THE EFFECT OF INCENTIVES TO PROMOTE CYCLING: A MOBILITY LIVING LAB

Bingyuan Huang, Corresponding Author
Centre for Transport Studies
University of Twente
Room Z238, The Horst,
Tel: +31 (0) 53 - 489 5203; Email: b.huang@utwente.nl

Tom Thomas
Centre for Transport Studies
University of Twente
Room Z222, The Horst, Enschede, The Netherlands
Tel: +31 (0) 53 - 489 2449; Email: t.thomas@utwente.nl

Benjamin Groenewolt
Keypoint Consultancy
Enschede, The Netherlands
Tel: +31 (0)53 – 482 5703; Email: Benjamin@keypoint.eu

Tiago Fioreze,
Centre for Transport Studies
University of Twente
Room Z212, The Horst, Enschede, The Netherlands
Tel: +31 (0) 53 - 489 4322; Email: t.fioreze@utwente.nl

Eric van Berkum,
Centre for Transport Studies
University of Twente
Room Z228, The Horst, Enschede, The Netherlands
Tel: +31 (0) 53 - 489 4886; Email: e.c.vanberkum@utwente.nl

Word count: 5335 words text + 3 tables/figures x 250 words (each) = 6085 words

Submission Date: 31st of July, 2017

ABSTRACT

As part of the Horizon 2020 project EMPOWER, this paper presents results from a case study on the impact of positive incentives on cycling behavior for around 70 participants in the Twente region of the Netherlands. This was done by using the SMART app in a real-world living lab environment. The SMART app uses challenges with rewards, feedback, and message functions to promote cycling. In this particular case, participants were challenged to cycle at least 10 times along a newly paved cycling road and get rewarded upon completion of the challenge. A post-challenge survey was sent through the app to evaluate participants' behavior. We found that the campaign resulted in new bike trips, on the newly paved road, made by users who completed the challenge, even after the campaign had ended. According to the survey, 44% of participants responded that their behavior had changed due to the campaign, and that they would keep on cycling more often after the campaign. Most users who did not complete the challenge said they do not need to use this road, but 20% of them indicated that they would cycle more if they got challenges and rewards more suited to their personal situation. This implies that challenges are more effective when they are customized based on individuals' historical travel patterns.

Keywords: Travel behavior, Living lab, Smartphone, challenge and rewards, soft measures.

1. INTRODUCTION

Road transport contributes to about 25% of the EU's total emissions of CO2 (1). As the main component of global greenhouse gas (GHG), CO2 emission is the main contribution to global warming. Therefore, the European Union stressed the urgent need to reduce the levels of CO2 emission. In addition to the negative impact for the environment, car driving is also associated with unhealthy behavior (e.g., Gordon-Larsen et al., 2009 (2)). Active modes of transport (i.e., cycling and walking) are not only environmentally friendly, but also seen as healthy alternatives (3)(4), in particular for relatively short trips within cities.

Fiscal regulations to discourage car use are effective measures to stimulate alternative transport modes, but are sometimes controversial regarding socio-economic equity (i.e. poor people cannot afford to use the car anymore, whereas rich people are less affected or not at all) and often lack public support. Instead of 'stick' measures, positive incentives such as travel planning, subsidies, marketing, rewards, and PT discounts could also stimulate the use of sustainable transport options. Positive interventions or "soft measures" are used within voluntary travel behavior change (VTBC) programs or active traffic and demand management (ATDM). We found several case studies in which such interventions were used to promote cycling (e.g., Baum, 2008 (5), Dubuy et al., 2013(6), Steven & Avineri, 2011 (7) and Y. Zhang et al., 2010 (8)).

However, in most of the cases, stated preference surveys were used to measure the intention for change, which is not the same as actual changing behavior. This situation is improving and changing with the use of information technologies, such as smartphones, where high-bandwidth connectivity and the growing adoption rate are said to be transforming the public realm and the way we live and interact in urban areas (9). These rapidly advancing technological are able to automatically detect travel behavior, offer real-time information about the traffic and provide rewards accordingly. There are some positive incentive programs that used mobile technologies to provide interventions for travel behavior change studies (e.g., Hu, Chiu, & Zhu, 2015 (10), Sanjust, Meloni, & Spissu 2014 (11), Ben-Elia & Ettema 2011 (12), Usui, Miwa, Yamamoto, & Morikawa, 2008 (13) , and Zhu et al., 2015 (14)), which all have proven that interventions through mobile technologies can successfully raise sustainable travel behavior change. These interventions are: rewarding sustainable behavior, providing feedback about behavior, encouraging behavioral change by goal setting and planning, and raising awareness of sustainable travel options by providing travel information. For example, Spitsmijden (12) focused on the effectiveness of rewards, CAPRI (14) used feedback by comparing behavior with others and by giving rewards accordingly. Casteddu Mobility Styles programs (11), Osaka, Japan, and Metropia (13)(10) used a combination of incentives.

