Perspectives on Seattle Women's Decisions to Bike for Transportation

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Abstract

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A tangle of health, quality-of-life, environmental, and economic concerns has prompted Seattle and other major US cities to pursue strategies that encourage more trips by foot, bike, and transit. Yet increasing bicycling rates remains a distinct challenge, as evidenced by the extremely low share of Americans—especially women—who choose the two-wheeled mode for their everyday journeys. Even in Seattle, which has earned accolades for bike-friendliness, men compose more than 70 percent of bike commuters. An understudied research area lies in determining why these gender differences exist, to what extent they can be overcome, and, in general, how best to attract cycling skeptics. A better understanding of motives for bicycling among both genders and their nuanced subgroups is essential if planners hope to shift more trips away from motorized modes and reap the array of benefits associated with active transportation.

This master's thesis contributes to the limited body of research on gender-related bicycling behavior and preferences by examining four major questions: (1) What are the major barriers associated with Seattle women's decisions to bicycle for transportation? (2) What are the key motives that may cause Seattle women to start or increase their cycling? (3) How do these barriers and motives differ among Seattle women who do or do not consider themselves daily riders? and (4) Based on these factors, what strategies might planners and other interested stakeholders employ to encourage more cycling among Seattle women?

This research centers on a quantitative analysis of responses from a non-representative

sample of 365 Seattle women, including 106 women who reported not riding for any of their everyday trips and 259 women who reported riding daily, collected through a survey by the Association of Pedestrian and Bicycle Professionals' Women's Cycling Project in 2010. Through a quantitative comparison of these two ridership groups, I investigated how barriers and motives vary by self-reported experience levels. My analysis was informed by the ecological model, which suggests that individual, social-environment, and physical-environment factors all play roles in transportation behavior.

Consistent with existing literature, safety in the presence of motorized traffic was the paramount concern for daily and non-daily riders alike. Weather, steep topography, distances between origins and destinations, route connectivity, and grooming and cargo issues also played important roles in the women's cycling decisions, especially for non-daily riders. By contrast, bike and equipment issues, presence of social supports in the community, and connectivity with transit appeared to be less relevant considerations. Based on these findings, I recommended that planners consider greater separation of bikes from motorized traffic, improve end-of-trip facilities, explore creative workarounds to steep topography, seek solutions to increase route connectivity, and enhance marketing activities that address cycling for transportation as a lifestyle.

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Chapter 1

INTRODUCTION

1.1 Research Context and Focus

A tangle of health, quality-of-life, environmental, and economic concerns has prompted Seattle and other major US cities to take actions that discourage use of single-occupancy motorized vehicles. There appears to be a strong consensus that boosting levels of walking, bicycling, and riding mass transit can help to meet a number of vital civic goals, ranging from reducing pollution to fighting chronic diseases (Pucher et al., 2010; Pucher and Buehler, 2011). Yet increasing bicycling rates remains a distinct challenge across the United States, as evidenced by the extremely low share of Americans who choose the two-wheeled mode for their everyday journeys to work, school, and other frequent destinations (US Census, 2010).

To understand the reasons for these low ridership levels, it is important to identify who in the US population is not bicycling and why. Notably, biking for utilitarian purposes is largely a pursuit of males, who outnumber females on the roads by a ratio of at least two to one, depending on the location and data collection method (Cascade Bicycle Club, 2009; City of Seattle, 2011; Pedestrian and Bicycle Information Center, 2010; Emond et al., 2009; US Census, 2010). An understudied but emerging research area lies in determining why these gender differences exist, to what extent they can be overcome, and, in general, how best to attract cycling skeptics.

Although there is no shortage of speculation as to why women are less likely than men to bike in the United States, very little published data describes US women's bicycling preferences and behaviors in detail, much less highlights differences between males and females. Broader existing research indicates that travel behavior for women and men has historically differed on a number of fronts, including distances traveled to the workplace, purposes of trips, and travel mode choice (Cascade Bicycle Club, 2009; City of Seattle, 2011;

Pedestrian and Bicycle Information Center, 2010; Emond et al., 2009). Women also tend to be more risk averse than men and to have differing standards for safety in public spaces (Eckel and Grossman, 2008; Borghans et al., 2009; Harris et al., 2006; Loukaitou-Sideris and Eck, 2007). How these complex factors translate to bicycling behavior per se remains less clear, as in general, research on determinants of bicycling behavior for either gender is inconsistent and incomplete (Pucher et al., 2010; Dill, 2009).

The purpose of this master's thesis is to contribute to the limited body of research on bicycling behavior and preferences by examining a research question that has not yet been explored in depth: the chief barriers and motives for biking for transportation among working-age women who live in Seattle. Discussions with local transportation planners and bicycling advocates have confirmed the existence of a persistent gender split in the city and established a need for additional insight into why relatively fewer women than men bike for transportation here.

The goal of this thesis is to aid planners' attempts to create equitable transportation networks that serve the needs of a wider spectrum of individuals, especially in Seattle but ideally in other US cities as well. If planners and other interested parties wish to promote an overall increase in the number of trips taken by bike, it is critical to gain a better understanding of why women do not take up this transportation form as actively as men and to frame strategies accordingly. As such, this thesis addresses four major questions:

- What are the major barriers associated with Seattle women's decisions to bicycle for transportation?

- What are the key motives that may cause Seattle women to start or increase their cycling?

- How do these barriers and motives differ among Seattle women who do or do not consider themselves daily riders?

- Based on these factors, what strategies might planners and other interested stakeholders employ to encourage more cycling among Seattle women?

For this investigation, I analyzed responses to a detailed national stated-preference questionnaire from a non-representative sample of 365 Seattle women, including 106 women who reported not riding for any of their everyday trips and 259 women who reported riding daily. Data came from the Association of Pedestrian and Bicycle Professionals' Women Cycling Project questionnaire in spring 2010. Through a quantitative comparison of daily and non-daily ridership groups, I examined how barriers and motives vary by these self-reported experience levels. In attempting to explain these responses, I favored the ecological model, which suggests that individual, social-environment, and physical-environment factors all play roles in transportation behavior. (Emond et al., 2009).

1.1.1 Organization of Document

This chapter continues with background on bicycling for transportation, including major justifications for this mode and overviews of cycling in the United States, cycling among females, and cycling in Seattle.

Chapter Two presents a literature review focused on five major threads with relevance to my research questions: (1) determinants of cycling as a transportation mode, (2) gender and travel behavior, (3) gender and physical activity, (4) gender and risk, and (5) gender and bicycling.

Chapter Three introduces the methods and dataset for this project, including the conceptual model, data source, questionnaire design, and information about the pool of respondents.

Chapter Four describes the findings in the Seattle sample for this survey, including a presentation of responses by daily riders and non-daily riders, and a comparison of the two groups.

Chapter Five discusses the most and least important factors in the respondents' cycling decisions and details the limitations of this study.

Chapter Six makes recommendations for focused actions in the planning realm and for future research directions, as well as provides conclusions.

1.2 Background

1.2.1 Justifications for Bicycling for Transportation

In recent years, many metropolitan areas across the United States have been placing a growing emphasis on policies and infrastructure changes designed to elevate local walking and bicycling rates, thanks in part to financial support from several federal programs (Pucher and Buehler, 2011; Pedestrian and Bicycle Information Center, 2010). The pursuit of these activities stems from a growing body of literature that speaks to proven and potential benefits of cycling and walking. Arguments in favor of non-motorized modes typically fall into three major and intertwined categories: health, environment, and economy.

Health Bicycling has proven public health benefits—in particular, those associated with achieving recommended physical activity levels (Pucher et al., 2010). It is well established that increased physical activity can reduce the incidence of chronic diseases associated with lack of exercise in men and women alike (Dannenberg et al., 2003). These conditions include obesity, cancer, heart disease, and stroke, as well as mental health problems such as depression. The Centers for Disease Control recommends at least 30 minutes on five days per week of moderate physical activity, which can include "riding a bike on level ground with few hills" (Centers for Disease Control, 2012).

The consequences of insufficient physical activity are dramatic. The World Health Organization estimates that 60 to 80 percent of the world's population does not get enough exercise to generate health benefits and that physical inactivity is responsible for about 22 percent of cardiovascular disease cases worldwide (de Hartog et al., 2010). All told, physical inactivity leads to some 1.9 million annual deaths internationally (Brown and Roberts, 2011). In King County, Wash., 15 percent of all adults reported not getting any physical activity in the last month, a percentage that rose between 2000 and 2009 (King County, 2009). In addition, some 55 percent of the county's adult population is overweight or obese, a percentage that grew from 2001 to 2010, particularly among women.

Active transportation, namely walking and biking, represents a promising way to accomplish physical activity goals because they are already among the most popular forms of

exercise (Litman, 2011; de Hartog et al., 2010). Meanwhile, a growing body of literature suggests that transportation and land use decisions—including the availability of adequate facilities for walking and bicycling—can make an important positive impact on health if they encourage health-promoting behaviors, such as regular physical activity, while reducing the probability of risks, such as unintentional injuries caused by conflicts between pedestrians or cyclists and motorists (Dannenberg et al., 2003). A study of health data in 50 US states and 47 of the largest 50 US cities found that areas with higher walking and cycling rates also had a higher percentage of adults who met recommended physical activity levels, as well as a lower share of adults with obesity and/or diabetes (Pucher et al., 2010). Although these findings were significant, the researchers could not conclude that active transportation alone caused the improved health outcomes.

To be sure, bicycling can have health drawbacks. One potential hazard is increased exposure to air pollutants when a cyclist rides within close range of motorized traffic and breathes more quickly as a result of physical exertion. Another risk is being involved in a traffic incident with a motorized vehicle, which can lead to injuries or even death. Both pedestrians and bicyclists face higher risks of fatal traffic incidents than do car drivers when measured by incidents per distance traveled (de Geus et al., 2012). However, an extensive review of literature on air pollution exposure and road traffic injuries indicates that the projected health benefits of cycling far outweigh these risks (de Hartog et al., 2010). Ultimately, shifting more trips to bikes from motorized modes could actually help to reduce air pollution, thus providing associated health benefits to society as a whole (de Hartog et al., 2010). Air pollution contributes to conditions like asthma and other respiratory diseases and can cause long-term lung damage in both children and adults (US Environmental Protection Agency, 2009). Studies also indicate that as the number of bicyclists on the road increases, the likelihood of injuries declines, a phenomenon sometimes known as "safety in numbers" (Pucher et al., 2010).

Environment Because bicycling is essentially a non-polluting mode, powered only by human energy, replacing motorized vehicle trips with biking trips offers a strong potential for environmental improvements. These benefits include reductions in air pollution, fuel usage,

and associated greenhouse gas emissions. In recognition of these possible rewards, many states and municipalities are recommending concerted efforts to boost walking and bicycling rates as part of their climate change action plans (Pedestrian and Bicycle Information Center, 2010).

There is general agreement among international climate change scientists that human activities bear major responsibility for the gradual warming that the Earth has experienced since the 1950s, and automobiles running on fossil fuels are a major contributor (US Environmental Protection Agency, 2009). According to the US Environmental Protection Agency, potential negative effects of climate change are numerous: health problems caused by longer heat waves or very cold spells and worsening air quality, differences in food costs and supply because of changes in vegetation, increases in both floods and droughts, damage to property and recreational opportunities in coastal areas that may more greatly affected by erosion, and impacts on the migratory patterns and habitat of wildlife.

In the United States, the transportation sector has consistently been the second-largest generator of carbon dioxide emissions after electricity generation, accounting for nearly 30 percent of carbon dioxide emissions in recent years (US Environmental Protection Agency, 2012). Of those transportation emissions, some 65 percent come from passenger cars or light duty trucks, which include sport utility vehicles, pickup trucks, and minivans. Transportation-related emissions have increased between 1990 and 2010, in large part because the number of vehicle miles traveled by passenger cars and light duty trucks also increased during that time period. At the same time, there were not large improvements in the fuel efficiency of vehicles on American roads.

Shifting car trips to walking and biking can also help to reduce traffic congestion, which can add to fuel consumption and carbon dioxide emissions. It is difficult to measure precisely how much these emissions could drop, as they relate to complex factors such as individual driver behavior, vehicle weights, roadway types, and traffic conditions (Barth and Boriboonsomsin, 2009). However, some models have shown that some congestion-reduction strategies could help to reduce carbon dioxide emissions by as much as 30 percent.

Economy One of the most basic benefits of bicycling is its very low start-up and maintenance costs. The annual cost of owning and operating an automobile can top $9,000 per year, but annual bike ownership and upkeep is estimated at little more than $100 (Pedestrian and Bicycle Information Center, 2010).

The potential economic benefits of bicycle usage are especially important because transportation has consistently composed the second-largest chunk of American household spending after housing and related costs (US Department of Labor, 2011). The average household or family unit devoted about 16 percent of its annual expenditures (an estimated $7,677) to transportation costs in 2010, with about 4 percent of its total annual expenditures going to gasoline and motor oil alone. With gasoline prices surpassing $4.00 per gallon in the Seattle area at this writing, the affordability of bicycle travel becomes even more dramatically apparent.

The lower costs of bicycling also create strong potential for promoting socioeconomic equity. People with lower incomes or disabilities tend to rely less heavily on driving (Litman, 2011). Thus, improving networks for walking and biking has the potential to aid socioeconomic equity goals by increasing access to valuable services and job opportunities among people who cannot afford to own a vehicle or regularly use public transportation or other pay-per-use modes, such as taxis.

In addition, a number of studies have attempted to quantify the economic benefits of bicycling at various scales. Several state-based studies have pointed to the multimillion-dollar revenues that have resulted from multiplier effect of the bicycling industry—that is, the creation of numerous supporting jobs ranging from manufacturing to tourism. One often-cited example is in the Outer Banks, North Carolina, which invested $6.7 million to install bicycle infrastructure and now claims $60 million generated in related economic activity sparked by bicycle tourism (Flusche, 2009). Studies in San Francisco and Toronto have also suggested that bicycling makes a positive impact on small retail businesses, with people who arrived by bike spending more money per month in local shops than those who drove (Flusche, 2009).

Economic benefits also stem from the improved health and well-being associated with regular exercise. Multiple studies have found that increased levels of physical activity can

result in medical and healthcare cost savings, ranging from $128 to as much as $1,175 per person per year, depending on the analysis approach (Flusche, 2009). Other research has found that people who are physically active miss fewer days of work, which has important implications for employee productivity and by extension economic progress (Brown and Roberts, 2011).

In considering these benefits, it is also worthwhile to recognize that installing bicycle infrastructure often requires a far smaller investment than motorized infrastructure. In one extreme example, California estimated it would cost $25 million per mile to repave a three-mile stretch of Interstate 710 in Los Angeles. By some estimates, however, creating a bike lane on an existing street can cost as little as $5,000 per mile year (Flusche, 2009).

1.2.2 Existing Conditions for Cycling in the United States

Despite its potential to afford a variety of benefits, bicycling for transportation remains a marginal pursuit in the United States as a whole. Bicycling represented only 1 percent of all types of journeys as measured by the 2009 National Household Travel Survey, the nation's largest measurement tool for all types of trips (Pedestrian and Bicycle Information Center, 2010). Walking is the vastly more popular non-motorized mode, accounting for about 10 percent of all journeys nationwide (Santos et al., 2011).

For commute trips, the share of bicyclists is even lower. Nationwide, only 0.5 percent of the some 137 million workers age 16 and older commuted to work primarily by bike, while some 86 percent drove a personal vehicle in 2010 (US Census, 2010). The US has not yet met its previous goal of doubling its bike transportation mode share from 1990 levels of 0.7 percent, as biking remains solely a recreational or exercise activity for most Americans (Krizek et al., 2009).

However, the cycling mode share for commuting is a few percentage points higher than the US national average in large cities like Portland (6 percent), Seattle (3.6 percent), San Francisco (3.5 percent), and Washington, DC (3.1 percent), as well as university towns like Berkeley (8 percent) and Davis, California (22.1 percent); Boulder; Colorado (9.9 percent); Gainesville, Florida (6 percent); and Cambridge, Massachusetts (6.8 percent) (US Census,

2010). Aside from in college towns, the typical cyclist in the United States tends to fit a certain profile: a white male, aged 18 to 44, with a relatively high income (Krizek et al., 2009). On the whole, cycling in the United States is nowhere near as prominent a transportation mode as in European countries such as the Netherlands, Denmark, and Germany, where rates can be 10 or more times greater nationally (Pucher and Buehler, 2008).

After decades of declining rates of walking and bicycling for commute trips, the US Department of Transportation (USDOT) in 1994 adopted its first-ever national strategy acknowledging the need to increase bicycling rates, improve pedestrian safety, and make "accomodations" for non-motorized modes (Pedestrian and Bicycle Information Center, 2010). This movement received another symbolic boost in 2010, when USDOT issued a new policy statement that reiterated its goal of increasing levels of bicycling and walking and proclaimed, "The establishment of well-connected walking and bicycling networks is an important component for livable communities, and their design should be a part of Federal-aid project developments" (US Department of Transportation, 2010).

Although funds for bicycle and pedestrian projects represent scarcely 2 percent of the overall federal transportation budget, total spending has nevertheless increased more than tenfold since the early 1990s to surpass $1 billion annually in 2009, thanks in large part to a boost in funds included with the post-housing-crash American Recovery and Reinvestment Act (Pedestrian and Bicycle Information Center, 2010).

State-level actions have also been on the rise. Half of US states had published goals to increase levels of bicycling and decrease levels of bicycling-related fatalities, and twenty-six states had adopted master plans for bicycling as of a 2009 survey (Steele and Altmaier, 2010). In addition, thirty-three of the nation's fifty most populous cities had stated goals of increasing bicycling levels and decreasing bicyclist fatalities, and thirty-seven had adopted bicycle master plans (Steele and Altmaier, 2010).

Cycling among Females

The advent of the bicycle in the late 19th century supplied new transportation and recreational opportunities to social groups that were previously more homebound. Women in

particular benefited from the freedom and independence granted by riding bikes for fun and to key destinations (Elston, 2002). "The bicycle supplies...a new pleasure—the pleasure of going where one wills, because one wills...Riding the wheel, our own powers are revealed to us...You have conquered a new world, and exultingly you take possession of it," wrote one female fan of bicycling in 1896 (Fee and Brown, 2003). Moreover, proponents, including physicians, viewed cycling as a healthy activity that the whole family could do together (Fee and Brown, 2003).

Yet by the mid-20th century, bicycling as a transportation form had begun to decline dramatically among both genders as car ownership became more affordable and commonplace and destinations became more spread out from center cities. Although a modest renaissance in bicycling has been occurring in the past few decades in some North American cities, research has consistently shown that men are more likely to be part of this movement than women (Emond et al., 2009; Steele and Altmaier, 2010; Moudon et al., 2005; Pucher and Buehler, 2011; Pedestrian and Bicycle Information Center, 2010).

Nationwide, male cyclists take at least twice as many trips for all purposes as do female cyclists (Emond et al., 2009). From 2001 to 2009, the share of all trips taken by bike by women in the United States remained at about 0.5 percent, yet that proportion grew slightly, from 1.2 to 1.7 percent, among men during that same time period (Pucher et al., 2011).

Women's trips accounted for only about one quarter of all bike commute trips nationwide in 2010 (US Census, 2010). This number appears to have declined from 2001, when women accounted for about one-third of commute trips by bike (Pucher et al., 2011). A similarly small proportion of female cyclists is apparent in other developed countries with overall low cycling rates, such as the United Kingdom and Australia (Garrard, 2003; Winters et al., 2010). In general, the proportions of male and female cyclists are closest in places where overall bicycling mode share is highest (Emond et al., 2009; Steele and Altmaier, 2010; Moudon et al., 2005; Pucher and Buehler, 2011; Transportation Research Board of the National Academies, 2005; Pucher and Buehler, 2008). For example, women are responsible for 45 percent of all bike trips in Denmark, 49 percent in Germany, and 55 percent in the Netherlands (Pucher and Buehler, 2008).

Although it is not entirely clear why these countries have greater levels of gender equity in their bike ridership levels, experts suggest that a major reason is that cycling is safer in those countries. Rates of fatalities associated with biking—when averaged from 2002 to 2005 per 100 million kilometers cycled—were about five times greater in the United States and more than three times greater in the United Kingdom than in the Netherlands (Pucher and Buehler, 2008). Germany and Denmark's bike fatality rates were three to four times lower than in the United States and United Kingdom for the same time period. Similarly, non-fatal injury rates for US bicyclists were about eight times higher than in Germany and some 30 times higher than in the Netherlands and Denmark.

