“I Don’t Understand…” Issues in Self-Quantifying Commuting

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ABSTRACT

In the context of addressing global warming issues one of the possible approaches is to provide individuals with tools that support behavior change toward greener practices, as for example in commuting. This paper illustrates the results of a study that we conducted on the effectiveness of self-tracking of commuting data where participants received daily feedback on the financial costs and CO_2 emissions associated to their mobility practices. In the results, we describe situations where users either misunderstood or did not accept the data and the models utilized to represent them, highlighting a limitation that diary instruments (and underlying models) of this type would have in supporting people to reflect upon and possibly change their mobility choices.

KEYWORDS

Self-tracking, Commuting, Qualitative research, CO_2 emissions, Sustainable mobility.

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1 Introduction

Global warming is a topic that raises many concerns at all levels in society. In response to these concerns the Ergonomics and HCI research community has been involved in looking for solutions, especially in the area of limiting the impact of human activities on the environment [2, 21, 22] and promoting change of practices to become more sustainable [13].

The use of personal informatics, also referred as quantified-self or self-tracking, is today made possible by the variety of tools and connected objects that are available to individuals and has been widely analyzed in the HCI research community [20]. One recognized use of personal informatics is to support change management [17]. The link between self-tracking and change management is in the reflexive position that users can adopt regarding their behaviors [19]. Based on the collected data and on the change that the user wants to achieve, personal informatics support the user by tracking progress toward a desired direction.

Many studies have focused on activity trackers that track the number of steps, the quality of sleep, the heart pulsation or burned calories. The majority of self-tracking practices target the domain of health and well-being [11], where models are fairly simple: a step is a step, the number of heart pulsations, and the number of calories burned. Despite the required low level of knowledge and relative simplicity of the underlying models, some studies have already reported the difficulty that users may encounter when having to interpret the figures provided by the trackers [12, 15].

When considering the sustainable mobility domain, we can expect the difficulty of people in relating to the numbers to even increase, since the phenomena are much more complex and difficult to reduce. If a user commutes with her car every day, how are we going to compute a fixed amount of money that is spent each day to go to work by driving a car? Should we include the initial cost of acquiring a car? The annual insurance fee? The costs of maintenance? If yes, how should it be integrated in the daily cost of driving a car to work? Then we should also add the cost associated to the fuel used for that specific trip. For the computation of CO_2 emissions, in a similar way, many questions are open. How should we calculate the CO_2 emissions of someone taking the bus? Should we take into account the number of passengers in the bus on that specific day? Or should we make an estimation as an average? We targeted specifically financial costs and CO_2 emissions due to commuting as these quantities are at the same time hard to compute accurately for people and can have a relative strong

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impact on decision making for taking one or another means of transport.

Current online tools for eco-feedback on mobility are based on disaggregated data among the various means of transport [10]. This means that for any mode of transport and a given distance, there is a cost and an amount of CO_2 emission that are associated (for instance an average CO_2 emission per distance and per passenger for public transport). However, as the computation is complex and is based on a range of factors (owning a car, having a public transport monthly pass, ride-sharing), it is difficult for a person to construct an accurate personal estimation of the impact of commuting practices [3, 8, 23].

There are studies on tools supporting greener mobility practices [4, 5, 9, 14, 16], but to the best of our knowledge, none of them details and discusses the model underlying the computation. This paper aims at contributing to the body of knowledge about how people reason in practice about this type of data.

2 Method and Settings

In order to study how people understand and accept figures of CO_2 emissions and costs due to commuting, a diary study has been conducted. We have chosen this methodology as it is difficult to gather information on commuting practices through observation over a long period of time.

We involved a group of ten participants recruited through a snowball sampling. The ages varied from 27 to 56. Our participants were all professionals, qualified as engineers, computer scientists, doctors, technicians, school teachers and sales assistants.

The diary study was divided into three main steps. The first one was a face-to-face semi-directed interview with the participants where they described precisely their commuting practices: the means of transport used, the reasons for choosing a given means of transport on a given day, the preferences that they may have for one or another means of transport and the constraints they may have in their professional or personal lives for commuting.

In the second phase of the study, the participants filled a pen and paper diary during 20 working days. Each day, they had to indicate the date, the means of transport used that day and the reason why they made that choice, if any. After the 20 days, the participants returned their diaries and we were then able to compute all the figures regarding the cost and CO_2 emissions of their commuting. The computation of the financial cost and CO_2 emission figures was manually performed and based on typical carbon footprint calculators publicly available at the time of the study [10], indicated as the eco-calculator in the rest of the paper.

