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Reducing car use by volitional strategy of action and coping planning enhancement

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ABSTRACT

Personalized travel plans have been regarded as potentially effective soft measures in mobility management. This research conducted a randomized social experiment aiming at citizen car-use reduction, and examined the effect of implementing two personalized travel plans: action plans and coping plans. The two types of plans were designed respectively for enhancing action planning and coping planning as the volitional factors of behavior change. The results supported the effectiveness of the combined action-plus-coping plan intervention in reducing car use, but not of the action plan alone intervention. In addition, the influence of intervention on behavioral intention, action planning, and coping planning, were also presented.

1. Introduction

Soft transport policy measures have been increasingly discussed and tentatively applied to achieving various goals of mobility management, particularly in Japan, Australia, Germany, the UK, and several other European countries (Cairns et al., 2008; Friman, Larhult, & Garling, 2013; Fujii & Taniguchi, 2006; Meloni, Sanjust di Teulada, & Spissu, 2016; Moser & Bamberg, 2008). Traditional hard measures on regulations and infrastructure, which have often been impeded by financial infeasibility, public opposition or political concerns (Cools et al., 2011; Garling & Schuitema, 2007; Jones, 2003). In contrast to such measures, soft measures in a relatively cost-effective method aim to trigger voluntary behavior change by influencing the psychological factors that underlie the behavior change process.

In the soft measures for mitigating car dependence or promoting public transport use, personalized travel planning (PTP) provides commuters with, or assists them in formulating, the individual-tailored information on travel behavior change based on their own travel needs or characteristics (Meloni et al., 2016). Such a personalized communication applied to voluntary travel behavior change has been considered more effective than mass communications or other non-personalized ones of which information is frequently neglected (Bamberg, 2013a; Fujii & Gärling, 2007; Fujii & Taniguchi, 2006; Gärling & Fujii, 2009). The theoretical grounding of PTP can be categorized into two main clusters: (1) the norm-activation model (Schwartz, 1977) and the theory of planned behavior (Ajzen, 1991) in which the identified cognitive factors, such as consequence awareness and personal norms, jointly constituting the motivational phase of behavior change process, and (2) the theories surrounding self-regulation (Gollwitzer, 1996; Gärling & Fujii, 2002) in which the factors, such as

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implementation intention and self-efficacy, underlying the volitional phase. Thus, the personalized travel plans (PTPs) that enhance these psychological factors might effectively lead commuters to break habitual travel behavior or form new one.

According to the two categories above, the strategies of PTP could be referred to, in this research, as "motivational strategy" and "volitional strategy" which are respectively based on the motivational phase and the volitional phase of behavior change process (Kuhl & Fuhrmann, 1998; Schmitz & Wiese, 2006). While the motivational strategies (e.g. travel awareness campaign) are applied earlier and wider than the volitional strategies (e.g. workplace travel plan formulation), the volitional ones have been gradually increasing in recent years (Cairns et al., 2008; Fujii & Taniguchi, 2006). However, the volitional factors that impact on behavior change, and the mechanism how the factors trigger behavior change, have been paid little attention by PTP schemes and their effectiveness evaluations. In the process of travel behavior change, only implementation intention is identified as the foundation of volitional strategy for bridging the intention-behavior gap (Sheeran, 2002). The lack of theoretical basis has prevented the volitional strategies of PTP from further development and extension.

In contrast, in the fields of health psychology, behavioral medicine, and education, the role of volitional factors and the effectiveness of developed interventions based on volitional factors in behavior change have been considerably explored (Bearth, Cousin, & Siegrist, 2014; Evans, Kawabata, & Thomas, 2015; Gaston & Prapavessis, 2014; Ghisi, Grace, Thomas, & Oh, 2015; Lhakhang, Godinho, Knoll, & Schwarzer, 2014; Sanetti, Collier-Meek, Long, Kim, & Kratochwill, 2014; Zhou, Jiang, Knoll, & Schwarzer, 2015). Among the volitional factors suggested by those studies, "action planning" and "coping planning" are two key mental simulations that help translate behavioral intention into target behavior.

Action planning is similar to implementation intention, but has been applied in facilitating more deliberate behavior, distinguished from implementation intention in more automatic one (Hagger & Luszczynska, 2014). Specifically, action planning refers to specific situational parameters ("when" and "where") and a sequence of actions toward target behavior ("how"). When these elements are explicitly specified by a person who has not yet formed a behavioral habit, the intention of actions is not easily ignored or dismissed (Gollwitzer & Sheeran, 2006; Schwarzer, 2008a).

The other mental simulation, coping planning, involves a link between "anticipation of barriers" and "strategy for overcoming barriers." The former anticipation is to foresee the scenarios that obstacle actions toward target behavior. The latter strategy is to in turn develop ideas for overcoming the scenarios in advance (Schwarzer, 2008a; Sniehotta, Schwarzer, Scholz, & Schuz, 2005). Imaging potential barriers and generating coping ideas may proceed only after contemplating situational parameters of actions and how to act (Schwarzer, 2008a). This sequence suggests that coping planning may make action planning adjustable and flexible, or otherwise reinforce it, and thereby more probably lead to behavior change.

For travel behavior change, action planning and coping planning also have been integrated into the theory framework of self-regulated behavioral change (Bamberg, 2013b) as the constructs in the actional stage. Hence, the understanding of the two planning constructs may provide insight into the behavior change process and the development of volitional strategies. However, to date there has been little empirical investigation on coping planning, or its conjunction with action planning, in travel behavior research. Moreover, the effect of coping planning techniques on travel behavior and psychological factors is less known. Therefore, the role of coping planning in voluntary travel behavior change and the effectiveness of soft measures based on coping planning need to be clarified.

