Challenged To Bike: Assessing The Impact Of A Nationwide Gamified Cycling Initiative

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Abstract

Cycling is promoted by a variety of initiatives and events all around the world. Given the popularity of such campaigns, there is surprisingly limited literature assessing their effectiveness and investigating the involved social processes. This paper presents findings in this regard for an an annual national biking campaign ("Bike to Work").
The campaign successfully encouraged 36% participating in the campaign to increase their amount of biking during the intervention period. Furthermore, 26% of those participating in previous years continued to bike more. The results show that in order to induce long-term behavior changes, gamified biking initiatives have to be embedded into everyday life, enable social interactions and provide mutual encouragement.

Keywords: Mobility behavior change, cycling, gamification, soft policy measures, bike to work, evaluation

1 Introduction

Growing cities as well as increasing greenhouse gas emissions are driving factors for a global rethinking of transportation systems. Biking can be seen as a central element to that, as it is a low-emission, low-cost, healthy and space efficient mode of transportation. To increase bike usage, cities are investing in cycling infrastructure and are implementing bike share programs. Additionally, numerous initiatives, publicity campaigns and events are being supported to promote biking. The aims of such "soft" policy measures typically include motivating car users to voluntarily switch to more sustainable modes of transport, e.g. cycling [1]. Evidence on the effectiveness of such interventions is, however, either inconsistent, can hardly be generalized, or is non-existent at all [2].
With growing popularity of gamification approaches for triggering behavior changes in different contexts, the use of game elements like incentives or rewards in products, services and campaigns aiming at modal shift is also on the rise [3]. Some examples are bike programs, such as "bike-to-work" events, which can be found globally [4]. Such promotional programs often use elements like competition, lotteries, team experience or awards, adding an emotional quality to the more objective arguments for biking, such as health benefits, time saving or climate change mitigation.
Yet, just as for other soft policy measures, studies on the actual effectiveness of gamified biking campaigns are still scarce: Rose & Marfurt [5] evaluated the impacts on travel behavior change

of a major one-day bike-to-work and found that 27% of those riding to work for the first time due to the event continued to do so. For a similar one-day initiative to promote active transport to school no clear effect could be shown [6]. Piatkowski et. al. [7] identified different groups participating in one-day bike-to-work events and identified barriers to increased commuter cycling. Despite the small number of existing literature on the general effects of gamification in the mobility context, the findings indicate its usefulness to provoke behavior and attitude change. Playful elements enrich the user's motivation and engagement in specific activities as well as in exploring new possibilities and options [8–10]. Concurrently, the success of interventions strongly depends on the nature of the gamified system, the applied game mechanics and the types of players [8]. Due to the contextual complexity of daily life and daily mobility routines, also other behavior than originally intended may be triggered by gamified interventions [9, 11]. Hence, a better understanding of potential reactions to soft policy initiatives is key to designing successful interventions.

This paper presents an evaluation study accompanying the 2015 Austrian national cycling initiative called "Bike to Work" (German: Radelt zur Arbeit), a one-month campaign that promotes bike commuting which has been conducted annually since 2011. Based on the hypotheses that gamified biking initiatives can trigger mobility behavior changes for specific target groups, the case study is discussed with respect to the following questions:

How and to what extent are gamified biking initiatives affecting behavior change?

Which aspects of gamified biking initiatives are most effective for inducing behavior change?

Which groups can be identified within participants of by gamified biking initiatives to increase biking on their work trips?

2 Study Design

The "Bike to Work" initiative (in German: "Radelt zur Arbeit", www.radeltzurarbeit.at) is designed to encourage people to cycle on their commute. It is conducted by an Austrian biking advocacy group with financial support from the Austrian government. "Bike to Work" has been held for the fifth time in 2015 and is taking place each year during May. In 2015 over 14,800 participants joined the campaign, making it the largest of this kind in Austria.

Participants are required to sign up on the campaign's website and to form teams of two to four. They can also volunteer as so-called company coordinators which help their colleagues with registration and the creation of teams. Furthermore, they typically promote the campaign within the company. The initiative provides incentives in form of different prizes (e.g. vouchers for leisure activities or bike gear). These are distributed by (1) having a lottery for all teams achieving a minimum of 50% bike commutes for each member and (2) giving prizes to participants who are randomly called, if they biked on the day they receive the call.