One of the problems of aforementioned studies is that subjects are fully aware of the fact that they are participating in an experiment. This may induce them to behave in a more positive way in order to pleasure the experimenter (15). Furthermore, direct measurements of the effects are often lacking and behavioral change is often measured indirectly. For example, Metropia sent emails during the experiment to ask participants about their habitual behavior, and Casteddu Mobility Styles program used surveys to ask participants' potential behavior change, without using smartphone sensors to track the real behavior change. The smartphone app usage inconvenience, the experimental look and feel of the used apps, and the use of surveys to measure effects, are limitations of these studies. Even though those studies are valuable, they do not gain rich insights into the complex interactions of the user with the environment, or the user context (15) (16). Living

lab experiments, on the other hand, can overcome those limitations and provide real-life contexts (17) (16). Living Labs are a rather new phenomenon which started to emerge in the beginning of 2000. The initial focus of Living Lab was to test innovative technologies in home-like environments (18). As the concept has grown, a real-world context is one precondition in a Living Lab experiment.

Last but not least, aforementioned studies were not specifically focusing on cycling. Metropia and Spitsmijden analyzed peak hour avoidance, CAPRI studied a parking behavior program, Casteddu Mobility Styles programs focus on mode change to a light rail service. Osaka, Japan involved cycling behavior analysis, but the main focus was all non-auto transport modes. This is unfortunate, because as mentioned earlier, cycling (and walking) can capture a significant share of car trips within cities. Therefore, there are already numerous commercial apps such as Strava, CycleMaps that promote cycling by using gamification methods. Other apps such as BetterPoints, Fietstelweek, CommuteGreener are providing real rewards to promote cycling. All those projects show a potential to encourage cycling, but lack rigorous scientific analysis to evaluate their effects.

This study is part of the Horizon 2020 project EMPOWER (19), in which positive interventions are used in real-world Living labs to promote sustainable travel behavior (change), such as cycling. Within EMPOWER, the SMART (jointly developed by Mobidot and the municipality of Enschede) app has been used to promote cycling. The objective of this paper is to test the effectiveness of positive interventions in a living lab environment.

The paper is organized as follows: Section 2 explains the methodology and the design of the interventions strategies, the SMART system, and reviews the pilot study; Section 3 presents the results of the discussions; and Section 4 provides conclusions and future works.

2. METHOD

SMART App

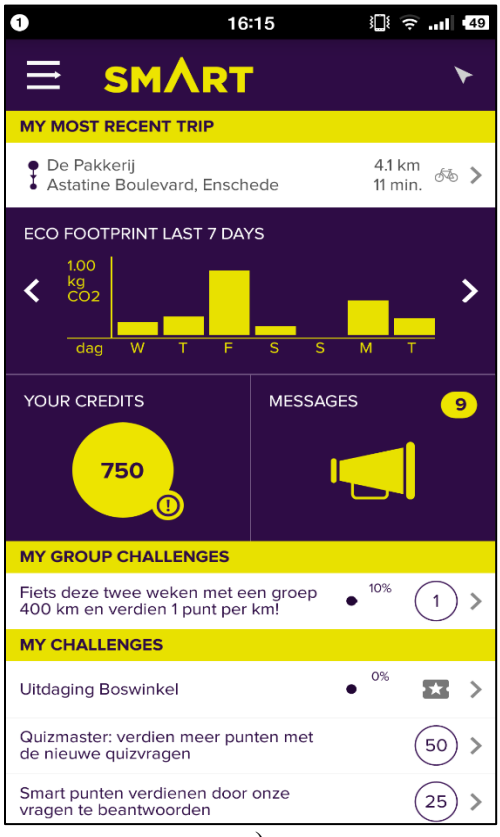
The positive incentives were provided through the SMART app (20). In this subsection, we describe the SMART app based on the principles of persuasive technology. TravelSmart (21) and Casteddu Mobility Styles programs (11), for example, have successfully adopted the principle of persuasion (22) to promote travel behavior change. The persuasive system design (23) is used for the design of software and information systems to reinforce, change and / or shape attitudes and behavior. The design consists of four principles and the application of the persuasive design principle in the SMART app is shown in Figure 1, Figure 1(a) depicts the SMART app dashboard. Users can explore the whole functions of the app from this page. The remaining figures are enlarged screenshots from other pages of the SMART app. The following shows the four design principles.