1.1. The present research

This research aimed to examine the effectiveness of the volitional interventions based on action planning and coping planning enhancement in citizen car-use reduction. For this purpose, a randomized social experiment in a pre-test-post-test control design in Taipei City, Taiwan, over one-month period was conducted. Two kinds of volitional interventions, "personalized action plans" and "personalized action-plus-coping plans," were developed and implemented in two distinct experimental groups. The action plan intervention mainly followed the PTPs assisting commuters to form alternatives to car use; in contrast, the action-plus-coping plan intervention combined the action plan intervention with a barrier-focused strategy to reinforce the formulated action plans or make the plans adjustable. The data collected in the experiment was used to analyze the effects of the two interventions in behavior change, from which the extraneous influence that revealed in the control group was eliminated. In addition to behavior change, the changes in behavioral intention (abbreviated as intention below), action planning, and coping planning were also analyzed to explore the influence of the interventions in the volitional phase. Finally, the recommendations for future travel behavior research on the development of volitional strategy and the volitional phase of behavior change were presented.

2. Method

2.1. Procedure and interventions

The participants of the social experiment were recruited in Taipei City, the capital of Taiwan. Because there is a high-quality public transport system in this city, it is feasible to persuade citizens to switch to public transport from car use that they are not captive to. The experiment was launched in March and ended in April of 2016 over a one-month period. The participant recruitment contained two stages: email invitation and web interview. Initially, invitation emails were sent to 8459 potential participants randomly from a list provided by a marketing research company in Taiwan; the list was

representative of the population of Taipei City. Among these invitees, 888 people agreed to participate by accessing the survey website. At the beginning of the website, an interview was conducted to filter the potential participants with all these conditions: (1) living in Taipei City from the previous week to the following month, (2) having a car driving license, (3) owning a car or having access to a car owned by others, and (4) not being a professional driver. Afterward, 163 participants were randomly allocated into the three groups (one control group and two experimental groups) described in the below sections. Each participant received shopping points worth 20 New Taiwan Dollars (65 cents) for completing each time phase of the survey. The overall experimental flow is shown in Fig. 1.

Between two time phases, there was a high dropout rate (25.8%). The dropout was partly because the participants with formulating incomplete, impracticable plans at Time 1 were excluded before Time 2. In addition, the dropout may be caused by the length of time spent at Time 1, particularly for the action-plus-coping plan group. In this group, the participants completing the survey at Time 1 may expect a high time cost of the survey at Time 2 and thus dropped out, even though they have been notified of the exact required time for each time phase beforehand. Consequently, 121 participants were treated as the final sample of analysis.

2.1.1. Control group

At Time 1, 53 participants in the control group were assessed on their intention, action planning, and coping planning by a questionnaire. They were also asked to report each travel mode use frequency and duration of intra-city trips day by day during the past week. Without any intervention, they were then informed of the date of the next questionnaire survey a month later. Except for the 11 participants dropping out, the same participants ($n = 42$) attended the survey at Time 2, in which they answered the same questionnaire on psychological factors and behavior as at Time 1.

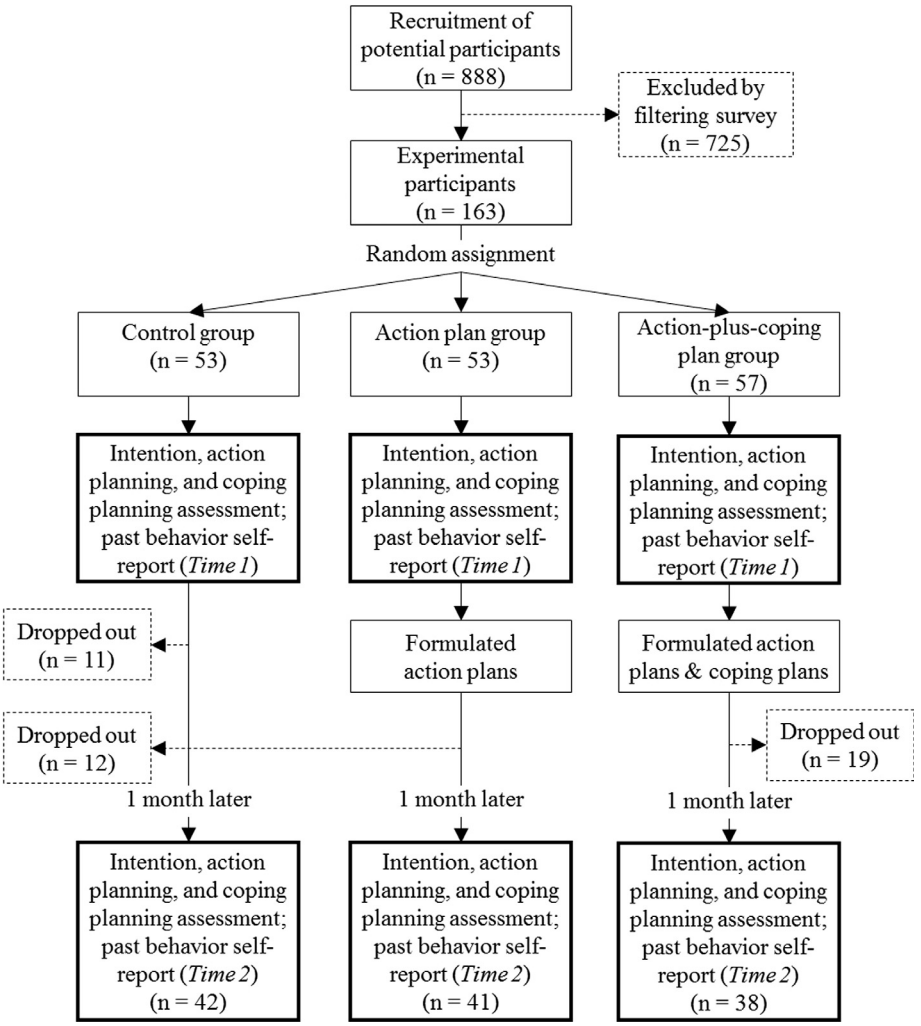

Fig. 1. Experimental flow.

2.1.2. Action plan group (experimental group 1)

At Time 1, 53 participants in the action plan group also answered the questionnaire on intention, action planning, and coping planning, as well as travel mode behavior. Differently from the control group, these participants received the intervention of personalized action plans immediately following the questionnaire. This intervention aimed to trigger them to include specific situational parameters (when and where to act) and a sequence of actions (how to act) in the mental simulation for switching from some current car use to public transport.

