POLICY BRIEF

Voluntary Travel Behavior Change

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Project Description

This project reviews and summarizes empirical evidence for a selection of transportation and land use policies, infrastructure investments, demand management programs, and pricing policies for reducing vehicle miles traveled (VMT) and greenhouse gas (GHG) emissions. The project explicitly considers social equity (fairness that accounts for differences in opportunity) and justice (equity of social systems) for the strategies and their outcomes. Each brief identifies the best available evidence in the peer-reviewed academic literature and has detailed discussions of study selection and methodological issues.

VMT and GHG emissions reduction is shown by effect size, defined as the amount of change in VMT (or other measures of travel behavior) per unit of the strategy, e.g., a unit increase in density. Effect sizes can be used to predict the outcome of a proposed policy or strategy. They can be in absolute terms (e.g., VMT reduced), but are more commonly in relative terms (e.g., percent VMT reduced). Relative effect sizes are often reported as the percent change in the outcome divided by the percent change in the strategy, also called an elasticity.

Summary

Strategy Description

Voluntary Travel Behavior Change (VTBC) programs are a range of travel demand management techniques that are designed to change the behavior of travelers by discouraging single-occupancy vehicle trips and encouraging alternative modes of transportation such as carpooling, taking transit, walking, and biking. This is accomplished through outreach and education that targets individual attitudes, goals, and behaviors; increasing awareness of the impacts of travel choices; and equipping travelers with the skills necessary to analyze and alter their travel behavior (Fujii et al., 2009; Steg 2003). While the primary goal for VTBC programs is to reduce driving, there is also potential for co-benefits of public health with shifts to public transit and active transportation.

Behavioral Effect Size

Evidence from a wide variety of VTBC programs and contexts suggests 5-9% reduced car use (trip frequency or mode share) and 5-9% reduced vehicle miles traveled by city-level program participants. Very little evidence is reported at the city level, but at least one study suggests that widespread VTBC programs reduced city-wide car use on a similar magnitude in three medium-sized (population under 150,000 and population density under 8,200 persons per square mile) English cities (Sloman et al., 2010).

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Strategy Extent

VTBC programs can be implemented quickly and cheaply in any setting. Evidence suggests their cost-effectiveness is also high, making this strategy effective for rapid benefit accrual. At least one meta-analysis (Semenescu et al., 2020) could find no discernable difference in effects by city size, suggesting VTBC programs are broadly applicable.

Strategy Synergy

Some evidence suggests VTBC programs are best suited for contexts with local public and government support, where alternative modes such as transit and active transportation are well supported, and where destination accessibility is high (Cairns et al. 2004). This suggests synergy with land use and infrastructure investments is possible.

Equity Effects

The potential for VTBC programs to increase social equity is great, given that transportation is an important determinant of health. This is especially true of benefits from the shift from car to active travel, for example in one study injuries per active mile travel were reduced (Sloman et al., 2010). However, like any program, authentic and culturally specific outreach is necessary. For example, materials should be in multiple languages using plain language. Without this type of outreach, social equity disparities can increase or persist.

Strategy Description

Voluntary Travel Behavior Change (VTBC) programs are a range of travel demand management techniques that are designed by governments to change the behavior of travelers by discouraging single-occupancy vehicle trips and encouraging alternative modes of transportation such as carpooling, taking transit, walking, and biking. This is accomplished by outreach and education targeting individual attitudes, goals, and behaviors; increasing awareness of the impacts of travel choices; and equipping travelers with the skills necessary to analyze and alter their travel behavior (Fujii et al., 2009; Steg 2003). VTBC programs take a variety of forms, but they can be characterized into two broad categories - mass communication campaigns and travel feedback programs (TFP).

Mass communication campaigns distribute information through means such as broadcast media, the internet, newsletters, and public notices. They have been used extensively to influence public attitudes about issues related to transportation, as well as public health and environmental issues (Cairns et al. 2004). The promotion of transit services through marketing and promotions is a typical example of a mass communication campaign. Importantly, communication campaigns need to be made in languages and through culturally appropriate messages otherwise they could further social inequity.