First, the principle of task support design presents the user's primary task and supports the user in finalizing this task. In the SMART app, we present the task by challenges, and we provide feedback on historical behavior (i.e. on trips made in the previous days and weeks). In doing so, we provide the user with information on the progress of the challenge (Figure 1(a,b)). This is done by continuously tracking (using GPS, accelerometer data, etc.), and using advanced algorithms that combine travel speeds and travel routes to determine which transportation mode the traveler is using. The observed trips (including route and mode) of the user are shown in the front end. The operator can provide challenges and messages to users, which also will be shown in the front end

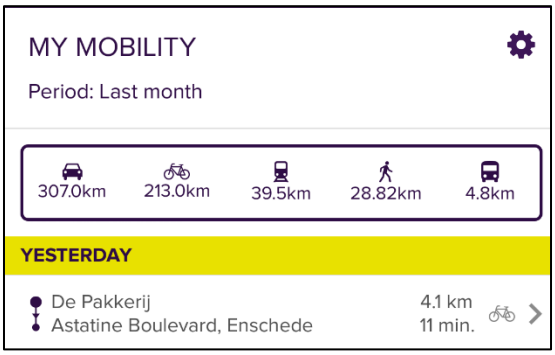
(Figure 1(c)).

Secondly, the principle of dialogue support stimulates users to keep moving towards their goal or target behavior. In SMART, rewards are provided upon completion of the challenge (Figure 1(d)). If the challenge is accepted by the user, the system starts to keep track of the targeted behavior, and shows the process in the front end. When the challenge is fulfilled, the system will immediately give the corresponding amount of points. The earned points can then be redeemed for various discounted products and services. Note that non-cash incentives may ultimately make users more satisfied (24), and that from an earlier study we also concluded that in kind gifts from a web shop have a more positive impact than cash rewards (25). Furthermore, event and traffic information are also offered through messages (Figure 1(e)). SMART can give useful information about the actual local traffic situation and notifies users in case of road works or large scale events that lead to extra traffic. Based on this, SMART can also suggest travel alternatives to help the user to optimize their travel plans.

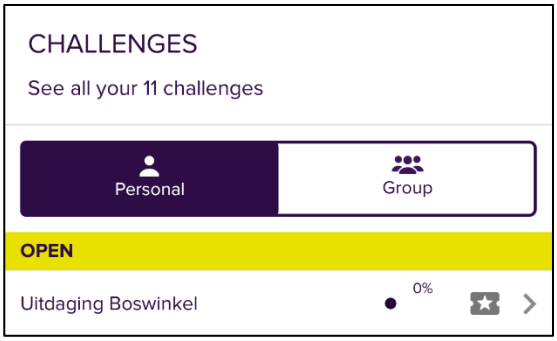
Thirdly, the principle of system credibility provides to the user with credible and authentic information from an acknowledged source. For example, a mobile application with good reviews that is regularly updated by its developer(s) and supported by trustworthy source(s) is expected to be credible. The SMART app is regularly updated and maintained by Mobidot and supported by the municipality of Enschede. Moreover, its users are informed in advance about privacy protection and the travel mobility data is updated every day. At last, there are new challenges updated regularly as well as well-known shops to redeem vouchers (Figure 1(f)). All these features help to support the system credibility of the SMART app.



a)



b)



c)