Therefore, in this intervention, initially they reviewed their current daily car trips, selected a type of trip based on which one was thought most likely to be replaced by public transport, and chose a date within one month to perform the switch. For its performance, then they filled in a form containing "main purpose of trip," "performance date," "planned departure time from home," "departure time, arrival time, and stations or locations of selected public transport," "expected arrival time to destination" in the outward travel, and the similar items in the return travel. In this procedure, the instructions of using Google Maps to assist in formulating the action plans were provided for the participants (the steps performed in order shown in Table 1).

After these steps, they were informed of the date of the next questionnaire survey a month later. There were 12 participants dropping out or formulating incomplete action plans. At Time 2, the remaining participants ($n = 41$) answered the same questionnaire on psychological factors and behavior as at Time 1.

2.1.3. Action-plus-coping plan group (experimental group 2)

At Time 1, the experimental process for 57 participants in the action-plus-coping plan group proceeded as the action plan group. However, these participants additionally received the intervention of personalized coping plans following the completion of personalized action plans. The coping plans aimed both (1) to trigger the participants to deliberate the potential barriers that would emerge when attempting the switch from car use to public transport drafted in the action plans, and (2) to develop their own strategies for overcoming those barriers.

Hence, the intervention requested participants to read the statements of six potential barriers to switching from car use to public transport that involved (1) "inflexibility of departure time," (2) "longer commuting time," (3) "difficulty of reaching the places not near a station," (4) "weather interference," (5) "un-freedom of doing other errands on the way," and (6) "inconvenience of carrying things" (Thomas, 2014; Zhang, Stopher, & Halling, 2013). Afterward, regarding the potential barriers, they read the suggestions that this research provided (e.g. incorporating commutes by walking and cycling into exercise plans; choosing shopping places by public transport accessibility). They then turned to a coping plan form to develop and write down their corresponding ideas (or to write down the ideas that have been used) for overcoming each potential barrier. In addition to the potential barriers described in the form, they were also invited to write down the encountering barriers that were expected to emerge during attempts to reduce car use by themselves. Similarly, the corresponding ideas were developed and written down for each of the proposed barriers (the steps performed in order shown in Table 1).

After completing the action plans and the coping plans, the participants were informed of the date of the next questionnaire a month later. There were 19 participants counted as dropping out, including those whose action-plus-coping plans were incomplete. At time 2, the same questionnaire on psychological factors and behavior, as at Time 1, was applied to the remaining participants ($n = 38$).

2.2. Measures

All participants in each group received the assessments of two times on intention, action planning, coping planning, and behavior as depicted in Fig. 1. The identical measurement was used at two times for each group. The measures of constructs are illustrated below.

2.2.1. Intention

Intention to reduce car use was measured using a 7-point scale ranging from 1 (strongly disagree) to 7 (strongly agree) by the following four statements: "I intend to reduce car use frequency," "I intend to reduce car use time," "I think over how to reduce car use as far as possible," and "I intend to make an effort to reduce car use."

2.2.2. Action planning

To measure action planning on where, when, and how to commute by public transport replacing car trips, the scenario statements and their own following questions, pertaining to each of using train, metro, bus, and walking, were shown to participants. Specifically, participants initially received one of the scenario statements "Assuming that you are planning to use *M* (train/metro/bus/walking) in some trips instead of your car, do you know..." Each statement was afterward followed by a configuration of the following questions: (a) "how to search schedule," (b) "how to check required travel time," (c) "how to check station locations," and (d) "how to transfer to other lines." These questions were rated from 1 (no, not at all) to 7 (yes, exactly). The configuration of questions for each mode was not identical, allowing for different features and conditions of modes in the research area. Hence, the *M* (train) contained the questions (a) to (c), the *M* (metro/bus) all the questions, and the *M* (walking) only question (b).

Table 1
Steps of action plan and coping plan interventions.

Action plan intervention requesting participants to...
1. Review current daily car trips and select one to be replaced by public transport
2. Choose a date for initially attempting alternative to car use in the selected car trip
3. See the instructions of using public transport apps to search public transport modes and arrange schedules for commuting
4. Search and choose public transport modes for the selected trip
5. Note the planned departure time from home for the selected trip in the action plan form
6. Note the departure time, arrival time, and stations or locations of the chosen public transport modes in the action plan form
7. Note the expected arrival time to destination in the action plan form
8. Note the items in the steps 5 to 7 from destination to home for the return travel in the action plan form
9. Download the webpage including the completed action plan form to a computer/mobile device
Coping plan intervention requesting participants to...
1. Read a statement of the potential barrier about "inflexibility of departure time"
2. Read corresponding suggestions on the potential barrier
3. Develop one's own ideas or the ideas based on the provided suggestions for overcoming the potential barrier in the coping plan form
4. Read a statement of the potential barrier about "longer commuting time," and repeat the steps 2 to 3
5. Read a statement of the potential barrier about "difficulty of reaching the places not near a station," and repeat the steps 2 to 3
6. Read a statement of the potential barrier about "weather interference," and repeat the steps 2 to 3
7. Read a statement of the potential barrier about "un-freedom of doing other errands on the way," and repeat the steps 2 to 3
8. Read a statement of the potential barrier about "inconvenience of carrying things," and repeat the steps 2 to 3
9. Note one's own encountering barriers to switching from car use to public transport, other than the potential barriers listed by this research, in the coping plan form
10. Repeat the steps 2 to 3 for each of one's own encountering barriers
11. Download the webpage including the completed coping plan form to a computer/mobile device

2.2.3. Coping planning, measurement issues and improvement

The majority of coping planning measurement in previous studies have often followed Sniehotta et al. (2005) and Schwarzer, Lippke, and Luszczynska (2011), in which an important common basis for its measurement was developed. However, when the measurement method was directly followed without a case-tailored transformation, the generalized items in the method would be applied to measure coping planning on particular barriers. Such an item assessing to what extent it is true for a subject to have made a detailed plan regarding, for example, "what to do in difficult situations in order to act according to my intentions," or "how to cope with possible setbacks," has been adopted to measure coping planning on the barriers in a particular target behavior (e.g. Gaston & Prapavessis, 2014; Pakpour & Sniehotta, 2012).

