Self-selection and attrition biases in app-based persuasive technologies for mobility behaviour change: Evidence from a Swiss case study

App-based persuasive technologies are increasingly used to promote sustainable travel behaviour. We investigate the evidence on the (opt-in) self-selection effect in the adoption and lasting use of these apps, which might raise selection and attrition biases and consequently lead to wrongly estimate their potential and actual impact. We analyse baseline mobility data gathered from users of a persuasive app promoting public transport and active mobility launched in 2018 in Bellinzona (Switzerland): km per day (total and by car) travelled during the app validation period, when the behaviour change motivational features were not enabled. To estimate the possible self-selection bias, we compare these data with the reference population, using data taken from the Swiss Mobility and Transport Census; to study the possible attrition bias, we look at the relations between baseline mobility and the number of weeks of app's active use. We find no evidence of self-selection or attrition biases.

Francesca Cellina

University of Applied Sciences and Arts of Southern Switzerland (SUPSI)

Insitute for Applied Sustainability to the Built Environment (ISAAC)

via Trevano, 6952 Canobbio, Switzerland

francesca.cellina@supsi.ch

Giuseppe Vittucci Marzetti

Department of Sociology and Social Research

University of Milano - Bicocca

via Bicocca degli Arcimboldi 8, 20126 Milan, Italy

giuseppe.vittucci@unimib.it

Marco Gui

Department of Sociology and Social Research

University of Milano - Bicocca

via Bicocca degli Arcimboldi 8, 20126 Milan, Italy

marco.gui@unimib.it

1. Research questions

Mobile apps promoting a reduction in individual car use, in favour of active mobility and public transport are increasingly adopted at the city level. The scientific literature about them is however controversial on their actual behaviour change effectiveness.

Their use is in fact characterised by an opt-in, voluntary framework, which may bias experimental research designs aimed at assessing their behaviour change impact. Two types of biases, in particular, may affect experimental results:

- Self-selection biases: who are their users, from the mobility perspective? Are they «already converted» users of public transport and active mobility? Or are they «mainstream car drivers»?
- Attrition biases: app-based interventions are affected by high «app churn» (drop-out) rates. Is there any correlation between the number of weeks of app use and the mobility characteristics of the app user?

2. Methods and data

We analyse baseline mobility data collected in the *Bellidea* app-based behaviour change intervention run in 2018 in Bellinzona (Southern Switzerland), for 13 consecutive weeks.

The *Bellidea* app was made freely available to any interested citizen either living, working or studying in the city. During the first two weeks of app use, the app simply collected mobility data, without any behaviour change feature, and requested validation (confirmation of the detected transport mode) for any travel segment. We regard these data (overall travel kilometres per day and travel kilometres by car per day) as the mobility baseline of the *Bellidea* users, and compare them with the Swiss Mobility Transport Census (SMTC) mobility data collected in 2015 for the region of Bellinzona.

We also consider the number of weeks of active app use ("active weeks") for each user, namely the number of weeks for which, out of the 13 weeks of app availability, mobility data were collected.

Data are available for n = 207 users, namely the number of app users for which, out of the 721 app-registered users, collected at least two weeks of mobility data.

3. Self-selection bias

The comparison between the *Bellidea* mobility baseline data and the corresponding mobility data of the reference population, collected by the 2015 SMTC, provides no evidence of self-selection bias: there are no statistically significant differences between the *Bellidea* users and the reference population, neither considering daily total travel distances nor considering mean daily travel distances by car.
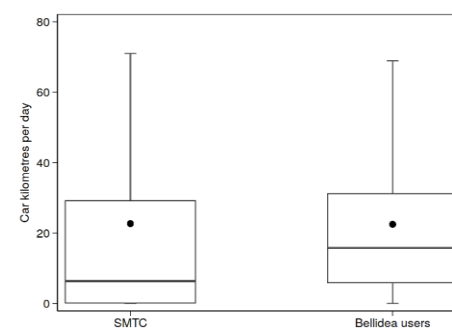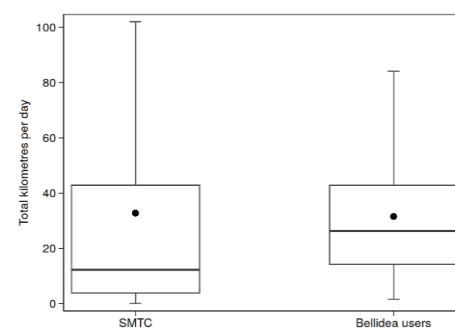

Box plots with means (filled circles) of mobility data in the 2015 SMTC data available for Bellinzona (left) and mobility baselines for *Bellidea* users (right).