Participants can either track their daily commutes with a smartphone app, or log into a website to insert the distances covered by bike. The team performance and the individual mileages are shown within the app and on the website. Figure 2 shows the tracking tab and the statistics tab of the "Bike to Work" smartphone app.

FIGURE 1. Screenshots of the "Bike to Work" (German: "Radelt zur Arbeit") app showing the tracking tab (left) and the statistics tab (right).

For this case study, the following persuasive elements and hypotheses are regarded:

- Commitment: Participants agree to bike commute within the month of the initiative and strive to remain consistent with this commitment, which is also likely to be reinforced by other team-members.
- Competition: Behavior change is motivated by comparing individual performance to other team members and by comparing team performance to other teams.
- Tangible incentives: Behavior change is motivated through the chance to qualify for a lottery by reaching a concrete goal (minimum of 50% bike commutes per member in each team during the intervention period).
- Raised awareness: By regularly reporting mobility choices participants reflect on otherwise intuitive behavior and start to question existing habits.

3 Methods

3.1 Study Sample

Out of the 14,809 subscribers of this year's initiative 498 individuals participated in the study by answering a standardized online questionnaire. Out of all survey respondents, 157 provided additional qualitative data by responding to open questions in the questionnaire. A question regarding mode shifts was added to the questionnaire at a later time during running the survey resulting in n=92 for this item. Within the sample, nine participants have been additionally enlisted for semi-structured qualitative in-depth telephone interviews.

Study participants were recruited with a link on the campaign's website and on different social media channels and they were eligible to participate in a lottery offering the winners bike racks for their work place. This opportunity may have caused a selection bias, as regular bikers might be more interested in having sufficient biking infrastructure and might be generally more interested in the initiative.

3.2 Collection and Analysis of Data

The standardized online questionnaire included questions about the respondents' overall perception of the "Bike to Work" campaign, biking behavior before and during the initiative, potential long-term effects, and the influence of different motivational factors encouraging biking. In addition, participants could provide supplementary comments. The content of the in-depth telephone interviews was audio-recorded and partly transcribed for the analysis process. The qualitative data was analyzed using thematic analysis according to Braun & Clarke *[12]*. In order to compare the distribution of motivational factors between groups of participants Pearson's chi-squared tests with Yates' continuity correction were applied. Estimates of proportions within all participants are based on sample means. 95% binomial confidence intervals are based on Clopper-Pearson *[13]* and fulfill the requirements according to Brown et al. *[14]*. The statistical analyses were conducted using R *[15]*.

4 Results

4.1 General Satisfaction with the Initiative and Mode Shifts

Participants of "Bike to Work" have been very positive about the initiative. The question: "How do you like 'Bike to Work 2015'?" with a scale ranging from 1 "Not at all" to 7 "Very good" the initiative achieved a mean rating of 6.33 [SD=1.00]. This result has been confirmed by the in-depth interviews were all respondents expressed their satisfaction with "Bike to Work". Regarding mode shifts due to participation a reduction of car use was reported by 38.5% [95% CI 28.4%, 49.2%] of the respondents and a reduction in public transportation use was reported by 34.0% [95% CI 24.5%, 44.7%].

4.2 Changes in Bike Commuting Frequency

"Bike to Work" brings together people with very different rates of bike commuting. As can be seen in table 1, the general biking behavior is mainly structured as follows: 54.6% report that they usually commute by bike almost on a daily basis ("daily bikers"), 23.9% bike several times a week ("regular bikers"), and the remaining 21.5% ("occasional bikers") bike less often than that. The teams described in the qualitative data reflected this mix of participants, resulting in a group dynamic of having regular bikers motivate occasional bikers.

