



## Using a stages of change approach to explore opportunities for increasing bicycle commuting



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### ABSTRACT

Given the potential benefits of bicycling to the environment, the economy, and public health, many U.S. cities have set ambitious goals for increasing the bicycle share of commute trips. The Transtheoretical Model of Behavior Change, which seeks to describe how positive and permanent change can be fostered in individuals, may shed light on how cities can most effectively increase bicycle commuting. We use the model's "stages of change" framework to explore the potential for increased bicycle commuting to the UC Davis campus in Davis, California. Our analysis uses data from the 2012 to 2013 UC Davis Campus Travel Survey, an annual online survey that is randomly administered to students and employees at UC Davis. Based on their responses to questions about current commute mode and contemplation of bicycle commuting, respondents are divided into five stages of change: Pre-contemplation, Contemplation, Preparation, Action, and Maintenance. We construct a Bayesian multilevel ordinal logistic regression model to understand how differences in socio-demographic characteristics, travel attributes, and travel attitudes between individuals explain their membership in different stages of change. In addition, we use this model to explore the potential of various intervention strategies to move individuals through the stages of change toward becoming regular bicycle commuters. Our results indicate that travel attitudes matter more to progression toward regular commute bicycling than travel attributes, tentatively supporting the efficacy of "soft" policies focused on changing travel attitudes.

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### Introduction

In the United States, less than 1% of workers usually commute to work by bicycle (United States Department of Commerce, 2009). Given the potential benefits of bicycling to the environment, the economy, and public health, many U.S. cities have set ambitious goals for increasing the bicycle share of commute trips. To achieve these goals, cities have made substantial investments in bicycle infrastructure in recent years. New York City, NY, for example, nearly tripled its supply of bike lanes and paths between 2000 and 2010 (Pucher et al., 2011). The efforts of these U.S. cities seem to be paying off as many cities have seen substantial increases in bicycle commuting; New York City saw its commute bicycle mode share increase by 50% between 2000 and 2010 (Pucher et al., 2011).

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But several studies of bicycle commuting have concluded that attitudes matter as much as infrastructure, and possibly even more so (Handy and King, 2010; Heinen and Handy, 2011). These studies suggest that a psychological approach to the development of strategies for increasing bicycling could lead to increases beyond what infrastructure improvements alone can produce. Indeed, public health researchers and practitioners have achieved substantial success in changing health-related behaviors, including physical activity behavior such as bicycling, by understanding and addressing the underlying psychology of these behaviors. Of particular importance to these efforts is the Transtheoretical Model of Behavior Change, which views change not as an event but as a process that occurs in stages and provides direction for achieving behavior change (Prochaska et al., 1992).

In this paper, we apply the “stages of change” framework from the Transtheoretical Model to explore the potential for increased bicycle commuting to the University of California, Davis campus. Our analysis uses data from the 2012 to 2013 UC Davis Campus Travel Survey, an annual online survey administered to a random sample of students, staff, and faculty at the university. Based on their responses to questions about current commute mode and contemplation of bicycle commuting, respondents are divided into five stages of change: Pre-contemplation, Contemplation, Preparation, Action, and Maintenance. We construct a Bayesian multilevel ordinal logistic regression model to understand how differences between individuals explain their membership in different stages of change. In addition, we use this model to explore the potential of various intervention strategies to shift the probability of stage membership toward the Maintenance stage, that is, toward becoming a regular bicycle commuter. Our results highlight important differences in these five groups and point to the need for a range of targeted policies and programs to increase bicycle commuting.

### Conceptual approach and literature review

Emerging from the field of psychotherapy and developed by James Prochaska, the Transtheoretical Model of Behavior Change describes processes of individual behavior change (Prochaska et al., 1992). The Transtheoretical Model (TTM) seeks to explain how positive and permanent behavior change can be fostered in individuals. Since its inception, the model has frequently been applied to areas of smoking cessation, exercise behavior, alcohol consumption, and contraceptive use (Zimmerman et al., 2000).

According to the Transtheoretical Model, individuals move through the following series of five stages when voluntarily changing their behavior (Prochaska et al., 1992):

- **Pre-contemplation:** individuals do not intend to change their “problem behavior” in the foreseeable future.
- **Contemplation:** individuals are thinking about overcoming a behavior, but have made no commitment to take action.
- **Preparation:** individuals intend to take action in the immediate future.
- **Action:** individuals have modified their behavior to overcome their problems.
- **Maintenance:** individuals have sustained an action and are working to prevent relapse.

In order to encourage movement toward the Maintenance stage, Prochaska et al. (1992) explain, public agencies or other entities must target intervention strategies to specific stages of change. Research has shown that interventions based on the TTM, tailored to target individuals in specific stages of change, are more effective than general interventions at changing behavior (e.g. Zimmerman et al., 2000).

A handful of studies have used the TTM in examining interventions to increase the use of non-driving modes in the general population. Mutrie et al. (2002) and Rose and Marfurt (2007) both used the TTM as a tool to evaluate the success of intervention strategies that aimed to increase use of alternative travel modes by looking at movement between the stages before and after an intervention. While these studies demonstrate that the TTM can be a useful framework for evaluation, neither study examined socio-demographic, attitudinal, or other differences among individuals in different stages of change. The TTM has also been applied to bicycling in Dar-es-salaam, Tanzania to identify barriers and motivations to bicycling as well as policy interventions that could encourage bicycling (Nkurunziza et al., 2012). The authors used a series of binary logistic regression models, one for each sequential stage pair, to understand the relationship between stage membership and barriers, motivations, and policies. This approach allowed the authors to evaluate whether individuals in certain stages of change are more or less responsive to certain types of interventions. Applying the TTM to understand bicycle use is related to recent work on bicyclist typologies in Portland, OR, where Dill and McNeil (2012) tested a typology for categorizing bicyclists that included four categories: Strong and Fearless, Enthused and Confident, Interested but Concerned, and No Way No How. Although this study characterizes the relationship of individuals to bicycling in a static way, in contrast to the focus of the TTM on stages of change, the authors do discuss appropriate policy interventions to increase bicycling for each category of bicyclists.

Several studies have applied the TTM to survey data collected in a university setting in order to gauge individuals' readiness to use alternative transportation modes for their commute, much in line with the current study (Gatersleben and Appleton, 2007; Shannon et al., 2006; Fu et al., 2012). These studies suggest that attitudinal and geospatial factors correlate with the stages of change. Gatersleben and Appleton (2007) found that a two-week intervention targeted at non-bicyclists caused these individuals to progress from the Pre-contemplation stage to the Action stage and resulted in more positive attitudes toward bicycling and changed perceptions of certain barriers. Shannon et al. (2006), using a modified three-stage TTM, found that individuals in the action/maintenance stages generally attached less importance to barriers, such as travel time

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