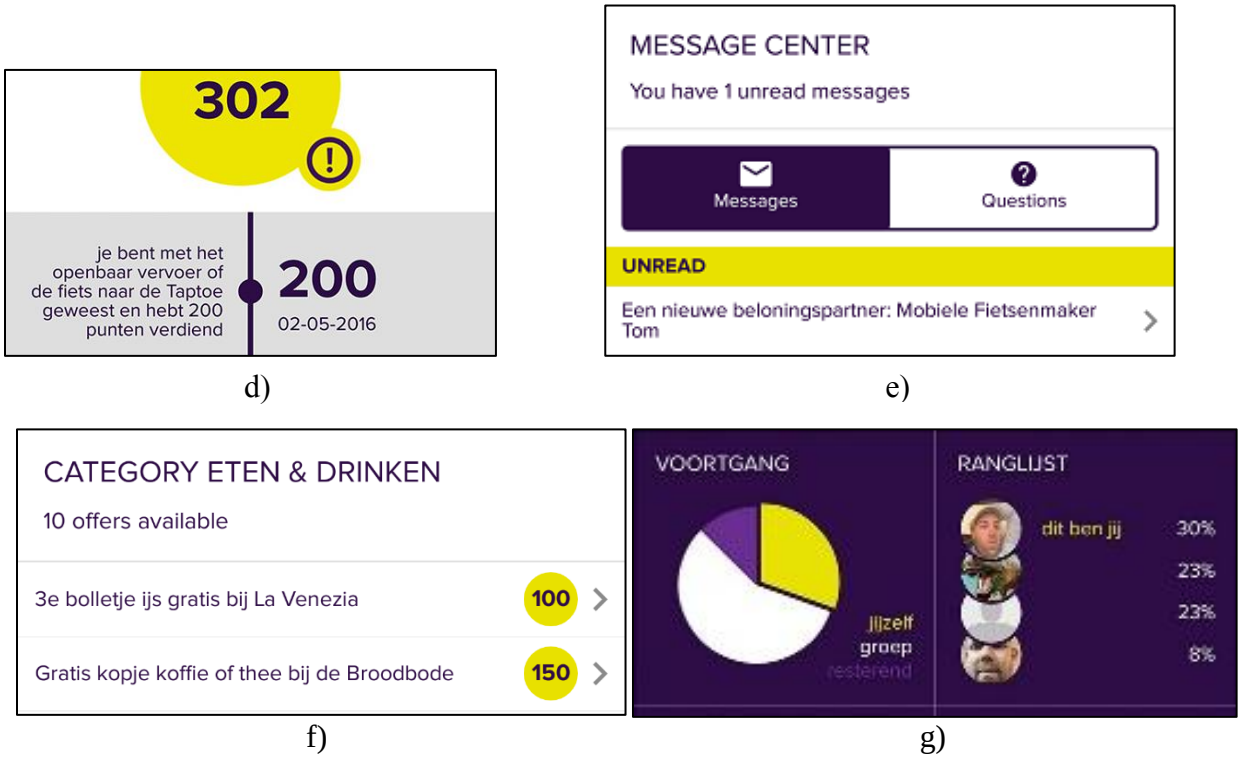


FIGURE 1 a) Dashboard, task support, feedback and monitoring; b) Task support, monitoring; c) Task/challenge, d) Dialogue support, reward result, e) Dialogue support, messages, f) System credibility, third party redeem stores ; g) Social support

Finally, social support motivates users by leveraging social influence. The SMART app involves group challenges in which participants can invite friends to fulfill the challenge together (Figure 1(g)). However, in the Boswinkel campaign, social support was not included.

Case study design

The case study includes two parts, first the implementation, monitoring and evaluation of the challenge and rewarding scheme, and secondly post-challenge survey to evaluate the participants' view on their behavior. The whole case study was designed and carried out through the SMART app.

In this cycling promotion campaign, named the Boswinkel challenge, participants were challenged to cycle at least 10 times along a newly paved cycling road (in the Boswinkel neighborhood). The campaign period was from the beginning of October to the beginning of December 2016 (week 41-49 in 2016). During this time period, there were no other challenges. Users who downloaded the SMART app needed to select and join the challenge. After finishing the challenge, a voucher was awarded to the user who could redeem it in the local shops. The case study was carried out in the city of Enschede, a midsized city in the Netherlands with approximately 158,000 inhabitants.

Participants who used the SMART app were recruited via different municipal communication channels in which the main objective was to promote the cycling city ambition in general, and to

promote the use of the newly opened Boswinkel route in particular.

Participants were not told that they were participating in an experiment and could join at any time within the duration of the campaign through the SMART app. As a result, we created a real-life context—a living lab to truly analyze the traveler' behaviors. However, as the participants could immediately use all functionalities of the SMART app, we are not able to do a before measurement, which is an important drawback of this study. Moreover, we cannot disentangle in this experiment whether either the added comfort of the new route itself or the challenge with reward lead to extra cycling trips.

To tackle the question whether and why participants change their behavior, we used the SMART experience sampling question service, which allows to send personal questions triggered by specific events. The questionnaire was sent out immediately after completion of the challenge or after the campaign for participants that did not complete the challenge. First, participants received the question why they did or did not complete the challenge. Then they were asked whether they had cycled more along the Boswinkel route during the challenge and whether these trips were new trips, trips that were previously made by car or public transport, or trips that were previously made by bike but along a different route. In the case that participants had indicated that they had cycled more along the Boswinkel route, they received two follow-up questions. In the first question, they were asked about the reasons to cycle more (due to the new infrastructure, due to the challenge & reward, or due to some other external factors). In the second question, they were asked whether they would keep on cycling more often.

3. RESULTS

Trip data

In total, 139 SMART users joined the Boswinkel challenge. However, 59 users did not have more than 4 weeks continuously GPS travelling data, and were therefore excluded from the analysis. Of the remaining 70 users, 32 completed the challenge. Those users were labeled as Finish Group (FG). The other 38 users who did not complete the challenge were labeled as Did Not Finish Group (DNFG).

As mentioned earlier, due to the set-up of this campaign, we do not have measurements before week 41 when the campaign officially started. However, we have measurements after the campaign ended in week 49. Users downloaded the app over the entire course of the experiment, where almost all 70 users accepted the challenge immediately when they downloaded and registered for the App. Unfortunately, this means that the challenge period is not the same for each user as most users downloaded the app after the start of the campaign. Although this mimics realistic real-world behavior, it complicates the evaluation. Only 14 users in FG and 14 users in DNFG have participated during the whole campaign. This first sample was used to evaluate the campaign period. Fortunately, as most people only started in the second half of the campaign, more people were tracked during the end and after the campaign. To compare the behavior during and after the campaign, we used a five week period from week 46 until week 51. For this second sample, we had 24 users in FG and 24 users in DNFG. The two samples do not overlap completely for FG, 11 users in challenge period sample were in the during and after challenge sample. For DNFG, all

users in challenge period sample were also in the second sample.

