Assessing the Impact of Normative Messages in Encouraging the Use of Sustainable Mobility. An Experimental Study

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ABSTRACT

The travel behavior of urban communities represents one of the most important key factors in implementing behavioral interventions to promote sustainable mobility. This study investigates whether receiving a normative message alongside feedback information (on time and cost savings, reduced emissions, and burnt calories) can contribute to persuading individuals toward sustainable mobility. For this purpose, we conducted a randomized controlled trial experiment in 2021 in the metropolitan area of Cagliari. We intercepted a sample of students and workers who usually commute by car and proposed to them a personalized sustainable alternative (walking, cycling, or public transport). Then, we contacted participants again asking about their intention to use the proposed alternative, after presenting them with one of five randomly assigned normative messages: descriptive, injunctive, descriptive+injunctive, injunctive+descriptive, and no message (control group). For our analysis, 577 responses to the last survey were considered. Results show that a large share of the sample (36.9%) intended to change their travel behavior. Furthermore, we found that the injunctive normative message is significantly more effective for public transport. Instead, no significant differences were detected when an active mobility alternative was proposed. Finally, our analysis revealed different normative measures' effectiveness depending on the trip characteristics of the suggested alternative and the individuals' socio-demographic characteristics.

KEYWORDS

Injunctive norm; Descriptive norm; Behavioral monitoring; Sustainable mobility; Persuasive message; Personalized Travel Plan

1. INTRODUCTION

The indiscriminate use of motorized private vehicles has become a well-known issue in modern cities (Figueroa *et al.*, 2014). To reduce the harmful externalities associated with excessive car usage and mitigate the impacts of climate change in urban environments there is a need to set up integrated, coherent, and coordinated policies aimed at making private and motorized vehicles less preferable compared to clean and healthy means of transport. Within this framework, it becomes critically important to closely monitor the travel behavior of urban communities and implement behavioral interventions directed at persuading them to adopt sustainable travel alternatives. These behavioral strategies, known as Voluntary Travel Behavior Change (VTBC) programs, have become an established instrument to induce an intentional and sustainable travel behavior change (Brög *et al*., 2009; Fujii & Taniguchi, 2006; Möser and Bamberg, 2008; Rose & Ampt, 2001; Meloni *et al*. 2017; Semenescu *et al*., 2020; Sottile *et al.*, 2021a). Specifically, these measures, through information and communication, aim to change individuals' socio-psychological factors, like attitudes and norms, which have been demonstrated to play a key role in influencing people's mode choice (Pronello & Gaborieau, 2018; Spears *et al*., 2013; Steg, 2005; Steg & Vlek, 2009).

A question of great interest is whether messages based on individuals' social norm can increase the nudging power of these measures. Following the promising outcomes of several non-transportation studies, which reported the efficacy of interventions based on norms to reduce energy, water, meat consumption and food waste (Farrow *et al*., 2017), some researchers started to investigated whether measures based on such a psychological construct could contribute to encourage people to use an environmental friendly travel alternative (Kormos *et al*., 2015; Riggs, 2017; Huber *et al*., 2018; Piras *et al*., 2021; Gravert & Collentine, 2021; Mundaca *et al*., 2022; Hauslbauer *et al*., 2022). However, because of the different methodologies employed and the contradictory findings reported by these previous

works, much uncertainty still exists between the relationship between the role of persuasive norms and the individuals' propensity to change travel behavior.

One source of weakness of past research regards the type of norm employed in the persuasive message. Cialdini *et al*. (1990), in their seminar paper, described two different norms: descriptive norms, defined as the normal or typical behavior carried out in a specific situation, and injunctive norms, which concerns the rules or beliefs regarding a morally approved or disapproved behavior. The majority of existing works focused uniquely on one type of persuasive normative message, either descriptive (Kormos *et al*., 2015; Gravert & Collentine, 2021) or injunctive (Riggs, 2017), and only a handful number of papers (Piras *et al*., 2021; Mundaca *et al*., 2022) tried to establish which one has the largest effect on people's travel behavior. Nevertheless, none of these previous studies investigated the effectiveness of a single message that combines both the descriptive and injunctive norm in a coherent and complementary way.

Furthermore, even when the distinct effects of descriptive and injunctive norm messages are addressed, there has not been a distinction between commuting trips and other out-of-home activities. As widely demonstrated in past literature (see for example: Lavieri & Bhat, 2019; Piras *et al.*, 2021; Sottile *et al.*, 2022) trip motivation is a critical factor in travel behavior, especially during the modal choice phase, and past behavior plays an influential role depending on the reason individuals decide to move from origins to destinations (Aarts *et al.*, 1998). For this reason, some papers (Eriksson *et al.*, 2008; Kormos *et al*., 2015) argue that normative interventions that try to encourage less use of cars could have a more significant effect on habitual trips, such as home to work trips, compared with less habitual trips, such as those made for shopping or leisure purposes.

Third, there is a lack of studies jointly testing the effect of norm nudging and the provision of information on the performance, in terms such as those of travel time, cost and GHG emissions, of

sustainable travel alternatives. In most cases, informative measures have been tested along with hard measures, such as the deployment of economic incentives (Gravert & Collentine, 2021) or the development of a new public transport infrastructure (Sottile *et al.*, 2015; Piras *et al.*, 2022), but not beside the delivery of normative messages. From a marketing strategy perspective, this knowledge would help understand whether the development of a communication campaign based on these two different interventions, information and persuasion, can actually improve the impact, in terms of travel behavior change, of the campaign itself, or induce undesirable synergistic effects. Indeed, some individuals could focus solely on the content of the normative message, either injunctive or descriptive, while others could take into consideration only the benefits of the proposed travel alternative.

Given the above discussion, the purpose of this study is to investigate the effectiveness of a normative intervention on the intention to change travel behaviors from the use of private cars to more sustainable, clean, and healthy means of transport. The measure was tested in conjunction with the delivery of a Personalized Travel Plan (PTP), which included comparative feedback between the private motorized vehicle used and the suggested sustainable alternative in terms of travel time, cost, CO_2 emissions, and calories burned, for the commuting trip to work/study. In our experiment, we tested different kind of norms: descriptive and injunctive. In particular, we randomly delivered to the participants one of the following five different combinations of messages: i) only descriptive, ii) only injunctive, iii) descriptive first and then injunctive, iv) injunctive first and then descriptive, v) no messages (*i.e.*, the control group). The assessment of the efficacy of the normative messages was made using both descriptive statistics and statistical methods. Specifically, we compared the effect of the messages for the different types of suggested sustainable alternatives (walking, cycling, or public transport) and for different levels of comparative feedback. These levels were based on the variation, reported in the Personalized Travel Plan, in travel time, cost, CO_2 emissions, and burned calories between the car and the sustainable alternative. Finally, we assessed the effectiveness of the normative messages depending on the socio-demographic

characteristics of the individuals. The data used to determine the results were gathered in the metropolitan area of Cagliari (Italy).

The rest of the paper is structured as follows: in Section 2, a review of previous works related to social norm interventions is presented; in Section 3 we describe our program and the methodology through which we built the PTP for each participant, and we analyze the characteristics of the sample; then, we present the results obtained from the data analysis; and finally, we discuss the results and provide the conclusions.

2. LITERATURE REVIEW

Although there is evidence of a correlation between travel behavior and social norms, as well as an established body of research on compliance mechanisms deriving from persuasive intervention based on the delivery of social norm information in other pro-environmental domains (Abrahamse & Steg, 2013; Farrow *et al*., 2017), there is still limited experimental research studying the effectiveness of social norm interventions in promoting sustainable travel behavior change. Humans are inherently social creatures and tend to be influenced, whether consciously or unconsciously, by the behaviors, attitudes, and beliefs of others (Maness *et al*., 2015). According to social psychologists, social influence can be attributed to two main reasons (Deutsch & Gerard, 1955; Cialdini & Goldstein, 2004). The first reason is informational, as people consider others as sources of information to gain an accurate understanding of reality and make informed decisions more effortlessly. The second reason is normative, as individuals tend to be swayed by the behavior of others in order to conform and be accepted by their social reference group (Abou-Zeid *et al*., 2013; Cherchi, 2017).

According to Maness *et al.* (2015), social influence can shape people's behavior through two mechanisms: conformity and compliance. Conformity occurs when individuals are influenced directly by seeing and perceiving the behaviors of others. Compliance, on the other hand, involves the use of

external sources of influence, like advice, commands, advertisements, policies, laws, and ideal models (Maness *et al.*, 2015). In their literature review, Abrahamse and Steg (2013) define a list of persuasive strategies that make use of social influence to steer behavior change. Among these strategies are "Block leaders and social networks", in which one or more volunteers inform peer individuals in their social network about the desired behavior; "Modelling", which involves the presence of models who demonstrate the recommended behavior, assuming that others will adopt it after observing them; "Socially comparative feedback", in which individuals receive feedback that compares their performance with that of their peers (see "Quantified Traveler" by Jariyasunant *et al*., 2015 for an application on travel behavior); and "Social norm information", the most popular social influence intervention, which entails delivering information about how peers are behaving (descriptive norm) or what behavior they would approve of (injunctive norm). The latter is also the persuasive strategy analyzed in the present study.

In the field of transportation, many authors have already emphasized the significant role of social norms in both medium-to-long-term decisions, such as purchasing a private vehicle and determining its type (Belgiawan *et al.*, 2017; Cherchi, 2017; Kim *et al.*, 2014; Seleem *et al.*, 2021; Vöegle *et al.*, 2021), and short-term decisions, such as the use of sustainable transport means (Bamberg *et al*., 2007; Kim & Rasouli, 2022; Murray *et al*., 2010; Zhang *et al*., 2016). The significance of social influence has often been assessed through the utilization of Stated Preference surveys, where the proportion of individuals involved in a particular behavior or choice (descriptive norm) varies across different choice scenarios (Araghi *et al.*, 2014; Cherchi 2017; Kim *et al.*, 2014; Kim & Rasouli, 2022). Alternatively, researchers have utilized questionnaires in which respondents expressed their level of agreement, using a Likert scale, with statements measuring various aspects of social influence, such as the perceived social pressure of behaving in a certain way (injunctive norm), or the level at which a behavior is prevailing within their social reference groups (descriptive norm), and analyzed them in relation to travel behaviors using mainly

Structural Equation Models (Bamberg *et al.*, 2007; Belgiawan *et al.*, 2017; Murray *et al*., 2010; Seleem *et al.*, 2021; Zhang *et al*., 2016).

