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Theory of routine mode choice decisions: An operational framework to increase sustainable transportation

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ABSTRACT

A growing number of communities in the United States are seeking to improve the sustainability of their transportation systems by shifting routine automobile travel to walking and bicycling. In order to identify strategies that may be most effective at increasing pedestrian and bicycle transportation in a specific local context, practitioners need a greater understanding of the underlying thought process that people use to select travel modes. Previous research from the travel behavior and psychology fields provides the foundation for a five-step, operational Theory of Routine Mode Choice Decisions. Walking and bicycling could be promoted through each of the five steps: awareness and availability (e.g., offer individual marketing programs), basic safety and security (e.g., make pedestrian and bicycle facility improvements and increase education and enforcement efforts), convenience and cost (e.g., institute higher-density, mixed land uses, and limited, more expensive automobile parking), enjoyment (e.g., plant street trees and increase awareness of non-motorized transportation benefits), and habit (e.g., target information about sustainable transportation options to people making key life changes). The components of the theory are supported by in-depth interview responses from the San Francisco Bay Area.

1. Introduction

In the last two decades since the United States Congress passed the federal Intermodal Surface Transportation Efficiency Act, there has been a surge of interest in making urban transportation systems more sustainable. Agencies at all levels of government have searched for strategies to reduce single-occupant automobile travel, including policies to shift local driving to pedestrian or bicycle modes.

At the federal level, the 1994 National Walking and Bicycling Study set a goal to double the percentage of trips made by walking and bicycling (Federal Highway Administration, 2010). More recently, the White House Task Force on Childhood Obesity (2010) established a benchmark to increase the percentage of children walking and bicycling to school from 12.7% to 19.5% by 2015. Between 2007 and 2012, the number of states with published goals to increase walking and bicycling more than doubled. Now 35 of the 50 states have goals to increase walking, and 35 have goals to increase bicycling. Of the 51 most populous cities in 2012, 36 have published goals to increase walking and 47 have published goals to increase bicycling (National Alliance for Bicycling and Walking, 2012). For example, the Portland Bicycle Plan for 2030 envisions increasing bicycle mode share from 6% to 25% of all trips by 2030 (City of Portland Bureau of Transportation, 2010), and the Philadelphia Pedestrian and Bicycle Master Plan establishes a goal to increase bicycle commuting from 1.6% to 5% and increase pedestrian commuting from 8.6% to 12% by 2020 (City of Philadelphia, 2010). Interest in pedestrian and bicycle transportation is not limited to the largest, most metropolitan communities. More than 250 local and regional agencies throughout the United States have established "Complete Streets" policies to provide for the needs of pedestrians and bicyclists as a part of roadway improvement projects (Complete Streets Coalition, 2012).

These policies indicate that many communities seek to shift automobile travel to walking and bicycling. Strategies to increase sustainable transportation include pedestrian and bicycle infrastructure development (Pucher et al., 2011), land use planning (Ewing and Cervero, 2010), and individual and social marketing (Brög et al., 2002; Anable 2005; Rose and Marfurt, 2007). Many studies cite the need for a comprehensive set of strategies to influence travel behavior (Krizek et al., 2009; Maibach et al., 2009; Pucher et al., 2010).

However, the effectiveness of particular interventions may depend on contextual characteristics. For example, bicycle infrastructure and programs have helped increase bicycle commuting mode share in neighborhoods near the urban core of metropolitan

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regions such as Portland, OR, New York, NY, and Washington, DC, but there has been less growth in bicycling in suburban parts of these regions where activity locations are more dispersed (Pucher et al., 2011). Certain interventions may also be more effective for people in specific travel behavior segments (Anable, 2005; Steg, 2005). For example, some people may be "malcontented motorists" who are frustrated with their high level of automobile use and desire to drive less. These people may be much more receptive to interventions encouraging bicycling and walking than people who are "complacent car addicts" who think it is difficult to change their travel behavior and do not see a moral obligation to drive less (Anable, 2005). Broad mode shifts require a clearer understanding of the barriers to choosing walking and bicycling for different types of people in different communities.

The purpose of this paper is to propose an operational theory of the mode choice decision process and support it with in-depth, qualitative interviews from the San Francisco Bay Area. This information is intended for planners, designers, engineers, and other transportation professionals who are charged with the task of achieving mode shift policy goals. Many strategies have been proposed to change travel behavior, but selecting the optimal set of actions to pursue in a particular community is challenging. Practitioners can use the operational theory as a guide to understand the mode choice process and identify actions that may have the most potential to increase walking and bicycling in their local social and geographic contexts.