Some researchers maintain that the reason for improved safety in these countries is a strong top-down focus on making cycling feasible for a large swath of the population through a variety of tactics. These strategies include providing separated bike facilities, such as on-street lanes and off-road paths; modifying intersection designs to prioritize bikes; calming traffic on minor streets; providing ample bike parking; supplying robust education about safe cycling; and implementing traffic laws that emphasize cyclist rights (Pucher and Buehler, 2008).

Women and men also cycle to work at more similar rates in smaller US cities with bicycle mode shares that are higher than the national average, such as Davis, California; Gainesville, Florida; Madison, Wisconsin; and Eugene, Oregon (Emond et al., 2009; US Census, 2010). Among US cities that have both a population greater than 500,000 and the highest bicycle mode share, the largest share of female bike commuters is in Philadelphia, followed by Boston (see Table 1.1) (US Census, 2010). (It was not immediately evident why that is the case.)

In Seattle, downtown bicycle commute counts have long shown a gap between the number of men and women riding to work, with women composing barely 30 percent of the ridership in 2011 (City of Seattle, 2011). Cascade Bicycle Club, the local advocacy group, has called out the underrepresentation of women in the Seattle cycling population as a way to measure progress toward "balancing the cycling demographics" in the city (Cascade Bicycle Club, 2009). Through an online survey in 2009, Cascade found that women were most concerned about disconnected bike routes and lack of bike lanes, which is consistent with similar

Table 1.1: Leading US Cities (*Population* $> 500,000$) for Bike Commute Mode Share with Gender Data, 2010, Source: US Census 2010, League of American Bicyclists 2011

City	State	Population	Workers	Bike %	Bike #	% Female Bikers
Portland	OR	585,429	286,228	6.0%	17,035	35%
Seattle	WA.	610,710	339,160	3.6%	12,306	30%
San Francisco	CA	805,463	437,814	3.5%	15,208	33%
Washington	DC	604,453	296,717	3.1%	9,288	32%
Tucson	AZ.	521,132	219,852	3.0%	6,504	35%
Denver	CO	604,414	296,453	2.2%	6,514	35%
Philadelphia	PA	1,528,306	583,734	1.8%	10,503	**42%**
Boston	MA	621,383	309,620	1.4%	4,369	39%
Albuquerque	NM	547,585	257,422	1.4%	3,519	34%
Chicago	IL	2,698,831	1,168,318	1.3%	15,096	28%
San Diego	CA	1,311,886	620,939	1.0%	6,390	31%
Austin	TX	795,518	412,291	1.0%	4,242	22%
Los Angeles	CA	3,797,144	1,706,116	0.9%	16,101	22%
New York	NY	8,184,899	3,615,588	0.8%	27,917	21%
Columbus	OH	789,939	379,334	0.7%	2,498	33%
Baltimore	MD	620,583	256,622	0.7%	1,788	19%
Milwaukee	WI	595,587	249,594	0.7%	1,723	22%
Phoenix	AZ	1,449,481	620,072	0.6%	3,576	10%
San Jose	CA	949,197	426,136	0.6%	2,708	16%
United States		**309,349,689**	**136,941,010**	**0.5%**	**731,286**	**26%**

findings by a survey from a San Francisco bike advocacy group.

In recent years, a series of formal and informal efforts have cropped up in an effort to better understand why this gender gap exists and to seek solutions. One of the cornerstone efforts is the Women Cycling Project (WCP), formed in 2010 by the Association of Pedestrian and Bicycle Professionals, a growing national organization composed of planning professionals who focus on pedestrian and bicyclist planning. In partnership with two prominent national advocacy groups, the Alliance for Biking and Walking and the League of American Cyclists, the Women Cycling Project has hosted annual webinars and other events to discuss ways to increase the number of women interested in biking for recreation and transportation. In 2012 the group organized its first National Women Cycling Forum as part of the National Bike Summit in Washington, DC, an annual lobbying event for bicycling advocates from across the United States. A nationwide online questionnaire sponsored by WCP forms the basis of the data analysis for this thesis.

Focused local efforts are also contributing to these efforts across North America. In Vancouver, British Columbia, the local Translink public transit agency titled its latest cycling strategy "Cycling for Everyone" and set a goal of making cycling "feel safer so that by 2040, 50 percent of all trips are made by females" (Translink, 2011). As of 2008, women made only 28 percent of the cycling trips in the metro region. "The proportion of cycling trips made by females is an important indicator to measure how safe cycling conditions are perceived to be," the report said. Translink proposes conducting additional market research about cycling with an emphasis on reaching women.

The city of Portland, Oregon operates a program known as "Women on Bikes," which offers free women-only bike clinics and group rides. City officials have credited the program with helping to increase the number of women biking on Portland streets from 21 percent of all riders in 1992 to 31 percent of all riders in 2010 (Haughney, 2011; Portland Bureau of Transportation, 2012).

In Los Angeles and surrounding areas, which hold a reputation for historically automobile-oriented planning, a new non-profit advocacy coalition called Women on Bikes SoCal launched a campaign in February 2012 aimed at doubling the number of women and girls riding bikes during the next five years (Women on Bikes SoCal, 2012). A major component of these

efforts is education. The organization hopes to raise enough funds to hire a dozen "highly trained female bicycle safety instructors" to teach in the region, particularly in lower-income and minority communities.

A nationally-oriented group called Girl Bike Love in 2012 established May 13—Mother's Day—as a first-ever global day to draw attention to women's cycling issues. The movement, known as CycloFemme, invited women around the world—and their male supporters—to organize group rides and participate in bike races on "to honor the past, celebrate the present, and empower the future of women in cycling." A nascent Seattle group called Critical Lass sponsored an associated ride. Other Seattle-area bicycle organizers stage regular women-targeted riding events, including one series named Menstrual Mondays.

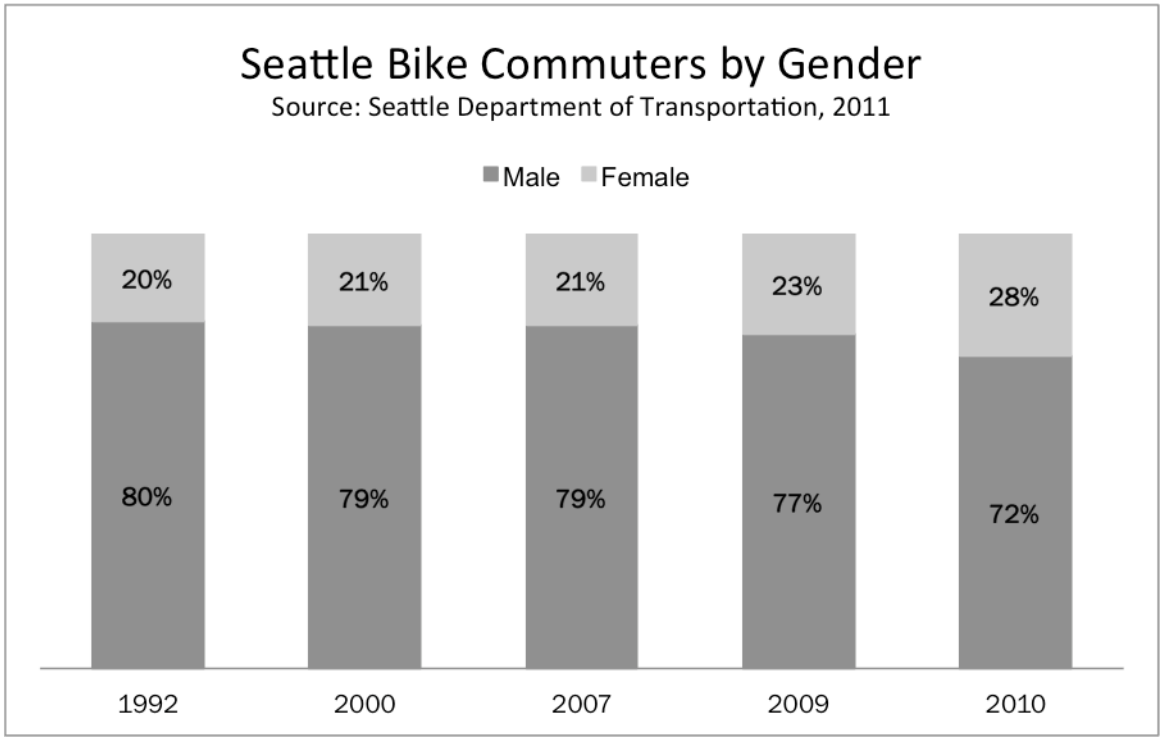
Cycling in Seattle

Seattle holds a strong national reputation as a bicycle-friendly city, including a "gold" rating from the League of American Bicyclists (League of American Bicyclists, 2009). In recent years, both Seattle and Washington State have ranked in the top third of all states for their bicycling mode share, safety record, funding, staffing, and advocacy capacity (Steele and Altmaier, 2010). Seattle was also one of the first US cities to establish a bicycle program in its Department of Transportation (City of Seattle, 2007).

Seattle has consistently ranked among the top large US cities for its percentage of commute trips by bike. Bicycling accounted for 3.6 percent of all commute trips in Seattle in 2010, making it second only to Portland, Oregon (6 percent) for rate of bike commute trips in cities with more than 500,000 residents (US Census, 2010). The mode share nearly doubled between 2010 and 2000, when it was only about 1.88 percent (City of Seattle, 2007). These numbers likely underestimate the rate of bicycling in Seattle and other US cities, as they does not consider bicycle trips for other everyday purposes, such as shopping, exercising, or visiting friends. Beyond the Census estimates, very little local data exists at the city level on number of bicycle trips per day, aside from mostly annual peak period commuter counts by the Seattle Department of Transportation and Cascade Bicycle Club (City of Seattle, 2007).

In addition, limited local data exists on the gender composition or other demographics of Seattle bicyclists as a whole. City of Seattle counts at more than 20 downtown locations during peak morning travel hours (6:30 to 8:45 a.m.) indicate that women compose a relatively small but rising share of the city's bicycle commuters. In 1992, only about 20 percent of the commuters were women, but by 2010, that number had climbed to 28 percent, as shown in Figure 1.1. The percentage jumped most dramatically—about 5 percentage points—from 2009 to 2010, although it is not clear from discussions with city transportation staff why that is the case, except that the city has experienced a general rise in raw numbers of bike commuters in the past few decades. The latest Census data also estimated that 30 percent of bike commuters were female, which is consistent with city counts (US Census, 2010).

Figure 1.1: Gender Split in Downtown Seattle Bicycle Commute Counts, 1992-2010



Previous data indicates that the primary purpose of bike trips in Seattle was traveling to or from work, which accounted for 68 percent of respondents' last trips in a non-representative 2006 city questionnaire of about 1,500 residents (City of Seattle, 2007). About 17 percent primarily cycled for exercise or recreation, and about 8 percent rode for personal business or errands. The remaining trips were to visit friends or socialize, or to pursue other activities.

In the same survey, the biggest factor for respondents in deciding to cycle was traffic safety along their routes, followed by travel time, need for exercise, and weather, according to the same survey. About 70 percent of the respondents said installing bicycle lanes or building bicycle trails would make the biggest impact on encouraging bicycling in Seattle.

The Seattle Department of Transportation set a goal of tripling cycling levels between 2007 and 2017 and has begun efforts aimed at encouraging more trips by "willing but wary" cyclists (Seattle Bicycle Program, 2012). Central to these efforts is implementation of the Seattle Bicycle Master Plan, which has served as the guiding document for all bicycle-related infrastructure upgrades since its adoption in 2007 (City of Seattle, 2007). The plan calls for installing a 450-mile network of various bicycle facilities, including bike lanes, sharrows, trails, and cycle tracks. If all of its proposals are implemented, then 95 percent of the city's population will reside within one-quarter mile of a bike facility. The city in 2012 was in the process of updating its Bicycle Master Plan, which includes collecting updated data on residents' bicycling behavior and preferences.

Progress toward those goals has been steady in recent years. The raw number of cyclists in Seattle has increased every year, and the city has nearly doubled its mileage of bike routes from less than 70 miles in 2007 to about 130 miles currently (Cascade Bicycle Club, 2009; City of Seattle, 2007). Since 2007, the city has spent $36 million on bicycle projects, which include striping new bike lanes and sharrows, installing signs on routes, instituting traffic signals especially for bikes, repaving and constructing new segments of trails, providing new bike parking spots, creating and distributing bike network maps, and funding educational programs about cycling. The city is also experimenting with new approaches to bike facilities, such as green-painted bike lanes designed to boost their visibility; buffered lanes, which provide more space between cyclists and motor vehicles; and bike boxes, which

create a special zone for cyclists to wait ahead of motorized traffic and receive a head start at intersections (Seattle Bicycle Program, 2012).

In addition, the city works to encourage bicycling as part of a suite of efforts aimed at car trip reduction. The city operates various incentive programs, which offer participants the opportunity to win gift cards and other prizes if they pledge to shift away from car usage and to other modes, including transit, walking, and bicycling.

Although the Bicycle Master Plan calls for cutting cycling crashes by one third by 2017, cycling in Seattle is relatively safe compared to other large municipalities (Cascade Bicycle Club, 2009). Measuring bike crash or injury rates is difficult because of lack of consistent bicyclist counts, but estimates suggest that the rate has remained relatively constant, as the number of riders increased more rapidly than the number of crashes. The number of bike thefts also declined consistently between 2006 and 2008.

Beyond Seattle proper, increasing levels of cycling and walking is also a strong regional goal, as the region looks to reduce greenhouse gas emissions and relieve traffic congestion. Many of the major land use tenets espoused by Puget Sound Regional Council relate to improving pedestrian and bicyclist experiences (Puget Sound Regional Council, 2010). These goals include building compact communities; designing with walkers and bikers in mind; connecting streets, sidewalks, and trails; and managing the parking supply.

Chapter 2

LITERATURE REVIEW

In considering why women generally bike for transportation at lower rates than men in the United States, it is relevant to consult existing literature in several overlapping areas. This literature review summarizes major research findings on five major topics: (1) general determinants of cycling, (2) gender and travel behavior, (3) gender and physical activity, (3) gender and risk, and (4) gender and cycling.

2.1 Determinants of Cycling as a Transportation Mode

A growing body of literature has examined the effects of numerous factors on biking levels in the United States and elsewhere, with the goal of discerning how best to encourage wider adoption of the bicycle as a transportation mode. However, it is important to note that research on bicycling behavior in general, regardless of gender, remains quite limited, particularly when compared with research on walking or other physical activity (Handy et al., 2010; Dill, 2009).

Although there is some agreement on what factors help to promote or discourage biking, it is clear that a complex, intertwined set of variables governs selection of this mode by men and women alike. Thus, determining causal relationships or the magnitude of effect of various factors has proven extraordinarily difficult for researchers who specialize in this topic. One particular challenge lies in explaining whether personal preferences and lifestyle choices are relatively more or less important than infrastructure and facilities for walking and biking (Forsyth and Krizek, 2010).

Generally, areas have experienced the greatest success in boosting biking rates not through a single tactic but instead through "comprehensive" packages of complementary activities. These actions include compact land use planning, restrictions on car use, bike infrastructure installation, and pro-bicycle educational and incentive programs, according

to a recent international review of 139 studies of infrastructure, programs, and policies designed to increase cycling (Pucher et al., 2010).

Although many of their findings remain inconclusive, researchers have examined several major factors as possible correlates to uptake of bicycling:

Safety Concerns Numerous polls and surveys suggest that a major determinant of whether people cycle lies in whether they perceive bicycling to be safe—and that many people, indeed, perceive cycling to be unsafe (Geller, 2009; Gatersleben and Appleton, 2007; Pucher and Buehler, 2008). The number of bicyclists killed in traffic incidents nationwide decreased by 14 percent between 1995 and 2008, but per capita US injury and death rates for bicyclists remain higher than those in countries with higher bicycle mode share (Steele and Altmaier, 2010). Concerns about too much motorized traffic and a lack of a safe place to cycle nearby were top deterrants cited by would-be cyclists in one Seattle study (Lee and Moudon, 2008).

Roger Geller, bicycle coordinator for the Portland Office of Transportation in Oregon, argued that cities that have reached very high levels of bicycle use have done so because they "substantially removed the element of fear associated with bicycling in an urban environment" (Geller, 2009). Geller and the City of Portland in 2005 devised a "Four Types" continuum of cyclists in order to strategize ways to increase bicycling use in Portland (Geller, 2009). In order to better understand their city's potential for attracting new riders, they divided the population into four categories: (1) a small minority of "strong and fearless" riders, who will ride anywhere regardless of the conditions; (2) the "enthused and confident," who probably compose less than 10 percent of Portland residents and are comfortable riding alongside motorized traffic but would prefer bike-specific facilities; (3) the "interested and concerned," an estimated 60 percent of the city population who are curious about cycling and like riding bikes but are too nervous about safety to ride regularly on city streets; and (4) the "no way, no how" group, which composes an estimated 33 percent of the city's population and has absolutely no interest in cycling under any circumstances.

The ideas underlying this typology have since received endorsements from other city bicycle coordinators and represent an important way of guiding bike planning strategies in

the absence of adequate data on this topic (Geller, 2009). Other researchers have conceived at least three types of cyclists: advanced riders (class A), basic riders (class B), and inexperienced riders (class C) (Krizek et al., 2009). Class A cyclists are the most confident in traffic and do not generally object to cycling on arterial or busier streets, while class B cyclists ride less often and are relatively less confident riding with motorized traffic. Class C cyclists, who typically include children and the elderly, choose not to ride on roads with traffic or without chaperoning.

Infrastructure and Facilities In general, increased availability of various bicycling infrastructure, including lanes and paths, has a high correlation with increased levels of cycling (Forsyth and Krizek, 2010). There is evidence that at least some cyclists—particularly more inexperienced ones—prefer dedicated bicycle lanes over riding on streets without special facilities (Krizek, 2006). Bike lanes and paths are associated with greater levels of commuter cycling at the city level in many of the 90 largest metropolitan areas in the United States (Buehler and Pucher, 2012). Some studies, however, suggest that more experienced cyclists prefer on-street bike lanes to off-road paths, underscoring the need to think beyond one-size-fits-all approaches to bike infrastructure (Pucher et al., 2010).

Disagreement remains over whether bicycle facilities separated from motorized traffic—through raised curbs, bollards, medians, parallel vehicle parking, and other means—are a viable and, moreover, safe way to improve cycling levels (Forsyth and Krizek, 2010; Forester, 1983). Proponents suggest that separated facilities, including cycle tracks, do not produce higher rates of injuries and furthermore help to increase the perception of safety, which can thereby encourage more people, particularly the more risk-averse set, to ride bikes (Lusk et al., 2011). This school of thought relies on the notion that as more cyclists are on the streets, their overall safety improves and risk of incidents declines. Critics, however, argue that crash data does not back up the superiority of separated facilities and that separated facilities add extra layers of complexity to intersections, sparking greater potential for conflicts and incidents between cyclists and motorists (Forsyth and Krizek, 2010; Krizek et al., 2009).

End-of-trip facilities, such as parking and showers, also appear to have a positive effect

on ridership levels. In some studies, the presence of secure parking at the destination is strongly associated with making cycling more attractive (Pucher et al., 2010; Hunt and Abraham, 2006). The availability of showers at the destination also had a modestly positive effect on cycling rates.

Land Use and Distance Land use policies can play a role in bicycling decisions by determining the distances that citizens must travel to reach desired destinations. Studies have confirmed that a major barrier among non-cyclists is the perception of long travel distances or times (Forester, 1983; Gatersleben and Appleton, 2007).

A strong market exists for everyday cycling trips measuring less than about 2.5 kilometers (1.5 miles), according to an international review of more than 300 walking and bicycling studies (Krizek et al., 2009). However, only 27 percent of all trips by all transportation modes among US citizens measure less than 2.5 kilometers, as opposed to 44 percent in the Netherlands, 41 percent in Germany, and 37 percent in Denmark, where cycling levels are far higher (Pucher and Buehler, 2008). This greater number of longer trips, brought on by generally less compact land uses in the United States, may explain in part why biking is less popular in the United States.

Lower-density developments, which typically result in residences located farther from work and services, help to promote car usage over arguably slower, less-efficient modes (Buehler, 2011). Lower-density areas also make car use more attractive because they tend to have greater availability of parking and less traffic congestion than more crowded, inner-city environments (Buehler, 2011). Existing studies also show that walking and cycling are more common in neighborhoods classified as transit-oriented, as opposed to those considered automobile-oriented, which is the case in many parts of the United States (Duncan et al., 2005).