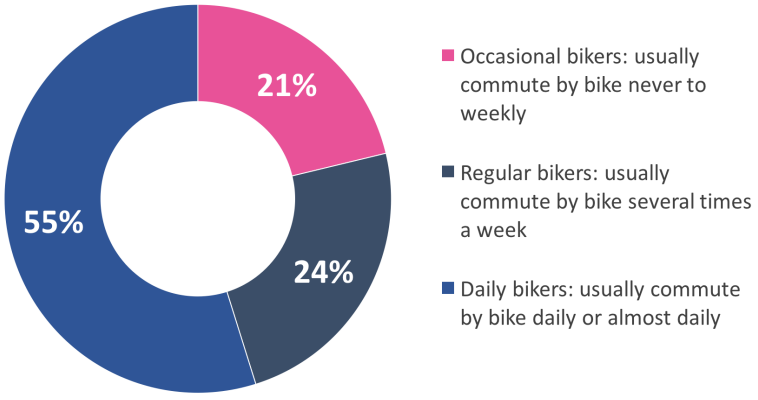

FIGURE 2. Share of participants grouped by usual frequency of bike commuting

Table 1 furthermore shows the change in bike commuting frequency during the campaign. Within the full sample 36.1% increased their frequency of bike commuting during „Bike to Work“.

	Occasional bikers	**Regular bikers**	**Daily bikers**	**Full Sample**
Usual frequency of bike commuting	never to (almost) weekly	several times a week	(almost) daily	
Number of respondents*	107	117	272	496
Share among all respondents	21.4%	23.9%	54.6%	100.0%
Change during Bike to Work				
Biked more often	77.6%	52.1%	12.9%	36.1%
Biked the same	21.5%	47.9%	87.1%	63.7%
Biked less often	0.9%	0.0%	0.0%	0.2%
Total	100.0%	100.0%	100.0%	100.0%

* Two respondents skipped this question.

TABLE 1. Overview of group sizes for regularity of biking and change in frequency of bike commuting during the campaign.

Among the occasional bikers, more than three out of four (77.6%) biked more often than usual during the month of the initiative. This group, which can be regarded as the ones drawn into more regular biking by the campaign, account for 16.7% of all “Bike to Work” participants [95% CI 13.6%, 20.3%]. One reason for this change was that the campaign acted as a trigger to try bike commuting. Interviewee #99 who moved to a new town six weeks before joining “Bike to Work” used to go to work by car despite the short distance of 1.7 km (1.1 mi). Getting an information about the campaign from her employer, knowing about other teams that participated in the previous year and having a colleague who already biked daily to team up with made her start to ride the bike for her commute. Participant #351 rediscovered biking due to the campaign: *“I used to live in a small town and biked a lot back then, but as I moved to a bigger city and had small kids I almost never used the bike. Now I have rediscovered biking”*. Another reason for the high share of increased bike use during the initiative within the occasional bikers can be found in the eligibility criteria for the lottery (minimum of 50% bike commutes per team member), which required a significant change of the participants’ mobility behavior. This led to a temporary change in order to achieve the goal: *“It is okay for one month. But for me it is also very cumbersome” (#367).*

Although the general frequency of bike commuting in the group of regular bikers is already comparatively high, still 52.1% increase their bike use during the initiative. The analysis suggests that this stems mainly from changes in situations where participants usually would not have chosen to ride the bike to work, mostly regarding days with bad weather. Typical statements for this group include: *“[Bike to Work] is indeed motivating us all to ride the bike, even when the weather is bad” (#106), “I ride now even when it is raining whereas previously I would have taken public transport” (#246), “Before [Bike to work] I took the car when there was rainy weather. Now I am riding my bike and even if there are some scattered showers I will be fine” (#224).*

Among the group of daily bikers a comparatively low number of 12.9% increased their bike use, which can be expected given the fact that this group is already mainly using a bike to get to work. The increase can be mainly attributed to the same weather related effects.