Some earlier studies highlighted the positive effects deriving from the application of a persuasive normative campaign on the use of private cars. In their small-scale field experiment, Kormos *et al*. (2015) found that normative messages whose content is "more prevalently" descriptive, *i.e.*, messages that over-reported others' successful efforts in switching toward sustainable mobility, were associated with an increased reduction of private vehicle use. Similarly, Riggs (2017) found that a social norm message tapping on altruistic values (benefit for the environment) can produce a significant effect on the intention to forfeit the right to parking in a university campus for one week, compared to the effects of gifts and monetary rewards. In contrast, in a much more extensive and recent study, Gravert and Collentine (2021) found a null effect on public transport ridership for a descriptive normative message and a more significant impact of financial incentives on uptakes and habit formation.

Unlike the above studies, a few recent applications compared the effectiveness of different persuasive normative messages. In their study, Piras *et al*. (2021) found empirical evidence of greater effectiveness of an injunctive normative message compared to a descriptive one on the intention of using public transport and reduce the use of the car. Instead, they did not detect any difference in effect between the two messages for the intention of using the active mobility. Likewise, Mundaca *et al*. (2022), who analyzed the effect of social norm nudges on the willingness to use a car sharing service, found that only the use of an injunctive norm had the potential to steer behavior in the desired direction.

Finally, there are additional studies that made use of other kinds of normative nudges to steer a travel behavior change. Particularly, Hauslbauer *et al*. (2022) compared the effects of a descriptive social norm message with those of a default nudge in increasing the number of purchased public transport tickets. The authors concluded that no substantial differences were found between the two treatment groups and

a control group. Instead, Huber *et al*. (2018) tested two different social norm indicators on the willingness to voluntary use carbon offsetting to compensate for their past car usage. The effects of group information and institutional decisions were compared. Results showed that group information alone was ineffective, whereas combining the two treatments significantly increased the offsetting payments.

At the same time, in the last few decades, there has been an increasing amount of literature investigating the effect of informational measures on people's travel behavior. The present study specifically employs one such measure known as Personalized Travel Plans (PTPs). PTPs aim at changing people's travel choices by delivering individualized information carefully tailored to their needs and circumstances (Cairns *et al*., 2008). Since the 1980s, PTPs have gained worldwide recognition and adoption. Notably, the most famous commercial applications are TravelSmart (Brög *et al*., 2009; Ma *et al*., 2017), TravelBlending (Rose & Ampt, 2001), and the travel feedback programs (TFPs, Fujii & Taniguchi, 2006). Systematic literature reviews and meta-analyses have shown that such programs can lead to a reduction in the car modal split share between 5% and 15% (Chatterjee, 2009; Bamberg and Rees, 2017; Friman *et al*., 2013; Semenescu *et al.*, 2020). Recent applications of PTP programs confirmed the results of older studies, observing an increase in no-car use proportion (Ahmed *et al.*, 2020; Esztergár-Kiss *et al.*; 2021, Piras *et al.*, 2022). For example, Piras *et al.* (2022) reported that the implementation of a PTP program, in combination with the introduction of a new light rail line, contributes by 12% to travel behavior change.

2.1. The current study in context

In the current paper we contribute to existing insights on the capability of normative messages in eliciting a travel behavior change in three different ways. First, unlike most of the earlier works, which tested the effect of only one type of normative message, we investigate the efficacy of different type of messages, based on the descriptive/injunctive norm alone or descriptive and injunctive norms together.

Then, we evaluate how different segments of individuals (e.g., males vs females) react to the provision of the message. Second, we tested the effect of the normative intervention jointly with the delivery of a Personalized Travel Plan, so as to 1) verify whether normative messages can strengthen the impact of information, 2) assess the influence of the normative messages depending on the travel alternative's feedback (time, cost, CO2 emissions, kcal burnt) provided to the participant of the study. Third, although some past research mixed up commuting and non-commuting trips in their analysis, we focus only on the effect of the intervention for home to work/study trips. As a matter of fact, as we argued in the introduction, it is possible that a normative nudge could have a different effect depending on the purpose of the trip. Furthermore, we decided to concentrate only on commuting trips also to give a clearer picture of the effectiveness of the soft measure, because of their higher frequency and impact on the overall urban transport system.

Based on prior studies, our research hypotheses are as follows:

- H1: The effect of the injunctive message is greater than the effect of the descriptive message.
- H2: The impact of the normative message may be hindered if the feedback regarding the proposed sustainable travel alternative is not competitive when compared to the benefits of using a car.

3. APPLICATION

3.1. The "Svolta" program

The present analysis makes use of data collected during the Voluntary Travel Behavior Change program "*Svolta*". The main aim of the program was the promotion of pro-environmental travel behavior in the context of Cagliari (Italy). The data collection consisted of four different steps (Figure 1).

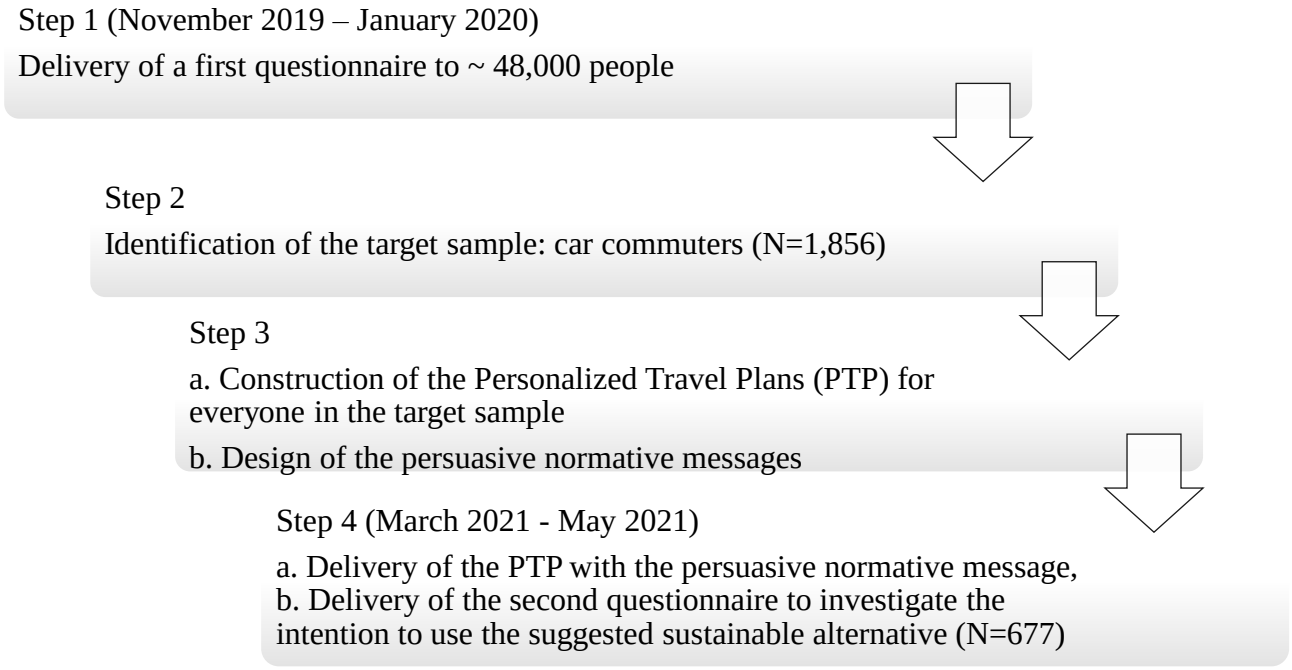

Figure 1 Phases of the program

In the first step, conducted between November 2019 and January 2020, we contacted potential participants to the experiment. To reach them out, we sent emails to staff and students at the University of Cagliari, the staff at the Regional Government of Sardinia, and at the municipality of Cagliari. Additionally, we conducted a promotional campaign using traditional communication channels such as TV, radio, posters, and postcards, as well as social media platforms like Facebook, Instagram, and Twitter. We asked them to fill out an online questionnaire to learn about their current travel behavior for home to work/study trips and gather information about their socio-demographic profiles.

During the second phase, the analysis of the questionnaire responses made it possible to identify the target of our experiment, *i.e.*, individuals who declared to commute by car (1,856 individuals).

In the third step, we constructed a Personalized Travel Plan (PTP) (Sanjust di Teulada *et al.*, 2015; Piras *et al.*, 2018), suggesting the sustainable travel alternative most suitable for each participant in the target (walking, cycling, and public transport in order of sustainability level). We chose to suggest only

one alternative for homogeneity purposes, since most participants had only one alternative available among the three which were feasible. Moreover, sequentially suggesting more than one alternative could have limited the efficacy of the persuasive normative intervention just to the first alternative and not to the following ones. Sustainable alternatives have been chosen in order of sustainability: walking, cycling, and eventually public transport. If the walking trip did not adhere to length, slope, and safety constraints, the biking alternative was analyzed, and if even this one did not comply with all restrictions, public transport was the alternative proposed. After that, we computed for both car and the proposed alternative the following feedbacks, considering time frames of both one day and one month: journey time, monetary cost, CO_2 emissions, and burned calories. Then, we designed the normative intervention to be applied simultaneously with the delivery of the Personalized Travel Plan. In particular, we defined four different persuasive textual messages and randomly assigned the participants to one of the following five groups: 1) descriptive message, 2) injunctive message, 3) descriptive then injunctive message, 4) injunctive then descriptive message, and 5) no message (control group).

Then, in the fourth step, conducted between March and May 2021 we applied the behavioral measure, which included the PTP and the normative message. An email was sent to each individual within the target sample, containing a link to access the PTP and the persuasive message. The same link included a follow-up questionnaire to assess participants' intention to change their travel behavior for their home-to-work/study trips, from private cars to the suggested sustainable alternative.

As a result, 677 individuals responded to the second questionnaire, resulting in a response rate of 36.5%.

3.2. The Personalized Travel Plan

Using the information about each participant's home and workplace locations, we sought the best sustainable alternative through the Google Maps Directions API.

- Walking was suggested for trips up to 2 km. We also checked for the presence of sidewalks and paths that were safely walkable along the possible routes.
- Cycling was suggested for trips between 2 and 5 km, with an average uphill slope under 2.5%. The presence of safe cycling paths and the possession of a bicycle were also ascertained.
- Public transport was suggested in all the other cases.

The threshold distances used to determine which sustainable alternative to propose have been determined by analyzing the outcomes of the initial questionnaire implemented during the first phase of the experiment (Step 1 of Figure 1). In particular, we discovered that the majority of people walking to work/school covered distances of less than 2 km, while those who choose bicycling tend to travel distances of up to 5 km. The threshold distance associated with walking aligns with prior literature (Keijer & Rietveld, 2000; Chillón *et al*., 2016). Furthermore, the threshold value for cycling also falls within the ranges reported in existing literature (Hansen & Nielsen, 2014; Nordengen *et al*., 2019; Banerjee *et al*., 2022).