Still, associations between the built environment and active transportation usage are inconsistent (Foster et al., 2011; Pucher et al., 2010). One question that remains unanswered is how far most people are willing to bike to their destinations and how these distances vary among subgroups of society, such as women or people with lower incomes. A Seattle study found that people living within one-half mile of a separated bicycle path were at least 20

percent more likely to bike at least once per week, as opposed to people living between one-half and one mile away from the path. But the same study also found that the person's proximity to on-street bike lanes did not affect their bicycle use (Moudon et al., 2005). A Minneapolis-St. Paul study found just the opposite: no relationship between proximity to an off-street bike trail and likelihood of biking, but an increased likelihood of biking among people who lived within 400 meters of an on-street bike facility (Krizek and Johnson, 2007).

In addition, it is clear that distance is not the sole determinant, as even after controlling for trip distance, Dutch, German, and Danish residents make a far higher share of their local trips by bike than US residents (Pucher and Buehler, 2008; McClintock, 2002b). Furthermore, although there is evidence that shorter trip lengths (as measured by time) make cycling more attractive, some cyclists remain more likely to favor routes that take a longer amount of time if those routes are more separated from traffic (Hunt and Abraham, 2006). Little research exists on the relative importance of the directness versus the pleasantness of a route in cycling decisions.

Economics of Car Ownership In the United States, Australia, and other developed countries with relatively high car mode share, driving cars generally costs citizens less than other forms of transport (Krizek et al., 2009; McClintock, 2002b). European countries like Germany that have car ownership costs, including higher gasoline prices and sales taxes on vehicles, also tend to have higher rates of bicycle usage, which suggests some association between those variables (Buehler, 2011).

Although car and light truck ownership has been on the rise in the Netherlands, Germany, and Denmark since 1970, those ownership rates have grown less steeply, and a smaller proportion of those countries' residents own cars, than in the United States, in large part because of high taxes and fees associated with vehicle ownership (Pucher and Buehler, 2008; McClintock, 2002b). It is likely that the availability of strong alternatives to the car, such as robust non-motorized transportation infrastructure and public transportation systems, also contributes to these low car ownership rates (Pucher and Buehler, 2008).

The price of parking also can prove an important factor in whether a person decides to walk or bike instead of drive a car. Overall, when citizens are forced to pay closer to

the true costs of parking, they are more likely to pursue alternatives to the car. Although little concrete research explores the influence of parking costs on bicycling, there is evidence that the perception of strong parking difficulties is a major motivator for walking instead of driving (Krizek et al., 2009).

Natural Factors Numerous studies have found that rain, very hot or very cold weather, and dark conditions can discourage cycling (Handy et al., 2010; Forester, 1983). Flatter topography also tends to make cycling more attractive, while hills can be a barrier (Buehler, 2011; Gatersleben and Appleton, 2007; Lee and Moudon, 2008; Forester, 1983).

Clearly these factors are not the sole determinant, as numerous high-ranking cycling cities in the United States, including Seattle, Portland, and San Francisco, are renowned for their rainy weather and/or steep grades.

2.2 Gender and Travel Behavior

Since at least the late 1970s, transportation specialists have begun to acknowledge that differences exist in travel behavior between genders in the United States and elsewhere (Transportation Research Board of the National Academies, 2005). Researchers have found that important factors in determining travel behavior differences include distance, urban form, age, gender, household car availability, safety, and children's travel preferences.

Most existing transportation research on either gender has focused on automobile-based behaviors, typically in the context of the journey to work. In general, working-age women tend to work closer to home and have shorter work commutes (Transportation Research Board of the National Academies, 2005). Overall, they make more daily trips of any kind but spend less time on those trips and travel fewer miles than working-age men (Transportation Research Board of the National Academies, 2005; Root and Schintler, 1999).

The purposes and pathways for women's trips also tend to be different from those of men. Previous research using national US survey data suggests that women are more likely than men to engage in trip-chaining on their way to and from work and have a larger number of total trip-chaining activities per day than men (Transportation Research Board of the National Academies, 2005). Trip chaining is generally defined as the practice

of taking a sequence of trips connected by two anchor places, such as home and work, although precise definitions vary. For example, from 1995 to 2001, working women in two-income households in the United States were twice as likely as working men to pick up and drop off children at school on the way to work (Transportation Research Board of the National Academies, 2005). Lifestyle factors, namely gender and the presence of children in the household, have been found to be the biggest explainers of differences in trip-chaining behavior (Transportation Research Board of the National Academies, 2005). Women are also more likely than men to make trips related to household responsibilities, such as shopping, child care, and transporting passengers. Data from the 2001 National Household Travel Survey shows that US women made 77 percent more trips with their children than do men, as well as 19 percent fewer trips without their children (Transportation Research Board of the National Academies, 2005).

Some more recent studies suggest that the travel behavior of women and men is gradually becoming more alike, but the evidence is mixed (Transportation Research Board of the National Academies, 2005). On the one hand, the historic gap in work commute time lengths between men and women has been on the decline as more women have entered the labor force (Transportation Research Board of the National Academies, 2005). In addition, some data suggests that the proportion of women who drive to work, as opposed to using modes such as transit, is almost identical to that of men (Dickinson et al., 2003). However, other studies suggest that women are more likely to take public transport than to drive (Transportation Research Board of the National Academies, 2005). One study of German men and women found that demographic and activity-based factors make a difference; for example, likelihood of car use decreases with age and increases with number of children in the household and longer numbers of work hours (Transportation Research Board of the National Academies, 2005).

Little research exists on the walking-based travel behavior of women, although what does exist tends to suggest that women make more walking trips and cover longer distances on foot than do men (Transportation Research Board of the National Academies, 2005). An analysis of a large sample of 2001 National Household Travel Survey data found that female adults between the ages of 18 and 64 had slightly higher odds of taking "active" trips—that

is, by walking or biking—than males in that age group, but males in every other age group (children from 5 to 10 years old, adolescents from 11 to 17 years old, and elderly men 65 years or older) had a greater likelihood of walking or biking (Yang et al., 2011).

There is also little data exploring whether land use decisions affect men's and women's travel behavior in different ways. However, one recent study found that women who live in New Urbanist-style neighborhoods, which prioritize compact and "walkable" designs, are more likely to walk more often than women who live in less walkable neighborhoods, but they still would not walk as much as men living in such neighborhoods (Transportation Research Board of the National Academies, 2005).

Identifying differences in travel behavior among men and women, or within subsets of female groups, has been a relatively straightforward exercise. What is more difficult and will require further research is pinpointing the reasons for these differences.

2.3 Gender and Physical Activity

Although insufficient physical activity is a global phenomenon that affects both genders, numerous studies have suggested that women are even less likely than men to exercise in their leisure time (Bengoechea et al., 2005; Azevedo et al., 2007; Brown and Roberts, 2011). This lower inclination to exercise among some women may help to explain gender discrepancies in cycling for transportation.

For example, a survey of Brazilian men and women found that both genders walked similar amounts, but men were more likely to engage in moderate to vigorous physical activity (Azevedo et al., 2007). In addition, men were more likely than women to meet various recommended criteria for physical activity, such as completing more than 150 minutes per week of moderate exercise. However, it is important to note that the vast majority of both genders reported zero days of physical activity of any kind in the previous week.

Several studies have reported that the primary barrier to leisure-time physical activity in women is a perceived lack of time because of work, family, or childcare commitments (Eyler, 2003; Brown and Roberts, 2011). However, this evidence is mixed, as the few studies that have directly considered physical activity inherent to other everyday activities, such as housework, transportation, and occupational activities, as opposed to dedicated exercise

activities, have observed no gender differences.

Differences in physical activity levels also exist within subgroups of women. Women who are younger, white, college-educated, weigh less, and have no children at home have been found to be more likely to engage in sports or exercise (Sternfeld et al., 1999). Increased social supports and confidence in one's abilities to handle exercise amid other responsibilities have been associated with a greater likelihood of participating in these activities. Urban- or suburban-dwelling women are less likely to be sedentary than rural women, arguably in part because they have better access to physical infrastructure, such as sidewalks, and are located within reasonable walking or bicycling distance of various services (Eyler, 2003).

There is limited research on gender differences in perceived environmental influences on physical activity, but limited findings suggest that differences do exist. A randomized telephone survey of men and women in Alberta, Canada, found that men and women had different perceptions of their surroundings that in turn affected their likelihood of being physically active (Bengoechea et al., 2005). The women in that study were more likely than men to feel their neighborhoods were unsafe for walking at night, although these perceptions of poor safety were not linked to lower levels of leisure-time physical activity. They were also less likely to feel that they had easy access to places for physical activity or good availability of stores to buy things within easy walking distance of home.

Various studies have also shown that women in general are more likely than men to avoid activities in public spaces because of safety fears (Loukaitou-Sideris and Eck, 2007). This perception of safety has been shown to be a more pronounced concern for minority women, who were more likely than white women to report that feeling unsafe in their neighborhoods is prohibitive to exercising.

2.4 Gender and Risk

Gender differences in risk tolerance may help to explain discrepancies in bike ridership levels, as a major barrier to greater uptake of bicycling is the perception among many people that it is a less-safe transportation mode than alternatives (Geller, 2009).

A review of studies from the economics, sociology, and psychology fields indicates that women and men have demonstrably different attitudes toward taking risks (Eckel and Gross-

man, 2008). The bulk of these studies suggest that women are more averse to risk-taking than men (Harris et al., 2006). For example, in field experiments, women have been found to allocate significantly more of their pension investment accounts than men to low-risk, fixed-income investments, as opposed to higher-risk employer stock, and men have been found to bet more and bigger high-risk bets at horse and dog races (Eckel and Grossman, 2008). In addition to gambling and money-related risks, women have also been less likely than men to take risks related to health, such as not applying sunscreen, and to recreation, such as partaking in "extreme" sports (Harris et al., 2006).

Research in the transportation realm also shows women to be more risk-averse than men. For example, women are more likely to wear seatbelts while driving and are less likely to continue driving through yellow lights, drive at speeds greater than the limit, or break traffic laws (Harris et al., 2006). Other studies have shown that women are typically more alert to threats in their surroundings and are more likely than men to halt walking trips for perceived safety reasons (Transportation Research Board of the National Academies, 2005). One study in three different Maryland communities concluded that women tend to be more concerned than men with traffic issues and crime, more sensitive to safety risks in their environments, and more likely to change their walking behavior on the basis of these feelings (Transportation Research Board of the National Academies, 2005). In a Danish study, women were more likely than men to exercise certain cautious behavior when cycling—for example, always stopping their bike before turning left (Bernhoft and Carstensen, 2008).

However, in contextual situations that control for levels of competence, knowledge and confidence, women were more likely to take risks if they had higher levels of expertise (Eckel and Grossman, 2008). In another study, women were more likely than men to take certain risks in the social realm, such as disagreeing with a parent on a major issue or admitting their tastes were different than a friends' (Harris et al., 2006). These findings may have important implications for the role of education in promoting arguably more unfamiliar practices, such as cycling, among women.

2.5 Gender and Bicycling

A small but growing number of scholars and professionals have attempted to identify and measure factors that account for the gender divide in bicycling for transportation. An overview of findings on potential factors specific to women follows.

Perceived Safety and Security: A number of surveys in the United States, Canada, and Australia demonstrate that women view traffic safety concerns as a strong barrier to cycling (Garrard, 2003; Dill, 2009; Dickinson et al., 2003). Where women perceived that drivers in their community act safely toward cyclists, they were more likely to cycle, in contrast to men, for whom this factor was not a significant influence (Emond et al., 2009).

Women in a UK survey cited concerns about threats to their personal security as a reason for opting to drive their cars to work as opposed to cycle, even when they lived near enough to make cycling feasible (Dickinson et al., 2003). Some researchers posit that people who are less confident with cycling—young, old and female cyclists, by their estimation—may respond well to cycling infrastructure changes that make them perceive cycling as safer (Forsyth and Krizek, 2010).

Interestingly, there is little evidence that female cyclists are in reality less safe on the roads than are males. One UK study found that motorists overtaking cyclists gave significantly more space to a bicyclist who appeared to be female (but who, for the purposes of this study, was actually a male wearing a long wig). The researcher theorized that this phenomenon may have occurred because motorists perceive women to be less experienced—and thus less predictable in their movements—with bicycling, or perhaps because of politeness on the part of the drivers or the belief that women are more "frail" (Walker, 2007).

Facilities and Infrastructure: In general, researchers do not have sufficient data to fully understand the role of infrastructure on cycling behavior by either gender (Dill, 2009). There is evidence that riders of both genders prefer separate paths or lanes over sharing roads with motorized traffic, and installation of bike lanes has been shown to increase overall cycling levels in some instances (Pucher et al., 2011). There is also evidence that presence of dedicated bicycle facilities is more important to women—a phenomenon that is likely to

be closely linked to concerns about safety and security.

Among women in six small US cities with high cycling rates, feeling comfortable using bicycle facilities was the strongest predictor of their decisions to cycle (Emond et al., 2009). Other studies have found that women generally have a preference for riding on quieter streets, even if it means creating a slightly longer overall trip in time or distance (Pucher et al., 2010; Emond et al., 2009; Garrard et al., 2008; Transportation Research Board of the National Academies, 2005). There is also evidence that women place more value than men on the availability of lighted paths and paved shoulders (Transportation Research Board of the National Academies, 2005).

Even in Denmark, where cycling rates are far higher, women were more likely than men to choose routes with cycle paths and signalized crossings, whereas men were more interested in choosing the fastest route (Bernhoft and Carstensen, 2008).

In an observational study in Melbourne, Australia, women demonstrated a preference for off-road bicycle paths over on-road lanes or roads with no bicycle facilities, although this particular study was unable to conclude whether these preferences differed from men (Garrard et al., 2008). Another smaller Australian study found that female commuters were more concerned with facility type (an on-road lane versus no bicycle facility) than were males (Garrard et al., 2008).

Lifestyle and Household Responsibilities: Existing research about travel behavior suggests that women tend to have more complex trip-taking behavior than men because they are more likely to engage in activities, such as picking up children or shopping, that require transport of goods or passengers. Limited studies have found that these responsibilities prompt some women to perceive bicycling as less feasible or attractive (Emond et al., 2009; Steinbach et al., 2011). These complex responsibilities appear to explain in part why in one UK survey, women were significantly less likely to cycle to work than men, even if they lived within a distance that they considered to be close enough to cycle (Dickinson et al., 2003).

However, these trends do not hold up as strongly in European countries with high cycling rates, suggesting that personal perceptions and confidence levels can be more influential in cycling decisions than actual barriers associated with household responsibilities (Emond

et al., 2009).

General attitudes and culture: More difficult to quantify is the role of attitudes and general cultural norms on women's decisions to bike for transportation, but existing evidence suggests that cultural attitudes play an important role in bicycling uptake (McClintock, 2002a).

In a study in six small western US cities, women who agreed that they need a car for doing the things they like to do were less likely to bicycle, and women who reported concern for the environment were more likely to cycle (Emond et al., 2009). Both of these phenomena were unique to women in the sample and did not occur among men.

Other surveys have also suggested that women are more likely to perceive bicycling as something they cannot reasonably do and that is more in the realm of activities designed for fit, young men (Gatersleben and Appleton, 2007; Steinbach et al., 2011). In a UK survey of bike commuting behavior, women were significantly more likely than men to report that nothing could be done to prompt them to begin cycling to work (Dickinson et al., 2003). Another UK study proposed that cycling preferences are intensely bound up in social structures and that increasing rates of cycling among women will only occur once infrastructure is in place that allows "anyone" to cycle, not just those who identify strongly as cyclists (Steinbach et al., 2011).

Chapter 3

METHODS AND OVERVIEW OF DATA

3.1 Conceptual Framework

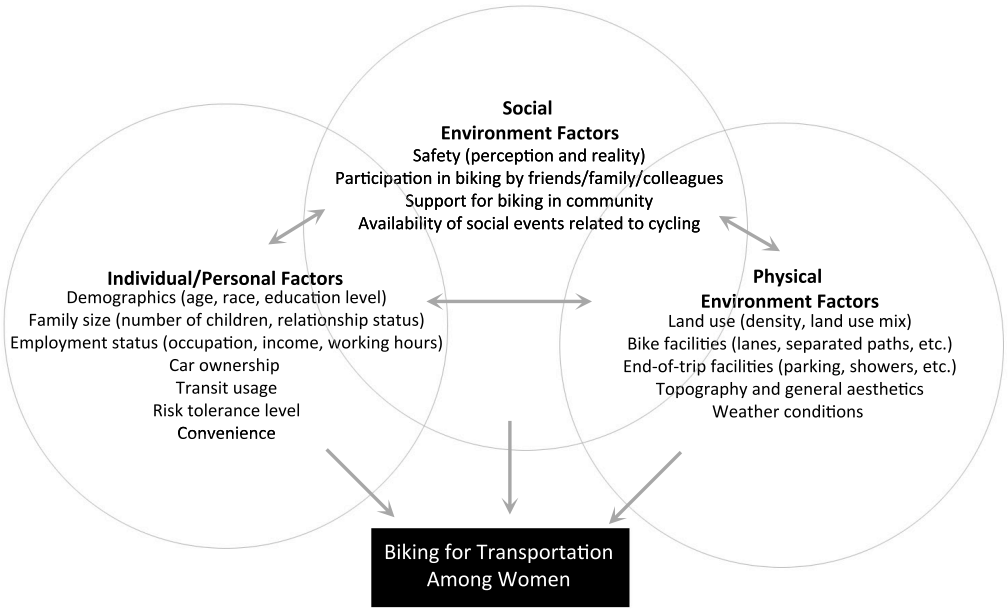
The basis for this analysis is the ecological model, which is frequently used in public health investigations about physical activity, nutrition, violence prevention, and other lifestyle choices. The ecological model, sometimes called the social-ecological model, considers a complex suite of intertwined factors, including individual, physical-environmental, and societal considerations (Centers for Disease Control, 2007; Emond et al., 2009).

Under an ecological model, a researcher may investigate, for example, whether an individual's level of social support or own sense of self-efficacy is a stronger determinant of whether he or she will exercise, as compared to the presence of potentially motivating built environment factors, such as sidewalks or bike paths.

I selected the ecological model because leading researchers in the health and built environment fields have advocated for its use in comparable examinations of the multidimensional reasons that people choose to bike for transportation or exercise (Saelens et al., 2003; Emond et al., 2009; Handy et al., 2010; Xing et al., 2010). This model contrasts with more traditional, engineering-field ways of modeling travel behavior, in which utility—in other words, how quickly and efficiently one can get from an origin to a destination using a particular mode—is the primary consideration, and social-environmental factors are not readily taken into account. I believe the ecological model offers a more nuanced approach to understanding the role of gender in bicycling decisions.

Figure 3.1 illustrates my application of the ecological model to potential reasons why women may or may not choose to bike for transportation.

Figure 3.1: Conceptual Framework for Investigating Women's Decisions to Bike for Transportation



3.2 Dataset Selection

This analysis relies upon a large dataset collected in spring 2010 by the Association of Pedestrian and Bicycle Professionals through their ongoing Women Cycling Project (WCP). WCP seeks to better understand why women cycle for transportation at far lower rates in the United States than do men and to create strategies for closing the gender gap.

After determining that insufficient time and resources existed to conduct primary data collection for this project, I sought secondary data on women's cycling behavior and preferences that had not already been analyzed in depth. However, it soon became clear that the few existing comprehensive datasets on bicycling behavior are generally limited to federally sponsored estimates of bicycle commuters as part of the US Census and the National Household Transportation Survey (Steele and Altmaier, 2010).

Through an intensive literature review and brainstorming process, I determined that the WCP dataset held the greatest potential for contributing to the scarcity of information on women's cycling behavior because of its very detailed set of questions and national geographic scope, including self-reported city and state location information for its respondents. I began discussions about using this dataset with the WCP questionnaire project manager, Fionnuala Quinn, in fall 2011 and obtained access to the data in January 2012.

3.3 Questionnaire Design

The inaugural WCP questionnaire posed 38 questions about a wide array of topics, including average miles ridden in various seasons and weather conditions, common trip purposes, motivation for cycling, family history of cycling, and, most important for this analysis, potential barriers to and motives for starting or increasing cycling.

WCP leaders offered the questionnaire through the online hosting service SurveyMonkey between March and May 2010. They marketed the survey largely through email lists and blogs operated by bicycling advocacy groups and APBP members. In marketing the survey, APBP members encouraged their colleagues to try to reach women who are not already cycling and sought to gather information from as diverse a set of women as possible. WCP does not plan to continue the survey a regular event but rather viewed this data collection

as important to guiding its work at the time.