In Figure 2, we show the weekly average trip frequencies per person for the first sample from week 41 – 49, and the same trip frequencies for the second sample from week 46 - 51. We distinguish between bike trips and short car trips (smaller than 7.5 km) that could in principle be made by bike. We also show the bike trips that didn't go along the Boswinkel. The difference with the total bike frequency indicates to what extend the Boswinkel challenge was successful. Remember that the campaign promotes cycling along the Boswinkel route, not necessarily cycling in general.

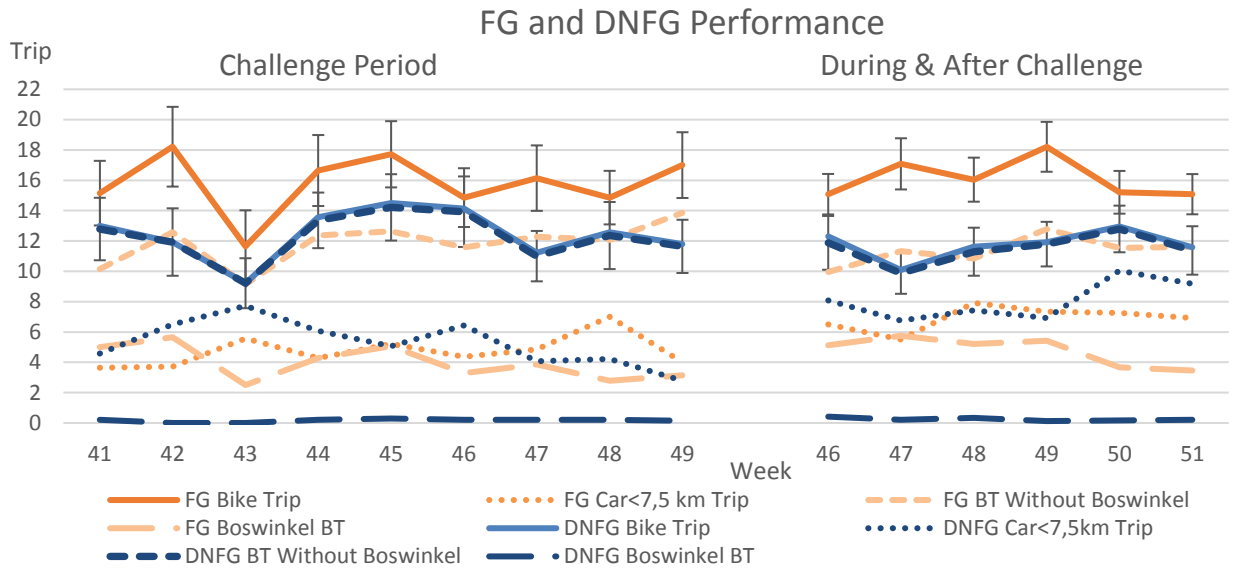


FIGURE 2 Trip frequencies during the campaign and Trip frequencies during the last few week of the campaign and after the campaign

Figure 2 shows the difference between the cycling frequencies of both groups. This difference is statistically significant for the second sample (week 46 – 51), which can be seen from the standard error bar in Figure 2. For car trips, the standard error is bigger than bike trips, so the difference between the two groups are not significant.

For both samples, the cycling frequency is consistently higher for FG than for DNFG. This difference can be attributed to cycling trips along the Boswinkel route, given that when we exclude the Boswinkel cycling trips, there is no significant difference in cycling frequency between the two groups. However, the fact that half of FG participants did not cycle more to finish the challenge (as reported from the post-challenge survey), gives a bit of uncertainty to our behavior change analysis with respect to the FG group. Nevertheless, the effectiveness of the campaign is supported by the post challenge survey. For the 24 users in the second half of the campaign, 14 out the 24 users answered the survey, and 9 out of 14 users reported that they cycled more on the Boswinkel route under the challenge, which implies that the campaign has likely resulted in new bike trips. Additionally, in case that there are users who did not cycle more on Boswinkel route in FG, so to exclude the extra new bike trips made on the Boswinkel route, FG made more cycling trips than DNFG. This suggests that FG is more cycle minded than DNFG.

However, there is no statistical evidence that the campaign had an effect on the number of (short) car trips. Although car trip frequency is on average higher for the DNFG group, this result is not statistically significant. Moreover, it is not clear if such a difference could be solely the result of the challenge. The DNFG group also has a somewhat higher rate of long distance trips (> 20 km). For example, 4.4 trips per person for DNFG (which corresponds to 12.6 % of the total number of trips) versus 2.6 trips for FG (which corresponds to 8.5 % of all trips). These trips are typically made by car. When people use the car more often for longer trips, they may also be inclined to use the car for short trips.

