GI_Forum 2021, Issue 2
Page: 251 - 258
Short Paper
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DOI: 10.1553/giscience2021_02_s251

Innovation for Sustainable Cities: The Effects of Nudging and Gamification Methods on Urban Mobility and Sustainability Behaviour

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Abstract

For more sustainable urban behaviour and mobility, innovative methods are needed to change behaviour. We discuss the results of an explorative study of the use of a personal mobility tracker (a digital, data-based tool) to motivate users to adopt a more sustainable city lifestyle. We examine motivational techniques that can influence citizens' personal mobility on a day-to-day basis. Using a personal mobility app that incorporates gamified elements and nudging, citizens become part of a community. They are motivated to cycle more and to explore sustainable services in the city through tours and visiting points of interest. We present the first results of a trial of this mobile app: characteristics of users, and empirical data that indicate a change in cycling behaviour. We also show effects of nudging on personal mobility.

Keywords:

sustainability, nudging, mobility behaviour, mobility tracker

1 Introduction

Cities are trying to integrate the UN's Sustainable Development Goals into their policies in order to promote sustainable (urban) living and fight climate change. Cities face multiple issues regarding sustainability. One of the biggest challenges is adjusting the modal split in transport, as car use still dominates in cities and their surroundings (European Platform on Mobility Management, 2018); transport accounts for a quarter of Europe's GHG emissions (European Environment Agency, 2018). Therefore, cities need to find ways to change citizens' mobility behaviour. However, it appears that pure promotion of, or information on, more sustainable behaviour alone do not motivate sufficiently (Huber et al., 2017). Nudging (i.e. guiding behaviour while still leaving room for personal choices) (Thaler & Sunstein, 2008) has started to establish itself as a promising method in governance and policy instrumentation. It is of great importance that new tools using nudging are created in such a way that their impact and efficiency can be evaluated. Thus, our key research question is how, using data from a personal mobility tracker, can motivational techniques be used to influence citizens' personal mobility?

This paper discusses the results of an explorative study concerned with the use of a digital, data-based tool to promote more active urban mobility at the same time as citizens are discovering other facets of sustainability (e.g. locally produced goods or locally grown food) within a city. Building on our previous theoretical work (Klieber et al., 2020), we are now able to present empirical data. The use of data is crucial in designing the tools necessary for triggering a more sustainable lifestyle, but also for measuring actual behavioural change.

First, we provide a theoretical overview of the data-based nudging approach, supported by a mobile app. Second, we report results on the effects of this approach.

2 Fostering sustainability goals through data-based interventions

Within a European research project (SimpliCITY, www.simplicity-project.eu), two cities are developing effective strategies to stimulate sustainable behaviour among citizens, who are engaged through behavioural nudges and gamified features in a personal mobility app. With the mobile app, the user becomes part of a community and is motivated to show more sustainable behaviour. They explore sustainable offers (e.g. locally produced goods, local environmental protection services) within the city via cycling. The use of data, for guiding behaviour (i.e. nudging), for gamification elements (e.g. location-based services, mobility tracker) as well as for measuring changes towards more sustainable behaviour, is central to the project. The following sections describe how the gamification and nudging elements in the app are planned and implemented, and how behavioural change is measured (see also Klieber et al., 2020, for a more detailed description of the methods).

2.1 Gamification

Gamification uses elements taken from gaming in other contexts, and has been successfully implemented in mobile apps for smart-city initiatives in order to keep citizens engaged (Kazhamiakin et al., 2016). Gamification can motivate users to engage more regularly, and can incite them to modify their behaviour (Engel, 2017; Hamari et al., 2014). In the personal mobility app discussed here, users earn reward points ('heartbeats') for carrying out activities – e.g. tours in their neighbourhood, visiting points of interest such as urban gardening spaces, solving quizzes and riddles, and using the mobility tracker when cycling. Active mobility is used for exploring sustainable services in the city. Users collect reward points for the specific neighbourhood of which they are part.

2.2 Nudging

Nudging can be described as a strategy to change people's behaviour without threat or severe economic consequences (i.e. fines). Nudging uses interventions that are 'easy and cheap to avoid' (Thaler & Sunstein, 2008, p. 6), while seeking to alter the way choices in relation to local environments are presented and made (Ly & Soman, 2013). It aims to guide people's behaviour in a desired direction while they are still free to make their own decisions. Interest in the method was sparked in various contexts (Lehner et al., 2016; Sunstein, 2014). In general,

people seem to be in favour of nudging, at least if the nudge fits with the interests and values of the majority of people (Reisch & Sunstein, 2016).