The questionnaire involved a mixture of open-ended and checkbox-style questions. Each respondent viewed the questions and, when applicable, possible responses in the same order. None of the questions required an answer, which resulted in some blanks from respondents. Almost every question asked respondents to check off predetermined answers, which included a "none of the above" selection in most cases. Many questions also offered an open-ended "other" option that allowed space for respondents to write in additional comments as desired.

Most of the questions required respondents to recall individual behaviors and state observations and preferences. The survey began and ended with requests for basic demographic information: the respondent's gender; city, state and country of residence; age range (delineated by ten-year increments); race; and highest level of education completed.

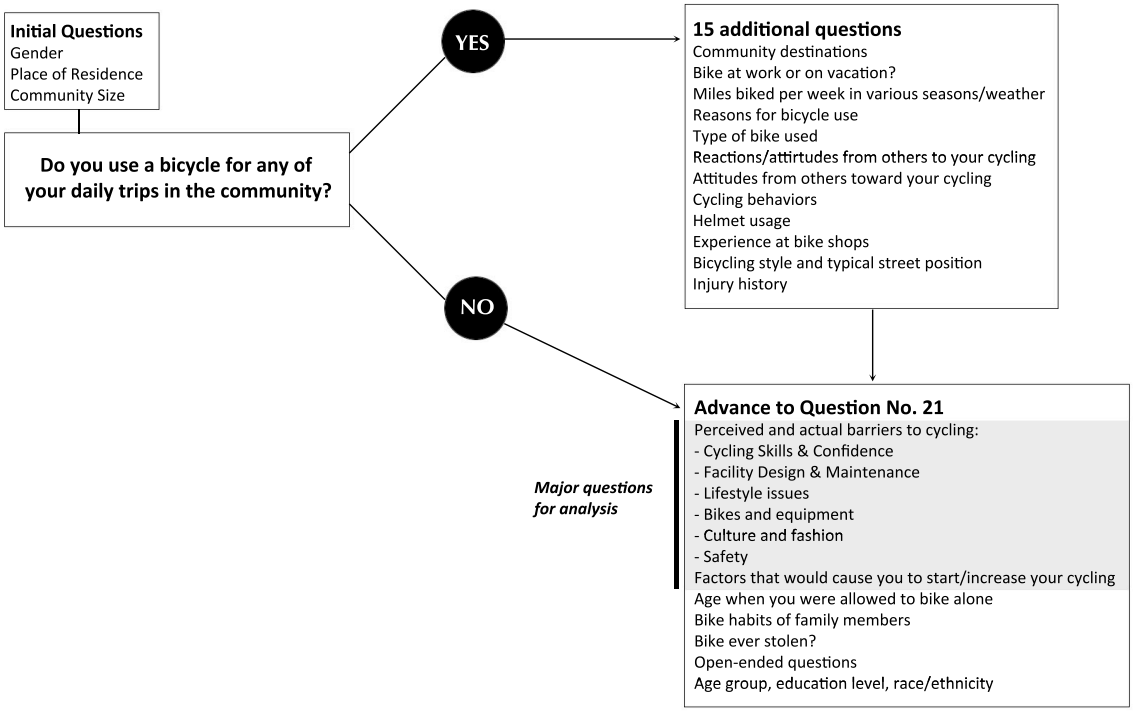
The questionnaire was designed so that respondents took two distinct paths depending on whether they selected a yes or no response to the fourth question, "Do you use a bicycle for any of your daily trips in the community?" The wording of this question interfered with the interpretation of the survey results, as described further in the Limitations section in Chapter 5.

Women who selected "no" advanced immediately to Question 21, beginning with a series of six questions in which they were asked to select from thematic groups of actual or perceived barriers to their cycling. For this study, this group of respondents were deemed "non-daily riders."

Women who selected "yes" continued with fifteen additional questions about topics such as for what purposes they ride, how many miles they ride on an average week in various seasons and weather types, what type of bike they ride, whether other family members or friends ride, and how they would characterize their cycling style. Then they proceeded to the same set of questions as the non-daily riding group about perceived or actual barriers to cycling. For this study, this group of respondents was deemed "daily riders."

Figure 3.2 illustrates the pathway that respondents took as they proceeded through the questionnaire and summarizes what questions they would receive if they selected yes or no to the daily riding question.

Figure 3.2: Pathway of Questionnaire Developed by Women's Cycling Project, 2010



3.4 Focus of Analysis

In order to address my established research questions, I chose to focus this analysis on answers by both daily and non-daily riders to seven questions, which occurred late in the survey:

21. Cycling skills & confidence: what factors influence your cycling decisions? (check all that apply)

22. Facility design and maintenance: what factors influence your cycling decisions? (check all that apply)

23. Life style issues: what factors influence your cycling decisions? (check all that apply)

24. Bikes and equipment: what factors influence your cycling decisions? (check all that apply)

25. Culture and fashion: what factors influence your cycling decisions? (check all that apply)

26. What are your safety concerns about bicycling? (check all that apply)

27. What would cause you to start or increase your cycling (check all that apply)?

A full list of the survey questions and possible answers is available in Appendix A.

3.5 Overview of Survey Respondents

The questionnaire generated 13,286 responses from the United States and abroad. Of the responses, 13,085 identified as female, and of that female group, 11,453 reported living in the United States.

Within those responses, 1,134 women reported living in Washington state, and 406 reported living in the city of Seattle. I removed an additional thirty-four records from this

Seattle sample because those respondents did not answer all of the questions identified for analysis.

I then removed seven records belonging to women in the oldest (71 and older) and youngest (under 20) age groups in order to create a working-age sample. I chose to focus on a working-age sample because the number of old and young respondents was far too small to draw statistically significant conclusions and because evidence shows that younger children, adolescents, and the elderly in the United States have significantly different bicycling behavior than their working-age counterparts (Pucher and Buehler, 2008). This study then focused on the remaining 365 Seattle women who responded to all of the relevant questions selected for this study and fall between the ages of 20 and 70.

Because the dataset involved existing data collected from human subjects and posed little to no risk to the participants, I filed an exempt status request and determination with the University of Washington Institutional Review Board in late February 2012. The IRB determined that the project qualified for this exempt status in a March 2012 letter.

Respondents had the option of including a contact email address in order to provide further details about their questionnaire responses and opinions on cycling. In order to preserve the privacy of the respondents, I deleted and destroyed all of the stored email address information from the dataset.

3.6 Prior Analysis of WCP Dataset

Portions of the WCP dataset were analyzed in fall 2010 by a graduate student at University of North Carolina-Greensboro (Sibley, 2010). This prior analysis examined responses to selected questions from all US women in the sample and compared their responses by age range and community size (e.g., large city, medium city, small town, suburb).

The UNC study focused on the most frequent responses to two particular questions: "What are your safety concerns about bicycling?" and "What would cause you to start or increase your cycling?" The study also examined responses to questions about helmet usage and distance bicycled on a good weather week in the spring.

Concerns about motorized vehicles—namely, distracted driving—were the most frequent safety concerns among all the respondents in the national dataset. Changes in infrastructure,

including the addition of more bike lanes and bike paths, were the most frequently selected responses to a question about what would cause the respondent to start or increase her cycling. Sibley also found that the respondent's community size was correlated with her responses. She recommended that planners consider the type of area in which their target audiences live when proposing interventions designed to boost women's cycling levels.

3.7 Statistical Analysis Methods

I used Microsoft Excel and the statistical software package SPSS 20 to refine and analyze a comma-delimited file downloaded from SurveyMonkey, the online survey administrator.

I sorted and pared down this original file to include only those respondents who answered "Seattle" in response to an open-ended question about their city of residence. I then removed columns containing answers to questions that were excluded from this analysis, as well as any open-ended, write-in responses entered in the "other" option for questions 21 to 26. Although these open-ended responses potentially contain valuable insight, I determined that I lacked sufficient time and resources to analyze these data qualitatively.

Then I coded the responses to each of the seven relevant questions, questions 21 to 27, for easier cross tabulation and later development of category-based summary scores. Each of the options listed in the seven questions effectively became a dichotomous question, where a checked response signified an answer of "yes" to that factor being relevant to the respondent, and a blank response signified a "no" response. I assigned each yes response a value of 1, and I assigned each unchecked barrier a value of 0.

I applied the same binary coding to question 4, "Do you use a bicycle for any of your daily trips in the community?" where a value of 1 signified that the respondent answered yes to the question, and a value of 0 signified that the respondent answered no.

I used the frequency tabulation tool in SPSS to compile descriptive statistics for age, race, and education level of the Seattle dataset as a whole, as well as within the daily and non-daily rider groups. I also conducted frequency tabulations and cross tabulations for the daily and non-daily ridership groups to tally the yes and no responses to each of the possible barriers and factors in questions 21 to 27.

Because the data was nominal, I ran Chi square tests in SPSS to examine whether

correlations existed between being a member of the daily or non-daily rider group and selecting each of the 66 barriers–and six "none of the above" responses–listed in questions 21 to 26. I also performed the same statistical analysis for the 27 options for motives to start or increase cycling listed in question 27. I ran the Chi square tests by running a cross tabulation for each answer option, with daily or non-daily ridership status on one axis and yes or no response to a given factor on the other axis.

After conducting these comparisons of individual answer options, I also compiled composite scores for each of the six categories of barriers—cycling skills and confidence, facility design and maintenance, life style issues, bikes and equipment, culture and fashion, and safety. My goal was to establish whether certain entire categories of factors appear to matter more to one group of riders than another.

I computed these scores in Excel by creating a new column that contained a sum of the yes responses in each category. For example, if a respondent checked off four factors in the skills and confidence question, the composite score for the skills and confidence category was computed as four. I also computed mean, median, mode, range and standard deviation values for the summary scores generated by each respondent in each of the categories.

I then conducted a comparison of means independent samples T-test in SPSS to evaluate whether significant differences existed in mean summary scores among daily and non-daily riders for each of the six barrier categories.

I carried out all tests for significance using with a 95 percent confidence interval ($p = .05$).

3.8 Description of Sample

The 365 working-age Seattle women in the final sample were not representative of the broader city female population.

The sample skewed disproportionately white (88 percent) and highly educated, with 96 percent of respondents holding at least a college degree. The age distribution did not represent the city as a whole, as some 65 percent of the sample fell between the ages of 20 and 40.

The responses also indicated that the survey reached a larger audience of regular bike riders than would be expected from Seattle as a whole. About 71 percent of the sample

($N = 259$) reported riding their bicycles for daily trips, while the remaining 29 percent ($N = 106$) said they do not use a bicycle for any of their daily trips in the community.

Although an analogous measure of daily trips for the entire Seattle population is not readily available, an estimated 2.2 percent of all Seattle females rode their bicycles for their work commute in 2010 (US Census, 2010). Thus, clearly this survey disproportionately attracted responses from women who are already interested in cycling for transportation.

3.8.1 Age, Race, and Education Level

Basic demographic information collected about daily and non-daily riders in this sample revealed very little difference between the two groups.

Both groups encompassed a similar distribution of age groups (see Table 3.1). The vast majority of responses came from women between the ages of 20 and 40. Slightly smaller fractions fell between the ages of 41 and 50. Very few responses in either group came from women between the ages of 61 and 70.

Table 3.1: Age by Ridership Group

Age	**Non-Daily Riders**	**Daily Riders**
20-30	**29%**	**35%**
31-40	**39%**	**30%**
41-50	16%	21%
51-60	11%	12%
61-70	5%	2%

Racially, both groups were overwhelmingly white (see Table 3.2). The non-daily ridership was marginally more racially diverse than the daily ridership. Small numbers of women identified as Asian, or Hispanic or Latino. The sample contained no one who identified exclusively as Hawaiian Native, Pacific Islander, or African American. However, a small fraction of each group selected at least two races from the list, including American Indian and African American.

Table 3.2: Race by Ridership Group

Race	Non-Daily Riders	Daily Riders
White	**82%**	**90%**
Other	4%	0%
Mixed Race	2%	3%
Hispanic or Latino	5%	2%
Hawaiian Native or Pacific Islander	0%	0%
Black or African American	0%	0%
Asian	8%	2%
American Indian	0%	2%

Both groups reported high levels of completed education, as nearly 95 percent of each ridership group had completed at least a bachelor's degree (see Table 3.3).

Table 3.3: Highest Educational Level Obtained by Ridership Group

Education Level	Non-Daily Riders	Daily Riders
Still in school	1%	0%
High School Diploma	4%	3%
College Degree	**45%**	**51%**
Graduate Degree	**49%**	**46%**
No answer	1%	0%

3.8.2 Additional Details about Daily Cyclists

The nature of the questionnaire design, in which the daily riders received fifteen more questions than the non-daily riders, resulted in far more detailed information about the bicycling preferences and attitudes of the daily rider group.

On the whole, the data demonstrated that women in the daily cycling group are confident riders who use their bikes as transportation to various destinations, as well as frequently while on vacation, and view cycling as an important way to boost their personal health and quality of life.

Trip Purpose and Distance The vast majority of the daily riders reported biking for a variety of utilitarian purposes, as shown in Table 3.4. The most popular trip purpose was work commuting, closely followed by errands, stores, and socializing. The relatively few daily cyclists who reported biking to school likely indicates that few of the riders are currently attending school.

Table 3.4: Most Popular Trip Destinations for Daily Riders

Purpose of trip	**%**
Work Commuting	85%
Errands	78%
Stores	76%
Socializing	74%
Ride on Vacation	72%
Neighborhood	69%
Recreational Facilities	67%
Community Facilities	47%
School	25%
Ride on the job	24%

Daily cyclists reported riding greater mileage distances per week in good weather than in bad weather, and they generally rode more miles in the spring and summer months than in the fall and winter. Winter was by far the lowest ridership season, in which nearly half of the daily riders rode less than 20 miles per week in good weather, and one-third of the daily riders rode zero miles per week in bad weather. Summer in good weather was by far

the most popular time to ride, as no women reported zero-mileage weeks during this time. Table 3.5 shows the variation in reported mileage by season and weather conditions.

Table 3.5: Reported Weekly Mileage of Daily Riders by Season and Weather Type

Miles Ridden	**Spring**		**Summer**		**Fall**		**Winter**	
Weather Type	*Good*	*Bad*	*Good*	*Bad*	*Good*	*Bad*	*Good*	*Bad*
No answer	1%	5%	1%	5%	1%	6%	2%	5%
0 miles	1%	12%	0%	7%	1%	13%	14%	**33%**
Under 4 miles	5%	17%	1%	16%	6%	18%	15%	14%
4-10 miles	11%	**19%**	7%	**19%**	11%	**19%**	12%	10%
10-20 miles	18%	15%	14%	14%	18%	15%	17%	11%
20-40 miles	**23%**	14%	19%	15%	**24%**	11%	**19%**	8%
40-60 miles	20%	4%	22%	10%	19%	4%	12%	3%
60-80 miles	11%	3%	14%	6%	10%	3%	6%	2%
More than 80 miles	10%	11%	**23%**	8%	10%	10%	2%	14%

Motivations Daily riders cited a multitude of reasons for using their bicycles for trips. A majority of the respondents selected seven separate motivations from a list of 14 options, as shown in Table 3.6.

The three most frequent responses, which were selected by almost every rider, reflected a focus on health and quality of life. Environmental and economic concerns also played key roles.

Social factors also mattered, as about 53 percent of daily riders bike because it's "something fun with family and friends." Convenience also played a role, as more than half said bicycling is "the easiest/quickest way for me to travel."

Only about one-quarter of the daily riders said they bike because they do not have a car. An even smaller fraction—11.5 percent—said they bike because they don't have good public transit options. In addition, about 20 percent of the respondents reported using their

Table 3.6: Existing Bicycling Motives for Daily Riders

Why do you use your bicycle for trips?	**%**
It's great exercise and keeps me in shape	93%
I enjoy being in the outdoors	85%
Bicycling reduces my stress	73%
It's very green and I am doing my bit for the planet	68%
It saves me money	63%
I can do something fun with family and friends	53%
It's the easiest/quickest way for me to travel	52%
It's the best part of my day	46%
I want to be a leader in my family and community	26%
I don't have a car	24%
I can stop and chat when I see people I know	24%
I look great bicycling	24%
I use my bike to get to my local bus stop/transit station	19%
I don't have good public transit options	12%

bikes to get to their local bus stop or transit station.

Cycling Style The daily riders' self-reported riding style and behaviors reflect a general trend of confidence, caution, and experience. Nearly all of the daily riders reported always wearing a helmet, perhaps in large part because doing so is required by King County law.

More than half of the daily riders described their riding style as "law-abiding," "assertive," and/or "cautious" (see Table 3.7). Relatively few selected "competitive" or, by contrast, "carefree." Nearly one-third professed to being "slow and steady."

Table 3.7: Riding Style for Daily Riders

Riding Style	**%**
Law abiding	**58%**
Assertive	**56%**
Cautious	**56%**
Slow & steady	31%
Carefree	18%
Competitive	15%

This trend toward cautious, law-abiding behavior became even clearer in a question that asked daily riders to check off which activities they engage in while riding (see Table 3.8). The most popular response was "I follow the rules as much as possible." Most daily riders also reported that they check new routes in advance and/or deliberately wear bright or reflective clothing. Very few daily cyclists reported engaging in what could be considered "risky" behavior, such as traveling with no lights at night, running red lights, riding the wrong way, or making cell phone calls.

Table 3.8: Typical Bicycling Behavior for Daily Riders

Do you engage in the following more than occasionally while riding?	**%**
I follow the rules as much as possible	**91%**
Check the weather and then decide what I'll wear for cycling	79%
Check new routes in advance on a map or website	76%
Deliberately wear bright/reflective clothing	68%
Wear special clothing and change at destination	64%
Check the weather and then decide whether I'll cycle	61%
Run stop signs	32%
Run red lights	15%
Wear dark clothing while riding at night	14%
Wear headphones	13%
Never ride in the dark	7%
Wrong way riding	5%
Travel with no lights at night	3%
Make cell phone calls	3%
Never ride alone	1%

Chapter 4

FINDINGS

4.1 Overview of All Responses

The main focus of this analysis was responses to Questions 21 to 26, which asked about actual or perceived barriers to cycling, and to Question 27, which asked which factors would cause the respondents to start or increase their cycling.

For Questions 21 to 26, all of the 72 answer options, which includes the "none of the above" option for each question, were selected by at least one respondent in the Seattle sample. Of the 66 barriers, only seven were selected by more than half of the entire sample.

In general, daily riders selected a smaller number of barriers than non-daily riders. Only six barriers were selected by a majority of the daily rider group, but eleven barriers were selected by a majority of the non-daily rider group (see Tables 4.1 and 4.2).

Within each group, the top five most frequently selected barriers were identical but in a slightly different rank order by selection percentage. By far, the most frequently selected barriers for each group and for the overall set of respondents came from the safety-related question, which accounted for four of the top five most frequent responses. Members of the sample selected a mean of about six barriers, or about 43 percent of the possible responses, from the safety category.

"Distracted driving" was the most selected factor for the entire set of respondents, as well as for each of the ridership groups. Other responses with the highest selection rates were "Vehicles turning right in front of me when I'm going straight," "Parked cars opening doors," and "Speed of cars." Weather ("too wet/hot/cold") was another a major barrier selected by both groups of women.

The least frequently selected barriers mostly related to equipment or skills and confidence. Only one respondent selected "I don't know how to ride a bike." Scarcely one percent of the respondents selected, "No other women in my neighborhood cycle," "I would look silly

Table 4.1: Barriers Selected by a Majority of Non-Daily Riders

Responses	**%**
1. Distracted driving	79%
2. Parked cars opening doors	71%
3. Speed of cars	70%
4. Weather is not suitable (too wet/hot/cold)	69%
5. Vehicles turning right in front of me when I'm going straight	67%
6. Volume of cars	64%
7. I dislike aggressive/distracted drivers	63%
8. I don't like riding close to all the buses and trucks	63%
9. Motorists who run red lights and stop signs	58%
10. Too many hills in the area	58%
11. Moving trucks and buses	54%

Table 4.2: Barriers Selected by a Majority of Daily Riders

Responses	**%**
1. Distracted driving	84%
2. Vehicles turning right in front of me when I'm going straight	73%
3. Parked cars opening doors	70%
4. Weather is not suitable (too wet/hot/cold)	65%
5. Speed of cars	61%
6. Motorists who run red lights and stop signs	53%

on a bike," or "It's so many years since I've cycled that I'm not sure that I can." About 2 percent of the respondents selected, "My cycling skills are really poor," "All the clothes and gear look so complicated," or "I can never get my brakes working right." On average, the respondents selected less than one barrier from the bikes and equipment category, making it the category with the lowest frequency of selection.