2. Proposed mode choice decision theory

This section proposes an operational theory, called the Theory of Routine Mode Choice Decisions, to describe how people choose transportation modes for routine travel purposes, such as local shopping or other errands. This theory suggests that there are five steps in the mode choice decision process (Fig. 1). The first part, (1) awareness and availability, determines which modes are viewed as possible choices for routine travel. The next three elements, (2) basic safety and security, (3) convenience and cost, and (4) enjoyment, assess situational tradeoffs between modes in the choice set. These middle three steps may be considered simultaneously or in various sequences. The final part, (5) habit, reinforces previous choices and closes the decision process loop. Socioeconomic characteristics explain differences in how individuals view each part of the process.

Operational theories like the Theory of Routine Mode Choice Decisions are useful because they can provide concise, understandable frameworks to summarize previous research for practical application. This theory draws on other studies that provide clues

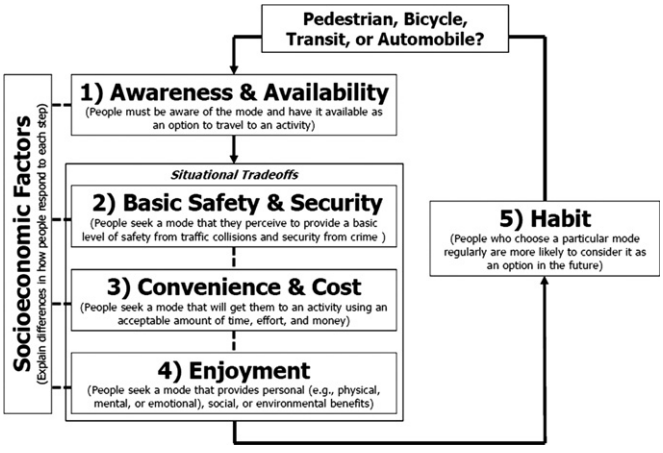

Fig. 1. Proposed Theory of Routine Mode Choice Decisions.

to how people choose between automobile, public transit, bicycling, and walking in certain situations. It combines findings from the travel behavior and psychology fields, as suggested by Van Acker et al. (2010). The travel behavior field has traditionally focused on time, cost, and socioeconomic factors but has more recently evaluated perceptions of the local environment and attitudes towards specific modes. The psychology field has described the thought process used to select a travel mode, including intentions and habits.

2.1. Mode choice insights from the travel behavior field

Walking and bicycling tend to be less time-competitive with motorized modes over longer distances (Cervero and Duncan, 2003; Purvis, 2003; Kim and Ulfarsson, 2008), and these modes may have much higher travel times than automobiles for trip chains (tours) to multiple, dispersed activity locations (Bowman and Ben-Akiva, 2001). Plentiful automobile parking and low operating costs also benefit driving (Rodriguez et al., 2008; Krizek et al., 2009). Other travel barriers to walking and bicycling include traveling with other people, heavy packages, hills, and bad weather (Cervero and Duncan, 2003; Mackett, 2003; Kim and Ulfarsson, 2008). Local environment barriers to pedestrian and bicycle activity are related to a lack of facilities (e.g., sidewalks, bicycle lanes, or multi-use trails) (Dill and Carr, 2003; Clifton and Dill, 2005; Douma and Cleaveland, 2008; Handy et al., 2010), roadway characteristics (e.g., faster automobile speeds, higher automobile volumes, and difficult street crossings) (Ewing and Cervero, 2001; Gehl, 2002), and public space characteristics (e.g., sterile building facades, poor lighting, noise, and few street trees) (Appleyard, 1980; Landis et al., 2001; Gehl, 2002; Southworth, 2005; Ewing et al., 2006).

Individual and social factors are also important. Individual factors associated with driving rather than walking or bicycling include socioeconomic characteristics (e.g., greater automobile ownership, physical disabilities) (Meyer and Miller, 2001; Cervero and Duncan, 2003), concerns about traffic safety (e.g., risk of being struck by a vehicle) and personal security (e.g., risk of being a victim of crime) (Saelens et al., 2003; McMillan et al., 2006; Handy et al., 2010), lack of awareness of other travel modes (Rose and Marfurt, 2007), and habitual driving (Loukopoulos and Gärling, 2005). Some communities may perceive pedestrians and bicyclists to have lower social status than drivers (Mokhtarian and Salomon, 2001; Dugundji and Walker, 2005). Yet, there are also individual and social factors that motivate people to walk and bicycle, such as personal enjoyment (e.g., physical exercise, fresh air, time to be alone) (Handy et al., 2010) and concern for the environment (Kitamura et al., 1997; Mokhtarian and Salomon, 2001). Note that the influence of these factors on walking versus bicycling may vary greatly due to differences in travel speed, roadway positioning, and other characteristics (Krizek et al., 2009).

Although travel behavior research has identified many factors associated with walking or bicycling, it is not clear from this literature how, when, or in what order these factors are considered by individuals during the mode choice decision process. A psychological lens is needed to understand the thought process involved in choosing a particular travel mode.

