CHALLENGED TO BIKE: ASSESSING THE POTENTIAL IMPACT OF GAMIFIED CYCLING INITIATIVES

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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 from two case studies of gamified biking initiatives which have been evaluated using both quantitative-statistical and qualitative-interpretative methods: (1) a small-scale research experiment (“Frequent Biking Challenge”) and (2) an annual national biking campaign (“Bike to Work”). The two case studies provide insights into their general effects, on changes for different groups of bikers, the effectiveness of different elements of the interventions, and the methodological requirements for evaluating short and long-term impacts of campaigns aiming at increasing biking in cities. Both initiatives successfully encouraged people to bike more in the short run, 25% in the experimental group and 36% participating in the campaign increased their amount of biking during the intervention period. However, effects vary for different groups of bikers and only the “Bike to Work” campaign shows a lasting effect with 26% of those participating in previous years continuing 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
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.

The contribution of this paper is to examine the strategies employed in gamified biking campaigns with the aim of changing accustomed mobility behavior patterns. Results from from two case studies focusing on promoting commuting by bike through the use of game mechanics are presented. The first study describes an experimental intervention called “Frequent Biking Challenge” which we carried out in a small-scale randomized controlled trial over a period of four weeks during fall 2014 in the Cambridge/Boston area in Massachusetts, USA (12). It was complemented by a long-term qualitative evaluation nine months after the initial trial. The second case study presents an evaluation study accompanying the 2015 Austrian national cycling initiative called “Bike to Work”, a one-month campaign that promotes bike commuting which has been conducted annually since 2011. Both examples are comparable in terms of objectives, intervention period and gamification elements, although the nature of the two examples (small-scale experiment vs. established national event) causes significant differences in the sample sizes and hence explanatory power of the results. Still, each intervention and the comparison of them provide valuable insights into drivers of the success of biking campaigns.

Based on the hypotheses that gamified biking initiatives can trigger mobility behavior changes
for specific target groups, the case studies are 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?
• Which methods can be used for assessing the potential short- and long-term impact on mobility behavior?

The following two sections provide comprehensive descriptions of the case studies, each focusing on the intervention design, the methods used for evaluating the effects, and the results of the analysis. In the subsequent section, the main research questions are discussed by comparing the dominant characteristics and outcomes of the case studies. The last part of the paper includes conclusions and provides an outlook on further research, which will build on the findings presented in this paper.

CASE STUDY 1: FREQUENT BIKING CHALLENGE

Intervention Design

As part of a larger study to promote biking with different persuasive strategies we carried out small-scale experiments in fall 2014 (12). The “Frequent Biking Challenge” was one intervention within these experiments designed for encouraging participants to collect points for their bike rides in order to achieve different experience levels. We developed a web-based application (see figure 1) to visualize level names and descriptions, badges and a competition element in form of a leaderboard. At the beginning of the study all participants were invited to jointly reach a total number of points. After this collective goal was fulfilled, a social comparison feature was installed, showing the number of individual bike rides in comparison to the average rides of all participants and to the current front-runner’s number of rides.

Information was communicated to the participants via email. During the first week, participants received email updates on a daily basis; after that the frequency was reduced to three to four times per week. The emails were sent in the evenings in order to influence the planning of the next day by various messages. Figure 1 illustrates the visualization of levels and an example of an information update.
In particular, this approach focused on the following persuasive elements and hypotheses:

- **Triggering**: Mobility mode choices are altered by suggestions to ride a bike.
- **Competition**: Behavior change is facilitated through a leaderboard that allows individuals to see where they stand in an overall ranking (13).
- **Social comparison**: Enabling participants to compare their performance with the best and the average performance in a group motivates individuals to change their behaviour (13).
- **Raised awareness**: By regularly reporting mobility choices participants become aware of otherwise intuitive behavior and start to question existing habits.

**Methods**

The experiment was conducted over a period of four weeks (29 days) in October 2014 in Greater Boston (MA). The first 12 days were used to gather baseline data (pre-intervention phase). After that, the experimental group participated in the “Frequent Biking Challenge” for 17 days (during-intervention phase). The control group did not receive any intervention. This small-scale experiment was intended to provide first insights into potential reactions and requirements for subsequent large-scale interventions.
Study Sample

Participants were recruited through mailing lists at the Massachusetts Institute of Technology (MIT) and subsequently consisted mainly of students and to a lesser extend staff members. Based on a questionnaire including current mobility patterns, only people biking less than three times a week were selected as participants for the study. The resulting 29 participants were randomly assigned to the experimental group (n=13) or the control group (n=16).

For the analysis, only data from participants who had reported at least 80% of their daily trips was used in order to achieve a minimum level of data quality (experimental group: n=12; control group: n=10), consisting of 11 women and 11 men. To ensure access to bikes, all participants were provided with a one-month membership for the local bike-sharing scheme (Hubway) and a helmet if required.