4.3 Long-Term Effects

Participants of our survey who also participated in the “Bike to Work” initiative in previous years (n=381) were asked for the resulting long-term effect. Based on the responses it is estimated that 26.4% [95% CI 23.8%, 29.0%] of “Bike to Work” participants increase their level of bike commuting in the long run after they experienced the benefits of bike commuting

due to the initiative, which is much in line with findings of Rose and Marfurt *[5]*. *"I will extend 'Bike to Work' and will continue to bike to my workplace. I realized through this initiative how great it is to bike to my work. I am very enthusiastic and enjoy it every day" (#099)* In retrospective respondent #229 notably stated: *"Bike to Work 2014 has been the trigger to switch completely to the bike within the city and closer distances. Meanwhile, I am using the car just for trips over 100 km [62.1mi] or for hauling. I sold my own car and I almost never need public transport".* Although such drastic changes might be the exception rather than the rule, the data indicates a long lasting effect of the initiative. Additionally, 4.7% of the respondents stated that they had increased their bike commuting for a short period of time after "Bike to Work" but subsequently returned back to their usual mobility patterns.

4.4 Motivational Aspects

The results of the analysis of questionnaire data and qualitative data provide valuable insights into the motivational drivers of behavior changes in the course of the "Bike to Work" campaign and show that some of them differ depending on the usual frequency of bike commuting. Table 2 shows the compliance to different motivational factors according to the responses in the questionnaire survey and highlights the factors which are dependent on the usual rate of biking.

Group	***Occasional bikers***	***Regular bikers***	***Daily bikers***	***Full Sample***	χ^2	***p-value***
Usual frequency of bike commuting	never to weekly (n=103)	several times a week (n=116)	(almost) daily (n=266)			
Motivational factor						
Environmental protection	57.3%	54.3%	53.8%	54.6%	0.378	0.828
Health benefits	**69.9%**	**59.5%**	**45.9%**	**54.2%**	18.982	**<0.001**
Team spirit	**58.3%**	**45.7%**	**41.0%**	**45.8%**	8.927	**0.011**
Motivate others to bike	**14.6%**	**42.2%**	**44.0%**	**37.3%**	29.056	**<0.001**
Prizes	31.1%	33.6%	38.7%	35.9%	2.228	0.328
Biked distance	31.1%	39.7%	35.3%	35.5%	1.762	0.414
Individual statistics	38.8%	32.8%	30.8%	33.0%	2.158	0.340
Biking enthusiasm of colleagues	16.5%	20.7%	15.4%	16.9%	1.616	0.446

p-values are the results of Chi-Squared test for independency between all three groups. Bold numbers indicate significant dependences of the factors on the groups ($p<0.05$).
Survey question: "What motivated you while you were participating in Bike to Work?" Participants could select the items that they agreed with (dichotomus scale).

Table 2. Relevance of motivational factors during participation in "Bike to Work"**.**

The motivator with the highest compliance rate among all factors was "environmental protection". At the same time, this motivator does not stand out for its persuasive effect on non-regular bikers as it is equally important for all three groups.
Health benefits achieved the second highest compliance rate showing that bike commuting is seen as a way to live a healthier life and to include physical activity into everyday routines. This has also been confirmed by statements within the interviews: *"Otherwise I would often be too lazy to do some sports in the evening after I got home from work. But by commuting by bike one has to use the bike to get home as well and one has to pedal" (#224).* Here bike commuting and the decision to bike is even a way of committing oneself to do a physical activity. Commuting by bike may take more time than available alternatives, but it acts as a physical workout at same time. By that the choice for bike commuting can be a reasonable one as the loss in time is compensated by a gain in health and fitness. If doing sports is substituted with bike commuting on long distances altogether this can even be time efficient: *"Although I need over an hour one way, overall I am saving time" (#082)*. In that light "Bike to Work" provides a framework to start or increase bike commuting as a way of 'doing something' about one's health. As health benefits were mentioned significantly more often by occasional bikers

(69.9%) and regular bikers (59.5%), this aspect is a more prominent motivator during the Bike to Work participating for them than for daily bikers at 45.7% [χ^2=16.2, n=369, p<0.001 and χ^2=5.46, n=382, p=0.019].