When comparing the situation during and after the campaign, results are inconclusive. Figure 2 shows there is some indication that the bike frequency decreases and car frequency increases for DNFG after the campaign. This might be related to the fact that the challenge has ended. However, again this result is not significant. There is no evidence for a steep decline in cycling trips along the Boswinkel route after the end of the campaign. On the contrary, during the short measurement period (of two weeks) after the campaign, participants of the FG keep cycling along the Boswinkel route.

One of the reasons results are inconclusive is that there is quite some natural variation from week to week in the trip frequency. The relative week-to-week variation for is more than 10% (standard deviation with respect to the mean) and about 20% for the bike and short car trips respectively. This result suggests that it is quite hard to disentangle the effect of positive incentives from natural variation. Traditional before and after measurements of one day (or a few days) may only prove an effect when it is very large. For smaller effects, before and after measurements of weeks are needed to provide enough data to prove a positive incentive has an effect. Of course, the relatively small sample size may amplify the natural variation. However, there are indications that some (significant) part of this variation is caused by external effects that influence the whole group rather than a few individuals. Although not statistically significant due to the limited number of weeks, there seems to be a negative correlation ($r = -0.6$) between the weekly car and bike frequency for FG, and a positive variation between the weekly bike frequencies of both groups ($r = 0.5$). Such correlations are expected due to, for example, changing weather conditions. For example, week 43 showed quite some precipitation, coinciding with an increase in car trips and a decrease in the number of bike trips.

Post-challenge survey

Post-challenge survey was sent out through the SMART app for all participant immediately after the campaign. In total, 43 out of 139 participants took part in the post-challenge survey of which 23 participants completed the challenge, and 20 did not. The results are shown in Figure 3. For FG, half of the users (12 users) found the challenge too easy, and 7 of those 12 did not even need to cycle more to complete the challenge. Furthermore, 5 out of 23 users claimed they had to use the Boswinkel route quite often anyway and therefore they completed the challenge without changing their behavior. The remaining 6 participants indicated that they were motivated by the challenge and the reward, and 5 of them cycled more often along the Boswinkel route during the challenge.

Summarizing, 10 out of 18 users (55.6%) indicated they have changed their behavior, and all of them said they would keep on cycling more often (50% also claimed to cycle more on other routes).

Furthermore, half of them gave the challenge & reward as the sole reason for their behavioral change, whereas the other half claimed that both the newly paved route and the challenge & reward were the reason for behavioral change. In other words, all participants indicated that the challenge and reward played a role for them to cycle more. However, all 10 users changed their behavior to choose the Boswinkel route more often, but not related to mode change.

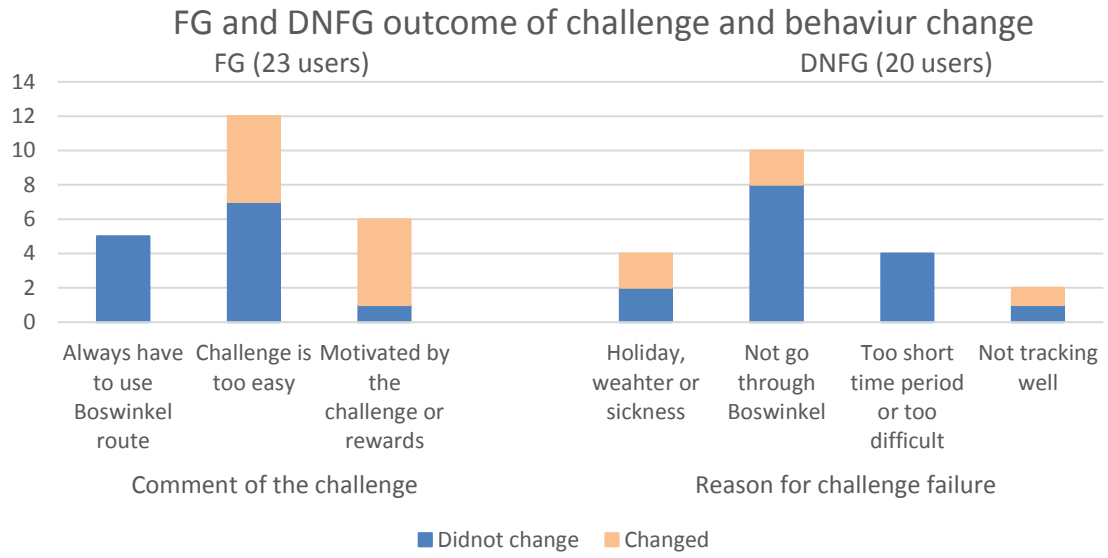


FIGURE 3 Reasons for completing (left) or not completing (right) the challenge.