Collection and Analysis of Data

All participants had to report their daily trips using a web-based application. For each trip, participants were instructed to select a trip purpose and the transport modes they used (single or multi-modal): “walking” (minimum 5 minutes walks), “biking”, “public transport”, “car” and “other”. Based on the collected data the share of biking among all modes was computed per person per day. In order to outweigh other effects than the introduced intervention influencing mode choice (e.g. weather), a controlled share of bike trips per day \(x_{g,d}\) between the daily bike share of each participant of the experimental group \(y_{g,d}\) and the mean of daily bike share within the control group \(\bar{y}_{c,d}\) was computed for each day by

\[
x_{g,d} = y_{g,d} - \bar{y}_{c,d}.
\]

To assess the effect of the intervention, we determine the average controlled share of biking for the time before the intervention \(z_{g,pre}\) and the average controlled share of biking during the intervention \(z_{g,during}\) given by

\[
z_{g,pre} = \frac{1}{N_{pre}} \sum_{d=1}^{N_{pre}} (x_{g,d}), \quad z_{g,during} = \frac{1}{N_{during}} \sum_{d=1}^{N_{during}} (x_{g,d}),
\]

with \(N_{pre}\) denoting the number of days before and \(N_{during}\) the number of days during the the “Frequent Biking Challenge”. The pre- and during-intervention values of the average controlled share of biking were then tested for normality with a Shapiro-Wilk test and compared with a one-sided paired-sample t-test. Per participant changes of bike share were tested with a two-sample t-test comparing daily bike shares of the pre-intervention and during-intervention days.

Additionally, qualitative data was obtained by a post-intervention online survey, through interviews with four participants (two from each the control and experimental group) and finally an open question email exchange with the study participants nine months after the initial study.

Results

There was a statistically significant (p<0.05) increase of the share in biking in the individuals’ modal split for three out of the 12 participants (25%) in the experimental group after starting the intervention. The comparison of the controlled share of biking for the pre-intervention phase \(z_{g,pre}\) [M=7.9%, SD=11.8%] and the controlled share of biking during the intervention \(z_{g,during}\) [M=5.5%, SD=30.8%] showed an increase of 13.5 percentage points \(t(11)=2.079, p = 0.031\). This underscores that the “Frequent Biking Challenge” lead to an increase in bike use above control group levels during the intervention.
The qualitative data collected directly after the intervention supported this result as participants reported, for instance, an increased awareness of biking as an alternative mode of transportation and to be slightly more engaged in doing so due to participating in the “Frequent Biking Challenge”. However, due to the overall small sample size these results must be taken as first insights that require further validation.

The long term evaluation, which was conducted nine months after the initial study, showed that two out of the three participants with increased bike usage during the intervention (participants #61, #62, and #66) returned to their initial mobility habits afterwards. Quitting the newly achieved habit had different reasons: one participant mentioned seasonal influences as the reason why she got back to her initial mobility routines: “I got out of the habit of daily biking over the winter, and now commute primarily on foot. I bike maybe once a week to run an errand or attend church, more or less what I was doing before the survey started” (#61). For another participant access to bikes was the main issue, as participants have been provided with access to the local bike sharing scheme, and keeping their increased levels of biking has also been a question of renewing their subscription or buying a bike. “I have since transitioned back to mostly walking. I feel that bike-share programs are not worth the cost, and unfortunately also lack a good place to store a personal bike” (#66). The third participant with an increased level of biking has been able to sustain this habit over time: “I renewed the Hubway membership subscription you gave me and have been biking about the same ever since” (#62). However, although there was this one participant with a lasting behavior change in the experimental group, it is questionable if the intervention itself caused the transition or the mere provision of access to bikes was the decisive factor for the participant’s new biking habit. Therefore no clear conclusions can be drawn for the question if the overall intervention design of the “Frequent Biking Challenge” did lead to a long lasting behavior change.

CASE STUDY 2: BIKE TO WORK

Intervention 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.
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.

**Methods**

*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.

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 (14).

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 (16) and fulfill the requirements according to Brown et al. (17). The statistical analyses were conducted using R (18).

Results

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%].

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.

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

<table>
<thead>
<tr>
<th>Usual frequency of bike commuting</th>
<th>Occasional bikers</th>
<th>Regular bikers</th>
<th>Daily bikers</th>
<th>Full Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>never to (almost) weekly</td>
<td>several times a week</td>
<td>(almost) daily</td>
<td></td>
</tr>
<tr>
<td>Number of respondents*</td>
<td>107</td>
<td>117</td>
<td>272</td>
<td>496</td>
</tr>
<tr>
<td>Share among all respondents</td>
<td>21.4%</td>
<td>23.9%</td>
<td>54.6%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Change during Bike to Work

<table>
<thead>
<tr>
<th></th>
<th>Occasional bikers</th>
<th>Regular bikers</th>
<th>Daily bikers</th>
<th>Full Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biked more often</td>
<td>77.6%</td>
<td>52.1%</td>
<td>12.9%</td>
<td>36.1%</td>
</tr>
<tr>
<td>Biked the same</td>
<td>21.5%</td>
<td>47.9%</td>
<td>87.1%</td>
<td>63.7%</td>
</tr>
<tr>
<td>Biked less often</td>
<td>0.9%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.2%</td>
</tr>
<tr>
<td>Total</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

* Two respondents skipped this question.