Team spirit (i.e. doing something together as a team) was at least related to three social processes influencing participants: First, commitment, as participation required each team member to obey the 50% bike trips rule in order to qualify for the lottery. Second, increased visibility of mode choices, as daily transportation choices become subject to judgements by others. *"On days I commute by car I'll get some 'friendly' remarks from colleagues" (#224)* Third, competition, as for some of the participants being in a team also meant competing with others. *"We have two teams and this year there was quite some competition going on" (#310). "Teams within our company that biked about the same as we did sent an email stating: 'Look, we have overtaken you in the ranking" (#224).* Being motivated by team spirit was mentioned significantly more often by occasional bikers at 58.3% compared to regular bikers (45.7%) or daily bikers (41.0%) [χ^2=2.96, n=219, p=0.08 and χ^2=8.24, n=369, p=0.004], showing the importance of participating together with colleagues and friends and that this is more relevant and more motivating for occasional bikers.

Motivating others to bike was a driving factor primarily for regular and daily bikers to join "Bike to Work" (p<0.001). *"I daily bike to work anyway, but with this initiative more people get motivated and some may stick with it" (#089).* Several respondents reported on the effectiveness in this respect, e.g. *"Because of Bike to Work I could motivate two colleagues to bike commute" (#210). "Since we have started two years ago I could persuade my brother in law as well as colleagues of mine to bike commute, especially as I am riding even during winter" (#106)*. This result also demonstrates the interrelation of motivational factors for frequent bikers (daily and regular bikers) and occasional bikers, as "Bike to Work" provides them with an opportunity to promote biking and get non-bikers and occasional bikers excited about the idea of bike commuting. This effect can be seen in Table 2 in the higher compliance for "motivate others to bike" for the regular and daily bikers and the higher proportion of "team spirit" for the occasional bikers. This result has been present in most of the qualitative data as well: *"This initiative is ideal to raise my colleagues' awareness for biking" (#437)* The formation of teams consisting of occasional and regular bikers *("Some in my team are already biking a lot; others were not so much before the initiative." #310*) may also set norm for the regularity of bike commuting. This role of already frequently biking people is comparable to previous findings pointing at their role for awareness raising and motivating others *[7]*.

Although prizes and the possibility to win them in the lottery are a main feature of this initiative, they rank only fifth within the list of motivators and are relevant for 35.9% of participants. This leads to the conclusion that the social interactions and mutual engagement introduced by the campaign are the true top features. However, prizes could be an important trigger to motivate people to join the campaign in first place. For them as for the remaining motivational factors (personal statistics, biked distance, enthusiasm of colleagues) no significant differences between the three groups of bikers emerged.