Insights into digital nudges show promising results (Meske, 2017; Schneider et al., 2018). In the context of developing our particular personal mobility app, we also investigate the effect of social comparison. Social comparison theory (Festinger, 1954) states that people tend to compare their own opinions, abilities and behaviour to those of other people for evaluation. Social influences can be successful in changing individual behaviour, notably in terms of sustainable living (Abrahamse & Steg, 2013). More specifically, people tend to modify their behaviour after seeing that a specific social group is showing a particular behaviour. Quite famously in the nudging literature, Nudge Lebanon (2019) demonstrated that a letter to people stating that most of their neighbours paid their electricity bill on time helped to improve the overall timeliness of payments. If there is strong identification with the relevant social group, the nudge has a greater effect (Doran et al., 2017). In our case, the community using the personal mobility app could serve as the relevant social group.

2.3 Measuring change in sustainable behaviour

Ajzen's (1991) theory of planned behaviour explains that behaviour is influenced by attitudes and subjective norms, as well as by people's perceived ability to behave in a particular way. These factors lead to an intention and subsequently to an actual behaviour. The theory of planned behaviour often informs efforts to change behaviour regarding the environment and sustainability (Macovei, 2015).

However, the effectiveness of an intervention can be evaluated only if the desired target behaviour can be measured in a valid manner. For the present study, we rely on self-reported behaviour in a before-and-after design, as well as on tracked (i.e. measured) mobility and sustainability behaviour.

3 Method

A personal mobility tracker, in the form of a mobile app, was tested from the beginning of August 2020 to end of September 2020; for the nudging phase, it was used again in April to May 2021.

Users downloaded the app to their smartphone, and after a sign-up were then part of the community. The main activities for users of the app focus on active mobility and exploring sustainability (see Figure 1); they use the mobility tracker when cycling, and can take tours around the city (which include points of interest and involve quizzes). They can explore regional and sustainable services (as a virtual list or as points of interest in the city), such as local shops or environmental organizations. Five different city tours were offered, which included a total of 18 points of interest (visiting these was logged through geolocation), and 114 regional and sustainable services that were represented in the community, such as local non-profit organizations, urban gardening spaces and second-hand stores.

The personal mobility tracker serves both to measure behaviour (i.e. the tracker for cycling), as well as a way to influence behaviour (awarding 'heartbeats', and sending notifications and reminders to individual users).

The data analysed included logs of each user's activities, as well as user-profile information (e.g. age, gender). Data was analysed using R Studio.

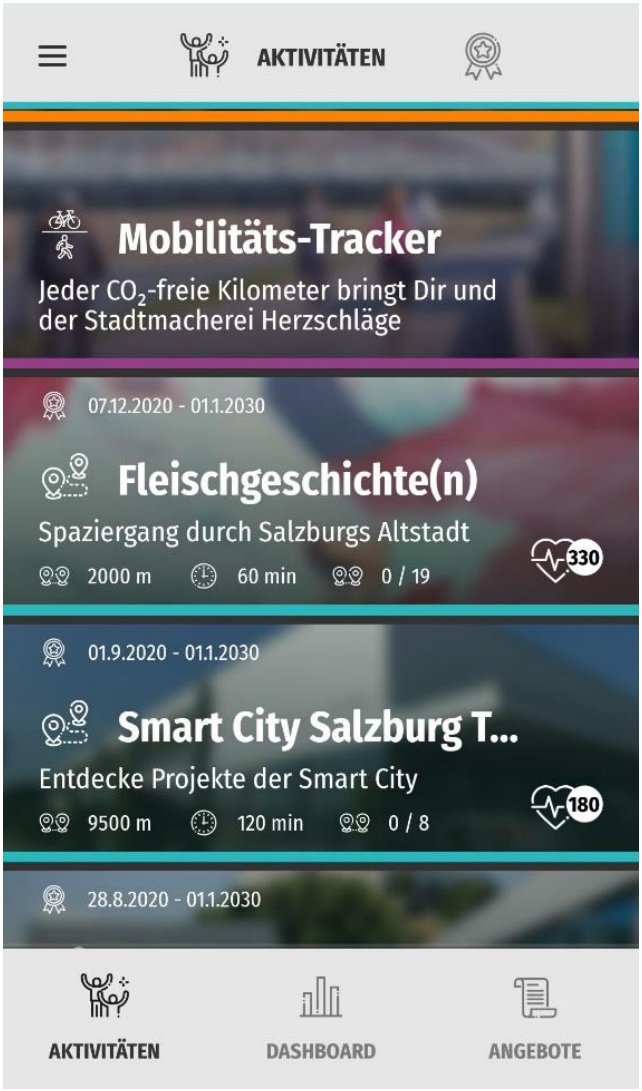

Figure 1: Screenshot from the mobile app: activities within the app.