Question 27, which asked which factors would cause the respondents to start or increase their cycling, generated a similarly wide spread of responses. Only three factors were selected by a majority of all riders: "more bike lanes" (62 percent), "completely separated off-road cycling paths" (53 percent), and "better connectivity/more direct routes" (55 percent). The least-selected response by both groups together was "starting-up cycling classes" (4 percent).

A more detailed breakdown of the responses within the daily and non-daily rider groups follows. A complete list of the frequency of selection of all barriers in Questions 21 to 27 for each ridership group is available in Appendices B and C.

4.2 Daily Cycling Group Responses

The daily cycling group selected barriers from the safety category more frequently than any other category. On average, daily riders made the fewest selections in the "bikes and equipment" and "culture and fashion" categories. The most popular factors for increasing cycling primarily centered on infrastructure- and facilities-related changes.

4.2.1 Cycling Skills and Confidence

In the cycling skills and confidence category, daily riders selected an average of 2.25 barriers from a list of 17 possibilities, which equates to about 13 percent of the possibilities. About 15 percent reported that none of the above barriers were concerns.

The most frequently selected factor by far was "Weather is not suitable (too wet/hot cold)" (see Table 4.3).

No other barriers were selected by a majority of the daily riders. The next most frequent selections were "Distance is too far" and "I dislike aggressive/distracted drivers."

Table 4.3: Top Cycling Skills and Confidence Barriers for Daily Riders

Response	**%**
Weather is not suitable (too wet/hot/cold)	**65%**
Distance is too far	39%
I dislike aggressive/distracted drivers	39%
I have personal safety/security concerns	22%
I don't like to ride after dark	16%
None of the above apply to me	15%
I had a scare/near-miss on my bike in the past	13%
I don't like being assertive with cars	10%
I'm afraid of the bike breaking down	8%
I'm not in shape to ride a bicycle	7%
It's hard starting up from a stop	3%
I don't know cycling rules	1%
Cycling has become too dangerous	1%
I would love to cycle again but I just don't know where to begin	0%
I don't know how to ride a bike	0%
My cycling skills are really poor	0%
It's so many years since I've cycled that I'm not sure that I can	0%

4.2.2 Facility Design and Maintenance

In the facility design and maintenance category, daily riders selected an average of 2.19 barriers from 12 possibilities, or about 18 percent.

None of the factors in this question was selected by a majority of the daily riders. About 25 percent of the respondents indicated that none of the above barriers applied to them (see Table 4.4).

Table 4.4: Top Facilities and Maintenance Factors for Daily Riders

	Responses	**%**
Roads are in terrible shape, potholes, debris, etc.		39%
Too many hills in the area		34%
I don't like riding close to all the buses and trucks		25%
None of the above apply to me		24%
Local roads are too busy for me to cycle on them		22%
There are dangerous pinch points on my route		22%
Some of my routes are not well lit		16%
I dislike car fumes		15%
They don't clear the ice/snow from the bike facilities		14%
No bike lanes or bike paths in my area		14%
There is nowhere for me to park my bike		10%
There are no facilities for locking bike/changing at my work		7%
Its difficult to ride my bike to transit		2%

"Roads are in terrible shape, potholes, debris, etc." was the most frequently selected barrier, and "Too many hills in the area" was the next most frequent response.

About one-quarter of daily riders selected "I don't like riding close to all the buses and trucks," "Local roads are too busy for me to cycle on them," and/or "There are dangerous pinch points in my route."

4.2.3 Lifestyle Issues

In the lifestyle category, daily riders selected few of the options. The mean number of barriers selected was a little more than one (1.15) from seven potential options, or about 16 percent. The most frequently selected response was that none of the above barriers applied (see Table 4.5).

Table 4.5: Top Lifestyle Issues Factors for Daily Riders

Responses	**%**
None of the above apply to me	37%
I have to wear nice clothes and look well-groomed at my destinations	31%
I have so much stuff to carry so I need my car	28%
I don't have time	25%
I have so many different errands that I need my car	17%
I have to drop my kids everywhere so I need to drive	7%
I would like to ride with other people	5%
I am comfortable in my car and not on a bike	3%

The most selected barrier after "none of the above apply to me" was "I have to wear nice clothes and look well groomed at my destinations."

"I have so much stuff to carry so I need my car" and "I don't have time" closely followed in response frequency.

Passengers and comfort with riding were not a major issue for daily riders. About 7 percent of the daily riders checked "I have to drop my kids everywhere so I have to drive," and only 3 percent selected "I am comfortable in my car and not on a bike."

4.2.4 Bikes and Equipment

In the bikes and equipment category, daily riders again indicated that very few of the listed barriers apply to them. The mean number of barriers selected was less than one (0.32) from

seven possible responses, or about 5 percent. A large majority of the daily riders reported that none of the barriers applied to them (see Table 4.5).

Table 4.6: Top Bikes and Equipment Factors for Daily Riders

Responses	%
None of these factors bother me	**76%**
I need fenders	9%
I'm afraid that I'll get stranded with a flat tire somewhere	7%
I don't like it when oil gets on my clothes from the chain	5%
My hands get dirty when I have to do anything with the bike	3%
I don't know how to carry stuff on my bike	3%
I can never get my brakes working right	2%
I don't know how to work the gears	2%

Each of the remaining responses was selected by less than 10 percent of the daily riders. Of those responses, the most frequently selected barriers were "I need fenders" and "I'm afraid I'll get stranded with a flat tire somewhere."

4.2.5 Culture and Fashion

In the culture and fashion category, daily riders checked off very few barriers. The average number of barriers selected was about one (0.94) from ten possible selections, representing about 9 percent. About 57 percent of the daily riders said none of the barriers in that category applied to them, making that the most selected answer option (see Table 4.7).

The most frequently selected barrier was "It's difficult bringing spare clothes." A similar percentage of daily riders checked the statements, "I hate arriving everywhere all red and sweaty," "Clothing/grooming are a problem," and/or "Helmets mess up my hair."

Only one daily rider checked off "All the clothes and gear look so complicated," "I would look silly on a bike," and/or "No other women in my neighborhood cycle."

Table 4.7: Top Culture and Fashion Factors for Daily Riders

Response	%
None of the above apply to me	**57%**
It's difficult bringing spare clothes	21%
I hate arriving anywhere all red and sweaty	19%
Clothing/grooming are a problem	18%
Helmets mess up my hair	17%
Shoes are an issue	14%
I'm afraid of negative comments about my appearance after cycling	3%
All those other women look so fit	2%
All the clothes and gear look so complicated	0%
I would look silly on a bike	0%
No other women in my neighborhood cycle	0%

4.2.6 Safety Concerns

Safety concerns generated more frequent selections for daily riders than did any other category (see Table 4.8). The average number of barriers selected was nearly six (5.87) out of 14, representing about 42 percent of the possible responses. This mean percentage was by far the highest percentage of all the categories. Safety was the only category in which at least one daily rider (four, to be exact) selected all of the barrier options listed.

"Distracted driving" was the most frequent concern. "Vehicles turning right in front of me when I'm going straight" and "parked cars opening doors" were the next most frequent selections.

"Speed of cars" and "motorists who run red lights and stop signs" also earned selection by a majority of daily riders.

None of the remaining factors was selected by a majority of the riders, although "volume of cars" came close.

In contrast to other categories, very few riders (2 percent, or five individuals) indicated

Table 4.8: Top Safety Barriers for Daily Riders

Response	%
Distracted driving	**84%**
Vehicles turning right in front of me when I'm going straight	**73%**
Parked cars opening doors	**70%**
Speed of cars	**61%**
Motorists who run red lights and stop signs	**53%**
Volume of cars	46%
Pedestrians stepping out in front of me without looking	36%
Someone stealing my bike while it's parked	36%
Moving trucks and buses	35%
Vehicles hitting me from behind when I am cycling	27%
Moving cars	23%
Crossing at intersections	21%
Other cyclists running into me	12%
Stranger attacks	10%
None of the above	2%

that none of the above factors applied to them.

4.2.7 Motives for Increasing Cycling

In response to a question about what factors would cause respondents to start or increase their cycling, a majority of daily riders selected two responses: "more bike lanes" and/or "better connectivity/more direct routes" (see Table 4.9).

The next most frequent response was "tax breaks/financial incentives," closely followed by "completely separated off-road cycling paths." "Wider lanes on the roads" also generated a large response level.

The least-selected option was "starting-up cycling classes." "Ladies-only cycling classes" also generated little interest. Daily riders were also unlikely to select "more encouragement from my friends and family" or "more fashionable" as motives for increasing their cycling.

4.3 Non-Daily Cycling Group Responses

Similar to the daily rider group, the non-daily cycling group selected barriers from the safety category more frequently than any other category. On average, the fewest selections by non-daily riders occurred in the bikes and equipment category. The most popular factors for increasing cycling primarily centered on infrastructure- and facilities-related changes.

4.3.1 Cycling Skills and Confidence

In the cycling skills and confidence category, non-daily riders selected on average of 3.82 barriers out of 17 possible answers, or about 22 percent. Only 3 percent selected the response, "none of the above apply to me."

"Weather is not suitable (too wet/hot/cold)" was the most frequently selected barrier (see Table 4.10). "I dislike distracted/aggressive drivers" closely followed.

None of the other barriers was selected by a majority of the non-daily riders. However, 45 percent of the non-daily riders selected "I have personal security/safety concerns," and 44 percent of the non-daily riders selected, "I don't like to ride after dark." More than one-third of the non-daily riders selected "I don't like being assertive with cars" (37 percent)

Table 4.9: Top Motives for Increasing Cycling by Daily Riders

Response	%
More bike lanes	**63%**
Better connectivity/more direct routes	**54%**
Tax breaks/financial incentives	47%
Completely separated off-road cycling paths	46%
Wider lanes on the roads	41%
Reduced traffic speeds/cars	35%
More bike racks everywhere	35%
Secure bike parking	34%
Showers and lockers at destination	31%
More people cycling	29%
Better lighting along routes	28%
More security and safety for cyclists	27%
Good local bike maps or websites so I could check out and plan my routes	22%
Ability to bring bike on train or bus	19%
Bike repair class	17%
Work-place encouragement	16%
Friendlier bike shop employees	15%
Cycling with a buddy more often	12%
Increased levels of other women cycling	12%
Easy-to-read information explaining about bike parts and the cycling rules	10%
Incentives from my school	8%
Organized social cycling events	7%
More bike racks at my transit station	6%
More fashionable	5%
More encouragement from my friends and family	4%
Ladies-only cycling class	2%
Starting-up cycling classes	1%

Table 4.10: Top Cycling Skills and Confidence Barriers for Non-Daily Riders

Response	%
Weather is not suitable (too wet/hot/cold)	**69%**
I dislike aggressive/distracted drivers	**63%**
I have personal safety/security concerns	45%
I don't like to ride after dark	44%
I don't like being assertive with cars	37%
Distance is too far	35%
I'm not in shape to ride a bicycle	18%
Cycling has become too dangerous	13%
I'm afraid of the bike breaking down	12%
I don't know cycling rules	9%
I had a scare/near-miss on my bike in the past	9%
My cycling skills are really poor	8%
I would love to cycle again but I just don't know where to begin	8%
It's hard starting up from a stop	5%
It's so many years since I've cycled that I'm not sure that I can	5%
None of the above apply to me	3%
I don't know how to ride a bike	1%

and/or "distance is too far" (35 percent).

Each of the other barriers was chosen by less than 20 percent of the non-daily riders. Only one of the respondents selected "I don't know how to ride a bike."

4.3.2 Facility Design and Maintenance

In the facility design and maintenance category, non-daily riders selected on average about three factors (3.06) from 12 possibilities, or about 25 percent. Only 9 percent of the non-daily riders selected "none of the above apply to me" (see Table 4.11).

Table 4.11: Top Facilities and Maintenance Factors for Non-Daily Riders

	Responses	**%**
I don't like riding close to all the buses and trucks	**63%**	
Too many hills in the area	**58%**	
Local roads are too busy for me to cycle on them	46%	
No bike lanes or bike paths in my area	25%	
Roads are in terrible shape, potholes, debris, etc.	25%	
I dislike car fumes	23%	
Some of my routes are not well lit	16%	
There are no facilities for locking bike/changing at my work	16%	
There are dangerous pinch points on my route	13%	
None of the above apply to me	9%	
Its difficult to ride my bike to transit	8%	
There is nowhere for me to park my bike	8%	
They don't clear the ice/snow from the bike facilities	6%	

More than half of non-daily riders selected "I don't like riding close to all the buses and trucks," making it the most frequently selected barrier in this category. "Too many hills in the area" also was selected by a majority. Nearly a majority of non-daily riders selected, "Local roads are too busy for me to cycle on them."

None of the other barriers was selected by more than 25 percent of the respondents. The least selected responses were "They don't clear the ice/snow from the bike facilities," "It is difficult to ride my bike to transit," and "There is nowhere for me to park my bike."

4.3.3 Lifestyle Issues

In the lifestyle issues category, non-daily riders selected on average nearly two barriers (1.86) out of seven possibilities, or about 27 percent. Only about 12 percent of the non-daily riders selected "none of the above apply to me."

As in the daily cycling group, none of the responses was selected by a majority of the non-daily riders (see Table 4.12). The most frequently selected barrier was "I have to wear nice clothes and look well-groomed at my destinations."

Other frequent selections were "I have so much stuff to carry so I need my car" and "I have so many different errands I need my car." "I don't have time" was chosen by 25 percent of the non-daily riders.

Table 4.12: Top Lifestyle Factors for Non-Daily Riders

Responses	**%**
I have to wear nice clothes and look well-groomed at my destinations	47%
I have so much stuff to carry so I need my car	41%
I have so many different errands that I need my car	31%
I don't have time	25%
I am comfortable in my car and not on a bike	21%
I have to drop my kids everywhere so I need to drive	13%
None of the above apply to me	12%
I would like to ride with other people	8%

4.3.4 Bikes and Equipment

In the bikes and equipment category, non-daily riders selected on average about one barrier (0.8) out of seven possibilities, or about 11 percent. Unlike in other categories, half of the non-daily riders indicated that none of the listed barriers applied to them, representing the most frequent response for this category (see Table 4.13).

Table 4.13: Top Bikes and Equipment Factors for Non-Daily Riders

Responses	**%**
None of these factors bother me	**50%**
I'm afraid that I'll get stranded with a flat tire somewhere	18%
I don't know how to carry stuff on my bike	16%
I need fenders	16%
I don't know how to work the gears	10%
I don't like it when oil gets on my clothes from the chain	10%
My hands get dirty when I have to do anything with the bike	7%
I can never get my brakes working right	3%

Each of the other barriers was selected by less than 20 percent of the respondents. The most frequent pick was "I'm afraid I'll get stranded with a flat tire somewhere," closely followed by "I don't know how to carry stuff on my bike" and "I need fenders."

4.3.5 Culture and Fashion

In the culture and fashion category, non-daily riders selected on average about two barriers (1.88) out of 10 possibilities, or about 19 percent.

None of the barriers was chosen by a majority of the non-daily riders (see Table 4.14). The most frequent response was "It's difficult bringing spare clothes."

About one-third of the non-daily riders selected "Clothing/grooming are a problem," "I hate arriving everywhere all red and sweaty'," and/or "helmets mess up my hair."

Table 4.14: Top Culture and Fashion Factors for Non-Daily Riders

Response	%
It's difficult bringing spare clothes	44%
Clothing/grooming are a problem	36%
I hate arriving anywhere all red and sweaty	34%
Helmets mess up my hair	31%
None of the above apply to me	28%
Shoes are an issue	16%
All those other women look so fit	9%
All the clothes and gear look so complicated	8%
I'm afraid of negative comments about my appearance after cycling	5%
I would look silly on a bike	3%
No other women in my neighborhood cycle	2%

Still, about 28 percent of the non-daily riders indicated that none of the barriers in that category applied to them.

4.3.6 Safety Concerns

Safety concerns proved similarly strong among non-daily riders, who selected on average about 6 (6.44) barriers out of 14 possibilities, or about 46 percent. This mean percentage was by far the highest mean selection percentage of all the categories. Only four of the non-daily riders indicated that none of the safety-related barriers applied to them (see Table 4.15).

Seven of the responses were each selected by a majority of the non-daily riders. The top concern was "distracted driving."

"Speed of cars," "Vehicles turning right in front of me when I'm going straight," and "volume of cars," were the next biggest concerns.

"Motorists who run red lights and stop signs" and "moving trucks and buses" were also

Table 4.15: Top Safety Barriers for Non-Daily Riders

Response	**%**
Distracted driving	**79%**
Parked cars opening doors	**71%**
Speed of cars	**70%**
Vehicles turning right in front of me when I'm going straight	**67%**
Volume of cars	**64%**
Motorists who run red lights and stop signs	**58%**
Moving trucks and buses	**54%**
Moving cars	44%
Vehicles hitting me from behind when I am cycling	33%
Crossing at intersections	32%
Someone stealing my bike while it's parked	30%
Pedestrians stepping out in front of me without looking	20%
Other cyclists running into me	11%
Stranger attacks	10%
None of the above	4%

frequent concerns.

Safety concerns unrelated to motorized traffic, such as "stranger attacks" or "other cyclists running into me," were seldom selected.

4.3.7 Motives for Starting/Increasing cycling

In response to a question about what factors would cause respondents to start or increase their cycling, non-daily riders selected "completely separated off-road cycling paths" more frequently than any other factor by 10 percentage points (see Table 4.16).

In addition, a majority of non-daily riders selected "more bike lanes" and/or "better connectivity/more direct routes."

About one-third of the non-daily riders selected "wider lanes on the roads" and/or "showers and lockers at destination." The least-selected factor was "more bike racks at my transit station."

4.4 Comparison of Rider Groups

Despite the large number of common barriers among the daily and non-daily rider groups, there were also notable differences among the frequency, number, and type of factors selected.

Non-daily riders selected, on average, a greater number of barriers from every category. This difference in mean number of barriers selected was found to be significant ($p = .000$) for five of the six categories: cycling skills and confidence, facility design and maintenance, lifestyle issues, bikes and equipment, and culture and fashion. However, the difference in the mean number of factors selected in the safety category was not found to be significant ($p = .138$).

Within each category, higher percentages of non-daily riders than daily riders tended to select individual factors. In most categories of barriers, a far smaller percentage of non-daily riders selected "none of the above apply to me."

Table 4.16: Top Motives to Start or Increase Cycling for Non-Daily Riders

Response	%
Completely separated off-road cycling paths	**70%**
More bike lanes	**60%**
Better connectivity/more direct routes	**57%**
Wider lanes on the roads	37%
Showers and lockers at destination	33%
Tax breaks/financial incentives	32%
More bike racks everywhere	29%
Secure bike parking	28%
Better lighting along routes	27%
More security and safety for cyclists	26%
Good local bike maps or websites so I could check out and plan my routes	26%
More people cycling	24%
Reduced traffic speeds/cars	24%
Bike repair class	20%
Cycling with a buddy more often	19%
Work-place encouragement	18%
Increased levels of other women cycling	15%
Organized social cycling events	14%
Easy-to-read information explaining about bike parts and the cycling rules	14%
Ability to bring bike on train or bus	12%
Starting-up cycling classes	12%
Ladies-only cycling class	11%
Friendlier bike shop employees	11%
More fashionable	10%
More encouragement from my friends and family	8%
Incentives from my school	6%
More bike racks at my transit station	5%

4.4.1 Cycling Skills and Confidence

In the cycling skills and confidence category, there were significant differences in how frequently daily and non-daily riders selected ten of the 16 barrier options, as well as "none of the above apply to me." Except for "none of the above," non-daily riders were more likely to select each of those ten barriers.

In SPSS, a comparison of means independent samples T-Test found a significant difference ($p = .000$) in the mean summary scores for this category. Non-daily riders selected on average 1.5 more barriers than daily riders (see Table 4.17).

Table 4.17: Skills and Confidence: Comparison of Summary Scores by Ridership Group

	Daily	Non-Daily	Difference
Average Summary Score	**2.25**	**3.82**	**-1.57**
Average as %	13%	22%	-9%
Median Summary Score	2	3.5	-1.5
Mode Summary Score	2	3	-1
Standard Deviation	1.70	2.07	
Maximum Score	8	11	-3
Minimum Score	0	0	
Maximum Possible Score	**17**	**17**	

Four barriers generated the largest discrepancy in frequency of selection between daily and non-daily riders:

- Non-daily riders selected "I don't like being assertive with cars" nearly four times more frequently.