As a result, the suggested sustainable alternative was active mobility, *i.e.*, walking or cycling for 19.9% (9.5% and 10.4% respectively) of the sample, whereas public transport, was proposed to the remaining 80.1%. The large share of individuals to whom public transport was suggested is not surprising if it is examined in reference to the study's context. Indeed, many of the home-work/study trips generated daily in this territory start in the suburban residential areas, with their destination being in the central city of Cagliari. Moreover, the uneven topography of Cagliari and the shortage of safe cycling infrastructures make traveling by bike difficult.

For all the participants, the PTP included all the practical information and indications they had to follow in order to adopt the suggested sustainable travel alternative. To inform the participants about the benefits achievable by switching modes, we highlighted, for both the car and the sustainable alternative,

four aforementioned feedbacks. Finally, one of the four persuasive normative messages was added at the bottom of the PTP for those not belonging to the control group (Figure 2).

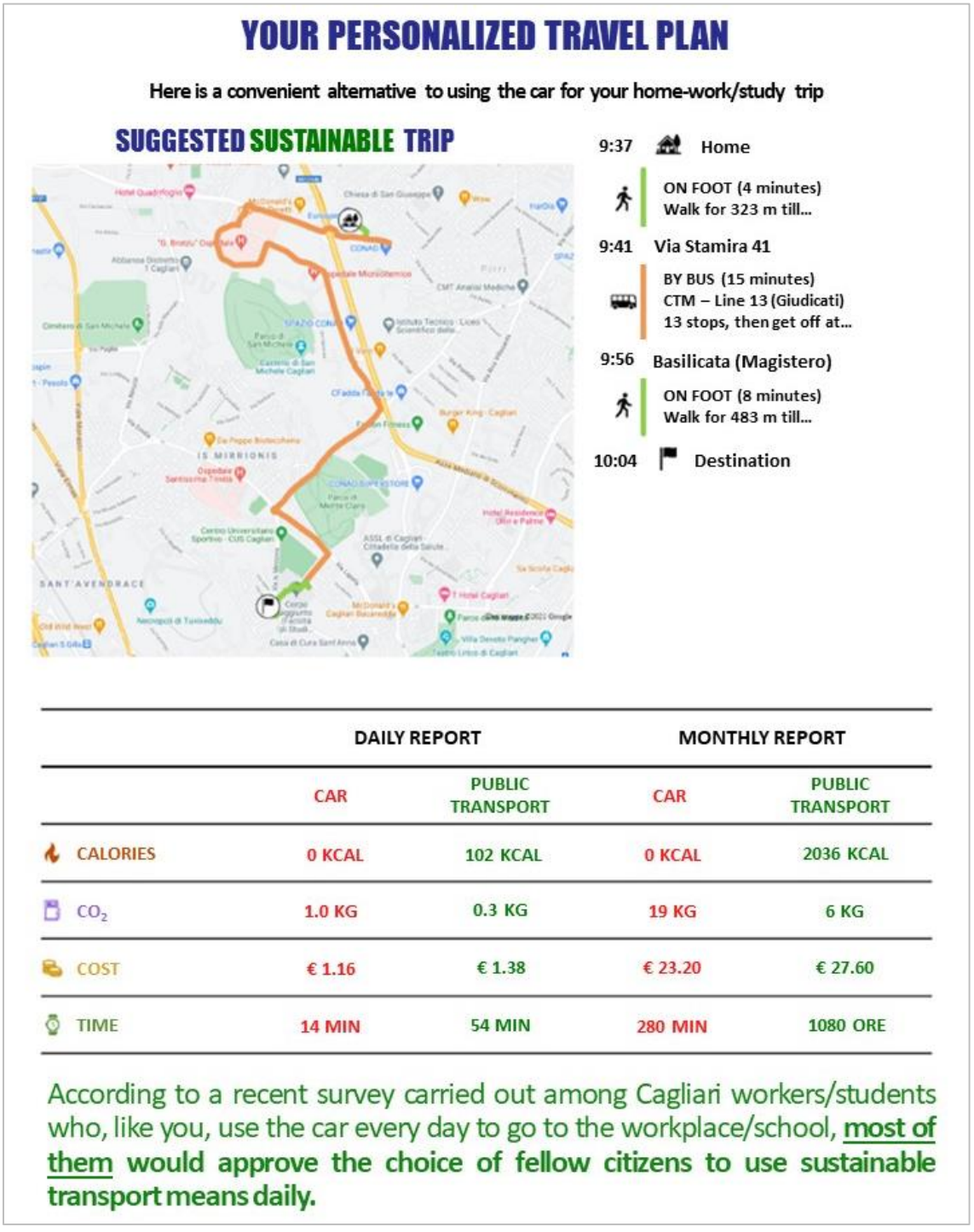

Figure 2 An example of PTP

Simulation of travel time and monetary costs

In terms of travel time, we used the information coming from the Google Maps Directions API, for all the alternatives considered.

For the monetary costs of using the car, we multiplied the length of the trip by the cost per kilometer. We used different cost values depending on the vehicle type used by the individual and the cost per kilometer included the fuel cost and the maintenance costs (see Appendix A). We employed the cost values provided by the *Automobile Club Italia* (ACI)[1]. Concerning public transport costs, we calculated the most convenient fare for each individual according to the annual trip frequency. Therefore, the minimum fare was calculated between yearly subscription, monthly subscription, and single ticket, splitting the cost appropriately based on the travel frequency stated. Data on vehicle type and annual trip frequency were obtained with the first questionnaire sent during the initial stage of the program. Finally, we set the monetary costs of biking and walking equal to zero.

Burned calories

The calories burned by walking were calculated by using an expression proposed by Van der Walt and Wyndham (1973):

$$kcal = duration \times \left(0.0599 \cdot \frac{mass}{speed} + 0.000366 \cdot mass \cdot speed\right) \times 5 \qquad [1]$$

The inputs of the expression are the duration of the trip, the body mass of the individual, and the walking speed. Since the walking speed on Google Maps is set to an average value of 4.4 km/h, expression [1] becomes:

$$kcal = duration \times (0.07612 \cdot mass) \qquad [2]$$

[1] https://www.aci.it/i-servizi/servizi-online/costi-chilometrici.html

In the case of the bicycle alternative, we used the expression suggested by Ainsworth *et al.* (2011):

$$kcal = duration \times (0.11333 \cdot mass) \quad [3]$$

Because the participant's body mass was unknown, we used two average values from previous research we conducted in the previous years in the same area (Sottile *et al.*, 2021b): 75.3 kg for males and 58.4 kg for females.

Calories burnt when traveling by car were set equal to zero, while for the alternative public transport we considered only the walking segments to and from the transit stops.

CO_2 emissions

The CO_2 emissions by car were estimated multiplying the trip length by the emission factor per kilometer:

$$CO_2 = Trip\ length_{\ car} \times\ unit\ CO_{2_{car}} \quad [4]$$

The latter value could vary depending on the vehicle style and its fuel type (see Appendix A). The emission factor we employed was provided by the *Department of Environment* (DEFRA) of UK[2].

For public transport, the emissions were estimated using the same expression. However, since a single trip could be completed using different typologies of public transport vehicles (*i.e.*, bus, train, and light rail), the total emission was calculated as the sum of the contributions of the single trip legs:

$$CO_2 = \sum_i Trip\ leg\ length_{\ i} \times\ unit\ CO_{2_i} \quad [5]$$

[2] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/726911/2018_methodology_paper_FINAL_v01-00.pdf

To obtain the emission factor per kilometer for a single passenger, we divided the vehicle emission factor per kilometer by the average number of yearly travelers (NT_{year}) and the annual number of rides for a single vehicle (NR_{year}).

$$unit\ CO_{2_i} = \frac{unit\ CO_{2_{vehicle}}}{NT_{year} * NR_{year}} \quad [6]$$

Finally, we set the CO_2 emissions produced by walking and cycling equal to zero.

Persuasive normative messages

The persuasive normative messages we considered could be descriptive, highlighting the "normal" behavior kept by peer individuals in similar contexts and situations, or injunctive, emphasizing the beliefs of peer individuals regarding an approved behavior.

In the present application, the descriptive normative message stated as follows:

"*Considering Cagliari workers/students who, like you, use the car every day to go to their workplace/university, it has been ascertained that a significant part of them is changing their travel habits by choosing to use sustainable means of transport daily*".

Whereas the injunctive normative message stated as follows:

"*According to a recent survey carried out among Cagliari workers/students who, like you, use the car every day to go to their workplace/university, most of them would approve the choice of fellow citizens to use sustainable means of transport daily*."

We also tested the combination of the two messages by delivering the two texts, one after the other, in both orders. Note that the normative data used in the message did not originate from a specific survey or technical report. The content of the message was fabricated for the purpose of our study, following a similar approach employed by some previous studies (Kormos *et al*., 2015; Piras *et al*., 2021; Hauslbauer

et al., 2022). This methodology allowed us to investigate the impact of a message emphasizing the use of green mobility among participants' fellow citizens on the choice between using a car and utilizing the suggested means of transport.

The four types of normative messages were randomly assigned to the 1,856 participants as follows: 464 were provided with the descriptive normative message, 464 with the injunctive one, 232 received the descriptive message and then the injunctive one, and 232 the injunctive message and then the descriptive one. Finally, the remaining 464 participants belonged to the control group and thus received no persuasive messages.

The final questionnaire

To quantify the effectiveness of the different persuasive normative interventions, we administered one last questionnaire to the participants. Following the framework of stated preference surveys, they had to assert whether they intended to change their modal choice given the suggested alternative scenario after being persuaded by one of the normative interventions. Therefore, once the participants saw the PTP and the normative message through the "Wufoo" platform[3], they were straight after asked to answer the following question:

Based on what you have just read, choose one of the following options:

- *I choose the sustainable alternative suggested in the PTP*
- *I choose the car*
- *None of the above*

[3] https://www.wufoo.com/home/?utm_bu=wufoo&utm_campaign=20_Wufoo_WF_BR_ROW_EN_Core_Exact_X&utm_content=WF_BR_ROW_EN_Core_X&utm_medium=c&utm_source=google&utm_term=wufoo&utm_kxconfid=s4bvpi0ju&gclid=CjwKCAiAzp6eBhByEiwA_gGq5HW4OM7_Ki72508ND9apx-K6nW1MwpeRKGbe2C9HuhZajNSk35vIfxoCMHYQAvD_BwE&gclsrc=aw.ds

The decision to use a dichotomous scale to measure the intention to change travel behavior was based on two reasons. Firstly, dichotomous intention refers to an intention or motive that is characterized by a clear and distinct duality or opposition. In the context of decision-making, a dichotomous intention may arise when a person is torn between two conflicting choices or outcomes. Naturally dichotomous single-action behaviors are often predicted by intention (Courneya, K. S. (1994)). The theory of reasoned action (TRA) assumes that intention (conceptualized as a continuum but measured on a multipoint scale) is somehow transformed into a dichotomous behavior. One could treat intention as an all-or-none phenomenon; either a person has an intention to perform a given behavior or he does not. Treating both intention and behavior as genuine dichotomies would allow the possibility of a perfect relationship between the two (Konerding, U. (1999)). This approach, which resembles Stated Preference surveys, helps to avoid ambiguous responses.