Thus, there are two issues that may arise when measuring coping planning in the above way. (1) For one thing, a generalized item without specifying a specific barrier situation may lead subjects not to think of their barrier in action and corresponding coping plans. Some studies have considered this issue to make the measure of coping planning case-tailored (e.g. Zhou et al., 2015). (2) For another thing, only rating "having made a detailed plan" (coping plan) may neglect that coping planning on dealing with barriers in practice also depends on to what degree a situation constitutes a barrier for a subject. Because a situation may cause different degrees of barrier for different subjects, coping planning could not be accurately reflected by only measuring the extent of coping plans from different baselines of constituted barriers. For example, one for whom a situation hardly constitutes a barrier may not need to develop coping plans in response to the situation; and similarly for the opposite case in which highly detailed plans may be derived from facing a large barrier. However, to date there appears to be no study addressing this issue when measuring coping planning.

Considering both the issues of coping planning measurement, therefore, in addition to specifying specific barrier situations for the first issue, this research proposed a new combined measurement in the ratio form of "perceived easiness in overcoming potential barrier" to "perceived level of potential barrier" for the second issue. The denominator term was to reflect to what degree a situation (potential barrier) constituted an influential barrier for an individual, and based on the barrier degree, the numerator term was to reflect the extent of coping plans that have been made on the barrier. Thus, coping planning on a given potential barrier *pb*, labeled as CP_{pb}, could be represented as:

$$CP_{pb} = (\text{perceived easiness in overcoming } pb)/(\text{perceived level of } pb) \quad (1)$$

Specifically, in this research, six potential barriers to switching from car use to public transport were given. The potential barriers contained "inflexibility of departure time," "longer commuting time," "difficulty of reaching the places not near a station," "weather interference," "un-freedom of doing other errands on the way," and "inconvenience of carrying things" (Thomas, 2014; Zhang et al., 2013). Regarding coping planning on each potential barrier, initially one question "When you use public transport, (*the detailed statement of the potential barrier*). Could (*the potential barrier*) be a barrier if you switch from car use to public transport?" was rated from 1 (no, not at all) to 7 (yes, largely) for the term "perceived level of *pb*." Following this question, the other one "Is it easy for you to overcome (*the potential barrier*)?" was rated from 1 (very difficult) to 7 (very easy) for the term "perceived easiness in overcoming *pb*."

2.2.4. Car use behavior

Concerning car use behavior, car use frequency and car use duration were separately self-reported for each day of the previous week. However, because the investigated travel behavior was not bound to a designated trip from a fixed origin district to a fixed destination, there were necessarily different total trip frequency and duration over a certain time period between commuters, and even between time periods for the same commuter. To eliminate the influence of total trips on the evaluation of car use dependence and its reduction (i.e., for the same degree of car use dependence, however, the more total trips, the more car use), therefore, the car use frequency and the car use duration were respectively divided by the total trip frequency and the total trip duration for each participant. The two indicators, car use frequency share and car use duration share, were obtained. The indicators can further reflect proportional reduction in car use compared with all transport modes, but cannot be completely equated with car use reduction. In this research, however, compared to absolute frequency and duration with total trip influence, car use frequency share and duration share may be more comparable between commuters and between time periods, and thus were used to represent the concept of car use dependence, and further its reduction.

3. Results

3.1. Characteristics of experimental participants

The demographic and travel-related characteristics of participants who completed the entire experimental procedure are shown in Table 2. Most of the participants (77.7%) were employed at workplaces. In addition, car and scooter respectively accounted for 34.7% and 32.2% of the most frequently used mode higher than public transport. This tendency agrees with a recent large-scale survey on daily travel mode use including Taipei City (Ministry of Transportation, 2016). Furthermore, the difference in the characteristics among the three groups was examined by chi-square or *F* test. Except for age and gender, other characteristics were not significantly different among groups.

3.2. Reliability and preliminary analysis

3.2.1. Reliability check

The reliability of psychological factors were tested prior to analyses using summation of their own measures. As reported in Table 3, for intention and action planning, the reliabilities at the two times displayed excellent internal consistencies among measures. In addition, the reliabilities of coping planning were satisfactory, suggesting to some extent that the measurement method proposed by this research appears to be applicable. Hence, based on the reliability analysis, the set of measures of each psychological factor was averaged to create a variable. The means of the variables for the participants in each group, at each time point, are shown in Table 3.

3.2.2. Change across time

The action-plus-coping plan group (labeled as AP&CP group) had a significant increase in coping planning. Although action planning of this group was almost unchanged, the other two groups significantly decreased their action planning, especially for the control group. Moreover, a significant increase in intention was also found in the AP&CP group. As for behavior, the AP&CP group significantly decreased their car use frequency share and car use duration share.

In contrast to expectation, the action plan group (labeled as AP group) showed a significant decrease in action planning, but the degree was markedly less than the control group. In terms of other variables, no significant change emerged.

The control group significantly decreased their intention and action planning. It was worth noting that this group also significantly decreased car use frequency share and car use duration share. These changes in the control group implied the presence of uncontrolled extraneous influences on intention, action planning, and car use during the social experiment. Hence, to understand the effectiveness of intervention, it was needed to further examine interaction effects and multiple comparisons.

3.3. Intervention effects

A three (control, AP, and AP&CP groups) by two (Time 1 and Time 2) ANOVA for each variable with repeated measures, and following multiple comparisons by post hoc tests, were used to explore the effectiveness of the action plan and action-plus-coping plan interventions. The results are reported in Table 4, and the means of each variable for the three groups at the two times are illustrated in Figs. 2–6.