- In addition, they selected "I don't like to ride after dark" almost three times more often than daily riders.

- Non-daily riders also selected "I have personal safety/security concerns" and "I dislike aggressive/distracted drivers" about twice as frequently as daily riders.

Daily riders were also more than five times more likely to select "none of the above apply to me," although it is important to note that only small fractions of either daily or non-daily riders made this selection.

The barriers without any significant difference in selection rates between daily and non-daily riders were:

- "I don't know how to ride a bike," "I'm afraid of the bike breaking down," "It's hard starting up from a stop," and "I had a scare/near-miss on my bike in the past," which all had similarly low rates of selection by both groups.

- "Distance is too far" and "Weather is not suitable (too wet/hot/cold)," which both had similarly high rates of selection by both groups.

4.4.2 Facility Design and Maintenance

In the facility design and maintenance category, there were significant differences in how frequently daily and non-daily riders selected eight of the 12 possible barriers, as well as the "none of the above apply to me" option.

In SPSS, a comparison of means independent samples T-Test found a significant difference ($p = .000$) in the mean summary scores for this category. Non-daily riders selected on average nearly one more barrier than daily riders (see Table 4.18).

"I don't like riding close to all the buses and trucks" yielded the largest discrepancy in selections. Non-daily riders were more than twice as likely as daily riders to select this option.

Non-daily riders were also about twice as likely likely to select "Local roads are too busy for me to cycle on them" and "Too many hills in my area."

By contrast, daily riders were more than twice as likely to choose "none of the above apply to me." They were also were somewhat more likely to select "Roads are in terrible shape, potholes, debris, etc." than non-daily riders.

Table 4.18: Facility Design and Maintenance: Comparison of Summary Scores by Ridership Group

	Daily	Non-Daily	Difference
Average Summary Score	**2.19**	**3.06**	**-0.87**
Average as %	18%	25%	-7%
Median Summary Score	2	3	-1
Mode Summary Score	0	3	-3
Standard Deviation	1.97	2.01	
Maximum Score	9	10	-1
Minimum Score	0	0	
Maximum Possible Score	**12**	**12**	

The barriers that lacked any significant difference between daily and non-daily riders and were selected by similarly low percentages (less than 25 percent) were:

- "There are no facilities for locking bike/changing at my work"
- "I dislike car fumes"
- "Some of my routes are not well lit"
- "There are dangerous pinch points on my route"

4.4.3 Lifestyle Issues

In the lifestyle issues category, there were significant differences in how frequently daily and non-daily riders selected four of the seven answer options, as well as "none of the above apply to me."

A comparison of means independent samples T-Test in SPSS found a significant difference ($p = .000$) in the mean summary scores for this category. Non-daily riders selected on average nearly one more barrier than daily riders (see Table 4.19).

Table 4.19: Lifestyle Issues: Comparison of Summary Scores by Ridership Group

	Daily	Non-Daily	Difference
Average Summary Score	**1.15**	**1.87**	**-0.72**
Average as %	16%	27%	-10%
Median Summary Score	1	2	
Mode Summary Score	0	1	
Standard Deviation	1.30	1.42	
Maximum Score	5	6	
Minimum Score	0	0	
Maximum Possible Score	**7**	**7**	

Daily riders were about three times as likely to check "none of the above apply to me" than non-daily riders.

Non-daily riders were nearly seven times as likely to select "I am comfortable in my car and not on a bike." They also selected three statements at nearly twice the rate of daily riders:

- "I have so many errands that I need my car" (1.88 times as frequent)
- "I have to wear nice clothes and look well-groomed at my destinations" (1.55 times as frequent and selected by nearly half of the non-daily riders)
- "I have so much stuff to carry so I need my car" (1.44 times as frequent as daily riders)

Each group selected "I don't have time" at identical rate. Other barriers that lacked any significant difference between daily and non-daily riders and were selected by similarly low percentages (less than 25 percent of either group) were:

- "I would like to ride with other people"
- "I have to drop by kids everywhere so I need to drive"

4.4.4 Bikes and Equipment

In the lifestyle issues category, there were significant differences in how frequently daily and non-daily riders selected four of the seven barrier options, as well as "none of the above apply to me."

However, it is important to note that the barriers in this category were selected relatively infrequently by members of both rider groups.

A comparison of means independent samples T-Test in SPSS found a significant difference ($p = .000$) in the mean summary scores for this category. Non-daily riders selected on average less than one more barrier than daily riders (see Table 4.20).

Table 4.20: Bikes and Equipment: Comparison of Summary Scores by Ridership Group

	Daily	Non-Daily	Difference
Average Summary Score	**0.32**	**0.80**	**-0.49**
Average as %	5%	11%	-7%
Median Summary Score	0	0	
Mode Summary Score	0	0	
Standard Deviation	0.71	1.18	
Maximum Score	4	6	
Minimum Score	0	0	
Maximum Possible Score	**7**	**7**	

Non-daily riders were nearly seven times more likely to select "I don't know how to work the gears" and more than five times more likely to select "I don't know how to carry stuff on my bike." However, neither of those responses was selected by a large percentage of the non-daily riders.

Non-daily riders were also more than twice as likely to choose "I'm afraid I'll get stranded with a flat tire somewhere" and a little less than twice as likely to select "I need fenders."

Daily riders selected "none of the above apply to me" at about 1.5 times the rate of

non-daily riders.

The barriers that lacked any significant difference between daily and non-daily riders and were selected by similarly low percentages (no greater than 10 percent) were:

- "I can never get my brakes working right"
- "My hands get dirty when I have to do anything with the bike"
- "I don't like it when oil gets on my clothes from the chain"

4.4.5 Culture and Fashion

In the lifestyle issues category, there were significant differences in how frequently daily and non-daily riders selected seven of the 10 barrier options, as well as "none of the above apply to me."

Except for "none of the above," non-daily riders were more likely to select all of the barriers where these differences are significant. It is important to note, however, that several of those factors were selected infrequently by both groups of riders.

A comparison of means independent samples T-Test found a significant difference ($p = .000$) in the mean summary scores for this category. Non-daily riders selected on average nearly one more barrier than daily riders (see Table 4.19).

Four factors were selected about twice as often by larger numbers of non-daily riders and vary significantly from the daily rider group:

- "Clothing/grooming are a problem"
- "It's difficult bringing spare clothes"
- "I hate arriving everywhere all red and sweaty"
- "Helmets mess up my hair"

Table 4.21: Culture and Fashion: Comparison of Summary Scores by Ridership Group

	Daily	Non-Daily	Difference
Average Summary Score	**0.94**	**1.88**	**-0.94**
Average as %	9%	19%	-9%
Median Summary Score	0	2	
Mode Summary Score	0	0	
Standard Deviation	1.41	1.77	
Maximum Score	8	7	
Minimum Score	0	0	
Maximum Possible Score	**10**	**10**	

The largest discrepancy between the two groups was for the statement "All the clothes and gear look so complicated," which was selected nearly 20 times more frequently by non-daily riders. However, extremely few women in either category made this selection.

Non-daily riders selected three other factors at vastly higher rates than daily riders, but again, because of the very small numbers of women selecting those factors, their meaning has less impact. Those factors were:

- "I would look silly on a bike"
- "No other women in my neighborhood cycle"
- "All those other women look so fit"

Daily riders selected "none of the above apply to me" twice as often as non-daily riders.

The barriers that lacked any significant difference between daily and non-daily riders and were selected by similarly low percentages (a maximum of 14 percent of either group) were:

- "No other women in my neighborhood cycle

- "Shoes are an issue"
- "I'm afraid of negative comments about my appearance after cycling"

4.4.6 Safety Concerns

In the safety concerns category, there were significant differences in how frequently daily and non-daily riders selected only five of the 14 barrier options.

The safety category was the only one where a comparison of means independent samples T-Test found no significant difference($p = .138$) in the mean summary scores for this category. Thus, both groups were almost equally likely to select similar numbers of factors on average (see Table 4.22).

Table 4.22: Safety: Comparison of Summary Scores by Ridership Group

	Daily	Non-Daily	Difference
Average Summary Score	**5.87**	**6.44**	**-0.57**
Average as %	42%	46%	-4%
Median Summary Score	5	6	
Mode Summary Score	3	6	
Standard Deviation	3.23	3.59	
Maximum Score	14	14	
Minimum Score	0	0	
Maximum Possible Score	**14**	**14**	

The biggest discrepancies in selection were for the factors "moving cars" and "moving trucks and buses," which were selected 1.5 to two times more frequently by the non-daily rider group. Non-daily riders also selected "volume of cars" 1.4 times and "crossing at intersections" 1.5 times more frequently than daily riders.

Daily riders selected "pedestrians stepping out in front of me" almost twice as often as non-daily riders.

None of the other safety barriers had significant differences in frequency of selection, and several of them had the highest selection rates of any barriers in the questionnaire.

There was also no significant difference in selection of "none of the above apply to me," with both groups selecting that option at almost equally low rates (4 percent for non-daily riders, 2 percent for daily riders).

4.4.7 Motives for Starting/Increasing Cycling

The vast majority of the possible motives for starting or increasing cycling were selected at similar rates by both daily and non-daily riders.

The most popular picks for both groups all related to infrastructure and facilities: "more bike lanes" (60 percent of non-daily riders, 63 percent of daily riders), "completely separated off-road cycling paths" (70 percent of non-daily riders, 46 percent of daily riders), and "better connectivity/more direct routes" (57 percent of non-daily riders, 54 percent of daily riders).

Only six of 27 possible factors had significantly different selection rates. Of the factors that were selected by a substantial number of respondents, the biggest discrepancies in selection rates were as follows:

- Non-daily riders selected "completely separated off-road cycling paths" 1.5 times more often than daily riders, making this option the top selection for non-daily riders.

- Daily riders selected "tax breaks/financial incentives" and "reduced traffic speeds/cars" about 1.5 more frequently than non-daily riders.

- Non-daily riders were much more likely to favor organized cycling events, including "organized social cycling events" (twice as likely), "starting-up cycling classes" (almost 16 times as likely) and "ladies-only cycling class" (almost six times as likely). However, very few women in either group selected those factors.

Chapter 5

DISCUSSION

5.1 Summary of Findings

The purpose of this study was to determine barriers to biking for transportation for working-age Seattle women, to establish whether differences exist among women who do and do not report riding daily, and to pinpoint factors that may influence women's decisions to start or increase their cycling.

The responses to the questionnaire suggest that a diversity of barriers and factors play a role. Some differences in barriers exist between the two groups, as the non-daily riders generally selected a greater number and variety of factors. But the two groups' selections also share many common themes, most notably, a strong emphasis on safety concerns. In fact, safety was the only category where the mean number of barriers selected did not differ significantly between the ridership groups.

All told, at least 66 barriers, some of which overlap, are implicated in the decision to bike both for daily and non-daily riders. Less than a dozen barriers were selected by at least half of either the daily or non-daily rider group.

The question about motives for starting or increasing cycling had a similar outcome, with safety- and infrastructure-related issues taking precedence over lifestyle factors among daily and non-daily riders (see Figures 5.1 and 5.2).

Because this survey allowed only measurements of frequency, not relative importance, it is important not to discount even those barriers and factors that did not achieve selection by a majority of the groups, as they may still hold great weight in the respondents' biking decisions.

Figure 5.1: Barriers to Cycling Selected by Majority of Non-Daily Riders

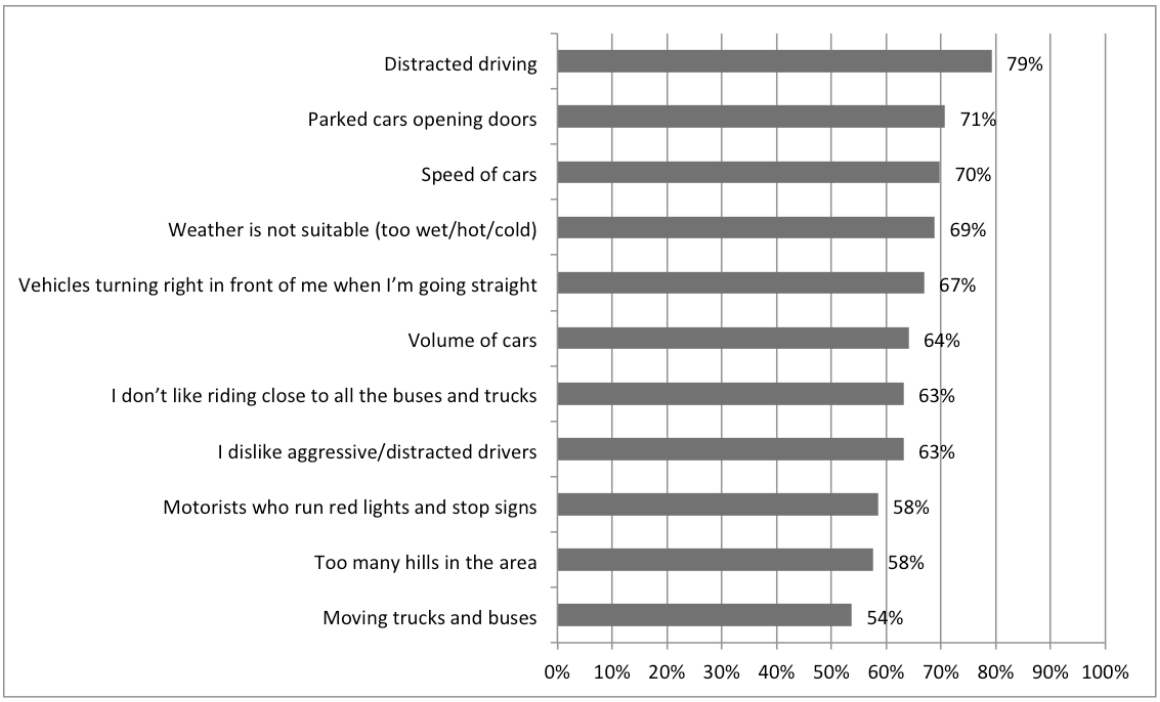
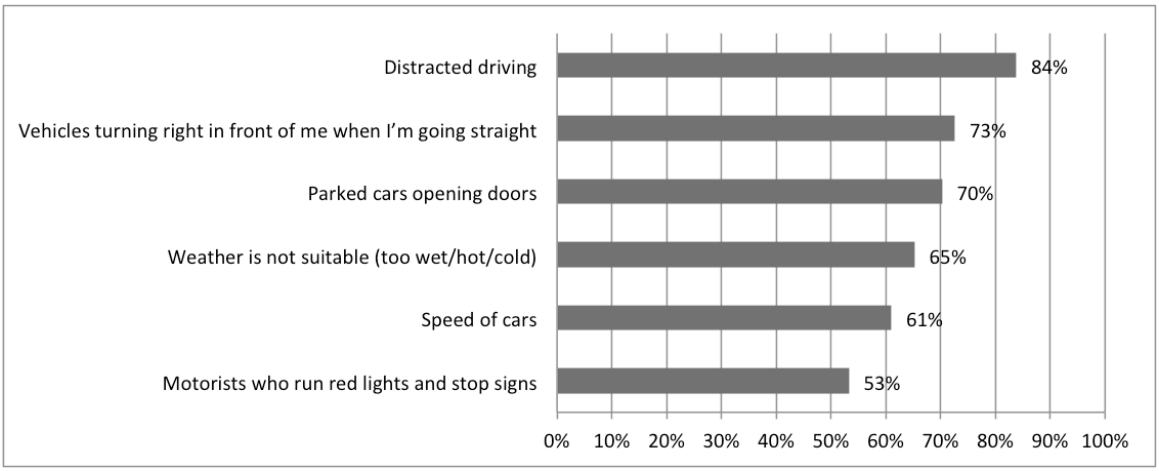


Figure 5.2: Barriers to Cycling Selected by Majority of Daily Riders



5.2 Most Important Factors

Although it is not possible to know the magnitude of influence of each of these barriers because of the survey design (see Limitations section), it is possible to estimate based on their relatively high frequency of selection that the following factors play an important role in working-age Seattle women's cycling decisions:

5.2.1 Safety

Safety appears to be by far the leading concern for all riders, as both daily and non-daily riders selected many statements about safety at similarly high rates.

Barriers related to motorized vehicles and associated behavior were paramount—namely, motorists who drive distractedly or aggressively, run red lights or stop signs, turn in front of cyclists, and open parked car doors without looking. Speed and volume of cars were among the most frequent concerns for both groups.

Non-daily riders were even more likely to express such concerns and also were more likely than daily riders to worry about riding close to cars, buses, and trucks. They were also more likely to perceive roads as too "busy" for cycling.

The top motives for starting or increasing cycling similarly reflect concerns about safety, as they call for infrastructure and facilities changes that support at least some degree of separating bikes from motorized traffic. The vast majority of riders in both groups said more bike lanes would cause them to start or increase cycling, and a large majority of non-daily riders selected completely separated, off-road paths.

The frequent selection of wider lanes on the roads, reduced traffic speeds and cars, and better lighting along routes by both groups also speaks to concerns about incidents involving motorized traffic and potential discomfort with current road conditions.

The previous national analysis of the WCP survey also found that safety concerns and safety-related infrastructure changes were major concerns for all women in the US sample (Sibley, 2010). As with the Seattle sample, the top safety concern for the sample of all US women was distracted driving, which was selected by 73 percent of the national respondents. The next four most frequent concerns also overlapped among the two samples: vehicles

turning right in front of the cyclist, parked cars opening doors, speed of cars, and motorists who run red lights and stop signs.

In addition, about 62 percent of all the US women surveyed said "more bike lanes" would cause them to start or increase their cycling, which means this factor was selected at the same rate by the Seattle sample as a whole. About 47 percent of all the US women reported that completely separated off-road paths would cause them to start or increase cycling, as compared to about 53 percent of all the Seattle women in the sample. The national analysis did not distinguish between daily and non-daily riders in its analysis. However, it completed analysis based on community size and found that women who live in rural areas tend to be less concerned with distracted driving and the addition of bike lanes or off-road cycle paths, as compared to women who reported living in cities or suburbs.

The results of this analysis also track with results from local surveys by the City of Seattle and Cascade Bicycle Club, in which traffic safety and availability of bike lanes and separated paths were consistently among the top concerns for respondents (City of Seattle, 2007; Cascade Bicycle Club, 2009). The findings in this thesis are also consistent with findings from the broader literature, which point to perception of safety and the presence of bike-specific infrastructure, including facilities that help to separate bikes from motorized traffic, as critical factors for would-be male and female cyclists alike (see Literature Review). Notably, countries with higher cycling rates, including the Netherlands, Denmark, and Germany, also have stronger safety records for bicyclists (Pucher and Buehler, 2008).

5.2.2 Weather

Undesirable weather was another top concern for women in this sample. It was among the five most selected barriers for all riders, and both daily and non-daily riders selected this barrier at similar rates.

Self-reported mileage data from the same WCP survey, as described in the Additional Details about Daily Cyclists subsection in Chapter 3, backs up the effects of weather for daily riders who received this question in the survey. About one third of daily riders reported cutting their cycling to zero miles per week in bad weather weeks during the winter. By

contrast, less than 1 percent of daily riders reported cycling less than 4 miles per week during good weather weeks in the summer, and more than half of the riders rode 40 miles or more weekly.

Concerns about weather are consistent both with existing literature on the subject and with the City of Seattle's survey in preparation for the 2007 Bike Master Plan release, in which weather was the fourth-most frequently selected factor in the respondents' cycling decisions (City of Seattle, 2007).

5.2.3 Hills

The notoriously steep topography in many Seattle neighborhoods clearly drew notice from the respondents to this survey, as overall, some 41 percent of the sample selected "too many hills in the area" as a barrier.

The responses to this question also highlight notable differences between the arguably more experienced riders in the daily group and those in the non-daily group. Some 58 percent of the non-daily riders reported hills as a barrier, but only 34 percent of the daily riders did. A chi square test found this difference to be significant, suggesting a correlation between ridership type and hills as a barrier.

Conflicting with this phenomenon, however, is the small percentage of riders in either group who selected the factor, "I'm not in shape to ride a bicycle," which would seem to relate to one's ability to tackle hills on two wheels. Perhaps what is more likely is that women are concerned about the aftermath of riding up a steep hill, as a greater percentage of women in each group selected "I hate arriving anywhere all red and sweaty."