Secondly, ordered scales, such as 5-point or 7-point scales, can occasionally be challenging for respondents to understand. By adopting a dichotomous scale, the choice process for participants can be simplified (Farrington & Loeber, 2000). Furthermore, to avoid forcing any decision, we let the possibility of choosing neither of the two modal alternatives. Indeed, given the wide timeframe of the experiment, participants could have changed their workplace, their residential location, or both. The importance of such a questionnaire lay in the possibility of linking stated intentions to future analyses of actual behavior.

As a result, of the 1,856 individuals belonging to the target population, 677 correctly inspected their PTP and answered to the last questionnaire.

3.3. Sample analysis

As a consequence of the random assignment of the four normative messages, the sample of 677 respondents to the last questionnaire is composed of 152 individuals nudged with the descriptive normative message, 168 individuals nudged with the injunctive normative message, 92 belonging to the

descriptive + injunctive normative group, 90 belonging to the injunctive + descriptive one, and 175 comprising the control group.

In the present analysis, 100 out of 677 observations that did not report the intention of continuing to commute by car or switching to sustainable mobility were not considered. Hence, the final sample we will employ for our analysis is composed by 577 individuals. As can be seen in Table 1, the sample is equally distributed in gender, 49.6% of the individuals are males and 50.4% are females. The average age of the individuals is 43.12 years, and the standard deviation is 11.75, with more than half of the respondents belonging to the 41 ÷ 60 years old group (55.3%). Since all participants commuted by car, they all have at least one car available for their commuting trips. The average number of cars in the household is 1.88, with a standard deviation of 0.74. Finally, concerning the residential location, half of the sample lives inside the municipality of Cagliari, 35.4% lives in the metropolitan area, whereas 14.5% lives in the rest of the Sardinian region. Figure 3 displays the spatial distribution of participants' trip origins, categorized according to various daily travel times for commuting purposes using cars. Notably, it emerges how individuals residing in the city of Cagliari experience shorter travel times, as it serves as the primary attractor for work- and study-related trips in the metropolitan region.

Considering just those participants who chose either to continue with the car or to use the suggested sustainable alternative, the results show that 127 respondents were nudged with the descriptive normative message, 143 with the injunctive normative message, 160 respondents received a combination of two normative messages, whereas 147 individuals belonged to the control group.

Table 1 Sample description

Variables	N	%	Avg.	St. Dev.
Total	577	100	-	-
Gender				
Male	286	49.6	-	-
Female	291	50.4	-	-
Age	577	-	43.12	11.75
18 ÷ 30 years old	116	20.1	-	-
31 ÷ 40 years old	112	19.4	-	-
41 ÷ 50 years old	131	22.7	-	-
51 ÷ 60 years old	188	32.6	-	-
Over 60 years old	30	5.2	-	-
Educational level				
At least a bachelor's degree	355	61.5	-	-
No degree	222	38.5	-	-
Personal monthly income				
under 1,000 €	117	20.3	-	-
1,001 ÷ 1,500 €	159	27.5	-	-
1,501 ÷ 2,000 €	173	30.0	-	-
over 2,000 €	128	22.2	-	-
Occupation				
Student	100	17.3	-	-
Not student	477	82.7	-	-
Number of cars per household	577	-	1.88	0.74
1	163	28.2	-	-
2	330	57.2	-	-
3 or more	84	14.6	-	-
Household composition	577	-	2.88	1.32
No children under 10 years old	451	78.2	-	-
At least one child under 10 years old	126	21.8	-	-
Residential location				
City of Cagliari	289	50.1	-	-
Cagliari metropolitan area	204	35.4	-	-
Rest of Sardinian region	84	14.5	-	-
Norm group				
Descriptive norm	127	22.0	-	-
Injunctive norm	143	24.7	-	-
Descriptive + injunctive norm	80	13.9	-	-
Injunctive + descriptive norm	80	13.9	-	-
Control group	147	25.5	-	-

Note: the reasons for aggregating the sample into these specific categories of age and income is that this way all the categories include, more or less, the same number of people

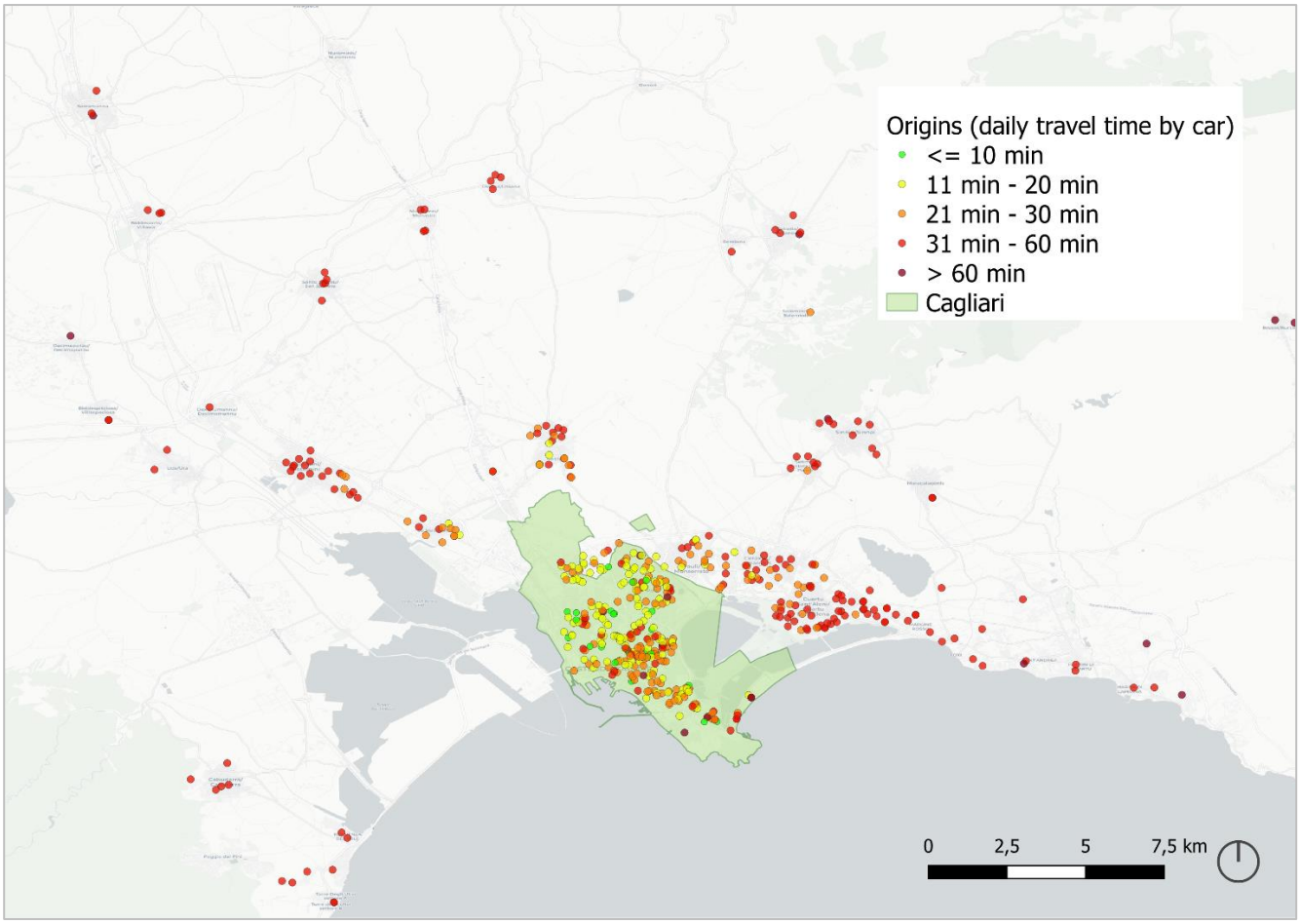

Figure 3 Spatial distribution of participants' trip origins sorted by daily travel time by car

3.4. Feedback analysis

If we compare the average feedback values of the private car with those of the suggested sustainable alternatives, we obtain a clearer picture of the transportation context of the study area considered in the experiment. Table 2 shows the average comparison between the car and the suggested sustainable alternatives in terms of daily travel time, monetary cost, carbon dioxide emissions, and burnt calories.

Notably, cars are, on average, faster than any sustainable alternative. While cycling is the only sustainable transport means with travel times comparable to the car, the average travel time for public transport is over double that of a private vehicle. This outcome can be attributed to the presence of very few reserved bus lanes in the city of Cagliari, which could increase the commercial speed of the public transport service. Moreover, the time spent looking for a parking spot usually does not compensate for

the increased travel time caused by walking to and from the bus stop, waiting for the next bus, loading/unloading passengers, and traffic congestion.

In terms of monetary costs, instead, using public transport can halve the average compared to the one of the car. However, usually, this is not enough to compensate for the increased travel time.

Concerning carbon emissions, public transport is the sustainable alternative that most decreases the average emissions per day. Indeed, even if emissions by walking and cycling are set to zero, those individuals to whom public transport was suggested need to travel longer distances and, therefore, emit more CO_2 compared to the others. Finally, cycling is the alternative that increases the average calories burned when reaching the workplace/school the most.