3.3.1. Intention

For intention, a significant interaction between group and time emerged, $F(2, 118) = 4.94$, $p < 0.01$, $\eta^2 = 0.08$. Hence, post hoc analyses by one-way ANOVA with Scheffe procedure, which is more rigorous than other multiple comparison procedures, were further employed for Time 1 and Time 2. No significant difference among groups was found at Time 1. However, a significant one was revealed at Time 2, $F(2, 118) = 3.18$, $p = 0.046$, in which multiple comparisons indicated a significant difference between the AP group and the AP&CP group (at $\alpha = 0.1$) (AP&CP > AP, $p = 0.086$). In addition, the changes across

Table 2
Characteristics of experimental participants for entirety and three groups.

Characteristic	Control group (N = 42)	Action plan group (N = 41)	Action-plus-coping plan group (N = 38)	All participants (N = 121)	
Age					$\chi^2(8, N = 121) = 18.97$, $p = 0.02$
20–29	11.9%	14.6%	18.4%	14.9%	
30–39	35.7%	34.1%	57.9%	42.1%	
40–49	40.5%	43.9%	10.5%	32.2%	
50–59	11.9%	2.4%	13.2%	9.1%	
Above 60	0%	4.9%	0%	1.7%	
Gender					$\chi^2(2, N = 121) = 19.16$, $p < 0.01$
Male	31.0%	70.7%	73.7%	57.9%	
Female	69.0%	29.3%	26.3%	42.1%	
Monthly income (USD)					$\chi^2(10, N = 121) = 12.79$, $p = 0.24$
Less than $300	4.8%	4.9%	0%	3.3%	
$300–$749	7.1%	9.8%	5.3%	7.4%	
$750–$1499	57.1%	29.3%	47.4%	44.6%	
$1500–$2299	14.3%	41.5%	34.2%	29.8%	
$2300–$2999	9.5%	7.3%	10.5%	9.1%	
Above $3000	7.1%	7.3%	2.6%	5.8%	
Employment status					$\chi^2(12, N = 121) = 13.85$, $p = 0.31$
Employed at workplace	78.6%	75.6%	78.9%	77.7%	
Employed at home	4.8%	4.9%	7.9%	5.8%	
Self-employed at workplace	4.8%	9.8%	5.3%	6.6%	
Self-employed at home	0%	0%	5.3%	1.7%	
Student	2.4%	7.3%	2.6%	4.1%	
Homemaker	7.1%	0%	0%	2.5%	
Non-working & none of above	2.4%	2.4%	0%	1.7%	
Most frequently used mode					$\chi^2(12, N = 121) = 10.43$, $p = 0.58$
Car	38.1%	36.6%	28.9%	34.7%	
Scooter	23.8%	39.0%	34.2%	32.2%	
Train	2.4%	0%	2.6%	1.7%	
Metro	16.7%	19.5%	26.3%	20.7%	
Bus	7.1%	0%	5.3%	4.1%	
Bicycle	2.4%	2.4%	0%	1.7%	
Walking	9.5%	2.4%	2.6%	5.0%	
Main trip travel time (one-way)	40 min	37 min	39 min	38 min	$F(2, 118) = 0.08$, $p = 0.92$

Note: "Most frequently used mode" and "Main trip travel time" were asked by "which transport mode do you most often use in your daily life" and "how much time does your main travel take (one-way)" respectively. The two items did not refer to the behavioral variables in the following analyses, which were obtained from the additional self-report travel diary.

time within groups in Section 3.2.2 (also marked and illustrated in Figs. 2–6) have showed that the control group significantly decreased their intention, but the AP&CP group significantly increased it. Thus, these results seem to suggest the effectiveness of the action-plus-coping plan intervention in improving intention, as compared to no intervention and to the action plans alone.

3.3.2. Action planning

For action planning, a significant interaction between group and time emerged, $F(2, 118) = 8.94$, $p < 0.01$, $\eta^2 = 0.11$. Similarly, owing to the presence of interaction effect, the post hoc analyses were conducted. There was no significant difference among groups at Time 1, but there was a significant one at Time 2, $F(2, 118) = 3.22$, $p = 0.044$. Further for Time 2, two significant differences of the two experimental groups from the control group were indicated (at $\alpha = 0.1$) (AP > Control, $p = 0.095$; AP&CP > Control, $p = 0.097$). Although the changes within groups have displayed that all groups decreased their action planning, the two experimental groups switched action planning from lower than the control group at Time 1 to significantly higher than it at Time 2. Thus, the above results may support the effectiveness of both interventions, the action plans and the action-plus-coping plans, in maintaining action planning under the possible influence of extraneous factors.

Table 3
Cronbach's α, means, and paired *t*-tests of variables by group before and after intervention.

Variable (Cronbach's α at T_1; T_2)	Group	Mean (SD) at T_1		Mean (SD) at T_2		Mean difference of $T_2 - T_1$	*t*-value	Cohen's *d* or Cohen's *h*
Intention (α = 0.95; 0.98)	Control group	5.13	(1.02)	4.64	(1.52)	−0.49	−1.91*	−0.29
	AP group	4.54	(1.37)	4.60	(1.75)	0.06	0.30	0.05
	AP&CP group	4.88	(1.28)	5.37	(1.22)	0.49	2.62**	0.43
Action planning (α = 0.91; 0.94)	Control group	5.67	(1.06)	4.73	(1.00)	−0.94	−8.70***	−1.34
	AP group	5.60	(1.04)	5.30	(1.13)	−0.30	−2.01*	−0.31
	AP&CP group	5.35	(1.08)	5.31	(1.41)	−0.04	−0.21	−0.03
Coping planning (α = 0.75; 0.88)	Control group	1.16	(0.85)	0.92	(0.63)	−0.23	−1.54	−0.24
	AP group	0.96	(0.63)	0.90	(0.42)	−0.06	−0.82	−0.13
	AP&CP group	0.93	(0.47)	1.61	(0.92)	0.69	5.15***	0.84
Car use frequency share	Control group	0.57	(0.57)	0.39	(0.38)	−0.18	−2.02**	−0.37
	AP group	0.26	(0.26)	0.29	(0.31)	0.03	0.70	0.07
	AP&CP group	0.37	(0.37)	0.16	(0.19)	−0.21	−3.60***	−0.49
Car use duration share	Control group	0.67	(0.57)	0.44	(0.39)	−0.23	−2.54**	−0.47
	AP group	0.36	(0.31)	0.37	(0.35)	0.01	0.24	0.03
	AP&CP group	0.45	(0.37)	0.21	(0.24)	−0.24	−3.84***	−0.51