TFPs are a more sophisticated form of VTBC program. They differ from mass communication campaigns in several important ways. TFPs use feedforward information, such as travel diaries, to encourage participants to actively examine their travel behavior. TFPs also use feedback to convey the consequences of travel behavior change. Feedback provided to participants may include information about reductions in pollution, greenhouse gas emissions, or calories burned from physical activity (Fujii et al., 2009). This information helps individuals and households to understand and quantify the impacts of changes in travel behavior.

Personalized feedback is often based on analysis of travel diaries and surveys that participants complete during a program. This analysis not only serves as a tool for providing feedback, but also as a means of evaluating program effectiveness. Changes in vehicle miles traveled (VMT), emission reductions, or use of alternative transportation modes can be examined through before and after comparisons of travel behavior shown in diary and survey information.

Travel feedback programs are often directed toward households, although they have also been used in workplace (See Employer Based Trip Reduction brief) and school travel plans. They are normally focused on encouraging a switch from driving to other modes, but VTBC programs have also been used to encourage more efficient use of automobiles. This can be accomplished by having households identify opportunities to combine trips (trip chaining), change trip timing to avoid congestion, or increase vehicle occupancy rates.

Strategy Effects

Behavioral Effect Size

The evidence collected from selected studies on VTBC program evaluations, summarized in Table 1, indicates that VTBC programs can reduce car use (only one location in one study was a California city (Sacramento) (Brög et al., 2009)). Studies have produced varying estimates of VMT reduction in the range between 5 and 9% and car mode share by a similar percent, depending on types of interventions, the geographic area of the study, and study design. Meta-analysis studies, considering selected studies in this brief and other studies, have found similar estimates (Möser and Bamberg, 2008; Semenescu et al., 2020). The effects have been measured through before/after study designs (usually within a few years) leaving uncertainty about the longer-term trends and maintenance of the effects. It is likely that effects attenuate over time, and that longer programs are more likely to have larger effects, although the influence of intervention duration was not clear from this evidence.

VTBC program evaluators have reported significant reductions in vehicle miles traveled among program participants in US cities. Brög et al. (2009) report that 12 TravelSmart programs conducted in nine U.S. cities have resulted in an average of 8% reduction in car use among participants. TravelSmart programs in three cities in Oregon resulted in reductions in solo driving of 3 to 11% (Socialdata America, 2007). This corresponded with a 9% reduction in VMT among participants. Using a modified version of the IndiMark system, Cooper (2007) reported a 24 to 58% reduction in drive alone trips among participants in three urban Seattle neighborhoods. This is an outlier study that may deserve additional attention due to its success. More common effects are those observed by for example Guo and Peeta (2020), which found approximately 10% less weekly driving time on average among participants, possible relocators (people moving residential locations) in Tippecanoe County in Indiana. Similarly, Garcia et al. (2016) found 5.2% decrease of time allocated to travel in private car to time allocated to all travel among participants in Valencia, Spain.

Various VTBC programs have been used in many countries for the past several decades. Three large-scale, sustained VTBC programs in medium-sized (population under 150,000 and population density under 8,200 persons per square mile) English cities were evaluated by Sloman et al. (2010). Combined, their estimated impact was a reduction of 9% in car driver trips and 5 to 7% in VMT. These effects were not only for participant households, but for each study city as a whole when implemented on a large scale, suggesting VTBC programs can have a wide impact extent.

Möser and Bamberg (2008) conducted a meta-analysis of 72 VTBC programs in Europe and Australia. They found that these programs resulted in a statistically significant increase of 5 percentage points in the proportion of trips taken by non-car modes. This was equivalent to a 9% decrease in car use. Similarly, analyzing 30 prior evaluation studies, Semenescu et al. (2020) found a 7% reduction of mode share by car use.

Table 1. Effects of VTBC on car use: Results from Studies

Study	Study Location	Study Design	Outcome Measure	Effect
Sloman et al., (2010)	3 medium-sized cities in England (population under 150,000 and population density under 8,200 persons per square mile)	Before and after travel surveys, without control group	Vehicle Miles Traveled	5-7% decrease (City-level)
Socialdata America (2007)	Salem-Keizer, Eugene, Bend in Oregon	Before and after travel surveys, with control group	Vehicle Miles Traveled	9% decrease (Participants)
Cooper (2007)	Seattle neighborhoods in Washington	Before and after travel surveys, with control group	Drive alone trips	24-58% decrease (Participants)
Brög et al. (2009)	9 cities in USA	Before and after travel surveys, with control group	# car trips	2 - 11% (average 8%) decrease (Participants)
Möser and Bamberg (2008)	Europe and Australia	Meta-analysis of 72 programs	Auto mode share	9% decrease
Garcia et al. (2016)	Valencia, Spain	Before and after travel surveys, with control group	Time allocated to travel in car/Time allocated to travel	5.3% decrease (Participants)
Guo and Peeta (2020)	Tippecanoe County in Indiana	Before and after travel surveys, with control group	Driving time	10% decrease (Participants)
Semenescu et al. (2020)	Many countries	Meta-analysis of 30 studies	Auto mode share	7% decrease