2.2. Mode choice theories from the psychology field

Psychological theories focus on the cognitive process involved in selecting a travel mode. For example, the Theory of Interpersonal Behavior (TIB) suggests that mode choices depend on individual attitudes towards available modes and social influences (similar to enjoyment), habits, and facilitating conditions (e.g., travel time and cost; individual socioeconomic characteristics) (Galdames et al., 2011). TIB contains several components of the proposed Theory of Routine Mode Choice Decisions.

The Theory of Planned Behavior (TPB) emphasizes social behavioral controls that modify a person's original intention and influence the actual travel mode that is chosen (Bamberg and Schmidt, 1998; Lee and Vernez-Moudon, 2004; Montaño and Kasprzyk, 2008). The Transtheoretical Model (TTM) describes processes involved in changing to a more healthy behavior, such as walking or bicycling rather than driving (Prochaska et al., 2008). These processes include several parts similar to elements of the proposed theory, including raising consciousness (similar to awareness), making a firm commitment to change (similar to habit), and recognizing that social norms are supporting the healthier behavior (similar to enjoyment). However, the TPB and TTM tend to represent a thought process related to performing a particular behavior (typically a normative goal) rather than choosing between alternatives.

Schwartz and Howard (1981) proposed a Model of Normative Decision-Making (NDM) that can be used to explain mode choices made for altruistic, environmental reasons. This theory involves four main stages: (1) attention, (2) motivation, (3) evaluation, and (4) decision. Attention includes awareness and availability of a mode and also includes consideration of the environmental consequences of using a mode. Motivation encompasses acting consistently with a personal value system, meeting social expectations, and achieving "non-moral" motives (e.g., save money or time, feel comfortable and safe). Evaluation weighs the benefits and costs of each component of the motivation stage. Finally, a decision to use a particular mode is made if the benefits and costs show a clear preference for the mode. Klöckner and Matthies (2004) added the concept of habit to the NDM so that it applied to repeated, not necessarily altruistic, mode choices. While the NDM is not formulated as a five-step feedback loop, it contains most of the elements of the proposed theory.

Recently, efforts have been made to integrate more utilitarian factors, into psychological mode choice theories (Klöckner and Friedrichsmeier, 2011). The Comprehensive Action Determination Model (CADM) was used to represent university students' choices of using an automobile versus other travel modes (Klöckner and Blöbaum, 2010; Klöckner and Friedrichsmeier, 2011). The CADM includes four main components, including intentional influences (similar to awareness), normative influences (similar to enjoyment), situational influences (similar to basic safety and security and convenience), and habitual influences (similar to habit).

The Practical Cycling System Design Model (PCSDM) is an operational theory. Smith et al. (2011) oriented this theory towards practitioners in an effort to increase bicycling for routine travel purposes in New Zealand. It draws on Diffusion of Innovations Theory (Rogers, 2003) and the Contemplation of Change Model (Sullivan and O'Fallon, 2006) and includes three steps that are necessary to increase bicycling mode choice: (1) "Plant the cycle seed," (2) "Make it easy to choose to ride a bicycle," and (3) "Create a pleasurable experience." The first step involves raising awareness, the second suggests the importance of convenience, and the third emphasizes enjoyment. This theory places less emphasis on the relative attractiveness of competing modes than the proposed Theory of Routine Mode Choice Decisions, but its steps are in a similar order.

3. Supporting evidence from interview subjects

Interviews conducted with subjects in the San Francisco Bay Area highlight the importance of each of the five steps of the operational Theory of Routine Mode Choice Decisions. Qualitative methods, such as in-depth interviews, are an important tool for understanding travel behavior (Clifton and Handy, 2001). For example, 24 interviews were conducted in Porto, Portugal (Bierão and Sarsfield Cabral, 2007), 19 were done in Brighton and Hove, England (Gardner and Abraham, 2007), and 32 were utilized in Edinburgh, Glasgow, and Dunfermline, Scotland (Hine and Scott, 2000). These previous interview-based studies identified certain themes, such as the importance of travel time and reliability, personal control, and cost of finding information when making mode choices.

Potential San Francisco Bay Area interviewees were identified after being surveyed at retail pharmacy stores in 20 shopping districts in fall 2009. A total of 1003 people were surveyed, and they were given the option to provide their contact information for a possible follow-up interview. All 172 survey participants who provided their contact information were asked to be interviewed; 26 people agreed to this request. Interviews were conducted in spring and summer 2010. The 26 interviewees lived in a variety of local environments and represented different ages and genders (Table 1). Some were wealthy while others were poor; some were single while others were married; some lived on their own while others lived with a partner or parent; some had children while others did not; some worked more than 50 h per week while others were retired; and some had lived in the same neighborhood for decades while others had only lived in their current location for one or two years.

The in-depth interview responses validated that people considered each of the five components of the proposed theory when making mode choices. Specific quotes from these interviews are presented in the sections below. The survey results also help support the theory and are cited in several sections below. Additional details about the survey and interview methodology are provided in other references (Schneider, 2011).

