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# Design challenges in motivating change for sustainable urban mobility

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ABSTRACT

In recent years, the design and deployment of persuasive interventions for inducing sustainable urban mobility behaviors has become a very active research field, leveraging on the pervasive usage of social media and mobile apps by citizens in their daily life. Several challenges in designing and assessing motivational features for effective and long-lasting behavior change in this area have also been identified, such as the focus of most solutions on targeting and prescribing individual (*versus* collective) mobility choices, as well as a general lack of large-scale evaluations on the impact of these solutions on citizens' life. This paper reports lessons learnt from three parallel and complementary user studies, where motivational features for sustainable urban mobility, including social influence strategies delivered through social media, were prototyped, tested and refined. By reflecting on our results and design experiences so far, we aim to provide better guidance for future development of more effective solutions supporting citizens' adoption of sustainable mobility behaviors in urban settings.



## 1. Introduction

The design of urban mobility policies and systems has become a key domain of investigation and intervention for governments and other stakeholders interested in promoting sustainability goals. In particular, with transportation accounting for about one third of the energy consumption in both the EU and the US, and single-occupancy vehicle (SOV) commuting rates still high, there are many obstacles to reducing pollution as well as other personal, societal, and environmental costs associated with this type of transportation choice. To support a larger adoption of sustainable mobility choices (e.g., use of public transport services) by urban travelers, several forms of persuasive solutions have been proposed recently (e.g., Dourish, 2010; Froehlich, Findlater, & Landay, 2010). Most of this work is inspired by Fogg's framework (Fogg, 1998, 2003) and has focused on designing systems that attempt to convince users to behave more sustainably. However, some critical analyses of the key assumptions and limitations of the persuasive sustainability systems developed so far have also recently appeared (Brynjarsdottir et al., 2012; DiSalvo, Sengers, & Brynjarsdóttir, 2010; Dourish, 2010). In particular, the main limitations identified are related to: (a) lack of user involvement in defining the behavior change interventions, (b) focus on targeting specific behaviors and choices of individual citizens instead of proposing more collective approaches addressing the relevant communities that could have a higher impact on adoption; (c) lack of large-scale, long-term studies showing the impact of the interventions on environmental attitudes and behavior change (Brynjarsdottir et al., 2012).

We present and discuss lessons learnt from three parallel and complementary user studies, where motivational features for sustainable urban mobility were designed by adopting a user-centered design approach. In particular, we focus on describing the main challenges we had to tackle in order to improve a series of persuasive features by leveraging on both individual and social influence strategies that were prototyped, tested and refined through three studies.

In Section 2, we cover previous work in the design of persuasive technologies and social media for sustainable mobility. In Section 3, we describe the design challenges faced in prototyping motivational features for sustainable urban mobility in three user studies. In Section 4, we discuss how the lessons learned from these studies

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can inform future design of more effective motivational features for sustainable mobility.

## 2. Related work

Persuasive sustainability systems aim to change behavior related to sustainability typically by raising individuals' awareness of their choices, behavior patterns and the consequences of their activities (Brynjarsdottir et al., 2012). Often, these systems sense and measure human activity related to resource usage, and provide information to the user in order to motivate change (Brynjarsdottir et al., 2012). A relevant example is reported by Froehlich et al. (2009) with the UbiGreen application, which runs on the personal mobile device of the user and adapts the background graphics of the phone to provide visual feedback that aims to reduce driving and to encourage greener alternatives, including carpooling, public transport, and pedestrian modalities. UbiGreen also makes use of automatic tracking, which has multiple benefits; e.g., it enables personalizing behavior recommendations that can lead toward more actionable suggestions (Gamberini et al., 2012) and provides a mechanism for validating the actual behavior of the user (Choudhury et al., 2008). However, as observed by Consolvo et al. (2008), accuracy of tracking is seldom sufficient to serve as a stand-alone solution and also the possibility to supplement and correct tracking errors must be provided.

More recently, tripzoom (Broll et al., 2012) has been proposed as an application to create mobility profiles with details about trips, places, mobility patterns, and transport modalities, also managing challenges that users try to achieve in order to get rewards; similarly, in the context of the Peacox project (Schrammel, Busch, & Tscheligi, 2013) mobile and web applications are designed to provide users with personalized multimodal tools in order to plan their journeys and reduce $CO_2$ emissions. In spite of these recent design proposals, clear results on their *effectiveness* based on field evaluations is still missing. Very few examples of user-centered design and user participation were found in guiding the type of user behavior to be changed and the way of measuring change due to the intervention. Most evaluations of behavior change interventions proposed in this area are rather short-term, involve small groups of participants, and provide limited evidence of lasting behavioral impact (Brynjarsdottir et al., 2012).