Co-benefits

Relatively few VTBC program evaluation reports have quantified greenhouse gas reductions. Sloman et al. (2010) estimate that long-term VTBC programs in three medium-sized English cities (population under 150,000 and population density under 8,200 persons per square mile) resulted in a citywide per capita carbon dioxide emission of approximately 50 kg. Based on UK emissions, this is equivalent to a 4.4% reduction in CO2 emissions from driving.

Fujii and Taniguchi (2005) evaluated 10 VTBC programs in Japan and estimated CO2 reductions of 19% among program participants. Only three of the ten programs used control groups in their evaluation, so this figure should be interpreted with caution.

Cellina et al. (2019) found statistically significant changes of CO2 emissions reduction by 22.4% in the Ticino region, urban areas where residents are highly dependent on cars, while no significant effect in the Zurich region with a good public transportation system.

While reduced car use from VTBC programs can provide some co-benefits in the form of reduced emissions and traffic, they can also increase transit use (Guo and Peeta, 2020). In many cases, increasing transit use is the main objective of such programs (e.g., Cooper, 2007). This is often achieved by including personalized transit schedule information and promotional passes in the package of information provided to participant households.

Other co-benefits include potential health benefits from increased walking and bicycling (e.g. 6% increase in physical activity (Ahmed et al., 2020)), improved community interaction, and increased viability of local businesses (Cairns et al., 2004).

Extent

Scale of Application: The results of the extensive five-year English VTBC program evaluated by Sloman et al. (2010) appear to indicate that city-wide impacts are achievable through sustained campaigns that target a wider audience. Not only that, but the magnitude of the effects can be similar to those reported by participants of program-specific evaluations. This suggests that the extent of a program's effectiveness is likely to rise with investment in proportion to the population it serves.

Efficiency or Cost: VTBC programs are notably cost-efficient. Prior studies in UK and Australia (Cairns et al., 2008; Parker et al., 2007; Taylor, 2007; Ker et al., 1999) found that VTBC brought more benefits than costs. For example, Cairns et al. (2008) estimated average cost of congestion relief by soft interventions in UK and found the cost is one tenth the average benefit of congestion relief.

Time / Speed of Change: Because VTBC programs are quick to enact compared to infrastructure and land use strategies, they have the potential to rapidly change travel behavior.

Location within the Region: One meta-analysis conducted by Semenescu et al. (2020) found insignificant effects of city size where the intervention was conducted on car use reduction. This suggests that VTBC programs may benefit many cities. However, the lack of evidence for effectiveness in Californian cities suggest more research in California is needed.

Differences between Regions: The effectiveness of VTBC programs on a city- or region-wide level is dependent on participation levels and spillover effects. Spillover may occur when non-participants learn of programs through media coverage or contact with participants. Variation in effectiveness is likely to be dependent on land use and transportation context (see Synergy).

Equity

Effects of the programs evaluated in the selected studies are not cross-tabulated by key socio-demographic data or other metrics that address social equity, something future research should add. Additionally, the lack of explicit equity evaluation indicates a need for future VTBC programs to be centered on social equity from the start. Although there is a lack of equity-specific findings, because of the many health benefits from reducing car use (emissions and injury reductions) and the inequality of the burden of disease associated with automobility, general VTBC programs may inherently support social equity. Targeted programs in communities of disinvestment and those facing the greatest environmental and social burdens are even more likely to achieve such benefits. However, any "top-down" government-to-community program should be cognizant of the needs as expressed by the communities it serves. Although it is not documented in this specific academic literature, it is possible that mass communication VTBC programs could fail to increase social equity, and even decrease it if the people of a community feel the communication overly criticizes their current behavior and norms or is othering by not adhering to language justice principles. Any form of mass communication or program recruitment needs to be accessible to people in a language that is used in their communities and include culturally relevant communication components.