Note: AP group = action plan group; AP&CP group = action-plus-coping plan group. Cohen's *h*, measuring the effect size between two proportions, was calculated for car use frequency share and car use duration share.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

3.3.3. Coping planning

For coping planning, a significant difference between group and time emerged with a larger effect size (measured by η^2) than for the other psychological factors, $F(2, 118) = 15.20$, $p < 0.01$, $\eta^2 = 0.20$. According to the post hoc analyses, no significant difference among groups was shown at Time 1, but a significant one was found at Time 2, $F(2, 118) = 14.07$, $p < 0.01$. Multiple comparisons for Time 2 indicated that the AP&CP group was significantly higher than the control group and the AP group ($p < 0.01$ for both). Namely, the AP&CP group increased their coping planning from the lowest one among the three groups at Time 1 to the highest one with significant differences from the other groups at Time 2. Meanwhile, the other groups had no significant change in coping planning. Thus, the effectiveness of the action-plus-coping plan intervention in enhancing coping planning may be supported.

3.3.4. Car use frequency share

Regarding one indicator of behavior, car use frequency share, a significant interaction between group and time emerged, $F(2, 118) = 3.77$, $p = 0.026$, $\eta^2 = 0.06$. The post hoc analyses indicated significant group differences at Time 1, $F(2, 118) = 5.90$, $p < 0.01$, as well as Time 2, $F(2, 118) = 5.30$, $p < 0.01$. For Time 1, a significant difference between the control group and the AP group was found by multiple comparisons (Control > AP, $p < 0.01$), whereas there was no significant difference between the control group and the AP&CP group. For Time 2, the significant difference at Time 1 disappeared, but a significant difference emerged between the control group and the AP&CP group (Control > AP&CP, $p < 0.01$). Thus, the implication was twofold: (1) formulating action plans alone without coping plans might lead to an opposite effect on reducing car use frequency. (2) The action-plus-coping plan intervention appears to have an impact on reducing car use frequency.

3.3.5. Car use duration share

Concerning the other indicator of behavior, car use duration share, a significant interaction between group and time also emerged, $F(2, 118) = 3.95$, $p = 0.022$, $\eta^2 = 0.06$. The post hoc analyses exhibited significant group differences at Time 1, $F(2, 118) = 5.80$, $p < 0.01$, and Time 2, $F(2, 118) = 4.77$, $p = 0.010$. Multiple comparisons for each time point displayed the differences between groups similar to the results for car use frequency share, except for a significant difference between the control group and the AP&CP group at Time 1 (at $\alpha = 0.1$) (Control > AP&CP, $p = 0.80$). This significant difference at Time 1 was the reason that the significant difference between the two groups at Time 2 did not constitute evidence that the action-plus-coping plan intervention was effective.

3.3.6. Relative effects of supported interventions

According to the above analyses, whether the effectiveness of the two interventions in influencing the variables was supported or refuted is organized in Table 5. Furthermore, the relative effects of the interventions were calculated for the supported relationships. Initially, an intervention effect (E) on a variable can be estimated as follows:

$$E = (expt_{t2} - expt_{t1}) - expt_{t1} \cdot \frac{(cont_{t2} - cont_{t1})}{cont_{t1}} \quad (2)$$

Table 4
Three (group) by two (time) ANOVA with repeated measures.

	Intention			Action planning			Coping planning		
	F (*dfs*)	p	η^2	F (*dfs*)	p	η^2	F (*dfs*)	p	η^2
Group effect	2.13 (2, 118)	0.12	0.03	0.62 (2, 118)	0.54	0.01	4.02 (2, 118)	0.02	0.06
Time effect	0.03 (1, 118)	0.88	0.00	22.76 (1, 118)	< 0.01	0.14	3.42 (1, 118)	0.07	0.02
Group × Time effect	4.94 (2, 118)	< 0.01	0.08	8.94 (2, 118)	< 0.01	0.11	15.20 (2, 118)	< 0.01	0.20
	Post hoc for each time			Post hoc for each time			Post hoc for each time		
Time 1	F = 0.10, ns			F = 0.99, ns			F = 1.40, ns		
Time 2	F = 3.18**			F = 3.22**			F = 14.07***		
	AP&CP > AP*			AP > Control*			AP&CP > Control***		
				AP&CP > Control*			AP&CP > AP***		

	Car use frequency share			Car use duration share		
	F (*dfs*)	p	η^2	F (*dfs*)	p	η^2
Group effect	6.73 (2, 118)	<0.01	0.10	6.22 (2, 118)	<0.01	0.10
Time effect	9.24 (1, 118)	<0.01	0.07	13.27 (1, 118)	<0.01	0.10
Group×Time effect	3.77 (2, 118)	0.03	0.06	3.95 (2, 118)	0.02	0.06
	Post hoc for each time			Post hoc for each time		
Time 1	F = 5.90***			F = 5.80***		
	Control > AP***			Control > AP***		
				Control > AP&CP*		
Time 2	F = 5.30***			F = 4.77**		
	Control > AP&CP***			Control > AP&CP**		

Note: ns: not significant. AP group = action plan group; AP&CP group = action-plus-coping plan group.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