3.1. Awareness and availability

People must be aware of a mode and have it available as an option to travel to an activity. The important connection between awareness and mode choice has been emphasized in several recent travel behavior studies (Brög et al., 2002; Dieleman et al., 2002; Rose and Marfurt, 2007). For example, some people automatically choose to use an automobile any time they run errands, so walking or bicycling are not possible mode choices for them.

Interview respondents suggested that awareness of pedestrian and bicycle modes can increase their use:

- "So if one person starts cycling, and everyone starts seeing it, everyone will start cycling."
  –Male, Age 40–49, Pleasanton
- "He rides his bike because the cost of gas and he's an environmental major…he became aware."
  –Female, Age 52, San Carlos

Lack of awareness of pedestrian and bicycle options may keep people traveling by automobile:

Table 1
Interview participant characteristics.

Local Environment[a]	Age 18–39		Age 40–59		Age 60+		**Total**
	Male	Female	Male	Female	Male	Female	
Urban	2	1	2	1		1	**7**
Inner Suburban	3	1	1	4	1		**10**
Outer Suburban			1	4	1	3	**9**
Total	**5**	**2**	**4**	**9**	**2**	**4**	**26**

[a] Local environments were classified by jurisdiction: Urban=San Francisco; Inner Suburban=Berkeley, Burlingame, Daly City, El Cerrito, Hayward, Oakland, Richmond, San Bruno; Outer Suburban=Brentwood, Concord, Danville, Fremont, Pleasanton, Livermore, Pacifica, Redwood City, San Carlos.

- "Just hop in the car…get where I'm going, and don't think about anything else."
  –*Female, Age 30–39, Daly City*
- "Working people that are driving…don't have the mind to think, 'Am I doing things right?' You are just surviving."
  –*Male, Age 30–39, Berkeley*
- "In the United States actually, we tend to think about the car being the first and the only mode of transportation, and we need to get out of that mindset."
  –*Female, Age 40–49, Pleasanton*

Mode availability is also important at the beginning of the mode choice process. The role of automobile ownership in determining automobile use has been noted by Van Acker and Witlox (2010). Bicycle ownership has a similar positive relationship with bicycling (Handy et al., 2010). Several interviewees emphasized the role of vehicle availability in mode choice decisions:

- "Some may simply have no vehicle. I know friends who have never driven…they take public transportation and have all their lives."
  –*Male, Age 55, San Francisco Third Street Area*
- "We only have one bike in the house, so when I have friends in town, walking, BART, and bus are the only options."
  –*Male, Age 30–39, San Francisco Mission Street Area*
- "I am unemployed and can't afford to buy a bicycle."
  –*Female, Age 20–29, San Francisco Market Street Area*

3.2. Basic safety and security

People seek to travel to activities using a mode that they perceive to provide a basic level of safety from traffic collisions and security from crime (Handy, 1996; Saelens et al., 2003; Clifton and Livi, 2005). This stage is similar to the safety, or self-preservation, tier in an adapted version of Maslow's Hierarchy of Needs (Kenrick et al., 2010).

Some interviewees mentioned that roadways with high-speed, high-volume automobile traffic prevented them from walking to nearby destinations because they were concerned about safety:

- "I can't walk there because of the cars that are speeding…and it really bothers me because it's the one little green open space that I could walk to…within 500 yards of my house, but I can't get there because of the traffic."
  –*Female, Age 40–49, San Francisco Third Street Area*
- "If there was less traffic…I probably would walk even more."
  –*Male, Age 30, San Francisco Fillmore Street Area*

Similarly, perceived traffic safety barriers prevented many interviewees from bicycling:

- "I wouldn't mind having a bike, but there's so many cars in the City, and people are getting hit all the time…there's kind of a safety factor…My work is actually close enough that I could bike, but…there's so much traffic and cars, I think it would be scarier than driving."
  –*Male, Age 30, San Francisco Fillmore Street Area*
- "I'm not a skilled bicyclist…on the road, so I don't really feel safe at all."
  –*Female, Age 30–39, Daly City*

- "Right now I wouldn't bicycle. I had a neighbor who had a terrible accident on a bicycle…"
  –*Female, Age 52, South San Francisco*
- "Bicycling itself…I would do it if I wasn't right up next to cars."
  –*Female, Age 52, South San Francisco*

Many participants preferred lower-volume streets and separated bikeways over on-street bicycle lanes:

- "It would be easier if they had certain streets just for biking, I think…They have a lot of bike lanes here, which is good, but I don't think I'd personally feel that comfortable even [bicycling] in the bike lanes."
  –*Male, Age 30, San Francisco Fillmore Street Area*
- "If I could ride my bicycle on the sidewalk again, I would probably be more apt to riding my bicycle. But the way it is now, they want you riding your bicycle on the streets makes it not appealing."
  –*Female, Age 30–39, Daly City*

The interview results were similar to findings from a survey of bicyclists in the Vancouver, BC region (Winters and Teschke, 2010; Winters et al., 2010) and a bicyclist route choice study in Portland, OR (Dill and Gliebe, 2008). The Vancouver survey showed that concerns about safety had the highest influence on respondent bicycling likelihood and that bicyclists preferred using multi-use trails and other bicycle facilities separated from automobile traffic over facilities shared with motor vehicles. Similarly, the Portland route choice study showed that bicyclists would divert 31% further from the shortest route between activity locations to ride on bicycle lanes, 45% further to ride on bicycle boulevards, and 55% further to use an off-road trail.