The third part of the study was a second interview with the participants, where we provided them with a compacted view of their commuting practices over the 20 days, where for each day, we represent for the user the means of transport used to go to commute. We also shared with the participants a representation of the financial costs and CO_2 emissions for each day. All the figures produced on the commuting of the participants were presented to them during interviews with all the required explanations in order to allow them to make sense of it. The goal of the second interview was to provide the participants with the compiled figures and then to discuss with them if and how those figures made them think about their commuting practices and choices.

We audio-recorded all interviews and collected participants' diary entries. All the interviews were entirely transcribed and analyzed together with the diaries. We identified themes using a thematic analysis [7]. For this study, we inductively identified themes starting from the data trying to find commonalities rather than having a pre-existing representation of understanding. We describe our findings in next section.

3 Findings

During the analysis, the emerging central theme was related to the difficulties that participants faced during the interview in understanding and accepting the figures emerging from their commuting habits. The eco-calculator model takes a socially and politically rich concept like environmental impact and reduces it to measurable reference units like CO_2 emissions and cost. Even within a sample of people with a clear disposition towards questioning their own environmental impact and their habits, there was a tendency to perceive the figures as incomplete and possibly unfair, as well as a difficulty in translating the data into actionable feedback, that is to say using it to make better choices vis-a-vis the transportation options available to them specifically.

The findings that we report here come from the last phase of the study which is indeed the second interview when we gave to the participants' feedback on their commuting practices.

3.1 Understanding the data

3.1.1 Grasping abstract quantities. As already reported in [12], when facing data without having access to information on the context or to a baseline, users may struggle to make sense of them. A difficulty we observed was in positioning CO_2 emission figures on some kind of directional scale – i.e. is it a little or a lot, good or bad, and in relation to what? For instance, after the researcher told P6 that she emitted 4000g of CO_2 per day, she asked and commented: *"Is it quite good? I can't appreciate it."* (P6). This is an issue as it does not support users in taking actions to change their behaviors toward greener practices. It demonstrates that there is a need to build a baseline of CO_2 emissions in order to help users to position their (commuting) practices also with respect to other people and for comparing the different options available in terms of means of transport.

3.1.2 Understanding the model. Alongside the difficulty in contextualizing abstract quantities on a (potentially normative) scale, users also faced a challenge in understanding what the model actually took into account and what it left out. This can be an issue when it comes to the perceived (un)fairness of the model (which we will discuss later), but also when weighting financial costs against environmental impact. P7 who was mainly riding a bike or using the tramway to go to work, and only occasionally using the car, identified some limits of the costs representation, presented during the second interview: "*I changed the tires on my bike during the course of the study. It was necessary, but you did not integrate this in the costs.*" (P7)

Because the cost of acquiring and maintaining of the owned means of transport were not included in the costs computed by the eco-calculator the numbers presented to P7 were perceived as not complete.

In a similar way, P3 who regularly took the public transport, questioned the cost associated to the monthly pass. As she explained: "*then there is a small correction factor that can refine the calculation of the cost, that is that you consider only the working days whereas we can use the pass also in the week-end*". Here, P3 meant that the choice of dividing the price of the monthly pass only over 20 days, i.e. the working days, did not fit with her representation of cost of the monthly pass. For her, it meant that she could get in a bus or tram anytime, any day in the month and so the cost of this pass should have been computed over the 30 days of the month. She explained that this would have seemed fairer to the representation that she had of the cost associated to the monthly pass.

The last situation we highlight in this section refers to P10 who got used to go to work with a combination of means of transport: bus and kick scooter. "*So in the end the combination bus + kick scooter is more expensive than the one with the car? I don't understand.*" P10 expressed the incoherence that he perceived between the figures proposed by the diary and his own representation of costs. After this feedback, the researcher had to explain and detail what is in the cost associated to driving (in this case only the fuel consumed for the trip) and the cost of the combination bus + kick scooter (the cost of one bus ticket). As the distance home-work is relatively small for P10 (less than 8km), and he had a small car with a low fuel consumption, the cost of the fuel for 8 km was less than a ticket in the bus. The limit of this computation of course is that it reduces the cost of the car to fuel consumption whereas the real cost of (owning and driving) a car is much higher than that.

3.2 Accepting the data

3.2.1 When the model fails to represent specific situations. The main objective of simulating a tool tracking commuting practices with a diary was to get a first evaluation of what could be its role, if any, in incentivizing users to adopt greener means of transport. It is therefore critical that the data is not only understandable, as discussed in the previous section, but also perceived as fair. Tracking data about CO_2 emissions singles individuals and families out and questions their habits (and potentially their privileges) vis-à-vis a global problem. But to do so effectively the model has to be able to properly contextualize the behavior of individuals and family units within the overall environmental impact of the collective (the city or metropolitan area, the country, etc.).