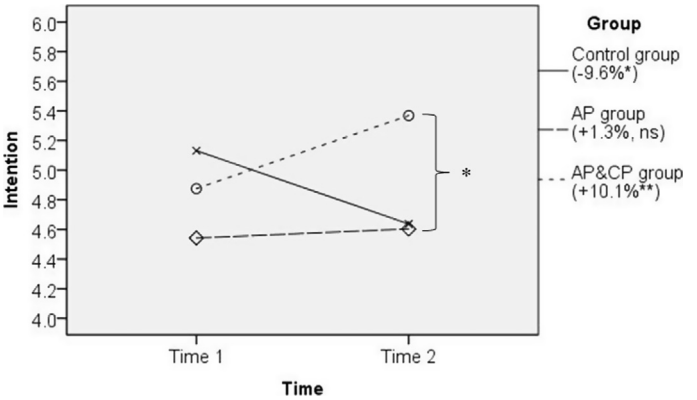

Fig. 2. Intention of three groups at two times (interaction effect: $F = 4.92^{***}$, $\eta^2 = 0.08$). $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$, ns: not significant. AP group = action plan group; AP&CP group = action-plus-coping plan group.

where $expt_{t1}$ and $expt_{t2}$ are the means of a variable for an experimental group at Time 1 and Time 2; $cont_{t1}$ and $cont_{t2}$ are the same for a control group. The term $(cont_{t2} - cont_{t1})$ could be regarded as a change amount caused by uncontrolled extraneous factors, which divided by $cont_{t1}$ is the change rate. Thus, in formula (2), the influence of extraneous factors, revealed in the control group, on the experimental group is evaluated and eliminated. Then, a relative effect of intervention (RE) can be calculated as below:

$$RE = (E/expt_{t1}) \cdot 100\% \tag{3}$$

Therefore, the relative effects attributed to the interventions were estimated by formula (3). The relative effect of the action plan intervention on increasing action planning was estimated to be 11.3%, but the increase in action planning did not trigger car use reduction. In addition, the action-plus-coping plan intervention was estimated to increase intention by 19.8%, action planning by 15.8%, and coping planning by 94.0%. In terms of car use behavior, the action-plus-coping plan intervention was estimated to reduce car use frequency share by 24.6%; however, owing to the presence of the significant difference between the control and the AP&CP groups at baseline (Time 1), this research was unable to address the effectiveness of this intervention in reducing car use duration.

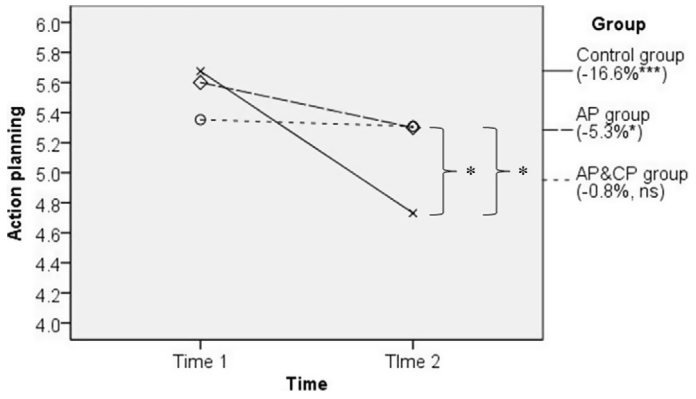

Fig. 3. Action planning of three groups at two times (interaction effect: $F = 8.94^{***}$, $\eta^2 = 0.11$). $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$, ns: not significant. AP group = action plan group; AP&CP group = action-plus-coping plan group.

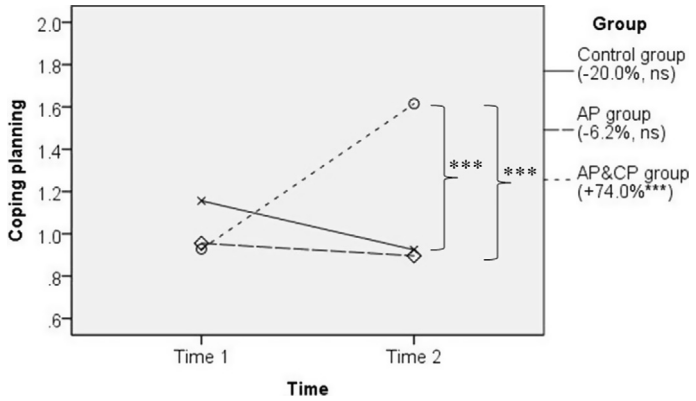

Fig. 4. Coping planning of three groups at two times (interaction effect: $F = 15.20^{***}$, $\eta^2 = 0.20$). $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$, ns: not significant. AP group = action plan group; AP&CP group = action-plus-coping plan group.

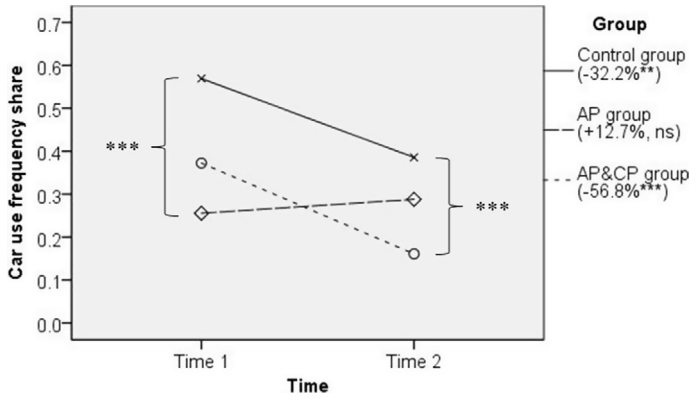

Fig. 5. Car use frequency share of three groups at two times (interaction effect: $F = 3.77^{**}$, $\eta^2 = 0.06$). $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$, ns: not significant. AP group = action plan group; AP&CP group = action-plus-coping plan group.