Table 2 Daily average comparison between the car and the suggested sustainable alternative

		Travel time [min/day]		**Monetary cost [€/day]**		**CO_2 emitted [$kgCO_2$/day]**		**kcal burned [kcal/day]**	
	N	**Avg.**	**S.D.**	**Avg.**	**S.D.**	**Avg.**	**S.D.**	**Avg.**	**S.D.**
Current alternative: Car	54	13.44	5.62	0.70	0.31	0.60	0.26	0	-
Suggested alternative: Walking		37.96	11.40	0	-	0	-	192.36	63.21
Current alternative: Car	61	19.51	5.07	1.40	0.54	1.18	0.45	0	-
Suggested alternative: Cycling		26.85	6.31	0	-	0	-	206.53	56.29
Current alternative: Car	462	38.84	22.87	4.78	4.99	4.15	4.38	0	-
Suggested alternative: Public transport		88.28	43.27	2.29	1.73	1.77	2.48	117.71	82.78

4. RESULTS

4.1. Overall intention to change

Aggregate results show that 213 respondents out of 577 (36.9%) expressed their intention to change their travel mode toward a more sustainable one. Therefore, as a result of the combination of a Personalized Travel Plan and a persuasive normative message, more than one-third of the sample intended to change their home-to-work travel habits. This result is in line with other Voluntary Travel

Behavior Change programs developed in the same context (Piras *et al*., 2018; Sanjust di Teulada *et al*., 2015).

However, the meaningfulness of this result changes if we consider all the 1,856 car commuters belonging to the experiment's target population. Indeed, supposing we consider also those who did not answer the final questionnaire as not interested in the program and therefore not intentioned to change their modal choice, the percentage would fall to 11.5%. The latter result is more in line with recent meta-analyses that evaluated how similar interventions would reduce the car modal split share by 5% - 7% (Bamberg & Rees, 2017; Semenescu *et al*., 2020).

4.2. Persuasive normative message effects

By disaggregating the results based on the type of normative message delivered, we can observe that the percentage of those who declared their intention to use the sustainable alternative is higher for those who received the injunctive normative message (Figure 4). By performing statistical tests on the percentage differences (Table 3), we found that the only two statistically significant differences are those between the injunctive norm and the injunctive + descriptive norm groups and between the latter and the control group. That is, delivering a normative message containing both the injunctive and the descriptive norm is counterproductive compared to the control group. This side effect could be attributed to the excessive length of the combined message, which delivered a large amount of information in a small space. This aspect could have compromised the effectiveness of the information provided, which instead should be not only useful but also readily understandable (Fogg, 2002).

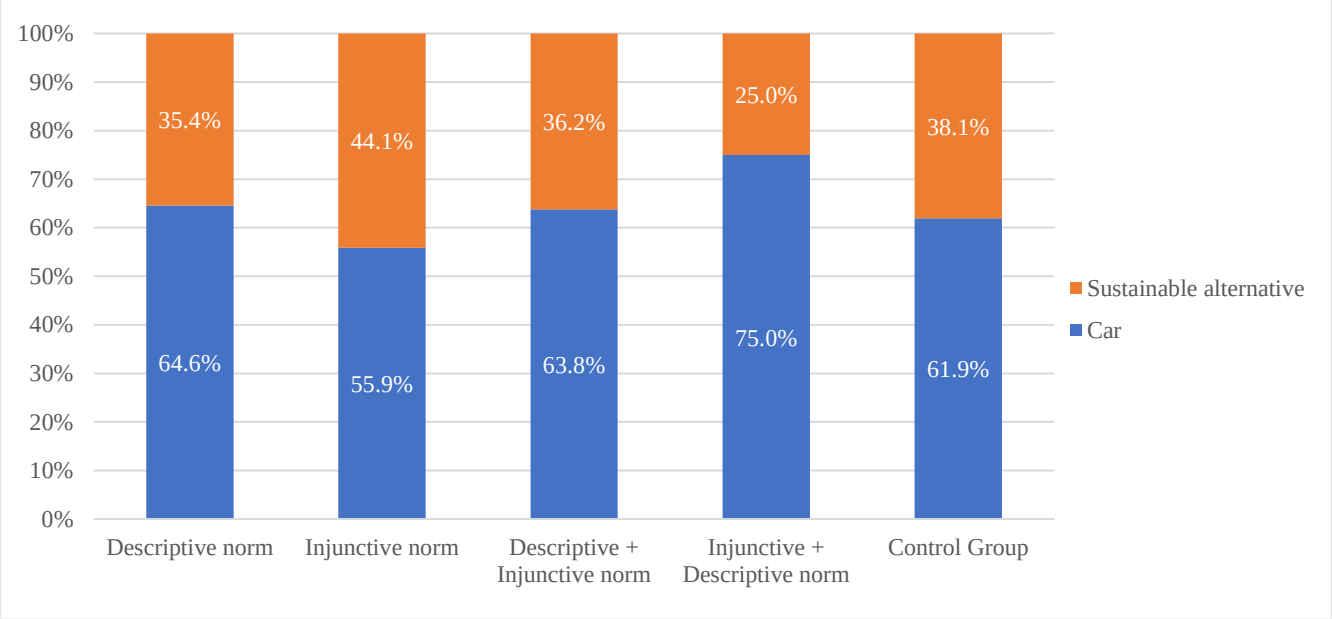

Figure 4 Intention to change: disaggregate results depending on the normative message

Table 3 Statistical test on the percentage differences between each normative group

t-test	Descriptive	Injunctive	Descriptive + Injunctive	Injunctive + Descriptive	Control group
Descriptive	-	-1.44	-0.12	1.57	-0.46
Injunctive	-	-	1.14	2.82(**)	1.03
Descriptive + Injunctive	-	-	-	1.54	-0.27
Injunctive + Descriptive	-	-	-	-	-2.00(**)
Control group	-	-	-	-	-

Note: (**) = *significant with a probability ≥ 95%.* (*) = *significant with a probability ≥ 90%*

4.3. Persuasive normative message effects for different suggested sustainable alternatives

If the results are disaggregated depending on the suggested sustainable alternative, we can see that there is a higher intention to choose walking and cycling compared to public transport (Table 4). This outcome, similar to the one reported by Ahmed *et al.* (2020), could be due to the higher benefits in terms of emissions reductions, reduced costs, increased physical activity, and, in general, could be connected to the level of service of the public transport network in the study area. Indeed, as discussed earlier,

although public transport is widely available and accessible in the whole study area, it is often not competitive with the car in terms of travel time. Indeed, the lack of reserved bus lanes forces public transport to share the road with private vehicles, making it highly susceptible to congestion and delays. Moreover, additional travel times due to walking, waiting, and intermediate stops outweigh the time lost when searching for a free parking spot. Consequently, for the same trip, the travel time by public transport is almost always higher than the one by car. In our case study, it is more than double on average.

Table 4 Intention to change: disaggregate results depending on the suggested sustainable alternative

		Choice				**Total**	
		Car		**Sustainable alternative**			
		N	**%**	**N**	**%**	**N**	**%**
Suggested sustainable alternatives	Walking	15	27.8	39	72.2	54	100
	Cycling	25	41.0	36	59.0	61	100
	Public transport	324	70.1	138	29.9	462	100

Regarding monetary costs, public transport is often cheaper than the car, by half on average in our sample. However, cost savings alone are not sufficient to motivate people to use public transport instead of cars. Additionally, internal individual barriers, such as attitudes toward public transport, perceived behavioral control, and the perception of possible health hazards on board of public transport vehicles, could have further hindered the willingness to use this alternative. Moreover, such internal barriers further aggravated after the beginning of the COVID-19 pandemic (Przybyłowski *et al*., 2021), during which this experiment took place. Moreover, the percentage of those who intended to shift away from the car is higher for walking compared to cycling. This result could be due to the low availability of cycling infrastructures in the study area, but also to psychological and situational factors that make it easier to choose walking rather than cycling.

To highlight any differences in the effects of the persuasive normative intervention among the three types of sustainable alternatives suggested in the PTP, we built the graph in Figure 5. Compared to the

control group, receiving a persuasive message based on injunctive or descriptive norms increases the willingness to walk (except for the injunctive + descriptive message) and decreases the intention of cycling (except for the descriptive + injunctive message). However, the small number of individuals who received the suggestion to walk and cycle makes these percentages fluctuate considerably, and statistically significant conclusions cannot be drawn.

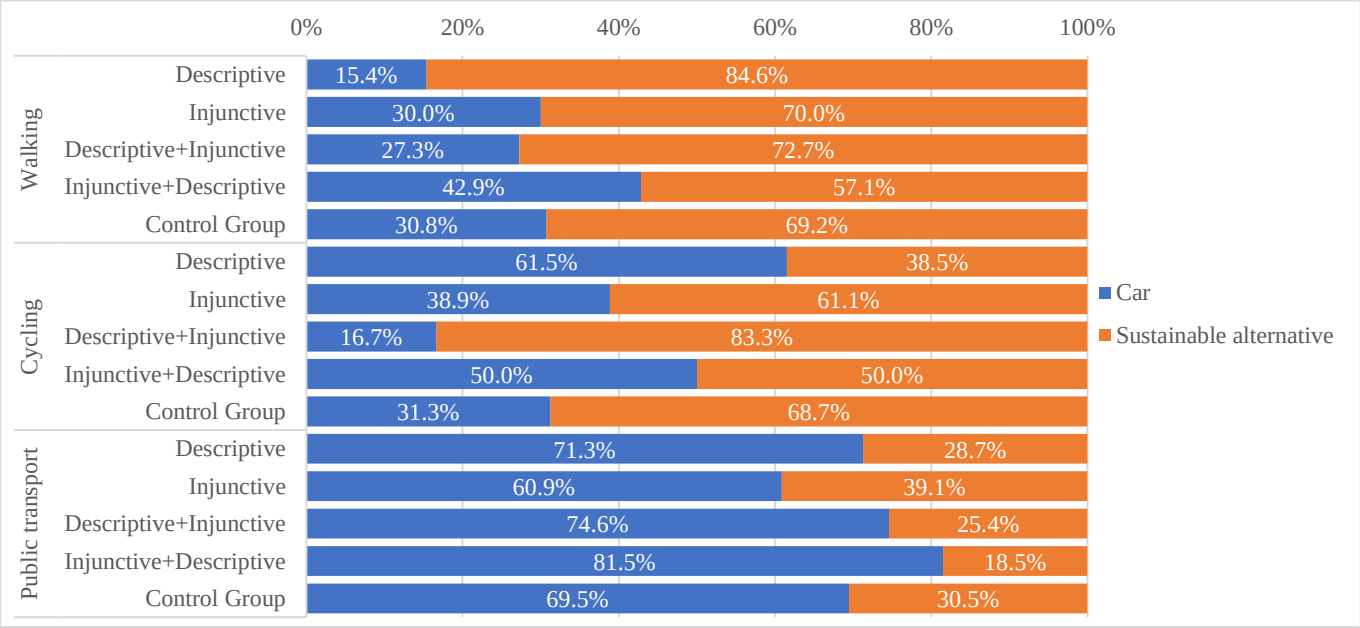

Figure 5 Intention to change: disaggregate results depending on the normative message and the suggested sustainable alternative

In order to obtain categories containing a number of observations sufficient to highlight any statistically significant differences among the effect of the normative messages, based on the suggested alternative, we aggregated those individuals to whom it was suggested to walk and use the bike in a single category named "Active mobility"[4] (Figure 6). We found no significant differences in travel behavior change amongst the groups who received a normative message and the control group when an active mobility alternative was proposed (Table 5). On the other hand, the injunctive normative message is

[4] The choice to aggregate walking and cycling alternatives and consider them as a unique means of transport has been done in previous works (see for example Ahmed *et al.*, 2020; Jariyasunant *et al.*, 2015; Piras *et al.*, 2021) as both modes are relatively inexpensive, from a monetary standpoint, and require moderate physical efforts.

significantly more effective than the two combined normative messages when suggesting using public transport (Table 5). Moreover, the injunctive norm group intends to use public transport more than the descriptive one, with a probability of about 89% (t-test = 1.61), and the control group, with a probability of about 83% (t-test = 1.38). Again, the injunctive + descriptive normative message becomes significantly counterproductive when compared to the control group.