The existing Seattle Bike Master Plan touches on the importance of topography in bike infrastructure installation decisions and backs up the notion that steep slopes can be a challenge for cyclists in the city (City of Seattle, 2007).

5.2.4 Cargo

How best to carry things by bike proved to be a large concern—and a motivator for choosing the car as a transportation mode—among non-daily riders, and some daily riders selected

related barriers as well.

More than 40 percent of non-daily riders and nearly 30 percent of daily riders selected the barrier "I have so much stuff so I need my car." In addition, more than 40 percent of non-daily riders and about 20 percent of daily riders reported difficulty with bringing spare clothes. A slightly smaller share reported that a large number of errands, which seemingly also involve a certain level of cargo, necessitated a car from time to time.

Interestingly, however, very few members of either group indicated that they did not know how to carry items on their bikes.

5.2.5 Distance

More than one third of all riders indicated that distance to destinations can be a barrier in their decisions to cycle, with about 35 percent of non-daily riders and nearly 40 percent of daily riders citing "distance is too far" as an influential barrier. About 25 percent of all riders and of the individual ridership groups reported that lack of time was a barrier to cycling, which may also be related to the distance traveled.

Concerns about distance were also borne out in the motives question, as more than half of the riders in each group said they would like to see "better connectivity/more direct routes." This concern is perhaps even more salient in Seattle, where numerous water bodies and highways can limit the directness of routes.

More than half of the daily riders, who received a question about why they bicycle for trips, reported that cycling is the "easiest/quickest way to travel." These responses may indicate that distance in itself is not the sole determinant in riding decisions and that traffic congestion and time commitments associated with car or transit travel may also play a role. In addition, 93 percent of daily riders said they ride because bicycling is "great exercise and keeps me in shape," which suggests that longer distances could actually be a selling point for some riders.

These concerns are consistent with those expressed by Seattle residents surveyed for the bike master plan. Indeed, in response to the question, "Which of the following factors plays a role in whether or not you ride your bike to your destination?" the second-most selected

answer after "traffic safety on a particular route" was "travel time" (City of Seattle, 2007). The master plan acknowledges this concern in part by calling for a system of wayfinding signs that assist cyclists on the street with finding the most direct routes to their destinations.

5.2.6 Grooming Issues

Dress and shoe requirements, hair, and other grooming-related issues were frequent concerns for both groups of riders, but more so for non-daily riders.

Nearly half of the non-daily riders and one-third of the daily riders selected the barrier "I have to wear nice clothes and look well-groomed at my destinations" when it appeared in the lifestyle issues category. In the next question about culture and fashion, the numbers dropped. Still, one-third or more of the non-daily riders reported general concerns about grooming issues, bringing spare clothes, helmet hair, and arriving at destinations red-faced and sweaty, while about one-fifth of the daily riders reported concerns about each of those barriers. These proportions are much smaller than those for safety or infrastructure-related barriers, but they are nonetheless substantial enough to warrant attention, particularly as they relate to seemingly less experienced cyclists.

A meager 5 percent of daily riders indicated that if biking were more fashionable, they would increase their cycling, suggesting that they are already sufficiently comfortable with the look of the two-wheeled mode. In addition, 64 percent of daily riders reported that they wear special clothing and change at their destination, and 68 percent deliberately wear bright or reflective clothing, which demonstrates a level of adaptation to potential gear norms of cycling.

At the same time, the proportion of non-daily riders who desired more fashionable cycling attire was double that of daily riders, suggesting that for some women, the fashionability of biking may be a selling point. The rise of boutique-like bicycle shops peddling hip clothing in Seattle and elsewhere could help to contribute to biking's image as a more inclusive pursuit transcending the domain of spandex-clad males.

5.2.7 End-of-trip Facilities

Closely related to grooming issues are concerns about the availability of adequate end-of-trip facilities, including parking, lockers, and showers.

More than one-third of daily riders and nearly one-third of non-daily riders said "more bike parking everywhere" would cause them to start or increase their cycling, and about the same share said shower and lockers at their destinations would provide that motivation.

Yet other questions make it less clear whether lack of these facilities is an actual problem for the respondents or whether perception plays a prevailing role. Ten percent or fewer of either group reported a lack of places to park their bike. A slightly larger percentage of non-daily riders—17 percent—reported that there were no facilities for locking their bike or changing at work, while only 8 percent of daily riders indicated this issue was a barrier.

5.2.8 Financial Incentives

This questionnaire collected limited information about the financial situations of the respondents, although their reported high education levels suggests they are likely to fall into middle to upper income brackets. Interestingly, however, nearly half of the daily riders and about one-third of the non-daily cyclists reported that tax breaks or financial incentives related to bicycling would cause them to start or increase their riding. In addition, one of the top reasons that daily cyclists reported using their bicycles for trips was, "It saves me money."

These findings suggest that additional financial incentives—or perhaps broader consumer education about existing cost savings associated with biking—could play a strong role in shifting more trips to bike, even among people who may already earn middle- or upper-class incomes. The discrepancy between selection of this option by daily and non-daily riders also suggests that perhaps non-daily riders are not considering the financial consequences of biking to the same extent and could potentially benefit from additional information on this front.

5.3 Least Important Factors

By contrast, a number of barriers and factors appear to be less important in the cycling decisions among the survey respondents, as evidenced by their less frequent selection:

5.3.1 Bicycle Maintenance and Equipment

Women in this sample did not appear to be very concerned about issues related to bicycle equipment and maintenance. Very few women reported concerns about such matters as operating bike gears, brakes not functioning properly, getting flat tires, and dirtying clothes or hands from chain grease.

Only a small number of women from either ridership group expressed interest in additional bike repair class offerings, women's only cycling classes, or "starting-up cycling classes," and even fewer said "friendlier bike shop employees" would influence their decisions to start or increase their riding.

The high education levels and familiarity with cycling reported by the respondents may help to explain why these concerns are minimal. A highly educated sample likely has sufficient income to purchase new parts and hire help for maintenance.

However, these findings are somewhat inconsistent with anecdotal reports from advocates for women in cycling. For example, at the national Women Cycling Forum in in March 2012, mountain bike racer Maria Streb proclaimed that women-only bike skills workshops are essential to getting more females on the road, and other female participants reported having "terrible" experiences in bike shops that had the potential to turn more amateur cyclists off to cycling (Snyder, 2012).

5.3.2 Social Support

Lack of support for female cyclists in the community did not appear to be a strong concern for the respondents. Only about 15 percent of non-daily riders and 12 percent of daily riders said that more women riding would in turn encourage them to start or increase their own cycling. Only 4 percent of daily riders and 8 percent of non-daily riders said "more encouragement from my friends and family" would prompt them to cycle more often.

In addition, only 8 percent of non-daily riders and 5 percent of daily riders selected "I would like to ride with other people" as a barrier to cycling from the lifestyle issues category.

However, these findings may be an anomaly reflective of a sample skewed toward more experienced riders, as they run contrary to anecdotal evidence about the success of women-only cycling programs to boost interest in the practice. For example, in a recent webinar organized by the Women Cycling Project, several founders of women-only recreational and educational cycling groups in areas ranging from Birmingham, Ala. to Minneapolis, Minn. reported that their programs had grown in membership and attracted strong interest from the communities in which they operated.

5.3.3 Connections to Transit

Concerns about connecting bike infrastructure with transit did not surface among the top picks for either group of riders. Very few respondents—only 8 percent of non-daily riders and 2 percent of daily riders—reported difficulty riding their bikes to transit.

Less than 20 percent of each rider group said the ability to bring their bike on the train or bus would cause them to start or increase their cycling. Less than 10 percent said more bike racks at their transit stations would cause them to start or increase their cycling. This response may be explained in part by the wording of the question, as the term "station" often brings rail transit to mind, and perhaps the respondents do not feel that Seattle's rail stations lack parking.

On a related note, very few daily riders (about 12 percent) reported that they bike because they lack "good public transit options," which suggests that Seattle offers generally sufficient transit options to its residents. This transit availability, coupled with concerns outlined above, may in turn help to explain the relatively low levels of transportation cycling among Seattle women. Women may opt to select transit, for example, as an alternative to biking if they view it as a way of overcoming safety concerns from riding with motorized traffic, bad weather, hills, grooming issues, longer distances, and other frequently selected barriers.

5.4 Limitations

The dataset used in this thesis suffers from a number of general limitations that prevent certain important conclusions.

First, the survey did not reach a representative sample of women, so its findings are not generalizable to the rest of Seattle women, much less to the United States as a whole. The findings nevertheless provide important insight on the opinions of working-age Seattle women, particularly those who already ride bikes for transportation.

Second, because this study takes a cross-sectional approach, capturing opinions from a subset of the population at one moment in time, it does not account for changes in opinions or attitudes that could occur before or after the respondent took the survey.

Third, this study does not allow for any conclusions about causation. Rather, only correlations can be determined between certain factors and bicycling behavior, and those associations are subject to additional limitations detailed below.

Fourth, because this study takes a stated-preference questionnaire format, its ensuing data is only as reliable as the respondents' opinions and recollections. For example, it is possible that women who report a lack of bike parking or bike lanes in their area are only perceiving this situation to be the case, when in reality there are ample facilities. Without having additional information about where the respondents live and work, it is impossible to know how accurately their responses reflect reality. Still, these perceptions are useful to have on record, as perceptions are often as important as reality in measuring the potential for behavioral changes.

Fifth, because the organizers of this questionnaire did not intend or attempt to reach men, there is no control group against which to compare the women's responses. Thus, it is not possible in this study to make claims about whether particular barriers to cycling correlate to gender per se or to determine whether women are more likely than men to respond in particular ways.

5.4.1 Questionnaire design and wording

The design of the survey and wording of questions also create limitations. One issue is that each respondent viewed the questions and, when applicable, possible responses in the same order. This design could introduce the well-documented phenomena of "response order effect" or "question context effect," in which the order of the answers or questions affects the responses that participants choose and thus is not an entirely accurate reflection of their opinions (Johnson et al., 1998). However, this may not be a large issue, as studies have found that these effects are more pronounced among people of lower education levels, and in this case, virtually all of the participants reported a college or higher education.

Another major challenge lies in the wording of the differentiating question that determined the survey path for each respondent. A reasonable person could interpret "Do you use a bicycle for any of your daily trips in the community?" in a variety of ways. For instance, a literal interpretation of the "daily" component could cause even a fairly regular cyclist to answer "no" to the question, thus preventing them from answering more detailed questions about their current cycling behavior and sending them immediately to the questions about barriers.

Thus, the non-daily cycling group may in fact contain women who are fairly confident about cycling and consider themselves to be cyclists, as well as women who have never ridden a bike. However, the very low number of non-daily riders who selected barriers such as "I don't know how to ride a bike" and "It's so many years since I've cycled that I'm not sure that I can" indicates that this group may not contain many women who never cycle.

In the same vein, women who answered "yes" to the daily cycling question may not literally ride daily but may have selected that response because they are already quite confident in their cycling and would ride daily if given the opportunity. Thus, the two groups may not be an accurate reflection of daily or non-daily riders but may still be a proxy for distinguishing the experienced or less-experienced cyclists, or perhaps the enthusiastic and less-enthusiastic cyclists.

The question and answer structure also makes it impossible to determine the magnitude of the effect of each barrier on the women's decisions to cycle or not to cycle daily. It is

possible to suggest, for example, that safety is one of the greatest concerns among daily and non-daily riders based on the high frequency rates at which certain barriers in the safety category were selected. However, it is not possible based on frequency information alone to say definitively whether one of those safety-related barriers is more important to an individual respondent's cycling decisions than another, perhaps non-safety-related, barrier.

5.4.2 Summary Score Compilation

This study's compilation of summary scores for each classification of barriers—skills and confidence, safety, equipment, and so on—is vulnerable to flaws for a few reasons. First, barriers in some categories overlap in content with barriers in other categories, and furthermore, there are items that seem to be able to fit into multiple categories. For example, "There are dangerous pinch points on my route" has been grouped in the facility design and maintenance category, but it could just as easily fit into safety concerns. In addition, "I am comfortable in my car and not on a bike" falls in the lifestyle issues category on the questionnaire, but it seems it could also relate to skills and confidence.

Second, it is possible that certain barriers within each category may carry more weight for certain respondents than others, yet the summary scores assume each barrier, if checked, has a value of one, and each unchecked barrier has a value of zero.

For these reasons, the summary score computed for each of the six categories is useful as a basic guide, particularly when viewed as a percentage of possible selections to establish the relative importance of various factors between the various groups, but it is not as definitive or precise a measure as it could be.

5.4.3 Limited Demographic Information

Although there is a good deal of information about what factors tie into daily and non-daily riders' decisions to bike, there is a glaring lack of information about perhaps one of the most important concepts to unravel: what causes these factors to matter or not matter to these women in the first place. It is especially difficult to extrapolate possible reasons because of the very limited demographic information collected about the women.

It would have been useful to have more information about the respondent's occupation, income, relationship status, number of children, home and car ownership status, average distances traveled between home, work, and other key destinations, and other personal-lifestyle variables that may have a strong effect on transportation mode decisions.

For example, very few women in the sample chose the statement, "I have to drop my kids everywhere so I need to drive," as a barrier. Through this survey alone, it is impossible to know the precise reasons why—for instance, whether most of the respondents simply have no young children, whether they share drop-off duties with a partner or family member or friend, or some other reason.

The lack of demographic information collected by the survey prevents more granular conclusions about particular subsets of women and why they may have selected the barriers they did. Surely a low-income twentysomething with two young children and a graveyard shift job across town will have different travel preferences than a single thirtysomething who works 9 to 5 only three miles from home or a fiftysomething married empty nester who works in a neighboring suburb. The ecological model of physical activity suggests that this heterogeneity should not be overlooked in attempting to explain these behaviors.

Chapter 6

RECOMMENDATIONS AND CONCLUSIONS

Despite their limitations, the major findings of this study allow for a number of broad recommendations for bicycle planning activities—and point to the need for new directions in data collection and analysis.

6.1 Recommended Actions

A number of the following five recommendations already appear in some form in the Seattle Bike Master Plan, as noted below. These recommended actions are specifically intended to reinforce and expand upon steps that appear to have the best potential to make a positive impact on working-age Seattle women's decisions to cycle for transportation.

1. Consider implementing additional strategies that separate bikes from motorized traffic. Arguably the strongest message to emerge from this questionnaire is the importance of separated facilities to so many women, particularly those who cycle less often and are likely less experienced with riding. In fact, separated cycle paths and bike lanes were the most frequently selected factor that would prompt non-daily riders to start or increase their cycling.

Installing separated facilities has historically been a complex and controversial issue in the United States, largely because there is no clear evidence that separated facilities make cycling safer or increase ridership levels (Krizek et al., 2009). To the contrary, research has repeatedly shown fewer crashes and injuries occur among bicyclists who ride on the road than on separated facilities, although that phenomenon may exist because cyclists on the road tend to be more experienced (Krizek et al., 2009). A recent US government-sponsored review of cycling practices in Europe was cautious on this front, recommending that separate facilities "be evaluated in the context of typical motorist and bicyclist behavior and safety

experience in the United States before being widely implemented" (Fischer et al., 2010). Some critics argue that there are insufficient proven benefits to justify the higher cost of designing and installing separated infrastructure (Krizek et al., 2009).

Despite these conflicting views, Seattle planners should take seriously the extraordinarily high interest in additional separated bicycling paths expressed by respondents in this study and evaluate the possibility of new installations. Opinions on separated facilities in Seattle and in the United States already appear to be changing, in large part because of a growing belief among non-motorized transportation professionals that separated facilities can help less-experienced cyclists overcome fears about riding with motorized traffic. Countries with higher rates of female cyclists—namely, the Netherlands, Denmark, and Germany—make extensive use of separated facilities, and the existence of this infrastructure may help to explain the increased gender parity and perceptions of safety in those areas (Pucher and Buehler, 2008).

The latest urban bikeway design guide by the National Association of City Transportation Officials calls for consideration of separated facilities on roads with high traffic volumes, regular truck traffic, high parking turnover rates, or speed limits greater than 35 miles per hour (National Association of City Transportation Officials, 2011). Recommended options include buffered bike lanes, which involve painting an at least two-foot-wide striped area between a conventional painted bike lane and an adjacent motorized traffic lane; and cycle tracks, which are lanes that are more fully separated from motorized traffic by a parked car lane, curb, or other device.

Seattle officials have also begun to implement some of these ideas on a small, somewhat experimental scale. Since 2011 the city has installed buffered bike lanes on several major thoroughfares, including a portion of Dexter Avenue, a major north-south thoroughfare heavily used by commuters to and from downtown. The city currently has no cycle tracks but is planning to install one in conjunction with the new First Hill Streetcar project (Fucoloro, 2012). By considering ways to create further separation between parked cars and bicyclists, such as through use of striping or low curbs between parking lanes and bike lanes, planners would help to address another top concern for both rider groups: getting hit by a parked car door opening.

Another important step in creating a stronger sense of separation from fast-moving traffic for bicyclists and pedestrians is the city's current process of installing several miles of neighborhood greenways (Seattle Bicycle Program, 2012). In this approach, which has already taken hold in Portland, Ore., residential streets receive specially tailored treatments, such as warning signs, traffic signals, median refuge islands, and parking restrictions, that aim to prioritize bicyclists and pedestrians on those corridors. Although these areas still allow passage of motorized traffic, they encourage slower speeds and serve to draw attention to non-motorized users. As such, greenways offer a viable response to concerns by daily and non-daily cyclists alike about riding in close proximity to faster-moving traffic and about having wider lanes for riding.

In making improvements to the bikeway network, planners should not shy away from what could be considered "redundant" facilities—say, a greenway or separated cycle track on a road that is parallel to an arterial street with an on-street bike lane. In order to increase ridership levels, it is critical to consider the varying needs of riders of different confidence levels and tastes (Krizek et al., 2009).

2. Prioritize expansion and improvement of end-of-trip facilities. Availability of ample and secure bike parking was a frequently selected factor for at least one-third of the women in both groups in their riding decisions. Seattle planners should continue to explore creative responses to this issue, including working with local businesses and employers to further encourage and incentivize parking provision and continuing to pursue larger-capacity bike parking facilities, such as through replacing existing car parking spaces with bike racks.

To be sure, local planners have already begun to address parking quantity concerns. The Seattle Municipal Code prescribes a minimum number of bicycle parking spaces based on various land uses, including office, residential, hotel, and retail, in new developments and in major renovations of buildings, with differing requirements for inside and outside downtown (City of Seattle, 2007). The Seattle Department of Transportation also installs bike racks based on citizen requests through its Bicycle Spot Improvement Program and has added thousands of new bike parking spots in the last five years (Seattle Bicycle Program, 2012). Local planners should conduct additional assessments to determine areas where additional

bike parking is necessary, particularly in areas with older construction, where city code may not directly apply.

Parking quality should also be leading concern. To the extent possible, planners should strongly consider methods of providing covered bike parking, as doing so can help to address not only concerns about parking availability but also the respondents' rampant concerns about bad weather. If cyclists know they have a relatively dry location to leave their bikes, then they may be more willing to ride in the rain. In addition, providing monitored longer-term parking areas, particularly in densely populated areas like downtown, could help to address concerns about personal security and bike theft.

A related issue is the availability of showers at trip destinations and lockers for associated clothes and toiletry storage. Limited data shows that shower facilities had a positive significant impact on peoples' willingness to bike to work (Pucher et al., 2010). Seattle city code already requires that employers provide at least one shower per gender per 250,000 square feet of gross office floor area to accommodate bicycle commuters (City of Seattle, 2007). Although many employers already provide such facilities, the city should explore new ways to incentivize these offerings more broadly, particularly in existing and older buildings. Green building systems such as LEED give points for provision of showers and bike parking facilities, but these codes are more relevant for new construction.

3. Explore creative ways to deal with steep topography. The threat of hills proved a major barrier for the women in this sample, particularly non-daily riders. In accordance with the Seattle Bicycle Master Plan, the city has implemented numerous miles of "climbing lanes" on hills in order to give cyclists more space to pedal up steep slopes alongside motorized traffic (City of Seattle, 2007). These measures may be beneficial for some cyclists, but they seem unlikely to address the concerns of less-experienced cyclists who reported a strong reluctance to travel "too close" to moving cars, trucks, or buses.