4. Discussion

4.1. Conclusions and implications

This research explored the effectiveness of enhancing action planning and coping planning, both of which have been considered to mediate volitional intervention effects, in travel behavior change. The two volitional interventions were

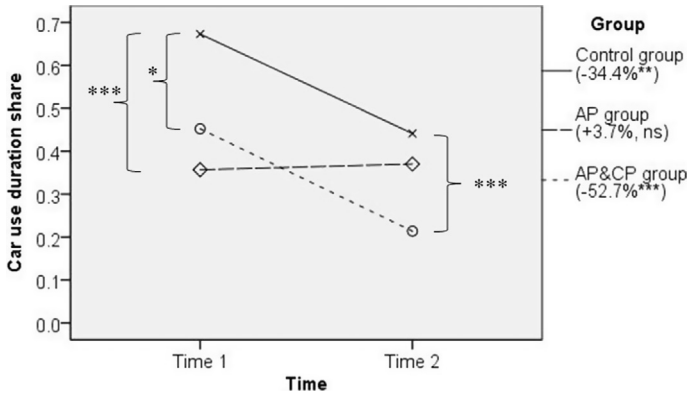

Fig. 6. Car use duration share of three groups at two times (interaction effect: $F = 3.95^{**}$, $\eta^2 = 0.06$). $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$, ns: not significant. AP group = action plan group; AP&CP group = action-plus-coping plan group.

Table 5
Relative intervention effect versus control treatment.

	Intention	Action planning	Coping planning	Car use frequency share	Car use duration share
Action plan intervention	Refuted	Supported *RE* = 11.3%	Refuted	Refuted	Refuted
Action-plus-coping plan intervention	Supported *RE* = 19.8%	Supported *RE* = 15.8%	Supported *RE* = 94.0%	Supported *RE* = −24.6%	–

developed, and the randomized social experiment was executed. The main results indicate that: (1) coping planning measured in the newly proposed method showed a high reliability; (2) the action plan intervention effectively enhanced action planning, but revealed the possibility of an opposite effect on car use reduction without formulating coping plans; and (3) the action-plus-coping plan intervention effectively enhanced intention, action planning, and coping planning, and decreased car use frequency share.

As for the implications of the findings, coping planning appears to play an important role in travel behavior change. For persuading commuters to switch travel behavior based on PTPs, it is more likely to enable them to achieve this goal by additionally assist them to identify potential barriers and develop coping ideas to overcome the barriers. Hence, aside from motivational strategies, soft transport policy measures should also consider volitional strategies of action and coping planning enhancement to reduce car use. Meanwhile, the construct "coping planning" should be paid more attention in travel behavior research, as in other fields in recent years such as health psychology (e.g. Gaston & Prapavessis, 2014; Lhakhang et al., 2014), hygiene (e.g. Zhou et al., 2015), and education (e.g. Sanetti et al., 2014). In these literature, similar to the present research, the importance of coping planning to behavior change has been emphasized.

Regarding the measurement of coping planning, this research proposed a new measurement method to attempt to more precisely reflect this construct (namely, for a higher content validity). Most previous measurements directly followed Sniehotta et al. (2005) and Schwarzer et al. (2011). As elaborated in this research, however, it should be addressed (1) to designate specific barrier situations that would probably emerge in attempting to change behavior, and (2) to distinguish between a barrier situation that would not necessarily constitute a barrier, and a barrier that would hinder behavior change. Based on the two principles, the reliability of coping planning was satisfactory in this research, whereas the validity of it still needs more investigation to be clarified.

Concerning the methodology of experiment, there are two keys, which this research followed, to the evaluations of travel behavior change programs. For one thing, this research conducted a randomized social experiment incorporating a control group across time to collect the panel data for a higher internal validity. This pre-test-post-test control (PPC) design could avoid some of the noted issues, for example, the errors from repeated cross-sectional survey (Stopher, Clifford, Swann, & Zhang, 2009), and the threats to internal validity in a treatment group pre-post test only design (Fujii, Bamberg, Friman, & Garling, 2009). These issues are critical for social experiments that receive considerable extraneous influence. For another thing, this experiment recruited participants from ordinary citizens with an additional filtering survey to avoid the issue of non-representative samples in many previous PTP program evaluations (Bamberg, Fujii, Friman, & Garling, 2011). Thus, this research may have a relatively high external validity, namely, the generalizability of results.

4.2. Limitations and future research

The present research, however, has limitations that will need to be addressed by future research. By what specific psychological process the volitional intervention induced citizens to reduce car use is not confirmed in this research. Hence,

one of the solutions is to establish a volitional behavior-change model incorporating volitional intervention variables. In such a model, in addition to a psychological change process after intervention, the potential opposite effect of requesting action plans without coping plans could be further explored. Another one is to deeply inspect the relationship between action planning and coping planning, and the mechanism how their relationship influences behavior change, which has raised some debate and discrepancy in literature (e.g. Schwarzer, 2008b; Schwarzer et al., 2011; Sutton, 2008). These explorations are indispensable for improving volitional strategies in soft transport policy measures.

In addition, as for measurement issues, because coping planning in this research was initially measured for travel behavior, there is necessarily room for measurement improvement. The concept of coping planning should also be further discussed, particularly for its more precise meaning in travel behavior, to grasp coping planning and apply coping plan interventions effectively.

An obvious weakness of this research is that the findings were based on a small sample size. Future research with the interest of action and coping planning-related intervention should broaden the sample size to further examine the effectiveness of planning intervention suggested in this research. Furthermore, even though this research adopted the PPC design, the validity of the results was still threatened by the potential self-selection bias, implied by the differences in age, gender, and pre-test behavior among groups. A PPC design is allowed to statistically control the pre-test nonequivalence, but cannot completely eliminate the threat to internal validity caused by non-randomization or self-selection (Fujii et al., 2009). The high dropout rate of this research may cause a self-selection bias. Thus, the planning intervention effects should be further confirmed with controlling the possibility of self-selection biases, for example, with a face-to-face assistance in travel plan formulation, and additional persuasive communication techniques for follow-up participation facilitation.

Moreover, the error of self-reported behavior data across a certain time-period may exist in this research, despite using the day-by-day report. This problem can probably be addressed by a GPS panel survey (Stopher et al., 2009) with self-reporting. The former could more accurately assess car use and main public transport use, and the latter could aim at short-distance modes such as scooter, cycling, and walking. For future research, high quality data is necessary for more precisely evaluating travel behavior change programs.

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