Beyond improved program to community communication, the importance of community-led programming and processes that have been shown to be integral to increasing social equity in other domains could be applicable to VTBC programs to make them more likely to increase social equity.

Synergy

VTBC programs are applicable in any location though the effectiveness of the program may vary by the setting. According to Cairns et al. (2004), VTBC programs are best suited to areas where:

- The community views traffic as a problem.
- Public transportation exists and excess capacity is available.
- Support exists from local government and transit providers.
- Walking and bicycling infrastructure exists and the environment is conducive to using these modes.
- Local employment, shopping, and service destinations are available and accessible.

This suggests that combining VTBC programs with strategies that target increased accessibility through land use and infrastructure change is necessary. This means that addressing these issues in tandem with VTBC may be necessary to successfully reduce car use and increase social equity.

Confidence

Evidence Quality

Because of the apparent effectiveness and relatively low cost, VTBC programs have attracted increased attention from policymakers. However, questions have been raised about evaluation methods used in some studies (Chatterjee, 2009; Fujii et al. 2009; Möser and Bamberg, 2008). These include concerns about research design, representativeness of populations included in the studies, quality of the data collected, and the validity of methods that have been used in evaluations (Möser and Bamberg, 2008). In addition, because VTBC programs are often implemented and evaluated by consultants that have been hired by local government, questions have arisen about potential lack of impartiality (Bonsall, 2009).

Partially in response to these criticisms, recent programs have increasingly used research designs and evaluation methods that facilitate independent statistical analysis of their results. This has included the use of control groups to isolate the effects of the VTBC program from those of other factors, such as changes in weather, infrastructure, general travel trends, and transportation prices. Wherever possible, studies chosen for this brief used control groups to evaluate effects.

For reported projects in the USA (Socialdata America, 2007; Brög et al. 2009; Guo and Peeta, 2020), studies incorporated a pre- and post-program control group to evaluate travel behavior changes in the participating households. Sloman et al. (2010) used household travel survey data from other cities of similar size, as well as control groups, to evaluate impacts in the three English cities in their study. All but three of the Japanese studies cited in Fujii and Taniguchi (2005) did not use control groups, so these results should be interpreted more cautiously. However, the authors found the effect sizes of the programs that used control groups did not differ substantially from those that did not.

Caveats

The programs described in this brief have been used primarily in urban areas with at least moderate population density. However, VTBC programs have also been used in suburban areas. Car use reductions have been reported from programs conducted in suburban areas of Perth, Australia, as well as more rural areas of Germany and the United Kingdom (Brög et al. 2009, Cairns et al. 2004). While examples of suburban and rural programs are few, these results indicate that some impact may be possible. In these cases, encouraging more efficient use of vehicles may be beneficial. For example, programs could encourage the combination of several trips (trip chaining) or higher vehicle occupancy rates.

Because VTBC programs are voluntary, their effectiveness depends on the number of households who elect to participate. This presents obvious difficulties in the planning and evaluation of these programs. This problem, known as self-selection, is discussed in more detail in the technical and background section below.

Examples

In the Spring and Summer of 2006, the Oregon Department of Transportation (ODOT) conducted a VTBC program in the cities of Bend, Eugene, and Salem-Keizer. Socialdata America was hired to conduct the studies and program evaluations using the company's proprietary IndiMark program (Socialdata America, 2007).

Participant households in each city were selected randomly for the program. These households received an announcement letter about the study, followed by a survey.

Households that returned the survey but did not express interest in the program were sent a thank you letter, information on efficient car use and park and ride facilities, and a transit day pass. Households with members that regularly used environmentally friendly transportation modes and those that expressed an interest in reducing their travel impact were provided a package of materials designed to encourage conscious consideration of their travel behavior.

One of the items was a one-week travel diary, to be completed by all household members.

The package also included an order form with a list of materials on travel alternatives. Materials selected by the household were provided without charge, along with promotional materials. Participants were encouraged to tailor the order to suit the needs of the household.

Following receipt of the order, materials were packaged and personally delivered to each household. Participating households were also given the opportunity to request a home visit from a transit, walking, or bicycling specialist. During these visits, they were provided with personalized advice and encouraged to try travel alternatives.