For the participants that did not complete the challenge, half of them (10 participants) did not need to use Boswinkel the route at all, and therefore could not complete the challenge. Others claimed external factors such as illness and weather (4 persons), the limited challenge period (4 persons) and malfunctioning of the tracking tool of the app (2 persons) as reasons for non-completion. It is worth noting that in the latter case, the participants complained about the GPS trajectory accuracy. However, it turned out that they only cycled through a small part of the Boswinkel route which was excluded by the algorithm, but which was not reflected in the textual explanation of the challenge. This is of course an issue when considering the trustworthy and credibility of the app. For the participants that did not complete the challenge, still 6 out of 20 persons indicated they had changed their behavior, and were planning to cycle more. In other words, if we would customize the challenges to the personal situation of the participant such that the challenge is perceived as not too easy or too difficult, high rates of behavioral change are likely based on these results.

4. CONCLUSION AND FUTURE WORK

In this study, we examined the potential impact of interventions to promote cycling by using the SMART app in a living lab environment. The intervention in this case study is the Boswinkel challenge in which participants were challenged to cycle along a newly paved cycling road (Boswinkel route) with rewards.

From our analysis, we can draw three main conclusions. First, the new paved Boswinkel route alone did not have a significant effectiveness to promote cycling. In other words, the challenge

and reward played a role for travelers to cycle more, which is supported from the survey that no users claimed the new route resulted in their behavior change, but resulted from the combination of the new paved route with challenge and rewards. Second, extra bike trips were made on the Boswinkel route during the campaign, as participants who completed the challenge made more cycling trips than participants who didn't complete the challenge, and the users who finished the challenge and joined the survey claimed they made more bike trips on the Boswinkel route. Additionally, the extra bike trips on the Boswinkel route were mostly created by change in route choice, since users who completed the challenge mostly live nearby the Boswinkel route and already cycled often. The effectiveness of the interventions for modal shift is not significant, however, some users who did not finish the challenge claimed they had modal shift from car to bike. The modal shift analysis needs a bigger sample size. Third, participants who completed the challenge kept cycling along the Boswinkel route after the campaign. These results were confirmed by the post-challenge survey, in which 56% of users indicated they have changed their behavior and planned to continue cycling more often after the campaign.

Moreover, from the survey we found that 20% of participants who didn't complete the challenge, still indicated they had changed their behavior and / or were planning to cycle more in the future. In fact, most people that indicated they had not changed their behavior either found the challenge too easy (or did not need to adapt their behavior) when they completed the challenge or found the challenge too difficult or not appropriate (because they did not need to use the Boswinkel route) when they had not completed the challenge. This clearly shows that personalized challenges, customized to the individual's need, i.e., based on the travel context of the individual (which can be derived from historic trip patterns), could significantly increase the amount of behavioral change. Moreover, respondents who either claim the challenge is too easy or too difficult / not appropriate to them, may be discouraged to participate in future challenges.

Due to natural variation in weekly trip patterns (partly due to small sample sizes), it is quite hard to disentangle the effect of positive incentives from external effects (such as weather). These external effects may have influenced modal split, i.e. the percentages of cycle and car trips (for example more car trips at the expense of bike trips during bad weather), or total demand (for example more traffic during events, or less during holidays). Although the data shows a slight decrease and increase respectively of the average numbers of car and bike trips, these findings are not statistically significant. In addition, as we used a living lab setting, it is hard to do (controlled) experiments with before and after measurements. To overcome these drawbacks, we are planning to monitor the participants over longer periods of time, in which they get multiple challenges, so that we have multiple outcomes. This will enable us to look for behavioral change over a longer period, distinguishing between challenges, in which we control for external effects such as weather or seasonality by for example using traffic counts (both for car and bicycles).

ACKNOWLEDGMENTS

This study is part of the Empower project, which is funded by the European Union's Horizon 2020 research and innovation programme. The authors would like to thank Johan Koolwaaij from the Mobidot, for his valuable help on data providing.