Participant P9 lives more than 35 km away from work and is used to commute either with car-sharing, or by bus or by car solo. According to the eco-calculator model used in the study, the greener option was car-sharing. The calculator was showing that there were less CO_2 emissions with car-sharing than with the bus. When the researcher explained that to P9, he was surprised and said: "*Ah... I emitted less CO_2 in car-sharing than in bus*". The researcher explained again how the emissions of CO_2 for public transport are computed (each passenger on a bus emits 103,3 g of CO_2 per km). In a similar situation, P5 said "*which would mean that car-sharing would produce less CO_2 than a bus even when it is full*?". This result was really surprising for P5 and P9 because it did not comply with the reality of facts as they perceived them. When P9 chose to go by bus, his car was not used over the trip whereas when he chose the option of car-sharing, the bus was circulating anyway. So, from his perspective, the travel by bus cannot correspond to a higher emission of CO_2 than the travel by car-sharing, because there is one less car on the road.

To go further, P10 added: "*yeah the thing about the bus is that you are not responsible for the itinerary, you use something that is there regardless and you do not directly emit anything*." Which expressed the gap between a global representation this participant had in opposition to a model that was providing daily feedback at an individual level.

3.2.2 Challenging self-representations. The previous example shows that an oversimplified and incomplete model can create confusion on the relationship between individual and collective means of transport and one's individual impact on CO_2 emissions within their community. This is particularly problematic given that one of the explicit goals of this type of tool is to help people challenge their self-representation and their habits.

The potential consequences of a naïve or uninformed understanding of one's own habits is illustrated by the reaction of participant P8, working at almost 40 km from her place and highly motivated in reducing her environmental footprint. So, when during the second interview the researcher explained to the participant that she emitted 6200g of CO_2 per day and that it was quite high compared to other participants, she said: "*I don't understand, I only take the train and ride my bike.*" In her representation, P8 only considered the type of means of transport to assess if it produced a high or low impact on the environment. She had put aside the fact that when you live far from your workplace, the CO_2 emissions due to transport are necessarily higher. The data allowed the participant to realize that she had a biased understanding of the environmental footprint. But while in this case the CO_2 measurement provided by the model was helpful, it required an explanation on the part of the researcher to contextualize the data to this person's specific situation.

4 Discussion and Conclusion

The research presented in this paper illustrates a situation where data of self-behaviors put the users at unease. The difficulties that can be encountered by individuals when facing data of self-behaviors can be grouped in two main categories: understanding data and accepting data.

There is a category of situations where individuals encounter difficulties in understanding data. It is possible that data are hard to grasp because even the basic units that are used are too abstract and far from a known reference. But even when there is some basic understanding of each single element of the computation, the level where the data are computed (based on a specific model) causes problems to individuals as they need to appreciate how the resulting data have been computed. There is a need to understand the model, to then be able to appreciate the figures built upon it.

The second level relates more to the notion of accepting the data. For that, the study show that people need to make a comparison between the gathered figures and the representation they have of themselves in their practices, commuting in our case. If there is a gap between the figures given and their self-representation, the participants, expressed misunderstanding and also judged the figures as being unfair.

A main reason why the eco-calculator model was leading to inconsistencies was that there was an implicit intent that the model should have supported explicitly [18] and that we discovered was not doing that so well. The intent of the eco-calculator was to support the adoption of greener practices. What appeared as an outcome was that, for several participants, the use of the bus led to more CO_2 emissions than car-sharing or moped. This conclusion would be very likely in opposition to what public authorities and common sense perceive as green transportation practices. Either the model inadequately computes the CO_2 emissions for feedback at an individual level, either car-sharing is really less polluting than public transportation and in that case it would be worth to acknowledge that and act accordingly.

We believe that this work can be inspiring for the quantified-self community about ways to answer to the need to better contextualize tracked data [6]. The results of this study are very specific, but the highlighted issues raised in this paper are directly aligned with the current open questions on the "Explainable, Accountable and Intelligible Systems" [1]. There is a need to provide users with tools for understanding the underlying models or algorithms supporting decision-making processes or figures that directly target them.