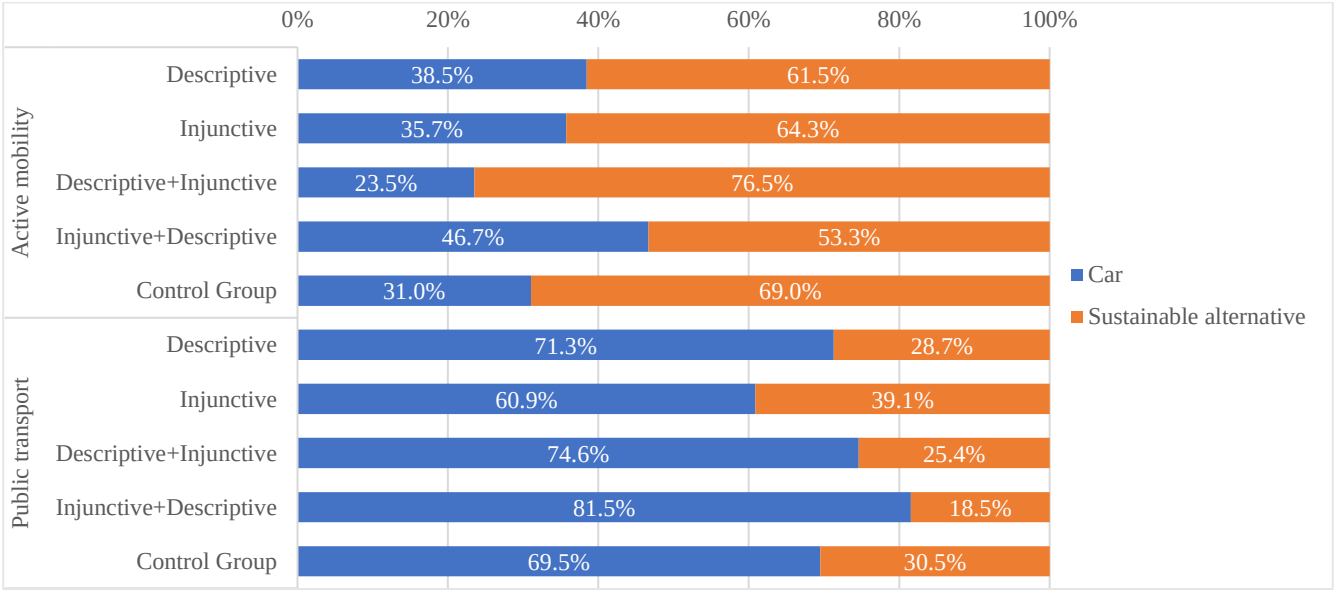

Figure 6 Intention to change: disaggregate results depending on the normative message and the suggested sustainable alternative. Walking and cycling aggregated into the "Active mobility" category

Table 5 T-tests on the percentage differences between each normative group, for both active mobility and public transport

T-TEST	Descriptive	Injunctive	Descriptive + Injunctive	Injunctive + Descriptive	Control group
Active mobility					
Descriptive	-	-0.21	-1.02	0.51	-0.58
Injunctive	-	-	-0.86	0.70	-0.37
Descriptive + Injunctive	-	-	-	1.38	0.55
Injunctive + Descriptive	-	-	-	-	-1.02
Control group	-	-	-	-	-
Public transport					
Descriptive	-	-1.61	0.46	1.49	-0.29
Injunctive	-	-	1.85(*)	2.86(**)	1.38
Descriptive + Injunctive	-	-	-	0.95	-0.72
Injunctive + Descriptive	-	-	-	-	-1.77(*)
Control group	-	-	-	-	-

Note: Active mobility = walking or cycling.
(**) = significant with a probability ≥ 95%. (*) = significant with a probability ≥ 90%

4.4. Effects of persuasive normative messages for different levels of reported feedback

As discussed previously, the differences between the feedbacks of the car (travel time, monetary cost, carbon emissions, and burnt calories) and the ones for the suggested sustainable alternative could have had a crucial impact on the willingness to change travel behavior. We were interested, therefore, in highlighting variations in the effectiveness of normative interventions depending on the magnitude of the feedback differences between the car and the proposed alternative. Thus, for every feedback, we calculated the difference between the car and the sustainable alternative for each individual and divided our sample into quartiles. Such a division was used to highlight possible non-linear effects of the feedback differences on the intention to change modal choice and to have enough observations in each subsample for the successive analyses. Then, for each quartile, we looked for statistically significant differences in the intention to change among the groups defined by the persuasive normative messages and the control group. For the sake of brevity, only the analyses of the first quartiles are presented.

Figure 7 shows how receiving any persuasive normative message decreases the willingness to change the modal choice compared to the control group, when the increase in travel time is less than 95%.

Therefore, it seems that when the travel time disadvantage of the sustainable alternative is less prominent, the effectiveness of persuasive messages decreases and instead becomes counterproductive. Statistical tests confirm that the differences are significant, except for the injunctive norm group (t=1.56, p-value=0.12, df=72).

Figure 8, instead, shows that the injunctive normative message increases the willingness to change travel mode toward the sustainable alternative for those belonging to the quartile with lower cost savings (<31%). Therefore, the injunctive normative message seems to help the choice of using the sustainable alternative when the benefits in terms of costs are low. By performing a statistical test on such differences, it comes out that they are significant only for the descriptive norm (t=1.87, p-value=0.07, df=63) and the descriptive + injunctive norm (t=1.87, p-value=0.07, df=63).

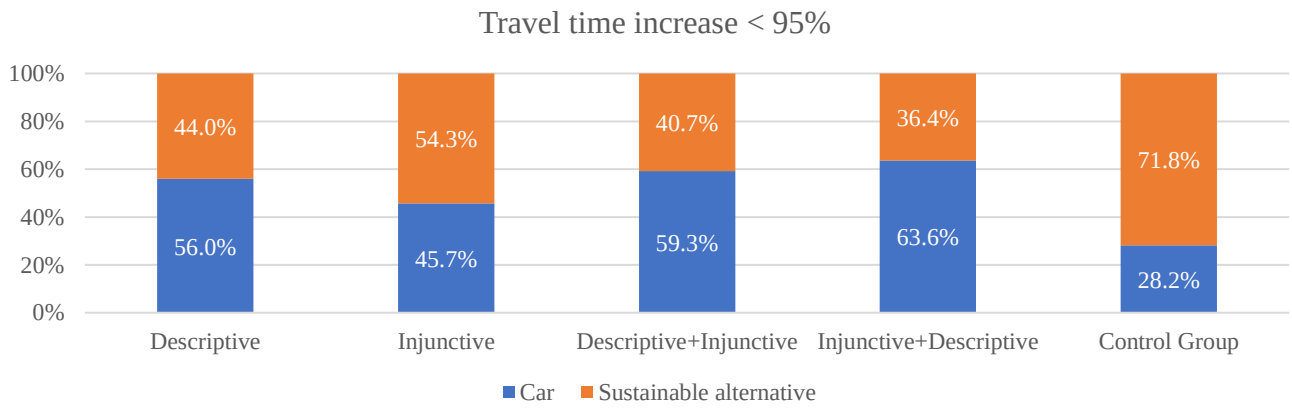

Figure 7 Intention to change: disaggregated results depending on the normative message, just for those with travel time increase <95%

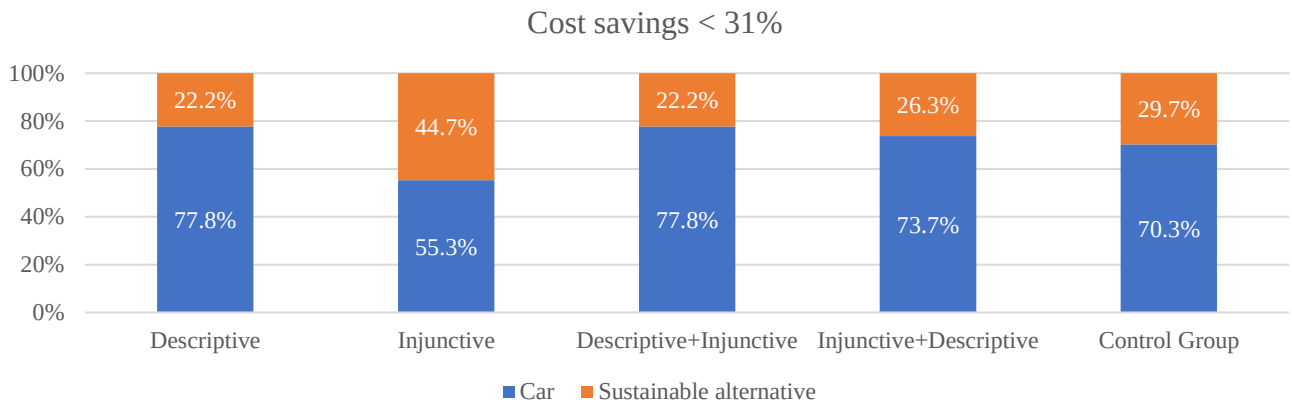

Figure 8 Intention to change: disaggregated results depending on the normative message, just for those with cost savings <31%

Regarding carbon emissions, Figure 9 shows how, for those who benefitted from the lowest CO_2 emissions reduction, receiving a descriptive or an injunctive normative message increased the willingness to use sustainable mobility compared to the joint messages and the control group. However, in the latter case, the difference is only slightly significant (respectively, t=1.15, p-value=0.25, df=71 and t=1.16, p-value=0.25, df=78). Finally, concerning the amount of calories burned using the sustainable mobility, Figure 10 shows that, for those who had the least increase in burnt calories (< 71.5 kcal/day), the injunctive normative message is the only intervention that does not decrease the intention to use sustainable mobility if compared to the control group. On the other hand, the other messages (descriptive t=-1.39, p-value=0.17, df=62, descriptive + injunctive t=-2.12, p-value=0.04, df=67, and injunctive + descriptive t=-2.05, p-value=0.05, df=54) seem to produce counterproductive effects instead.