Social features can be seen as a potential asset for supporting sustainable mobility systems and objectives, especially related to motivating change. In the context of behavior change toward low-carbon lifestyles (Zapico, Turpeinen, & Brandt, 2009) several persuasion principles were identified that evolve around the social dimension. These principles include, e.g., *social comparison*, *social facilitation*, *normative influence*, *social learning*, *competition*, *and praise*. Social influence has been utilized to facilitate sustainable behavior, e.g., in the context of domestic energy consumption (Foster, Lawson, Blythe, & Cairns, 2010; Gamberini et al., 2012; Spagnolli et al., 2011). In an 18-day trial with the Wattsup application (Foster et al., 2010), it was demonstrated that enabling comparison of energy consumption in a social network resulted in significant reduction of energy consumption. In the domain of reducing domestic waste, an application called BinCam was used (Thieme et al., 2012) to share photos of refuse thrown into a kitchen trash can on Facebook. The approach was concluded to increase perceived behavioral control of waste management of the study participants.

As behavior change is a long-term process, it could be more insightful to investigate the longer-term impact of any persuasive system and to be aware of the evolving needs of the user throughout the process. Maintaining longer term engagement with an application is sometimes challenging, but previous research has shown that interventions with a greater level of user interactivity seems to increase the success rate of the intervention and people remain engaged for longer (Vandelanotte, Spathonis, Eakin, & Owen, 2007). Any behavior intervention should also be tailored to the beliefs, preferences, and circumstances of each individual. Empirical evidence supports this view; a meta-analysis by Noar, Benac, and Harris (2007) showed tailored messages outperforming comparison messages in affecting health behavior change. It is also worth considering lessons derived from recent experiences in the area of social media and internet services development, where developers are adopting design methods and processes that extend over the long-term and across multiple development cycles (Johnson & Hyysalo, 2012; Simonsen & Hertzum, 2008). These design experiences suggest to include some level of technical flexibility in the design of features that are related to open-ended user practices, to enable their easier adaptation to long-term variations in user needs, preferences and practices. This is particularly relevant to persuasive sustainability features where the involvement of users and stakeholders in deciding on the type of desirable behaviors and practices to promote becomes crucial to facilitate a system adoption in the short and long-term.

## 3. Design challenges in promoting change for sustainable urban mobility

In this section, we present design challenges and lessons learnt from three parallel and complementary user studies conducted between 2012 and 2013 to assess users' reactions to alternative prototypes of persuasive strategies and interfaces for the urban mobility domain. One prototype providing motivational features with a self-reported journey diary was tested through a small scale study carried out in Trento (Italy) (Gabrielli & Maimone, 2013a, 2013b); another prototype providing automatic journey tracking and persuasive features was tested through a small scale study conducted in Helsinki (Finland) (Jylhä, Nurmi, Sirén, Hemminki, & Jacucci, 2013). Both studies followed the same methodological approach for assessing participants' attitude and behavior change. A third prototype integrating journey planning, basic persuasive features, and a self-reported journey diary was also evaluated through a large-scale trial conducted in the cities of Barcelona (Spain), Milan (Italy) and Helsinki (Finland).

### 3.1. Pilot study of a persuasive prototype with personalized notifications

#### 3.1.1. Design and method

We developed an Android prototype including basic motivational features to induce sustainable transportation choices, based on relevant previous work (Consolvo et al., 2008; Fogg, 1998; Munson & Consolvo, 2012) and related to the following behavior change strategies:

(1) Goal setting: The user was invited to set weekly goals for mode of transport to use and choose their relative priority.
(2) Self-monitoring: The users could track their progress toward goals and access a graphic representation of transport modes used over a week in order to support self-reflection about previous travel choices made.
(3) Personalized notifications: Personalized text messages encouraging sustainable travel choices were sent to the users, according to their profile and travel behavior (derived from usage logs). These notifications were prepared by two experimenters and sent once a week to the participant (based on the analysis of the type of journeys made that week) in order to influence their choices and behavior on