Concerns about personal security also prevented interviewees from walking or bicycling in some neighborhoods:

- "That's how I got mugged, walking from my car to my house…I thought I might be walking more, but when I actually [moved] here, I realized that I couldn't."
  –*Female, Age 40–49, San Francisco Third Street Area*
- "We don't live in a world that is as safe as it used to be…That's why most parents don't have their children biking around or walking out on the streets alone."
  –*Female, Age 40–49, Danville*
- "When you are walking in this neighborhood, there's nobody else walking. You look like a target here."
  –*Female, Age 40–49, San Francisco Third Street Area*

In addition, some interviewees did not bicycle because they were concerned about having their bicycle stolen.

3.3. Convenience and cost

People seek to travel to activities using a mode that requires less time, effort, and money (Mackett, 2003; Cao et al., 2006; Ewing and Cervero, 2010). Modes that involve less cognitive effort to use tend to be more attractive than modes that require users to gather information (Dziekan, 2008). Convenience may also include having adequate personal space and personal control over travel movements (Anable and Gatersleben, 2005; Gardner and Abraham, 2007). These components of convenience were evident in the San Francisco Bay Area interviews.

Many interviewees mentioned two overarching factors affecting the relative convenience and cost of walking and bicycling versus driving: (1) accessibility of activity locations and (2) availability and price of automobile parking (Fig. 2). First, better accessibility (i.e., shorter distances between activity locations) mitigated many barriers to walking and bicycling. Travel time was viewed as a prominent barrier. However, walking and bicycling were more time-competitive with or faster than traveling by automobile when activity locations

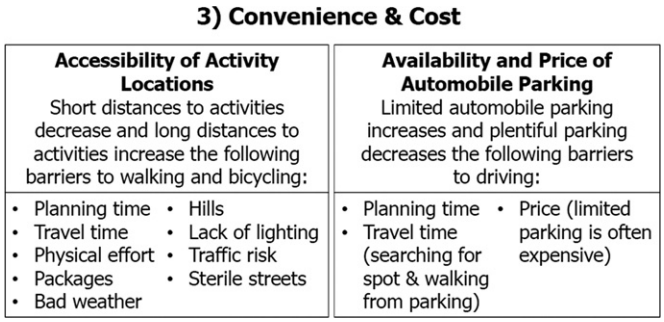

Fig. 2. Factors influencing the relative convenience and cost of walking and bicycling.

were nearby. Accessibility also reduced barriers such as travel planning time, physical limitations, heavy packages, bad weather, hills, and traveling with others. For example, bicycle planning time includes identifying the best roads and trails for bicycling. Planning a bicycle route generally takes longer when activities are dispersed and less time when activities are concentrated.

Second, the availability and price of automobile parking was an important determinant of mode choice for San Francisco Bay Area study participants. Shopping districts, employment centers, or other zones with scarce or expensive parking discouraged automobile use. Driving to these areas tended to require more planning time (to develop a parking strategy, such as searching for several blocks to find an open street parking space versus paying more money to park in an off-street lot close to an activity location) and travel time (to find an available space and then walk to the activity location). Traffic congestion was not often mentioned as a barrier that caused interviewees to change travel modes, but it is also a factor that adds to travel time and makes driving relatively less attractive than walking or bicycling.

The importance of accessibility between activity locations and automobile parking characteristics was highlighted by many interview quotes (Fig. 3). In general, driving tended to be more convenient than other modes for suburban participants because of longer travel distances, wide roadways, and plentiful automobile parking. In contrast, urban shopping districts tended to have high population and employment densities and mixed land uses that created short trip distances between homes, workplaces, stores, restaurants, and other activities. Parking tended to be more limited and expensive. This increased the relative convenience of walking and bicycling in these urban areas.

3.4. Enjoyment

People seek to travel to activities using a mode that provides them with personal physical, mental, or emotional benefits; helps them achieve social status; or makes them feel good about benefitting society or the environment (Kitamura et al., 1997; Mokhtarian and Salomon, 2001; Steg, 2003). These intrinsic and extrinsic motivations are incorporated into the concept of enjoyment, and they occur at several levels, including individual, social, and global (Vallerand, 1997). Individual benefits may include personal health (e.g., walking for exercise), social benefits may include status (e.g., driving to show off an expensive automobile), and global benefits may include supporting the natural environment (e.g., bicycling to reduce fossil fuel use and tailpipe emissions). Mode choices can provide benefits at several levels simultaneously. For example, driving in a comfortable car may provide personal emotional enjoyment and help a person conform to social norms (Steg, 2005).