REFERENCES

[1] Abdul, A., Vermeulen, J., Wang, D., Lim, B. Y., & Kankanhalli, M. (2018, April). Trends and trajectories for explainable, accountable and intelligible systems: An hci research agenda. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems* (p. 582). ACM

[2] Bates, O., Thomas, V., Remy, C., Nathan, L. P., Mann, S., & Friday, A. (2018, April). The future of HCI and Sustainability: Championing Environmental and Social Justice. In *Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems* (p. SIG01). ACM

[3] Betz, M., Schwartz, T., & Ramirez, L. (2010). Know Thyself: Monitoring and Reflecting Energy Consumption

[4] Bie, J., Bijlsma, M., Broll, G., Cao, H., Hjalmarsson, A., Hodgson, F., ... & Kusumastuti, D. (2012). Move better with tripzoom.

[5] Bothos, E., Mentzas, G., Prost, S., Schrammel, J., & Röderer, K. (2014). Watch your Emissions: Persuasive Strategies and Choice Architecture for Sustainable Decisions in Urban Mobility. *PsychNology Journal*, *12* (3).

[6] Boulard-Masson, C., Colombino, T., & Grasso, A. (2018, August). Analysis of 'Quantified-Self Technologies': An Explanation of Failure. In *Congress of the International Ergonomics Association* (pp. 579-583). Springer, Cham.

[7] Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology*, *3* (2), 77-101.

[8] Brazil, W., & Caulfield, B. (2014). Testing individuals' ability to compare emissions from public transport and driving trips. *Journal of Public Transportation*, *17* (2), 2.

[9] Bucher, D., Cellina, F., Mangili, F., Raubal, M., Rudel, R., Rizzoli, A. E., & Elabed, O. (2016). Exploiting fitness apps for sustainable mobility-challenges deploying the goeco! app. *ICT for sustainability (ICT4S)*.

[10] Carbon Footprint Calculators: https://www.transilien.com/fr/page-editoriale/le-calcul-des-emissions-de-co2, https://www.carbonfootprint.com/calculator.aspx

[11] Choe, E. K., Lee, N. B., Lee, B., Pratt, W., & Kientz, J. A. (2014, April). Understanding quantified-selfers' practices in collecting and exploring personal data. In *Proceedings of the 32nd annual ACM conference on Human factors in computing systems* (pp. 1143-1152). ACM.

[12] Coulter, A., Clegg, S., Lyons, G., Chatterton, T., & Musselwhite, C. (2008). Exploring public attitudes to person carbon dioxide emissions information.

[13] Froehlich, J., Findlater, L., & Landay, J. (2010, April). The design of eco-feedback technology. In *Proceedings of the SIGCHI conference on human factors in computing systems* (pp. 1999-2008). ACM.

[14] Gabrielli, S., Maimone, R., Forbes, P., & Wells, S. (2013). Exploring change strategies for sustainable urban mobility. In *Designing social media for change at the ACM SIG-CHI conference on human factors in computing systems (CHI 2013)*.

[15] Herrmann, M. R., Brumby, D. P., Oreszczyn, T., & Gilbert, X. M. (2018). Does data visualization affect users' understanding of electricity consumption? *Building Research & Information*, *46* (3), 238-250.

[16] Jylhä, A., Nurmi, P., Sirén, M., Hemminki, S., & Jacucci, G. (2013, September). Matkahupi: a persuasive mobile application for sustainable mobility. In *Proceedings of the 2013 ACM conference on Pervasive and ubiquitous computing adjunct publication* (pp. 227-230). ACM.

[17] Kersten-van Dijk, E. T., Westerink, J. H., Beute, F., & IJsselsteijn, W. A. (2017). Personal informatics, self-insight, and behavior change: A critical review of current literature. *Human–Computer Interaction*, *32* (5-6), 268-296.

[18] Lockton, D., Harrison, D., & Stanton, N. A. (2016). *Design with intent.* O'Reilly Media.

[19] Ptakauskaite, N., Cox, A. L., & Berthouze, N. (2018, April). Knowing What You're Doing or Knowing what to do: How Stress Management Apps Support Reflection and Behaviour Change. In *Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems* ACM.

[20] Rooksby, J., Rost, M., Morrison, A., & Chalmers, M. C. (2014, April). Personal tracking as lived informatics. In *Proceedings of the 32nd annual ACM conference on Human factors in computing systems* (pp. 1163-1172). ACM.

[21] Silberman, M., Nathan, L., Knowles, B., Bendor, R., Clear, A., Håkansson, M., ... & Mankoff, J. (2014). Next steps for sustainable HCI. *interactions*, *21* (5), 66-69.

[22] Thatcher, A. (2013). Green ergonomics: definition and scope. *Ergonomics*, *56* (3), 389-398.

[23] Waygood, E. O. D., & Avineri, E. (2011). Does" 500g of CO2 for a five mile trip" mean anything? Towards more effective presentation of CO2 information. In *Proceedings of the Transportation Research Board 90th Annual Meeting* (pp. 23-27).