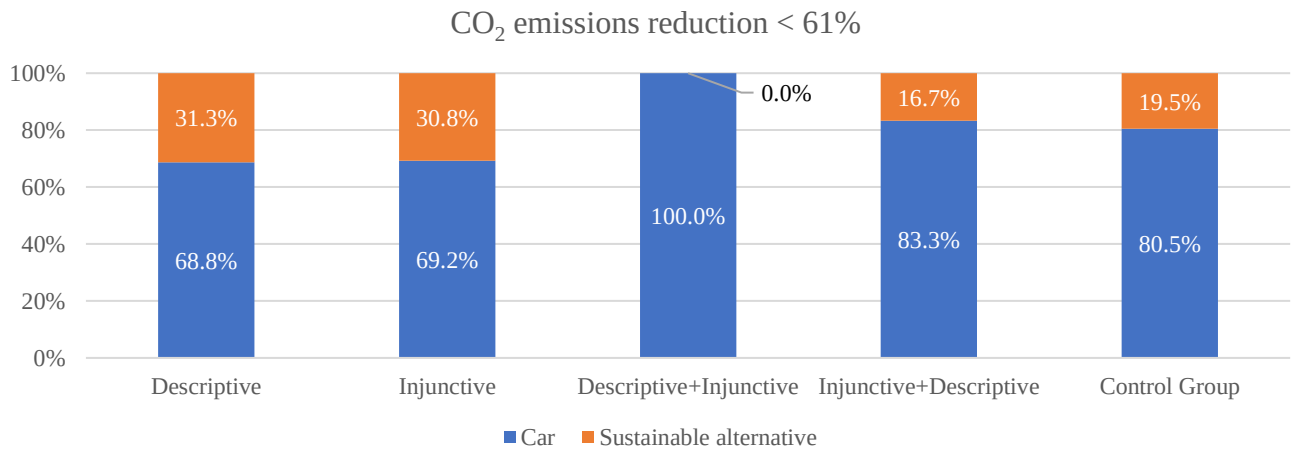

Figure 9 Intention to change: disaggregated results depending on the normative message, just for those with CO_2 emissions reduction <61%

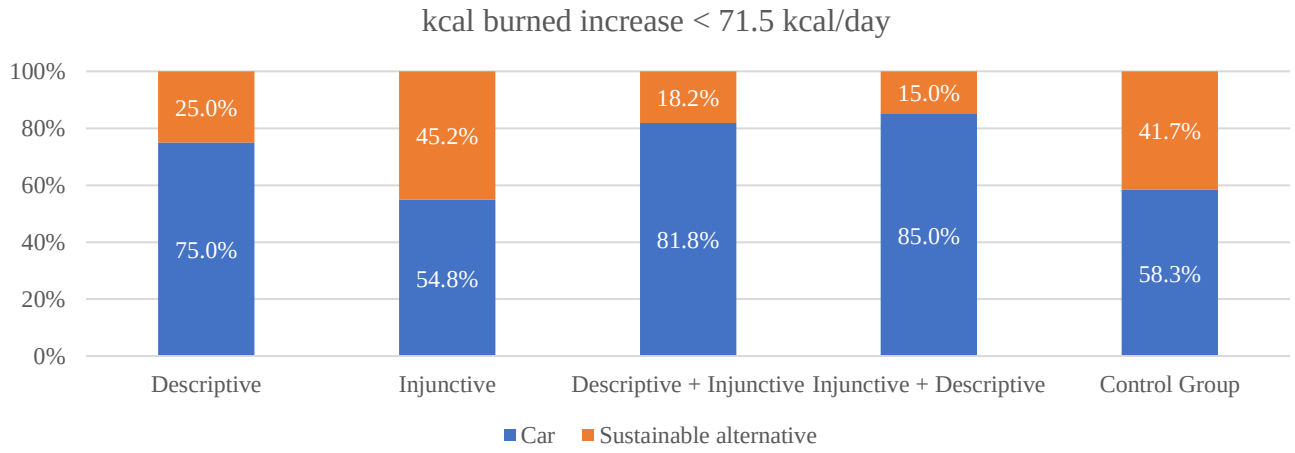

Figure 10 Intention to change: disaggregated results depending on the normative message, just for those with an increase kilocalories burned < 71.5 kcal/day

4.5. Persuasive normative message effects for different socio- demographic characteristics

Since the injunctive normative message turned out to be the most effective intervention, we focused the analysis just on the different effects of this type of persuasive message, also splitting the sample based on the socio-demographic characteristics of the individuals (however, in Appendix B, we report the results also for the other persuasive normative messages). Notably, by performing these comparisons, the following outcomes can be observed.

As shown in Table 6, the percentage of females intending to change modes goes from 34.9% in the control group to 48.5% in the injunctive norm group (t=1.69, p-value=0.09, df=149), whereas the figures for males do not vary significantly. Similar positive effects of the injunctive normative message are also associated with the subsample of individuals belonging to households in which more than one car is available (from 29.1% of the control group to 42.7%, t=2.06, p-value=0.04, df=211), and for people who do not possess a bachelor's degree (from 40.4% to 58.1%, t=1.93, p-value=0.06, df=117). No other statistically significant differences were identified for the remaining categories.

As it can be deduced from Table 6, in most cases, the socio- demographic subsamples within which the injunctive normative message is more effective are also composed by individuals who are less prone to change their travel behavior when no normative message is delivered (control group). Therefore, we can conclude that the injunctive normative message can help in choosing a sustainable alternative for those individuals presenting socio-demographic characteristics associated with lower propensity to travel sustainably, including females, people living in households with more than one car available, and people with a low level of education.

Table 6 Intention to change: effects of the injunctive normative message for different socio-demographic characteristics

			Car		Sustainable alternative	
		N	**N**	**%**	**N**	**%**
Monthly income						
> 1,000 €	Injunctive message	106	61	57.6	45	42.5
	Control group	116	77	66.4	39	33.6
< 1,000 €	Injunctive message	37	19	51.4	18	48.6
	Control group	31	14	45.2	17	54.8
Gender						
Female	**Injunctive message**	**68**	**35**	**51.5**	**33**	**48.5**
	Control group	**83**	**54**	**65.1**	**29**	**34.9**
Male	Injunctive message	75	45	60	30	40
	Control group	64	37	57.8	27	42.2
Residential location						
Outside Cagliari	Injunctive message	70	43	61.4	27	38.6
	Control group	71	51	71.8	20	28.2
Within Cagliari	Injunctive message	73	37	50.7	36	49.3
	Control group	76	40	52.6	36	47.4
Number of cars per household						
1	Injunctive message	33	17	51.5	16	48.5
	Control group	44	18	40.9	26	59.1
More than 1	**Injunctive message**	**110**	**63**	**57.3**	**47**	**42.7**
	Control group	**103**	**73**	**70.9**	**30**	**29.1**
Household composition						
No children under 10 y/o	Injunctive message	120	65	54.2	55	45.8
	Control group	115	70	60.9	45	39.1
At least a child under 10 y/o	Injunctive message	23	15	65.2	8	34.8
	Control group	32	21	65.6	11	34.4
Work condition						
Not student	Injunctive message	112	64	57.1	48	42.9
	Control group	122	75	61.5	47	38.5
Student	Injunctive message	31	16	51.6	15	48.4
	Control group	25	16	64	9	36
Educational level						
No degree	**Injunctive message**	**62**	**26**	**41.9**	**36**	**58.1**
	Control group	**57**	**34**	**59.6**	**23**	**40.4**
At least a bachelor's degree	Injunctive message	81	54	66.7	27	33.3
	Control group	90	57	63.3	33	36.7
Age						
Over 30	Injunctive message	108	61	56.5	47	43.5
	Control group	122	77	63.1	45	36.9
18 ÷ 30	Injunctive message	35	19	54.3	16	45.7
	Control group	25	14	56	11	44

Bold = difference significant with a probability ≥ 90%

5. DISCUSSION AND POLICY IMPLICATIONS

The findings of the current article, on the effectiveness of different type of normative interventions in persuading people to use sustainable modal alternatives, have a number of important practical implications.

Overall effect of normative messages. Foremost, the comparison of the responses of those who received a normative message and those who did not receive any (control group) has shown the existence of a relatively weak effect of the social norm intervention on the willingness to shift from private cars toward a sustainable alternative, in line with the work of Gravert and Collentine (2021). At the same time, our analysis revealed a greater significance of the effect of the injunctive normative message compared to the descriptive one. Contrary to what one might expect, the delivery of a message including both the descriptive and injunctive norm in a complementary and mutually confirmative way appeared to be counterproductive, reducing the probability to state their intention of using sustainable mobility for the individuals of the control group. This could be attributed to the excessive length and complexity of the combined message, confirming that, if we want to steer a travel behavior change, the information we provide about either descriptive norms or injunctive norms should be clear, simple and immediately readable and understandable for the user (Fogg, 2002).

The analysis of the effect of the messages depending on the feedback contained in the Personalized Travel Plan revealed that the injunctive normative message was found to be effective in helping to choose the suggested sustainable alternative in cases where this alternative was less convenient in terms of cost savings and the burnt calories. These results suggest that the injunctive normative message could at least partially “compensate” for the low benefits deriving from choosing a sustainable alternative. From a policy standpoint, this means that if we propose a travel alternative slightly disadvantageous in terms of

time and cost, in the case where this is advertised to car drivers as an alternative that is socially accepted by their peers (fellow citizens, family, friends), then it is possible to convince them to choose it.

Finally, it is important to highlight that the fictional nature of the information conveyed through the message may have hindered the impact of the normative message, leading to an outcome that did not meet the expected effect. This is particularly true for the descriptive message, as it relied on information that could be visually verified by individuals.

