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Impact of information intervention on travel mode choice of urban residents with different goal frames: A controlled trial in Xuzhou, China

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ABSTRACT

In order to assess the degree to which specific groups will adapt their travel behaviors after certain intervention, this study utilized a cluster analysis to discuss three segments' distinct goal frames, social-demographic properties, travel modes, and habitat, and then carried out an information intervention controlled trial to discover three segments' modal split shifts. The results indicate that the information have consistent and distinct impacts on travel mode choice by clusters. This consistency is embodied in the simultaneous and significant increase in travel times by green modes (walking, non-powered bicycle, or bus) and in the small but non-significant effects on reducing car use in the three clusters. The distinctness of the impacts is that information have a more effective influence on subjects with gain goal frames because their travel times by all three green modes greatly improved. Subjects with the hedonic goal frame are the least sensitive to information, with the only significant increase in travel times being by non-powered bicycle. This research also addressed the "attitude-behavior gap", weather impacts, and goal-oriented prompts. The findings suggest that policy interventions should be designed to improve public transit features, especially the bicycle system, rather than only to constrain car use, and that tailored policies should be targeted to specific groups with different goal frames.

1. Introduction

In recent years, developing countries, especially China, have experienced unprecedented smog and hazy weather, causing the government and the public to become strongly concerned about climate change and environmental issues. To strengthen demand-side management of energy consumption, promoting the energy consumption revolution will become a major issue in China and other countries in the future (Wang and Yang, 2016). Travel mode choice is closely related to household energy consumption, and modal shifts from car to foot, bicycle, or mass transit play a crucial role in the achievement of energy conservation and emission reduction (Wang and Liu, 2015; Zhang et al., 2015b). These policies should overcome the persistence of individual preferences to impel a green transformation of residents' travel motivations, attitudes, and behaviors.

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1.1. Information intervention

Behavioral intervention is a common strategy to promote a green transformation in residents' environmental behaviors, including economic, technological, administrative, and information interventions. In the rationalist deficit model, knowledge was a prerequisite for the formation of pro-environmental attitudes, which in turn was assumed to lead to pro-environmental behaviors. In this model, environmental behavior is considered to involve rational decisions on the basis of received information, and once new information has been accepted, knowledge and cognition reformed, and attitudes and intentions changed, all this will lead to pro-environmental behavior (Kaiser et al., 1996; Nilsson and Küller, 2000; Bamberg et al., 2003; Anable et al., 2006; Lorenzoni et al., 2007; Lane and Potter, 2007; Chen et al., 2014a, 2014b). Information interventions, promoted mainly by popular information modes such as television and newspapers (Winett et al., 1985; Völlink and Meertens, 2010) or niche information modes such as personalized brochures, workshops, and face-to-face interviews, have the purpose of appealing to residents to adopt green behavior (Geller, 1981; McMakin et al., 2002; Howell, 2014). Although their findings are not entirely consistent, i.e., the impacts of information intervention are not always valid, most researchers believe that information is conducive to the sustainable formation of proactive pro-environmental awareness and attitudes and to choices of environmentally friendly ways to travel, and that niche information modes are more effective (Staats et al., 2004; Abrahamse et al., 2005).

Information intervention trials on travel mode choice rely mostly on self-reported tests, which require subjects to fill out a questionnaire immediately after receiving information. However, the subjects often tend to speculate about the purposes of the trial and deliberately fill in the answers to favor social interests or to meet trial requirements. In other words, this approach cannot observe subjects' attitude and behavior changes occurring in natural situations or processes. However, using convenient and low-cost handset media for trials can break the constraints of field trials and give the subjects information in a natural and relaxed state without the stress brought about by norms and expectations. Hence, more and more studies have been using smartphones for information intervention trials (e.g., Chorus et al., 2007; Brazil and Caulfield, 2013).

1.2. Goal frames

Segmentation, which is a staged and targeted strategy for effective travel behavior interventions, can "allow a more systematic analysis of the potential (scope), impact, barriers, and requirements to change the behavior" (Anable et al., 2006). Unlike *a-priori* methods based on demographic segmentation (e.g., age, gender, income), travel behavior studies use *post-hoc* methods based on psychographic segmentation (e.g., values, attitudes, lifestyles) to analyze systematically the complexity of people's orientation towards travel (Lanzendorf, 2002; Anable, 2005; Anable et al., 2006; Kandt et al., 2015). Lindenberg and Steg (2007) proposed the goal-framing theory, which states that goals, which are a combination of motive and cognition, govern what people attend to and what knowledge and attitudes become cognitively most accessible. Goal framing, which pertains to enhancing the evaluation of a behavior, can be used to focus an individual's attention on specific aspects of information (Lindenberg and Steg, 2007; Avineri and Waygood, 2013). Individuals with hedonic goals are often difficult to persuade to reduce their car use simply for pro-environmental reasons (Lindenberg and Steg, 2007). Goal framing identifies part of the scene information as key information (Bamberg and Schmidt, 2003) that directly reflects the individual's salient beliefs (Kaiser et al., 1996). The theory of planned behavior (TPB) proposes that salient beliefs are a fundamental aspect of behavioral dynamics and that once these are activated by key information, people become willing to carry out actions (Ajzen, 1991). In short, individuals with different goals may have significantly different ways of attending to and accepting information, leading to differences in travel behavior (Gollwitzer and Bargh, 1996; Verplanken et al., 1997; Aarts and Dijksterhuis, 2000; Avineri and Waygood, 2013).

Goal-framing theory proposes three goal frames: hedonic, gain, and normative (Lindenberg and Steg, 2007). Hedonic goals involve improving one's emotional state to "feel better right now" (such as seeking pleasure or avoiding fatigue). Gain goals make people consider the pros and cons of an action so as to "guard and improve one's resources" (e.g., time and money). Normative goals, mostly with reference to environmental behavior, emphasize sensitivity to what ought to be done and how "to act appropriately". Residents with normative goal frames will concentrate on environmental and social benefits rather than emotions and personal interests when dealing with the "social dilemma". In a word, goal frames affect individual's cognitive processes, determine the individual's ease of access to knowledge in a given situation, and eventually lead to green transformations of environmental behavior (Lindenberg and Steg, 2007).

The existing literature refers to factors influencing travel mode, clustering analysis of groups, or experimental research involving behavioral intervention. However, comprehensive studies, especially from the perspective of goals and motivations to analyze the efficiency of behavioral intervention (Staats et al., 2004; Abrahamse et al., 2005), are still lacking. Residents with different goal frames have distinct preferences about accepting information; hence, further study of residents' distinct reactions to information is more conducive to advertising and education tailored to group-specific preferences and constraints and is more effective at promoting a green and sustainable transformation of travel mode choice (Abrahamse et al., 2005; Kandt et al., 2015).

Under these circumstances, this paper aims to conduct two main pieces of work. Specifically, first, cluster analysis was used to discuss three segments' distinct goal frames, social-demographic properties, travel modes, and habitat according to six travel goals. Then a controlled trial was carried out to discover three segments' modal split shifts before and after information intervention.