To evaluate the effectiveness of the program, participating households were asked to complete a second one-week travel diary at the completion of the study. These diaries were compared to the behavior of a control group of non-participants in the same area, who completed identical diaries.

As a result of the project, participant households reduced their vehicle miles traveled by an average of 9%, increased their active travel time (walking and bicycling) by 8%, and increased their number of trips by transit, walking and bicycling by 31%.

Technical & Background Information

Study Selection

Studies cited in the Voluntary Travel Behavior Change (VTBC) brief were chosen on the basis of their methodological soundness since there are no California-specific studies. The lack of evidence in California makes the effects reported here more uncertain when applied in California. However, because most VTBC programs target car commuters with planned alternative modes, geographic differences may not be that influential as evidenced by the fairly consistent findings across a variety of contexts (besides one study). Wherever possible, the studies chosen for the brief used control groups to evaluate before-and-after effects. For reported projects in the USA (Socialdata America, 2007; Brög et al. 2009; Guo and Peeta, 2020), studies incorporated a pre- and post-program control group to evaluate travel behavior changes in the participating households. Sloman et al. (2010) used household travel survey data from other cities of similar size, as well as local control groups to evaluate impacts in the three English cities in their study. Only three of the ten Japanese studies cited in Fujii and Taniguchi (2005) used control groups, so these results should be interpreted more cautiously. However, the results of programs that did not use control groups did not differ substantially from those that did.

The brief also includes results from two meta-analyses conducted by Möser and Bamberg (2008) and Semenescu et al. (2020). These meta-analyses evaluated prior projects using soft interventions, including some projects that could be classified as VTBC programs. These included personalized travel planning, travel awareness campaigns, public transportation marketing programs, and travel feedback programs. The goal of the meta-analyses was to determine whether the available empirical evidence indicated that broad implementation of VTBC programs was a legitimate means of reducing car use.

Although none of the studies examined by Möser and Bamberg used control groups, the authors attempted to address some of their shortcomings using quantitative meta-analytical techniques. For instance, they examined the data for the presence of reporting biases and used the pool of available study data to test for statistically significant effects. Möser and Bamberg caution that meta-analytical techniques cannot overcome the shortcomings of the experimental design in the original studies.

Methodological Considerations

Although VTBC programs have been used since at least the 1990's as a tool for marketing public transportation (Bonsall, 2009), it took a decade or more for researchers to begin to scrutinize the techniques used to evaluate their impacts (Chatterjee and Bonsall, 2009). Some early programs used research methods that did not allow statistical inferences to be drawn from their results. In particular, many programs did not use control groups to evaluate travel behavior change. These studies relied solely on pre- and post-program reports of driving behavior from those who participated in the program (Möser and Bamberg, 2008; Fujii et al. 2009). Experimental designs such as these cannot account for changes in travel behavior that may occur in the general population, for example due to changes in season, travel or fuel costs, public transportation service, or roadway construction.

As was stated in the Study Selection section of this document, studies that used control groups were chosen for this brief where possible. All of the programs reported in the brief at U.S. sites (Socialdata America, 2007; Brög et al. 2009; Guo and Peeta, 2020) did include control groups in their evaluations. In order to give a broad picture of effect sizes, some evaluations that did not use controls were included, and their results generally agree with those where control groups were included. In addition, the Möser and Bamberg (2008) meta-analysis of VTBC programs attempted to address some of the methodological shortcomings of earlier evaluations by examining pooled effect sizes. Semenescu et al. (2020) conducted a meta-analysis of VTBC programs using only experimental and well-controlled quasi-experimental studies. The results of these studies appear to indicate that household VMT is generally reduced by an average of 5 to 9% among those who participate in VTBC programs. This was used as the basis for the effect size reported in the brief.

With the exception of the Sloman et al. (2010) study of English towns, the effect sizes given in the brief are for participant households only. Overall impact is therefore dependent on the number of households who participate in the program. One difficulty of evaluating the wider impact of VTBC programs is the potential problem of self-selection, which has been recognized by researchers who have examined VTBC program evaluations. Self-selection occurs when those who are most likely to participate in the program are those who already have positive attitudes toward sustainable modes of transportation and the environment. These participants are therefore more likely to reduce their car use than the general population (Bonsall, 2009).