Levene's robust tests for equality of variances and one-tailed two-sample t tests for mean-comparison assuming unequal variances (null hypothesis: mean km/day in SMTC greater or equal to mean km/day for *Bellidea* users).

	Total km/day		Car km/day	
	Statistic	p-value	Statistic	p-value
Levene's test	22.66	0.000	18.18	0.000
t test	0.443	0.329	0.090	0.464

4. Attrition bias

The relation between baseline mobility data and app use over time provides no evidence of attrition bias: there is no strong evidence of statistically significant differences in the mobility baselines of the *Bellidea* app users, conditionally on the number of weeks they actively interacted with the app.
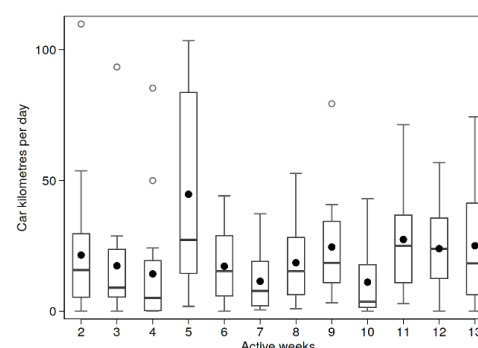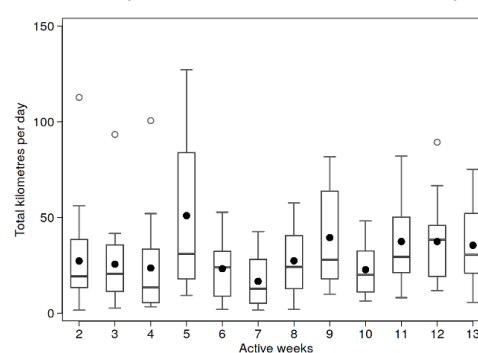
Baseline mobility of Bellidea users and length of app use: OLS estimates

Dep. var. (km/day):	(I) Total	(II) Car	(III) Total	(IV) Car/Total %
Active weeks	0.838*	0.319	0.529***	-0.390
	(0.459)	(0.429)	(0.195)	(0.558)
Car km/day			0.969***	
			(0.032)	
Constant	25.235***	20.106***	5.751***	68.400***
	(3.831)	(3.582)	(1.745)	(4.660)
Observations	207	207	207	207
R-squared	0.016	0.003	0.824	0.002
Breusch-Pagan test	0.135	0.080	0.600	0.743
RESET test	0.529	0.608	0.556	0.910

Standard errors in parenthesis. For Breusch-Pagan tests (H_0: regression disturbances are i.i.d.) and Ramsey RESET tests (H_0: model is not misspecified), p-values reported. Significance levels: * 10%, ** 5%, *** 1%.

Box plots with means (filled circles) of mobility baselines of *Bellidea* users over the number of active weeks: total daily travel distance (top) and daily travel distance by car (bottom).

5. Discussion and future work

Based on the above analyses, we conclude that the *Bellidea* app managed to attract and retain over time the interest by the "mainstream car driver" people of Bellinzona, namely the app's target group.

Consequently, it would be worthwhile to run additional behaviour change interventions based on the *Bellidea* app, and to assess their behaviour change impact.

Particularly, analysing whether possible changes in mobility behaviour are maintained over time would be essential.

Even though the self-selection framework does not produce selection and attrition biases, however, the number of observed app users is definitely limited, equal to just 207 individuals. Thus, further investigating the reasons for the interest in the app — and conversely, the reasons for the lack of interest by the large majority of the population— is vital to understanding whether devoting additional efforts and resources for app based persuasion in the mobility field is overall worthwhile and capable of producing a tangible impact at the city level. Evidence about the actual behaviour change impacts of the app would in fact allow to perform comparisons with other (soft) policy tools aimed at mobility behaviour change, thus further supporting urban decision-makers in the challenge of implementing effective mobility policies in the context of scarce resources which characterizes public policy-making.