Public transit and normative messages. In accordance with Piras *et al*. (2021) and Mundaca *et al*. (2022), we found that the delivery of an injunctive normative message resulted in being the only persuasive intervention able to increase the willingness to use public transport. Hence, the adoption of a policy based on the injunctive norm jointly with other travel demand management strategies, such as an informational marketing campaign, either at a generalized or personal level, about the benefits of using public transport, can be one of the tools available to policy makers to increase the level of public transport ridership. One example could be the development of a smartphone travel planning application that incorporates both real-time information and feedback about public transit services and messages highlighting that using public transport is a positive behavior approved by society. Similar applications have been recently tested with success in some countries (Anagnostopoulou *et al*., 2020, Esztergár-Kiss *et al*., 2021). Another area of possible application of behavioral measures based on injunctive normative messages is their use within the framework of mobility management activities promoted by employers, as social influences have been demonstrated to play a crucial role especially at workplaces (Scott *et al*., 2012). In the case of Italy, where public administrations, institutions and companies with more than 100 employees are required by law to set up the "*Piano Spostamenti Casa-Lavoro*" (home-workplace travel plan), mobility managers could employ nudging strategies based on injunctive norms to persuade more employees to commute by public transport.

Alternative strategies to stimulate the use of active mobility. On the other hand, when analyzing people's intention to change when the proposed alternative in the PTP was walking or cycling, we did not detect a significant impact of the persuasive normative messages. This outcome suggests that other psycho-social factors may come into play when choosing to switch from car to active mobility, and consequently strategies based on other kinds of latent constructs, such as attitudes and perceived behavioral control, need to be investigated. Nevertheless, participants to whom it was proposed to commute by walking or cycling, showed a significantly higher intention to change their travel behavior compared to those who received a PTP suggesting using the public transit. This result could be explained by the existence of a larger difference, in terms of travel times, between car and public transit compared to car and active mobility. Indeed, it is possible that people whose suggested alternative is not competitive with the private vehicle do not actually consider it as an alternative (Tuveri *et al*., 2020). It follows that behavioral measures based on Personalized Travel Plans should be focused on those people whose available sustainable alternatives present comparable level of service characteristics.

6. CONCLUSIONS

Prior research has documented the effectiveness of behavioral interventions based on the use of the social norm in several fields in the environmental domain (Farrow *et al*., 2017). However, studies in the field of travel behavior change are few and reported controversial results. To fill this gap, we set up a random controlled trial to analyze the effects of different types of normative messages. Specifically, we tested the effect of descriptive and injunctive norm interventions together with the delivery of a Personalized Travel Plan to exploit the potential of social norms when trying to break car use habits among a sample of car commuters in the metropolitan area of Cagliari (Italy).

First of all, the evaluation of the results of our experiment revealed that around one third of the participants (36.9%) expressed the intention to change their travel behavior, switching from the car to a

sustainable means of transport. However, our analysis revealed a weak effect of the normative messages, compared to the control group, for the willingness to shift away from the private car to a more sustainable means of transport. An insightful outcome of our research concerned the impact of the injunctive normative message, which resulted, when the public transport alternative was proposed, significantly more effective than the other normative messages in eliciting a change in the intention to commute by car. Furthermore, we discovered that the influence of the injunctive normative message varies depending on their socio-demographic characteristics. In particular, females, people with a low level of education and people who have more the one car available are those more susceptible to the influence of this kind of norm.

Having performed an experiment in which a specific normative message was randomly assigned to every individual and in which a control group was present, we have a good level of confidence about the outcomes presented in the study. In addition, the sample composition, which is representative of the population working and studying in the analysis area, and the random nature of the experiment, should have prevented us from incurring into biases due to unobservable factors such as the level of car habit and the attitude toward public transport. Nonetheless, due to the nature of the experiment, we cannot ascertain whether all participants actually read and correctly understood the messages delivered, especially in the case of the combined descriptive and injunctive messages.

The present study comes with some limitations. The first is that we measured intentions to change without monitoring actual behavior. This limitation could have led to an overestimation of the effectiveness of the PTP due to a possible effect of cognitive dissonance (de Vos & Singleton, 2020). To analyze this aspect, we will be monitoring the individuals' behavior in real-time by using a mobile app named "Svoltiamo". Secondly, we did not consider differences in the participants' psycho-social characteristics that could affect the choice process. To shed further light on the effectiveness of such

normative measures, in future research, we intend to specify and estimate a model which simultaneously considers the effect of the PTP, the normative intervention, and the individuals' socio-demographic and psycho-social characteristics altogether.

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APPENDIX A

Table A1. Travel cost for different car models [€/km] (Source: Automobile Club Italia)

	Gasoline	Diesel	Full Electric	GPL	Hybrid
	Cost [€/km]	**Cost [€/km]**	**Cost [€/km]**	**Cost [€/km]**	**Cost [€/km]**
City car	0.15	0.14	0.03	0.05	0.06
Utility car	0.17	0.13	0.03	0.06	0.07
Compact car	0.18	0.15	0.03	0.06	0.07
Station wagon	0.19	0.15	0.04	0.06	0.08
Sport sedan	0.22	0.19	0.05	0.07	0.08
SUV	0.30	0.24	0.05	0.08	0.09

Table A2. CO_2 emissions for different car models [g/km] (Source: UK Department of Environment (Defra))

	Gasoline	Diesel	Full electric	GPL	Hybrid
	CO_2 [g/km]	**CO_2 [g/km]**	**CO_2 [g/km]**	**CO_2 [g/km]**	**CO_2 [g/km]**
City car	119	110	0	115	70
Utility car	139	110	0	120	75
Compact car	152	129	0	120	84
Station wagon	171	149	0	155	92
Sport sedan	195	173	0	180	103
SUV	224	206	0	210	164

APPENDIX B

Table B1. Intention to change: effects of all the normative messages for different socio-demographic characteristics

			Car		Sustainable alternative	
		N	N	%	N	%
Monthly income						
Descriptive message	> 1,000 €	101	70	69.3	31	30.7
	< 1,000 €	26	12	46.2	14	53.8
Injunctive message	> 1,000 €	106	61	57.6	45	42.5
	< 1,000 €	37	19	51.4	18	48.6
Descriptive + Injunctive message	> 1,000 €	66	45	68.2	21	31.8
	< 1,000 €	14	6	42.9	8	57.1
Injunctive + Descriptive message	> 1,000 €	71	56	78.9	15	21.1
	< 1,000 €	9	4	44.4	5	55.6
Control group	> 1,000 €	116	77	66.4	39	33.6
	< 1,000 €	31	14	45.2	17	54.8
Gender						
Descriptive message	Female	62	41	66.1	21	33.9
	Male	65	41	63.1	24	36.9
Injunctive message	Female	68	35	51.5	33	48.5
	Male	75	45	60.0	30	40.0
Descriptive + Injunctive message	Female	42	22	52.4	20	47.6
	Male	38	29	76.3	9	23.7
Injunctive + Descriptive message	Female	36	29	80.6	7	19.4
	Male	44	31	70.5	13	29.5
Control group	Female	83	54	65.1	29	34.9
	Male	64	37	57.8	27	42.2
Residential location						
Descriptive message	Outside Cagliari	68	48	70.6	20	29.4
	Within Cagliari	59	34	57.6	25	42.4
Injunctive message	Outside Cagliari	70	43	61.4	27	38.6
	Within Cagliari	73	37	50.7	36	49.3
Descriptive + Injunctive message	Outside Cagliari	36	28	77.8	8	22.2
	Within Cagliari	44	23	52.3	21	47.7
Injunctive + Descriptive message	Outside Cagliari	43	37	86.0	6	14.0
	Within Cagliari	37	23	62.2	14	37.8
Control group	Outside Cagliari	71	51	71.8	20	28.2
	Within Cagliari	76	40	52.6	36	47.4
Number of cars per household						
Descriptive message	1	32	18	56.3	14	43.8
	More than 1	95	64	67.4	31	32.6
Injunctive message	1	33	17	51.5	16	48.5
	More than 1	110	63	57.3	47	42.7
Descriptive + Injunctive message	1	27	14	51.9	13	48.1
	More than 1	53	37	69.8	16	30.2
Injunctive + Descriptive message	1	27	20	74.1	7	25.9
	More than 1	53	40	75.5	13	24.5
Control group	1	44	18	40.9	26	59.1
	More than 1	103	73	70.9	30	29.1
Household composition						
Descriptive message	No children under 10 y/o	98	61	62.2	37	37.8
	At least a child under 10 y/o	29	21	72.4	8	27.6
Injunctive message	No children under 10 y/o	120	65	54.2	55	45.8
	At least a child under 10 y/o	23	15	65.2	8	34.8
Descriptive + Injunctive message	No children under 10 y/o	57	34	59.6	23	40.4
	At least a child under 10 y/o	23	17	73.9	6	26.1
Injunctive + Descriptive message	No children under 10 y/o	61	45	73.8	16	26.2
	At least a child under 10 y/o	19	15	78.9	4	21.1
Control group	No children under 10 y/o	115	70	60.9	45	39.1
	At least a child under 10 y/o	32	21	65.6	11	34.4

			Car		Sustainable alternative	
		N	N	%	N	%
Work condition						
Descriptive message	Not student	103	67	65.0	36	35.0
	Student	24	15	62.5	9	37.5
Injunctive message	Not student	112	64	57.1	48	42.9
	Student	31	16	51.6	15	48.4
Descriptive + Injunctive message	Not student	70	46	65.7	24	34.3
	Student	10	5	50.0	5	50.0
Injunctive + Descriptive message	Not student	70	53	75.7	17	24.3
	Student	10	7	70.0	3	30.0
Control group	Not student	122	75	61.5	47	38.5
	Student	25	16	64.0	9	36.0
Educational level						
Descriptive message	No degree	52	30	57.7	22	42.3
	At least a bachelor's degree	75	52	69.3	23	30.7
Injunctive message	No degree	62	26	41.9	36	58.1
	At least a bachelor's degree	81	54	66.7	27	33.3
Descriptive + Injunctive message	No degree	24	16	66.7	8	33.3
	At least a bachelor's degree	56	35	62.5	21	37.5
Injunctive + Descriptive message	No degree	27	19	70.4	8	29.6
	At least a bachelor's degree	53	41	77.4	12	22.6
Control group	No degree	57	34	59.6	23	40.4
	At least a bachelor's degree	90	57	63.3	33	36.7
Age						
Descriptive message	Over 30	94	64	68.1	30	31.9
	18 ÷ 30	33	18	54.5	15	45.5
Injunctive message	Over 30	108	61	56.5	47	43.5
	18 ÷ 30	35	19	54.3	16	45.7
Descriptive + Injunctive message	Over 30	69	46	66.7	23	33.3
	18 ÷ 30	11	5	45.5	6	54.5
Injunctive + Descriptive message	Over 30	68	51	75	17	25
	18 ÷ 30	12	9	75	3	25
Control group	Over 30	122	77	63.1	45	36.9
	18 ÷ 30	25	14	56	11	44

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