REFERENCE

1. European Commission. Road transport: Reducing CO2 emissions from vehicles | Climate Action. 2016, https://ec.europa.eu/clima/policies/transport/vehicles_en, Accessed January 16, 2017.
2. Gordon-Larsen P, J. Boone-Heinonen, S. Sidney, B. Sternfeld, DR. Jacobs Jr, CE. Lewis. Active commuting and cardiovascular disease risk: the CARDIA study. *Archives of internal medicine*, Vol. 169, No. 13, 2009, pp. 1216–23. http://archinte.jamanetwork.com/article.aspx?articleid=773531.
3. Park, S., L. D. Rink, and J. P. Wallace. Accumulation of physical activity leads to a greater blood pressure reduction than a single continuous session, in prehypertension. *Journal of Hypertension*, Vol. 24, No. 9, 2006, pp. 1761–1770. http://www.ncbi.nlm.nih.gov/pubmed/16915025, Accessed January 9, 2017.
4. Hamer, M., and Y. Chida. Active commuting and cardiovascular risk: A meta-analytic review.*Prev.* Preventive Medicine, Vol. 46, No. 1, 2008, pp. 9–13.
5. Baum, L. Smart Trips Summit-U: An Individualized Marketing Approach to Changing Travel Behavior. *TDM Review*, No. 4, 2008, .
6. Dubuy V, K. De Cocker, I. De Bourdeaudhuij, L. Maes, J. Seghers, J. Lefevre, K. De Martelaer, G. Cardon. Evaluation of a workplace intervention to promote commuter cycling: A RE-AIM analysis. *BMC Public Health*, Vol. 13, No. 1, 2013, pp. 587. http://www.biomedcentral.com/1471-2458/13/587 [Accessed November 13, 2015.
7. Steven, F., and E. Avineri. Has the introduction of the cycle to work scheme increased levels of cycling to work? 43rd Universities Transport Study Group Conference, Milton Keynes, UK, 5th-7th January, 2011. http://eprints.uwe.ac.uk/16917.
8. Zhang, Y., P. Stopher., and B. Halling. *Working paper: An evaluation of TravelSmart tools for travel behaviour change*. University of Sydney. Institute of Transport and Logistics Studies. 2010. http://sydney.edu.au/business/__data/assets/pdf_file/0004/80437/itls-wp-10-20.pdf.
9. Schaffers, H., C. Ratti, and N. Komninos. Special issue on smart applications for smart cities - new approaches to innovation: Guest editors' introduction. *Journal of Theoretical and Applied Electronic Commerce Research,* Vol. 7, No. 3, 2012.
10. Hu, X., Y. Chiu, and L. Zhu. Behavior Insights for an Incentive-Based Active Demand Management Platform. *International Journal of Transportation Science and Technology*, Vol. 4, No. 2, 2015, pp. 119–133. http://dx.doi.org/10.1260/2046-0430.4.2.119.
11. Sanjust, B., I. Meloni, and E. Spissu. An impact assessment of a travel behavior change program: A case study of a light rail service in Cagliari, Italy. *Case Studies on Transport Police, Policy*, Vol. 3, No. 1, 2014, pp. 12–22. http://dx.doi.org/10.1016/j.cstp.2014.04.002.
12. Ben-Elia, E., and D. Ettema. Rewarding rush-hour avoidance: Rewarding rush-hour avoidance: A study of commuters' travel behavior, Vol. 45, No. 7, 2011, pp. 567–582. Available at: http://dx.doi.org/10.1016/j.tra.2011.03.003.
13. Usui, T., T. Miwa, T. Yamamoto, and T. Morikawa. Development and Validation of Internet-Based Personal Travel Assistance System For Mobility Management. Presented at the 15th World Congress on Intelligent Transport Systems and ITS America's 2008 Annual Meeting, 2008, https://trid.trb.org/view.aspx?id=900298.
14. Zhu, C., J.S. Yue, C.V. Mandayam, D. Merugu, H.K. Abadi, B. Prabhakar. Reducing road congestion through incentives: a case study. Presented at Transportation Research Board 94th Annual Meeting, Washington, D.C., 2015.

15. List, J.A., and S.D. Levitt. What Do Laboratory Experiments Tell Us About the Real World ?
NBER Working Paper, 2005.
16. Mulder, I., and P. J. Stappers. Co-creating in practice: Results and challenges.*2009 IEEE International Technology Management Conference,* 2009 .
17. Pallot, M., B. Trousse, B. Senach, and D. Scapin. Living Lab Research Landscape : From User Centred Design and User Experience towards User Cocreation. *Technology Innovation Management Review*, Vol. 1, 2010, pp. 19–25.
18. Bergvall-Kåreborn, B., Holst, M., Ståhlbröst, A., Concept Design with a Living Lab Approach. Presented at the 42nd Hawaii International Conference on System Science, 2009.
19. EMPOWER. 2016, Available at: http://empowerproject.eu, Accessed January 12, 2017.
20. SMART. 2017, Available at: https://www.smartintwente.nl/, Accessed July 10, 2017.
21. Seethaler, R.. Using the six principles of persuasion to promote travel behavior change Preliminary findings of a TravelSmart pilot test. Presented at the Conference of the Australian Institutes of Transportation Research CAITR, CSIRO, Melbourne, Australia, 2005.
22. Cialdini, R. B. Harnessing the Science of Persuasion. 2001, .
23. Oinas-Kukkonen, H., and M. Harjumaa. Towards deeper understanding of persuasion in software and information systems. *Proceedings of the 1st International Conference on Advances in Computer-Human Interaction*, 2008, pp. 200–205.
24. Shaffer, V. a., and H. R. Arkes. Preference reversals in evaluations of cash versus non-cash incentives. *Journal of Economic Psychology*, Vol. 30, No. 6, 2009, pp. 859–872. http://dx.doi.org/10.1016/j.joep.2009.08.001.
25. Huang, B., T. Fioreze, T. Thomas, and E. Van Berkum. Cycle2Work : An Empirical Study on Potential Personalised Rewarding Schemes Delivered via Smartphone Technologies, Presented to the 12th ITS European Congress 2017.