0.73
	"Never doubt that a small group of thoughtful, committed citizens can change the world; indeed, it's the only thing that ever has.", Margaret Mead	0.61
	"Little decisions over time make a big impact on our lives.", Eric Samuel Timm	0.61
	"Sometimes if you want to see a change for the better, you have to take things into your own hands.", Clint Eastwood.	0.60
	"Act as if what you do makes a difference. It does.", William James	0.51
	"They always say time changes things, but you actually have to change them yourself.", Andy Warhol	0.50
	You can make a difference and SUPERHUB will show you how!	0.50
	"True life is lived when tiny changes occur.", Leo Tolstoy	0.46
DD	Did you know that traffic jams can be harmful for your health? The pollutants can get inside the car.	0.72
	"Not having to own a car has made me realize what a waste of time the automobile is." Diane Johnson	0.48
SS	"The most patriotic thing you can do is to take care of the environment and try to live sustainably.", Robert F. Kennedy, Jr.	0.59
	"What I do know, is that if we do not act soon, it is our children and our grandchildren who will have to pay the price.", J.Hall in The Day After Tomorrow	0.51
	"We are all interested in the future, for that is where you and I are going to spend the rest of our lives.", Woody Allen	0.46
SC	How green are you compared to your friends? Why not try a SUPERHUB Eco-challenge?	0.45
	Did you know that with SUPERHUB you can show your friends how eco-friendly you are?	0.40

BC	"Think of bicycles as rideable art that can just about save the world." Grant Petersen	1
	"Nothing compares to the simple pleasure of riding a bike." John F. Kennedy, 35th President of the United States	1
	"Cycling is a joy and faster than many other modes of transport, depending on the time of day. It clears the head." David Byrne	1
	If you cycle more often you will increase your fitness and save money.	1
	Using the bicycle on sunny days will not only save you money but make you feel great!	1
	Cycling you can enjoy places in your city that are impossible to reach by car.	1
	Cycling is not only fast and healthy - it causes no pollution!	1
	"I thought of that while riding my bicycle." Albert Einstein in reference to the Theory of Relativity.	0.85
	"Whenever I see an adult on a bicycle, I have hope for the human race." H.G. Wells	0.54
	Have you heard about the new bike sharing scheme your city has introduced?	0.49
BPT	Did you know that many people met their partner on public transport?	1
	Commuter trains are comfortable and you can work while you travel!	1
	"You can't understand a city without using its public transportation system.", Erol Ozan	0.85
	Using public transport rather than your car will save you money and help to improve the air quality for everyone in the city.	0.85
	"There is nothing like a train journey for reflection.", Tahir Shah, In Arabian Nights	0.72
	It is illegal to drink and drive, but you can always take the bus!	0.68
	Who says that to save your time you should use your car? Sitting on a bus or train you can give your attention to something much more productive like reading a book instead of paying attention to the road.	0.67
	Do you know that many fatal road accidents are caused by using cell phones? Using public transportation you can talk, check your Facebook profile, send tweets whenever you want and Stay Alive!	0.61
	Do you want to save money and the environment? Why not use public transport instead of the car?	0.60
	Did you know that the average speed of cars in the city center is only 19 km /h? Public transport is much faster!	0.58
	"I am not suggesting that just by taking the Metro, I will save billions. But I hope others will follow.", Veerappa Moily	0.51
BW	"All truly great thoughts are conceived while walking.", Friedrich Nietzsche	1
	Want to feel better this month? Why not try walking to work? Walking 30 minutes per day will use 100 calories. You could lose 3lbs by the end of the month - but don't buy chocolate on the way!	1
	Walking at least 1 hour per day helps you to be healthier, reduces stress and anxiety and increases wellbeing.	1
	"But the beauty is in the walking; we are betrayed by destinations.", Gwyn Thomas	0.79
	"Everywhere is walking distance if you have the time.", Steven Wright	0.55

The results showed that some categories obtained a much higher level of agreement between participants than others, for example, the 'positive aspects of cycling' agreement levels and therefore kappa values were very high, whilst other categories such as 'Advice on Sustainable Travel' and 'Sustainability Self-reflection' led to lower levels of agreement, and hardly any messages with kappa ≥ 0.4. This can be explained by the fact that some of the original messages had components of more than one category, for example, the following message "Did you know that many people use public transport at least once per week?" contains a positive statement about public transport and is also a social comparison statement, which effectively divided the participants choice between the two categories. Some refinement of the messages and categories has been made to enable clearer categorization for the next round of MT experiments. We have removed the 'Advice' category and any 'mixed message' messages will be replaced with less complex ones that provide a clearer persuasive message. A further iteration of the above procedure will be carried out with another 30 participants to allow validation of additional messages.

4 Conclusions and Future Work

In this paper, we have presented our early and ongoing work in designing persuasive notifications tailored to relevant travelers' profiles for behavior change interventions in the sustainable transport domain. We have reported work conducted to gather a corpus of 74 motivational messages and categorize them into 9 categories, with 45 messages being reliably categorized.

The next step is to run a study which presents participants with each traveler segment profile and asks them to provide the most appropriate notifications using the validated messages. This will result in an algorithm that selects message categories (and messages) depending on the traveler segment. It would have been possible simply to select message categories and messages that we thought would be appropriate for each of the segment types. However, by going through the process of crowd sourced intelligence for initially grouping messages by category and then choosing which messages (and hence, categories) would be most relevant to each segment type, we expect to obtain a more effective persuasive system.

Additionally, we will run a study in which participants rate the messages (on how effective, appropriate, persuasive, and motivational they are) for each segment type, to validate the algorithm. Overall, this approach will help us to develop and deploy a more effective and tailored persuasive intervention for the different types of urban travellers targeted in our project.

Using segmentation analysis should help sustainable mobility projects to develop a richer understanding of each group of people and will also provide relative numbers of people in each group for a target city. As different segments will respond differently to persuasive messages and interventions, using this technique as a foundation to tailor motivational messages provides a good framework for systems aimed at improving sustainable mobility, as well as for policy makers who would like to influ-

ence travel behavior. Some groups may be unlikely to change behavior under all but the most extreme of policy measures, so city level initiatives could target specific segments with more tailored sustainable transport interventions.

In addition to this segment profiling technique, data mining could also enable alternative behaviors to be suggested to users of persuasive systems for sustainable mobility. For example, when a dedicated mobile/web app has learnt about a user's regular travel habits, suggestions can be made such as to try public transport for a given leg of their journey. In this way the persuasive elements of the systems seamlessly integrate into the travel planning functionality.

We aim to create a synthesis of automated digital interventions based on intelligent analysis of tracked user behavior with explicit goal setting, adjustment, achievement-tracking, feedback and incentive mechanisms. Automated interventions could also cover opportunistic contextual interventions, such as suggesting alternative transport modes (e.g., renting a bike when there is public transport disruption).

Although the research presented in this paper is currently in a preliminary stage, we plan to deploy the results during a real world longitudinal trial that will involve a large-scale sample of citizens in Milan, Barcelona and Helsinki in the late summer of 2014.

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