Self-selection can lead to study populations that are not necessarily representative of the population as a whole. This can possibly result in an overstatement of impacts and limits on the generalizability of effect sizes from the VTBC programs. Results from the Sloman et al. (2010) evaluation and Möser and Bamberg (2008) and Semenescu et al. (2020) meta-analyses appear to indicate that the VTBC program effects persist when self-selection is accounted for, though the size of the effects may be somewhat smaller. Both studies found driving trip reductions of 5 to 9%, which agrees with the effect size found in other studies.

A second factor that must be considered in generalizing VTBC program impacts is neighborhood form and transportation infrastructure. For example, Seethaler and Rose (2009) contend that many cities and neighborhoods that are targeted for VTBC programs are chosen because of their higher potential for mode switching. These areas may be especially receptive to such programs due to their land-use mix and/or strength of non-automotive alternatives. This seems likely to be the case, as local governments are most apt to fund projects in locations where the return on expenditures is likely to be greatest.

Programs initiated in areas that offer few alternatives to automobile use are likely to have smaller effect sizes than those reported in the brief. In areas where transit service is limited or non-existent, and walking and bicycling are not feasible, any vehicle use reductions would likely result from the more efficient use of vehicles through increased occupancy or more efficient trip chaining. Very little research exists on VTBC programs whose main purpose is to reduce car use in rural or exurban areas, and more study would be required to determine if such programs could be effective. Further, the importance of context has important implications for social equity. Communities that have faced historical disinvestment, have few alternative travel options or where the burden of travel in general is great, may not benefit from VTBC programs. Prerequisite conditions (safe and efficient active and public transit, good accessibility) are needed for such programs to achieve benefits. Without those conditions VTBC programs are unlikely to succeed and may even spur more social injustice.

Some researchers have cited the reliance on self-reported behavior as a source of measurement error in VTBC program evaluations (Chatterjee, 2009). Most VTBC programs rely on travel diaries completed by respondents as an accurate source of before-and-after travel behavior. Although travel diaries are a standard tool in travel behavior research, under-reporting of trips and inaccurate data can present problems.

For example, comparisons of GPS and travel diary data of recent studies in Australia and the U.S. have indicated that between 20 and 30% of trips are typically not reported in travel diaries (Stopher, 2009). One potential solution to this problem is the use of GPS tracking, but this becomes expensive with large sample sizes, data management can become a problem, and privacy is always a concern. According to Stopher (2009) and Seethaler and Rose (2009), one cost-effective alternative is the use of odometer readings. These have been used in some Australian Travel Blending programs. While odometer readings may provide more accurate information on car use, they cannot address reporting issues with non-automobile modes.

The majority of studies in this brief report behavior changes from short-term programs involving individual households. However, the study of the Smarter Choices program in England by Sloman et al.

(2010) gives some insight into the potential for more comprehensive VTBC programs conducted at the citywide level. Smarter Choices was a five-year program that included personalized travel planning, travel awareness campaigns, public transportation marketing, and the promotion of walking and cycling. Evaluations conducted through citywide travel surveys indicated a 9% reduction in car trips, and 5 to 7% reduction in VMT. The study also found a 10 to 22% increase in bus use, a 26 to 30% increase in bicycle trips, and a 10 to 13% increase in walking trips in the three target cities.

The results of the Smarter Choices program appear to indicate the potential for comprehensive VTBC programs to encourage mode switching, in the absence of major changes in transportation infrastructure, although this is given the context of land use and infrastructure in those cities. The program also demonstrates the positive impact that such programs can have on transit ridership, which has been the primary goal of many VTBC programs (Jones and Sloman, 2006). An example is King County Metro Transit's In Motion program, which used a modified version of the IndiMark system to target households in four Seattle area neighborhoods (Cooper, 2007). Data collected from self-reports, bus-stop counts, and ridership data indicated a 20 to 50% increase in transit use during the program.

Data from the Smarter Choices program also indicated that the largest drop in vehicle use occurred among people who were at a "change in life" stage (e.g., recently changed jobs or retired) (Sloman et al., 2010). These findings, which agree with other research on life-stage change and travel behavior (i.e., Verplanken et al., 2008), illustrate the potential for increasing the impact of VTBC programs by targeting those who are actively considering their travel choices.

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