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.
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.

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.

<table>
<thead>
<tr>
<th>Motivational factor</th>
<th>Occasional bikers</th>
<th>Regular bikers</th>
<th>Daily bikers</th>
<th>Full Sample</th>
<th>( \chi^2 )</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental protection</td>
<td>57.3%</td>
<td>54.3%</td>
<td>53.8%</td>
<td>54.6%</td>
<td>0.378</td>
<td>0.828</td>
</tr>
<tr>
<td>Health benefits</td>
<td>69.9%</td>
<td>59.5%</td>
<td>45.9%</td>
<td>54.2%</td>
<td>18.982</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Team spirit</td>
<td>58.3%</td>
<td>45.7%</td>
<td>41.0%</td>
<td>45.8%</td>
<td>8.927</td>
<td>0.011</td>
</tr>
<tr>
<td>Motivate others to bike</td>
<td>14.6%</td>
<td>42.2%</td>
<td>44.0%</td>
<td>37.3%</td>
<td>29.056</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Prizes</td>
<td>31.1%</td>
<td>33.6%</td>
<td>38.7%</td>
<td>35.9%</td>
<td>2.228</td>
<td>0.328</td>
</tr>
<tr>
<td>Biked distance</td>
<td>31.1%</td>
<td>39.7%</td>
<td>35.3%</td>
<td>35.5%</td>
<td>1.762</td>
<td>0.414</td>
</tr>
<tr>
<td>Individual statistics</td>
<td>38.8%</td>
<td>32.8%</td>
<td>30.8%</td>
<td>33.0%</td>
<td>2.158</td>
<td>0.340</td>
</tr>
<tr>
<td>Biking enthusiasm of colleagues</td>
<td>16.5%</td>
<td>20.7%</td>
<td>15.4%</td>
<td>16.9%</td>
<td>1.616</td>
<td>0.446</td>
</tr>
</tbody>
</table>

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).
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% ($\chi^2=16.2, n=369, p<0.001$ and $\chi^2=5.46, n=382, p=0.019$).

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%) [$\chi^2=2.96, n=219, p=0.08$ and $\chi^2=8.24, n=369, p=0.004$], 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.

Another relevant aspect is 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.

DISCUSSION

The two case studies presented in this paper share several characteristics: both aim at increasing the share of biking in the daily mode choices of participants (though one is only focusing on commuter trips), in both cases the intervention took place over a limited period of time (four weeks), and both used persuasive strategies and game mechanics for achieving behavior change. At the same time, the two examples also differ in specific aspects, particularly due the types of intervention: the “Frequent Biking Challenge” was a nonrecurring, small-scale scientific experiment with limited sample size, and “Bike to Work” is an annual national campaign attracting thousands of participants each year. The subsequent discussion follows the initial questions of this study.

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, participants of the “Frequent Biking Challenge” on one side did show higher levels of biking during the intervention period. However, these elements by themselves might not be sufficient for inducing enduring behavior change. On the other side, 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 requirement 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.

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. In both case
studies participants were required to observe their own behavior by collecting data on their daily
mode choices, which eventually disclosed previously unconscious behavior patterns. This enabled
participants to deliberately reflect on their mobility habits and discover unexpected qualities of
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).

Which methods can be used for assessing the potential short- and long-term impact on mobility
behavior?

Regarding methodological aspects for assessing the impact of biking initiatives, the two case
studies show that both quantitative and qualitative methods need to be combined for describing
and understanding behavior changes. The “Frequent Biking Challenge” provides an approach for
controlled assessment of biking share changes based on trip data delivering valid interpretations of
actual behavior change. Applying its methods to a large-scale randomized controlled trial would
allow to draw conclusions on the causal effect of an intervention on actual bike usage. The
combination of quantitative and qualitative methods for evaluating the “Bike to Work” campaign
provides a deeper understanding on the social processes that are introduced by the campaign and to
have a better interpretation of quantitative survey data. The experiences presented in this paper
should be taken up in future research for evaluating comparable initiatives in order to contribute to
a better understanding of the potential effects of soft policy measures, in particular regarding
approachable target groups (which social groups can be motivated in which way) and achievable
modal shifts (which modes will be replaced by biking).

CONCLUSIONS AND OUTLOOK

In summary, this work showed 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 will be collated in order to prepare a large
scale experiment that will employ gamified elements in a “Biking Tourney” within the greater
Boston area. The campaign will be scientifically evaluated using a combination of quantitative and
qualitative methods. The results are expected to provide deeper insight into the social dynamics of
creating/stimulating behavior change in the absence of any tangible incentives.

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