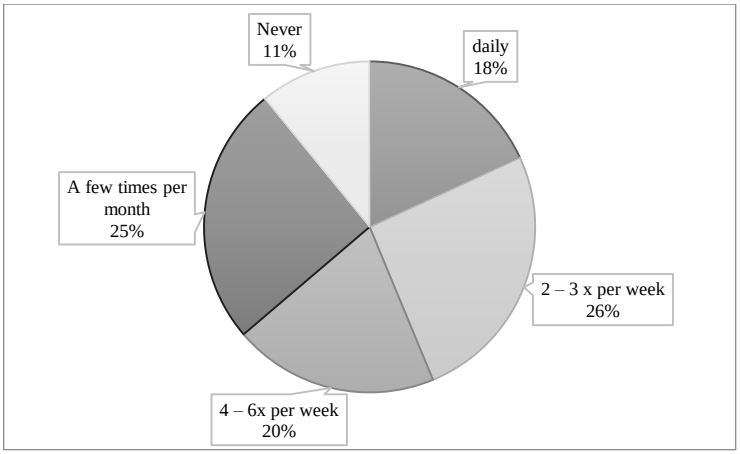

Figure 2: Habits of users: How often do you ride your bicycle?

4 Results

4.1 User characteristics

587 users in Salzburg, Austria, took part in the trial. Information from the user profiles showed that most were women (59.5% females, 38.6% male, 1.9% inter/diverse), with over half of the users (53%) aged between 26 and 45, and almost a quarter (22%) between 18 and 25. Almost two-thirds ride their bikes at least 2–3 times per week (see Figure 2). While this indicates a group that is already using active forms of mobility, more than a third of users ride their bike just a few times per month or never. This shows that the app is not simply "preaching to the converted", but is also reaching a broader group of citizens.

4.2 Effects of gamification

When users carry out activities using the app, they are rewarded with gamified 'heartbeats'. They collected a total of 1,969 heartbeats. Factors like gender or age influence the effect of gamification on engagement and behaviour (Koivisto & Hamari, 2014). We therefore looked at whether there are significant differences between men and women: men collected a total of 1,045 heartbeats, women collected 900, but no significant difference between the mean collected heartbeats was found ($t(312) = -0.99$, $p = .32$).

The mobility trackers revealed that users cycled 1,493 km in total. On average, men cycled 28 km over the course of the test period, and women 21 km. Statistically, however, the difference is not significant: ($t(57) = -0.53$, $p = .60$).

In order to estimate any effect on behaviour, some kind of comparison needs to be made. Simply looking at overall bicycle use within the app does not necessarily indicate a behavioural change, as the baseline for cycling within the sample was unknown (i.e. users perhaps cycled a lot already). For the first trial, a comparison with a self-reported estimate of alternative behaviours was made. After users finished tracking their cycle ride, they could indicate whether

they would usually have taken their car or the bus for this journey. This allows an estimation of the effect of the app on mobility behaviour. For 117 km cycled, users indicated that they would usually have taken the bus. For 207 km cycled, they would normally have taken the car.

4.3 Effects of nudging

Using a subset of users, we relaunched the app to test the effectiveness of social comparison as a data-based nudging method (N = 202). Over a period of two weeks from April to May 2021, users were sent six nudges (notifications) via the app. Each nudge focused on the comparison of their own cycling behaviour with that of other users (e.g. 'Your neighbours are leaving you behind on their bikes! Catch up and use the mobility tracker today!'). We compared the distances cycled before, during and after the nudges were sent, defining a two-week period for each condition. In the two weeks before nudging, cyclists covered a total of 469.3 km. During nudging, they cycled 600.8 km, which seems to indicate a positive effect of the nudging. After the nudging, they covered 652.7 km. However, it is unclear whether this was a result of the nudging, as the longer-term effects of nudging are unknown (Marteau et al., 2011). The weather could play a role, as before the nudges the average temperature was a little lower (5.6°C, 27.1 mm of rainfall) than the period during which the nudges were sent out (12.1°C, 11.6 mm).1 The two weeks after the nudging were the warmest, but they also had the highest rainfall (12.4°C, 62.6 mm). However, it seems that more users were motivated to get on their bikes when the nudges were sent out than during the period that followed: 28 tracked their cycling during the nudging period, compared to 11 in the following two weeks.

5 Conclusion

In sum, our preliminary results are encouraging regarding the effectiveness of using nudging and gamification techniques within a personal mobility app to foster cycling within a city. There is some evidence to suggest that nudging was successful, but more contextual factors (e.g. the weather) need to be taken into account; a combination of contextual data and nudging could be the most successful. In addition, nudges could be moderated by identification with the relevant community. As users become part of a neighbourhood, their engagement with activities can be logged in the app (e.g. the number of POIs in the neighbourhood that they have visited). Our first results might help to inform how nudging using digital tools could help foster behavioural change. However, before nudging is implemented on a broad scale, especially in combination with collecting personal data, it is essential to evaluate the ethical and legal implications.

[1] https://meteostat.net/de/station/11150?t=2021-04-22/2021-05-03 (accessed 8 November 2021)

Acknowledgements

This research has received funding in the framework of the Joint Programming Initiative Urban Europe (Making Cities Work, project SimpliCITY). Funding for Austria was received from the Austrian Federal Ministry of Climate Action, Environment, Energy, Mobility, Innovation and Technology, and for Sweden from Vinnova.

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