Interviewees provided many individual, social, and global reasons why they enjoyed walking and bicycling:

- "I think walking is good exercise."
  –Female, Age 50–59, Hayward
- "I have noticed that my stress level has gone down since I have walked and bussed more than I drive."
  –Male, Age 30, Burlingame
- "We enjoy walking in San Francisco and looking at things…she loves to read restaurant menus."
  –Male, Age 50–59, San Francisco Fillmore Street Area
- "It's a beautiful block with beautiful trees, and I love walking down that street."
  –Female, Age 40–49, San Francisco Third Street Area
- "They are doing an ecological service…they are [walking] for the environment." *–Female, Age 52, South San Francisco*
- People bicycle "for exercise, for convenience, and for fun."
  –Female, Age 20–29, San Francisco Market Street Area
- "[Bicycling is] a good way to get some exercise, and it's less pollution…part of it may be that it's kind of trendy."
  –Male, Age 30, San Francisco Fillmore Street Area

However, enjoyment of walking or bicycling did not guarantee that study participants would use these modes for routine travel to shopping and other activities. It was especially common for interviewees living in suburban areas to walk and bicycle for exercise in their neighborhoods, in local parks, and on nearby trails, but very few used active transportation modes to travel to activity destinations. Some interviewees who enjoyed walking and bicycling even sought out comfortable places to walk and bicycle for pleasure and drove to them.

3.5. Habit

People who choose a particular mode regularly are more likely to use it as an option in the future (Verplanken et al., 1994; Fujii and Kitamura, 2003; Klöckner and Matthies, 2004; Loukopoulos and Gärling, 2005). For example, someone who walked or bicycled to the store in the last week is likely to think about these modes as an option for their current tour. However, someone who has driven to all errands over the last year is unlikely to think of the possibility of walking or bicycling. As people develop routine choices, they may not consider as much information about other possible modes (Verplanken et al., 1994; Aarts et al., 1997). People who are in the habit of driving are more likely to drive on shorter-distance trips than people who drive less frequently (Gärling et al., 2000). This may be because habitual drivers perceive walking to require greater effort than people who drive less frequently (Loukopoulos and Gärling, 2005).

However, habits may only have a strong influence on travel behavior when conditions remain stable (Bamberg et al., 2003). Mode choice habits may be interrupted and reconstructed when people experience significant life changes, such as having children or retiring from work (Bamberg, 2006). Other important "life events" include buying a car, getting a driver license, moving to a new town, starting college, or changing jobs (Klöckner, 2004). People may be more likely to break a habit and use a new mode of transportation if their personal norms support the new mode (i.e., they believe that the new mode would be a positive change) (Matthies et al., 2006; Eriksson et al., 2008). Further, habits may apply to all mode choices made by an individual (e.g., always traveling by automobile, regardless of the trip purpose or geographic context) or only to specific journeys (e.g., always traveling by car from home to the grocery store, regardless of the number of items being purchased, but using a variety of modes for other purposes) (Verplanken et al., 1994).

In the proposed theory, habit is the final step in a feedback loop that increases or limits future awareness of using a

Fig. 3. Interviewee quotes about local transportation convenience and cost.

particular mode. Several interviewees emphasized the importance of habits:

- "I'm used to using a car. It's easy…I get in, I go."
  –*Male, Age 55, San Francisco Third Street Area*
- "The younger ones—a lot of them drive their cars to high school or to college…That's probably all they know, really."
  –*Male, Age 30, Burlingame*
- "I think that getting into the habit of [walking and bicycling] early makes one…more likely to continue doing them into their later years."
  –*Male, Age 55, San Francisco Third Street Area*

3.6. The role of socioeconomic characteristics

Previous research has identified many socioeconomic characteristics that are associated with mode choices, including age, gender, household size, employment status, income, household automobile ownership, and physical disabilities (Hanson and Hanson, 1981; Berrigan and Troiano, 2002; Cervero and Duncan, 2003; Kim and Ulfarsson, 2008). This Theory of Routine Mode Choice Decisions suggests that socioeconomic characteristics do not have a direct relationship with mode choice, but they influence each part of the decision process. For example, families living in poverty may not have access to an automobile or a bicycle, so their only available

modes are walking or public transit. Individuals with disabilities may be more sensitive to traffic crash or crime risk while walking because they are not able to move quickly to avoid collisions or evade perceived security threats. Parents with children may have significant time constraints that make the convenience of driving more important than the social and environmental benefits of walking or bicycling. Socioeconomic characteristics can also influence the enjoyment of certain modes. At one extreme, women may not enjoy bicycling or driving in some societies because cultural norms and laws prevent them from doing these activities. More subtly, a resident living in poverty may not enjoy bicycling because many people in his community perceive that bicycling for errands indicates low social status.