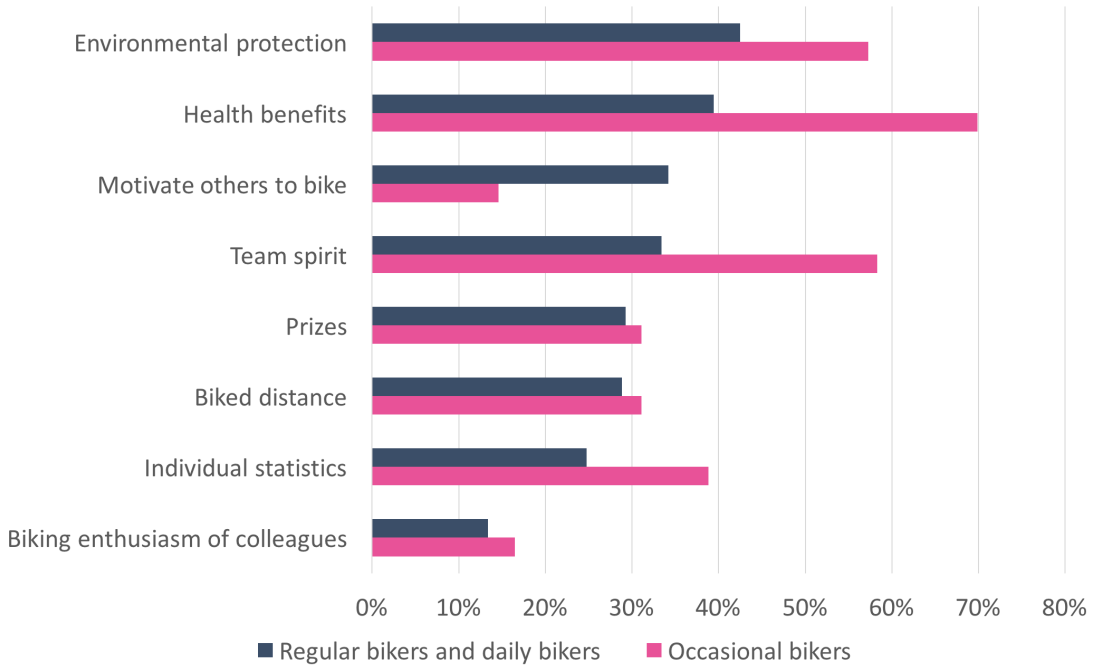

FIGURE 3. Importance of motivational factors (the groups regular and daily bikers are combined)

Another relevant aspect it the potential role of companies: They can support behavior changes of their employees as they may seek to encourage them to engage in healthy activities or contribute to increase ecological sustainability. In these situations, "Bike to Work" provided a useful framework. One company had created a corporate social responsibility project based and inspired on "Bike to Work" (#271). Another company was actively encouraging employees to join "Bike to Work" by providing information material, helping with the set-up process of the teams and even organizing a kick-off event (#411). Besides that, many private and public organizations help at least to distribute information about "Bike to Work" to their employees.

5 Discussion

The presented case study aims at increasing the share of biking in the daily mode choices of participants by a program lasting a limited period of time (four weeks). It used several persuasive strategies and game mechanics for achieving such a behavior change.

5.1 How and to what extent are gamified biking initiatives affecting behavior change? Which aspects of gamified biking initiatives are most effective for inducing behavior change?

As gamification elements like competition, points and rewards are effective measures for encouraging people to get involved in an intervention. However, these elements by themselves might not be sufficient for inducing enduring behavior change. [16] Biking campaigns such as "Bike to Work", unite long-standing frequent bikers, occasional and even non-bikers. They embed the idea of bike commuting into the everyday social context, such as collaborating with colleagues and put gamification elements on top of that. Furthermore, the reqirement for participants to form small teams of two to four seems to even enhance all of these effects. Combining social interactions, mutual encouragement and gamification elements, caused many participants to increase the amount of biking trips in their daily routine and it can be assumed that a considerable share of 26% of participants will keep their increased levels of bike commuting in the long run.

5.2 Which groups can be identified within participants of by gamified biking initiatives to increase biking on their work trips?

It turned out that the effect of raised awareness of individual mobility habits is of importance, particularly for participants who have rarely biked before enrolling in an initiative. As participants were required to observe their own behavior by collecting data on their daily mode choices, which eventually disclosed previously unconscious behavior patterns. The thereby introduce deliberate reflection on mobility habits seems to facilitate the discovery of benefits inherit to alternative modes of transport. This novel awareness paved the way for perceiving the value of specific benefits connected to biking. In the case of the "Bike to Work" initiative the two main drivers the participants discovered were health gains and social benefits (team spirit).

6 Conclusions and Outlook

In summary, this work shows that gamified biking campaigns can be very effective for raising awareness for biking and encouraging participants increase their level of cycling. Furthermore, the importance of social elements that foster mutual encouragement for adopting and maintaining new behavior was examined. Future work must explore the quantifiable effects of gamified interventions on mode shifts in more depth in order to answer a variety of crucial questions, e.g. how to robustly estimate the reduction of distances driven by cars or use of public transport. Furthermore, the data from "Bike to Work" shows that people commute by bike even though they usually use alternatives that are taking substantially less time. One explanation can be found in an offsetting effect of other motivational elements, such as health benefits. However, as this should be taken into consideration when transportation mode choices are discussed future research should look into the relativity of travel times as well.
The experiences drawn from the presented studies were used to design a large scale experiment employing gamified elements in a "Biking Tourney" within the the greater Boston area in fall 2015. [Wunsch et al. 2016: Gamification and Social Dynamics: Insights from a Corporate Cycling Campaign, to be published in at HCI International 2016 conference proceedings]

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