Lifestyle decisions can also be associated with changing mode choice habits over time (Bowman and Ben-Akiva, 1997). For example, a couple renting an apartment near shopping, work, social, and other activities in a neighborhood that is served by a good local bicycle network and frequent transit service may be able to travel easily without owning an automobile. In this situation, they may develop habits to walk and bicycle for routine travel. However, the couple may make a long-term decision to take higher-paying, more demanding jobs and have a child. Under these new household size and income conditions, the couple is likely to re-examine their mode choice habits. Their new time constraints and need to travel with a child may make driving attractive enough to purchase an automobile. They may even choose to purchase a house in a residential subdivision on the periphery of the urban area, which could result in a full re-examination of their mode choice habits. While some of their habits to walk and bicycle may remain, it is likely that the relative attractiveness of traveling by automobile in their new suburban setting would increase their driving frequency and could lead to more habitual driving in the future.

3.7. Order of basic safety and security, convenience and cost, and enjoyment steps

More research is needed to understand the order of the middle three steps in different situations. These three steps may be considered simultaneously or in various sequences. However, the intercept survey responses suggested an initial order for these three steps of the process. Basic safety and security is listed before convenience in the proposed theory. This is because some survey participants avoided walking or bicycling when they perceived them to be too risky, even though these modes could have potentially been more convenient than driving. For example, bicycling appeared to be a convenient choice for 66 of 397 survey respondents who traveled only to and from the shopping district: they owned a bicycle, carried one or fewer packages, did not have a disability, and could have completed their tour faster by bicycle than using any other mode. However, fewer than five percent of these respondents (3 of 66) actually bicycled. This low rate of bicycling may have been due partly to more than 50% of them (34 of 66) perceiving that bicycling had a high risk of crashes.

Enjoyment was listed after both basic safety and security and convenience because the proportion of survey respondents who reported enjoying walking (87%) and bicycling (61%) was much larger than the proportion of respondents who actually walked (21%) or bicycled (2%) as their primary tour mode. Since many people enjoyed the activities of walking and bicycling, it is likely that other barriers, such as perceived crash risk, perceived crime risk, or inconvenience prevented these modes from being used for routine travel.

4. Strategies to increase walking and bicycling for routine travel

The Theory of Routine Mode Choice Decisions can help planners, designers, engineers, and other practitioners implement strategies to increase the attractiveness of walking and bicycling at each stage in the mode choice decision process. Example strategies related to each of the five steps are shown in Table 2. Many of these strategies have been recommended in recent studies (Krizek et al., 2009; Maibach et al., 2009; Pucher et al., 2010; Boarnet et al., 2011; Pucher et al., 2011). They include transportation infrastructure and roadway design; education, encouragement, and enforcement; land use; and monetary actions. Some strategies in Table 2 are useful for making sustainable modes more attractive at one particular step in the thought process (e.g., increased enforcement can improve safety and security), while others may have benefits at multiple steps (e.g., constructing sidewalks can improve perceived safety, improve convenience, and may even increase awareness of walking as a travel option).

4.1. A comprehensive approach to increase sustainable travel

This study is not intended to suggest which strategies will be most feasible or effective in all situations; rather it presents a suite of options to consider. Some strategies can be executed quickly and may impact mode choices in the short term (e.g., individual marketing), while others may take many years to implement and may increase walking and bicycling in the long term (e.g., land use policies). Several researchers note that there are political and budgetary barriers to long-term land use and roadway design changes, so it may be more feasible to target individualized marketing efforts at groups of people who are most motivated and willing to change (Anable, 2005; Steg, 2005). Yet, marketing efforts may only have marginal effectiveness at increasing sustainable travel in neighborhoods that have dispersed activity locations and more challenging conditions for walking and bicycling (Maibach et al., 2009; Dill and Mohr, 2010; Handy et al., 2010). In order to facilitate sustained travel behavior changes, local conditions should provide a safe, secure, and convenient experience for people who try walking and bicycling for the first time (Smith et al., 2011).

The Theory of Routine Mode Choice Decisions suggests that broad mode shifts throughout a community will likely require a comprehensive approach that improves the attractiveness of walking and bicycling within all five steps. Practitioners should evaluate which of the five parts of the mode choice process may currently be barriers to routine walking and bicycling in their communities and identify opportunities to address them. A comprehensive approach may hold the greatest promise for achieving the significant mode shift goals established by many communities.

4.2. Local context

The optimal set of strategies to increase pedestrian and bicycle mode share in a particular community will depend on the local land use, transportation system, political, and socioeconomic context. Some strategies may be appropriate for a broad spectrum of communities and individuals, while others may work best in particular contexts. For example, a Bicycle to Work Day program may raise awareness of bicycling and increase bicycle commuting in many areas, but it may have limited effectiveness in communities that have poor conditions for bicycling (because people may be afraid to ride with high-volume, high-speed traffic). Increasing on-street parking rates may be effective at increasing walking to, from, and between activities in high-density urban areas with limited automobile parking, but it may have little impact in suburban areas with large, off-street parking lots.

Table 2
Example strategies to increase walking and bicycling through the mode choice decision process.

Example strategies	Steps in mode choice process addressed most directly by strategy				
	(1) Awareness and Availability	(2) Basic Safety and Security	(3) Convenience and Cost	(4) Enjoyment	(5) Habit
Transportation infrastructure and roadway design					
Design roadways & intersections with pedestrian & bicycle facilities during construction and reconstruction	X	X	X		
Increase connectivity of pedestrian & bicycle infrastructure (e.g., fill network gaps with sidewalks, multi-use trails, bikeway facilities, and roadway crossing facilities)	X	X	X		
Reduce automobile lanes and design local roadways to facilitate slow automobile speeds		X	X		
Provide secure short- and long-term bicycle parking near activity locations	X	X	X		
Post pedestrian & bicycle wayfinding signs	X				
Improve roadway lighting		X			
Plant street trees		X		X	
Design streets as public spaces with sidewalk cafes and street vendors		X		X	
Education, Encouragement, and Enforcement					
Offer individualized marketing in neighborhoods or at workplaces (e.g., send information and talk with individuals about walking & bicycling; walk & bicycle with people to work and other activities)	X				
Use surveys and social media to promote walking and bicycling to people who already walk and bicycle a little or who are frustrated with automobile travel	X				
Target pedestrian and bicycle promotion to people moving into new homes and workplaces					X
Target pedestrian and bicycle promotion at times when gas prices, tolls, or other automobile operating costs increase					X
Establish community encouragement programs (e.g., Bike to Work Day, Walk to School Week)	X			X	
Broadcast community messages about personal, social, and environmental benefits of walking and bicycling				X	
Institute bicycle sharing	X				
Coordinate bicycle give-aways	X				
Offer bicycle education (e.g., bicycling skills & rules of the road)		X			
Increase enforcement of crime and traffic safety laws		X			
Land Use					
Zone for higher-density, mixed-use developments with buildings close to the street			X		
Reduce requirements for off-street parking			X		
Develop buildings on land occupied by surface parking lots			X		
Monetary					
Increase automobile parking prices and other automobile operating costs			X		
Provide pedestrian, bicycle, and transit commuter benefits			X		

Parking price increases may also do little to increase walking and bicycling in business districts that sell large goods (because customers may still need to drive to carry their purchases) or are struggling economically (because marginally higher parking costs could push some customers to other competing shopping areas). Additionally, roadway design changes that increase the safety of walking and bicycling are important in all types of communities (to provide access for people who are not able to drive or choose not to drive), but they may have a greater impact on pedestrian and bicycle mode share in higher-density, mixed-use areas (because activities are located within convenient walking and bicycling distances).

5. Considerations

This paper proposes an operational theory that can help practitioners apply previous research on the mode choice process and increase sustainable transportation. The five components of the theory are supported by interview responses, but this study does not explore the relative importance of these steps. In addition, the middle three steps may be considered simultaneously or in various sequences, but this ordering has not been tested statistically. Finally, the interviewees represented a variety of people living in a diverse set of communities in the San Francisco region, but local built environments, topography, and cultural values in these communities may be different from other parts of the world. Future studies could test the relative strength and order of the five components in a variety of contexts.

While the 26 interview participants represented many different urban and suburban environments and traveled in a variety of ways, it is likely that these interviewees were more interested in the topics of transportation and urban planning than non-participants, so their responses may reflect this bias. Interviewing more community members in the future will make it possible to improve understanding of routine travel decisions.

6. Conclusion

The proposed Theory of Routine Mode Choice Decisions emphasizes the need for a comprehensive approach to shift routine automobile travel to other modes. In-depth interviews illustrate the importance of each of the five steps in the theory. Planners, designers, engineers, and other policy-makers should implement strategies that make walking and bicycling more attractive at all stages of the mode choice decision process. A limited focus on a single step, such as improving pedestrian

and bicycle safety, without increasing awareness of walking and bicycling, decreasing distances to stores, schools, and workplaces, or encouraging community support for active transportation modes may do little to reduce automobile use. However, if pedestrian and bicycle safety improvements are complemented with efforts to zone for land uses that increase accessibility between activities, convert extra parking lot space into housing or retail stores, and encourage walking and bicycling as acceptable forms of routine transportation in the community, this set of changes may result in more walking and bicycling. Comprehensive approaches that address awareness and availability, basic safety and security concerns, convenience and cost, enjoyment, and habits have the potential to increase sustainable transportation.

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