One potential approach to resolving this issue is through innovative marketing of existing routes. Planners should consider new ways to publicize and draw attention to less-hilly alternatives, as it is often possible to complete popular routes in Seattle with much less elevation gain and loss by adding a small amount of distance to the ride. Less-experienced

cyclists may not be aware of these alternative routes. Planners could consider placing a network of wayfinding signs that not only contain mileage to popular destinations, as is already the case in the Seattle bicycle wayfinding system, but that also highlight less-hilly route alternatives in areas where steep slopes can cause intimidation.

Although the existing Seattle bicycle map marks the steepest terrain, it would be beneficial for less-experienced cyclists to have access to a map that clearly shows, to the extent feasible, a continuous network of less-hilly routes. Ideally, these routes would also coincide with proposed neighborhood greenways or bike lane installations to provide additional protection for cyclists from motorized traffic.

The city should also consider installing modest ramps alongside the more heavily trafficked pedestrian staircases in many parts of the city in order to allow cyclists to push their bikes up steep sections more easily. Seattle Department of Transportation recently installed a pilot wooden "runnel" on a stairway that connects the Alki Trail and West Seattle Bridge Trail with a nearby buffered bike lane (Seattle Department of Transportation, 2011).

The Seattle Bicycle Master Plan already prescribes that cyclists be allowed to use existing "public hill-assist" technologies, including elevators and escalators in buildings that sit on high terrain (City of Seattle, 2007). However, to the extent possible, the city should work with local business owners to strike a balance that both publicizes the location of these services to cyclists and existence of these services and protects the security of private buildings. (Perhaps, for example, the city could offer to defray some of the costs of installing closed-circuit security cameras or providing cleaning or maintenance services to these escalators and elevators.) Many less-experienced cyclists may not be aware that these routes exist or that they would be allowed to make use of them.

A perhaps more avant-garde and expensive idea is to work with local transit agencies to improve the capacity of bike carriage on buses and streetcars, particularly on hilly routes, such as those that climb from downtown to Capitol Hill. Attaching large flatbed trailers outfitted with bike racks to the backs of buses or streetcars could allow for accommodation of additional bicycles beyond the three that most buses can currently hold. In order to ensure safety and fluid bus movement, transit agencies would need to establish rules about when and where buses could be attached and removed—for example, only at certain stops

both at the top and bottom of the hills involved.

4. Seek solutions for more direct and complete route connectivity. Because a large portion of this sample's daily and non-daily riders expressed interest in seeing more direct or connected routes, the city should continue to pursue its goals of installing some 450 miles of well-connected bicycle routes by 2017. Although spot improvements also matter, research shows that many cyclists value the connectivity of the overall network of routes more highly, so planners should consider these opinions to the extent possible when scheduling road upgrade projects (Krizek et al., 2009).

In addressing route connectivity, planners should also pay particular attention to potentially dangerous pinch points that can make cycling less attractive to less-experienced and experienced cyclists alike. For Seattle riders, one major example of such pinch points is the many bridges that connect northern neighborhoods to downtown and other destinations. Although some bridges, such as the Fremont Bridge and University Bridge, have relatively protected bikeways, others, like the Ballard Bridge, offer only a narrow corridor for cyclists and can prove intimidating for less-experienced riders. The Seattle Bicycle Master Plan identifies these corridors and others as ripe for improvements and should strongly consider installing more expansive protected facilities that would appeal even to less-experienced riders (City of Seattle, 2007). The ability to make safe and comfortable water crossings could play a large part in solidifying a less-experienced cyclist's decision to start or increase their riding, as there may literally be no other options for accessing certain destinations aside from crossing particular bridges.

5. Enhance targeted marketing activities that address cycling for transportation as a lifestyle. None of the above actions will reach their intended potential unless local residents and visitors—particularly those who are not regular transportation cyclists—become aware of various changes and improvements in offerings geared toward cyclists. "Soft" measures, such as creative marketing and careful consideration of cultural attitudes, in turn, become essential (McClintock, 2002a).

In order to develop successful marketing campaigns to attract additional skeptics to

cycling, planners must gain fuller awareness of their target audiences. Although it is clear that women are riding at lower rates than men, it is important to stay away from one-size-fits-all marketing campaigns intended to capture the attention of all women. Even the results of this limited survey show that there are differences among women. Without taking these differences into careful consideration, planners run the risk of alienating more confident female riders or failing to address the concerns of less-confident riders.

Many of the existing marketing strategies for bicycling focus on commute trips, with annual events like Bike to Work and School Month in May attracting thousands of participants in Seattle each year. Although these efforts are important and should continue, as peak traffic congestion occurs at commute times, planners should also explore ways of demystifying the usage of bikes for everyday purposes like shopping and visiting friends. Planners could explore the establishment of new partnerships with local businesses—including utilitarian destinations like supermarkets—to encourage rewards for customers who arrive regularly by bike. Discounts or freebies for bike travelers could help to drum up additional sales for area businesses and may help to offset any concerns that consumers arriving by bike would purchase smaller volumes of goods than those who drove in their cars.

These campaigns may be especially important for encouraging cycling among non-daily riders, who were much more likely than daily riders to report difficulties in carrying cargo or running errands without a car. However, it appears they would also make a difference for daily riders, as nearly a majority said that financial incentives would cause them to increase their cycling.

6.2 Future Research

Although this study makes useful contributions to the as-yet limited pool of information about reasons why women do or do not bike for transportation in Seattle, it represents only an initial step in what could be a much more robust body of research. What follows are suggestions for improving and further augmenting research on women's bicycling habits, with the goal of contributing to knowledge about how to increase bicycling uptake in areas where rates are low.

1. Include men in future studies. Without the addition of men as a control group, it will be impossible to determine whether concerns expressed in this questionnaire are particular to women and, in turn, how best to mold responses through planning efforts. Better understanding the gendered nuances of cycling behavior will help to guide coordination of targeted solutions based on any differences observed between genders.

2. Attempt to reach a more representative sample. It will not be possible to fully understand the low levels of cycling among all genders unless broader, more representative samples of the US population are included in future study. A concerted effort should be made to include a variety of races and ethnicities, geographic locations, education and income levels, family and household situations, and so on.

3. Collect vastly more demographic data from future study participants. The underlying question of why any of the dozens of possible barriers make a difference to the respondents—and to what extent certain demographic subsets care about particular factors—cannot be fully understood unless additional demographic data is available to help to establish patterns and relationships. Additional useful data includes but is not limited to: household size, household income, occupation, number of hours worked per week, car ownership status, homeownership status, distance from home to work, distance from home to other popular destinations, and number of children and ages.

4. Recraft certain survey questions and suggested responses. The WCP survey organizers have noted ways that they would change their questionnaire if ever reused but have no current plans to make the survey a regular feature. If other researchers conduct future surveys aimed at collecting similar data, they should strongly consider pursuing ways that respondents can assign ranks or priorities to particular barriers or factors. The use of dichotomous variables—i.e., a yes or no response—in this survey made it nearly impossible to quantify the magnitude of importance of certain factors.

To collect more precise information on such important topics, it may help to use a Likert scale or other similar method that allows respondents to provide more granular and

hierarchical information about their behavior and opinions. In particular, the question about daily riding that sent women on two different paths for questions should be recrafted so that the respondents offer more specific information about their riding frequency (for example, everyday, a few times per week, a few times per month, a few times per year, never). It would also be extremely useful for planners to understand how difficult a particular barrier—for instance, bad weather—is for a respondent to overcome relative to other possible barriers.

5. Compare barriers and motives for women living in different locales. Although this thesis focused on Seattle women because of local relevance, it would be useful to compare barriers for women in Seattle to women in other cities, both those with high cycling rates and those with low cycling rates. Such comparisons may help to determine which barriers cities with high cycling mode share have seemingly overcome or perhaps never had to face, as well as which barriers are particularly salient in lower cycling mode share areas.

6. Consider pursuing different or additional research design approaches. As stated-preference surveys are only as reliable as their respondents' answers, it would be helpful to pursue research designs that provide additional insight through other means of study.

A revealed-preference design, such as observational studies of how many women use particular types of bikeways as opposed to men, or how many women ride in bad weather as opposed to men, could give new perspectives on this issue. Forming focus groups or conducting detailed structured interviews with a representative sample of women may also allow for more detailed insight that cannot be captured in a mass-marketed questionnaire. A longitudinal study, checking in at points in a woman's life from young to old age, could also provide a fascinating look at how factors and preferences change over time.

In addition, a series of narrowly tailored approaches to exploring barriers to cycling within female subgroups could prove helpful—for example, surveying only teenage or younger girls, only university students, only members of a particular minority or income group, only women who never bike, or other niche groups that could help to shed light on this complex

topic.

6.3 Conclusions

Increasing rates of biking for transportation in Seattle and in the United States as a whole remains a distinct challenge. It is likely that achieving higher overall ridership rates will not be possible unless more women decide to participate than at present. At the same time, making cycling and other non-motorized modes more attractive options for a larger swath of the US population is likely to be a critical element of improving health, quality of life, environmental, and economic concerns in both short-term and longer-range planning efforts.

This analysis of 365 working-age Seattle women's responses to a nationwide survey begins to expand upon existing findings about barriers and motives for cycling among women in this area. Consistent with existing literature, it is clear that safety, particularly in the presence of motorized traffic, is a paramount concern for daily and non-daily riders alike. Planners should pursue infrastructure changes that improve at least the perception of safety and attempt to the extent feasible to offer urban cyclists more protection from motorized traffic. Weather, steep topography, distances between origins and destinations, route connectivity, and grooming and cargo issues also appear to play important roles in women's cycling decisions. By contrast, bike and equipment issues, presence of social supports in the community, and connectivity with transit appear to be less relevant considerations for the women in this sample.

The large number of limitations in this survey design prevents a definitive understanding of the magnitude of various factors in women's cycling decisions. They also mask the discrepancies that likely exist among various subgroups of women—e.g., those with children, those who do not own cars, etc. This survey only reached a small, non-representative sample of the women who live here and skewed toward more experienced cyclists. Furthermore, it is not possible from these findings to quantify just how much one factor makes a difference over another—or how these factors compare to what men would select.

Although this study contributed to the as-yet limited knowledge about female bicycling behavior and preferences in Seattle, gaining a stronger grasp on the large gender divide among cyclists in this city and in most major US cities warrants additional study. A better

understanding of motives for bicycling among both genders and their nuanced subgroups is essential if planners hope to shift more trips away from motorized modes and reap the array of benefits associated with active transportation.

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Appendix A

COMPLETE TEXT OF WOMEN CYCLING PROJECT SURVEY

The following pages contain a PDF output of the Women Cycling Project questionnaire as it appeared when hosted online by the SurveyMonkey website.

Writing Women Back into Bicycling

Welcome to the Women's Transportation Cycling Survey

The Association of Pedestrian and Bicycle Professionals (www.apbp.org) is interested in gathering input on transportation cycling issues. This particular survey is just for women and girls.

How long does this survey take? 15 minutes on average.

Can I share this survey with other women? Please do. The more women and girls you refer to this survey, the more it assists us in figuring out what factors need to be addressed to encourage women to cycle more places more often.The survey will remain open until Saturday May 15, 2010.

The quality of our project depends on the quality of your answers. Please consider the questions carefully. We reserve the right to remove responses that appear disingenuous.

Privacy Policy: Any personally identifiable information will be kept confidential to the project team. Any personal quotes or other details will be anonymized. If you want to participate in follow-up efforts related to this project, you will need to provide us with an email address at the end of the survey. We will not share your email address with anyone after the project is complete.

One final note: we recommend taking this survey from the comfort of your laptop or desktop browser. This survey is not formatted for mobile devices.

Writing Women Back into Bicycling

Part 1: A quick question before we get started

This survey is an opportunity for a woman or girl to tell her story. While we definitely appreciate that the gentlemen may have valuable views about this topic, this survey is by women for women and girls to capture a snapshot in time. In the future, we may construct a survey for the gentlemen as well.

1. Are you male or female?

- ○ Male
- ○ Female

Writing Women Back into Bicycling

Part 2: We would like to know a little about you before we get started

2. Where do you currently live?

City

State

Country

3. How would you characterize the area where you live?

- Large City
- Medium City
- Rural
- Small town
- Suburban

4. Do you use a bicycle for any of your daily trips in the community?

- Yes
- No

Writing Women Back into Bicycling

Part 3: This part of the survey covers bicycle use and mind-set

5. Do you ever use a bicycle as transportation to any of the following destinations in your community?

- ☐ Community facilities
- ☐ Work commuting
- ☐ Errands
- ☐ Neighborhood
- ☐ Recreational facilities
- ☐ Schools
- ☐ Stores
- ☐ Socializing

6. Do you ride a bicycle?

- ☐ On vacation
- ☐ On the job

7. How many miles do you typically bike per week:

	Spring	Summer	Fall	Winter
Good weather week				
Bad weather week				

Writing Women Back into Bicycling

8. Why do you use your bicycle for trips? (check all that apply)

- ☐ It's the best part of my day
- ☐ It's great exercise and keeps me in shape
- ☐ I enjoy being in the outdoors
- ☐ Bicycling reduces my stress
- ☐ It's the easiest/quickest way for me to travel
- ☐ I can stop and chat when I see people I know
- ☐ It saves me money
- ☐ I don't have a car
- ☐ I don't have good public transit options
- ☐ It's very green and I am doing my bit for the planet
- ☐ I use my bike to get to my local bus stop/transit station
- ☐ I can do something fun with family and friends
- ☐ I want to be a leader in my family and community
- ☐ I look great bicycling
- ☐ Other (please specify)

9. What type(s) of bike do you use?

- ☐ An old junker
- ☐ Road bike
- ☐ Hybrid bike
- ☐ Folding bike
- ☐ Mountain bike
- ☐ Dutch bike

Other (please specify)

Writing Women Back into Bicycling

10. What reaction do you get when cycling for transportation? (check all that apply)

- [ ] No one blinks an eye
- [ ] Sometimes I get strange looks
- [ ] I get mostly positive comments and questions
- [ ] I'm the seventh wonder of the world
- [ ] Some motorists tell me to get on the sidewalk
- [ ] Harassment
- [ ] Some motorists don't see me
- [ ] Motorists expect to see me and are courteous
- [ ] Some motorists are overly deferential

Other (please specify)

11. What attitudes do you encounter regarding your bicycling:

	Supportive	Negative	Safety concerns	Mixed reaction	No reaction
Family	○	○	○	○	○
Friends	○	○	○	○	○
Co-workers	○	○	○	○	○
Strangers	○	○	○	○	○

12. Do the reactions and attitudes to your cycling, make you:

- ○ Bike more
- ○ Bike less
- ○ They have no impact on my decisions

13. Do you engage in the following more than occasionally while riding (check all that apply):

- [ ] I follow the rules as much as possible
- [ ] Make cell phone calls
- [ ] Run red lights
- [ ] Run stop signs
- [ ] Travel with no lights at night
- [ ] Wear dark clothing while riding at night
- [ ] Wear headphones
- [ ] Wrong way riding

Writing Women Back into Bicycling

14. Do you engage in the following (check all that apply):

- ☐ Check new routes in advance on a map or website
- ☐ Check the weather and then decide what I'll wear for cycling
- ☐ Check the weather and then decide whether I'll cycle
- ☐ Deliberately wear bright/reflective clothing
- ☐ Never ride alone
- ☐ Never ride in the dark
- ☐ Wear special clothing and change at destination

15. Do you wear a helmet when you ride?

- ○ Always
- ○ Sometimes
- ○ Never

16. Do you wear a helmet when riding with your own children?

- ○ Yes
- ○ No
- ○ Sometimes
- ○ Not applicable

17. What is your experience at bike shops? (check all that apply)

- ☐ My bike shop is great and provides great service
- ☐ My bike shop makes a special effort to cater to women customers
- ☐ My bike shop is run by women
- ☐ I feel so intimidated every time I try and ask anything
- ☐ It's all guys and they ignore me
- ☐ It is dark and unappealing
- ☐ Everything is so complicated
- ☐ Everything is so expensive
- ☐ They have such a small selection of women's bike products
- ☐ Other (please specify)

Writing Women Back into Bicycling

18. How would you characterize your bicycling style (check all that apply)?

- ☐ Assertive
- ☐ Carefree
- ☐ Cautious
- ☐ Competitive
- ☐ Law abiding
- ☐ Slow & steady

19. When you ride on the street, what lane position do you take? (check one)

- ○ I ride as close as possible to the curb
- ○ I ride a few feet out from the curb
- ○ It depends on the traffic conditions
- ○ I will only ride in the street if there is a bike lane
- ○ I never ride on the street, only on off-road paths or trails

20. Almost everyone has had injuries when bicycling at some point. Have any of the following occurred to you (check all that apply):

	Fallen off bike	Knocked off by vehicle	Hit by opening car door	Deliberately pushed off
As a child				
As an adult				

Writing Women Back into Bicycling

Part 4: This part of the survey deals with perceived or actual barriers to ...

21. Cycling skills & confidence: what factors influence your cycling decisions? (check all that apply)

- ☐ I don't know how to ride a bike
- ☐ Distance is too far
- ☐ Weather is not suitable (too wet/hot/cold)
- ☐ I have personal safety/security concerns
- ☐ I'm afraid of the bike breaking down
- ☐ I don't know cycling rules
- ☐ Cycling has become too dangerous
- ☐ I dislike aggressive/distracted drivers
- ☐ I don't like being assertive with cars
- ☐ It's hard starting up from a stop
- ☐ I don't like to ride after dark
- ☐ I had a scare/near-miss on my bike in the past
- ☐ I'm not in shape to ride a bicycle
- ☐ I would love to cycle again but I just don't know where to begin
- ☐ My cycling skills are really poor
- ☐ It's so many years since I've cycled that I'm not sure that I can
- ☐ None of the above apply to me
- ☐ Other (please specify)

Writing Women Back into Bicycling

22. Facility design and maintenance: what factors influence your cycling decisions? (check all that apply)

- ☐ No bike lanes or bike paths in my area
- ☐ Local roads are too busy for me to cycle on them
- ☐ They don't clear the ice/snow from the bike facilities
- ☐ Its difficult to ride my bike to transit
- ☐ Too many hills in the area
- ☐ I dislike car fumes
- ☐ I don't like riding close to all the buses and trucks
- ☐ There are dangerous pinch points on my route
- ☐ Roads are in terrible shape, potholes, debris, etc.
- ☐ There is nowhere for me to park my bike
- ☐ Some of my routes are not well lit
- ☐ There are no facilities for locking bike/changing at my work
- ☐ None of the above apply to me
- ☐ Other (please specify)

23. Life style issues: what factors influence your cycling decisions? (check all that apply)

- ☐ I have to drop my kids everywhere so I need to drive
- ☐ I have so many different errands that I need my car
- ☐ I have so much stuff to carry so I need my car
- ☐ I don't have time
- ☐ I am comfortable in my car and not on a bike
- ☐ I have to wear nice clothes and look well-groomed at my destinations
- ☐ I would like to ride with other people
- ☐ None of the above apply to me
- ☐ Other (please specify)

Writing Women Back into Bicycling

24. Bikes and equipment: what factors influence your cycling decisions? (check all that apply)

- [ ] I don't know how to work the gears
- [ ] I can never get my brakes working right
- [ ] I'm afraid that I'll get stranded with a flat tire somewhere
- [ ] My hands get dirty when I have to do anything with the bike
- [ ] I don't like it when oil gets on my clothes from the chain
- [ ] I don't know how to carry stuff on my bike
- [ ] I need fenders
- [ ] None of these factors bother me
- [ ] Other (please specify)

25. Culture and fashion: what factors influence your cycling decisions? (check all that apply)

- [ ] Clothing/grooming are a problem
- [ ] It's difficult bringing spare clothes
- [ ] All the clothes and gear look so complicated
- [ ] I would look silly on a bike
- [ ] No other women in my neighborhood cycle
- [ ] All those other women look so fit
- [ ] I hate arriving anywhere all red and sweaty
- [ ] Helmets mess up my hair
- [ ] Shoes are an issue
- [ ] I'm afraid of negative comments about my appearance after cycling
- [ ] None of the above apply to me
- [ ] Other (please specify)

Writing Women Back into Bicycling

26. What are your safety concerns about bicycling? (check all that apply)

- [ ] Volume of cars
- [ ] Speed of cars
- [ ] Moving cars
- [ ] Distracted driving
- [ ] Motorists who run red lights and stop signs
- [ ] Moving trucks and buses
- [ ] Parked cars opening doors
- [ ] Vehicles turning right in front of me when I'm going straight
- [ ] Vehicles hitting me from behind when I am cycling
- [ ] Crossing at intersections
- [ ] Other cyclists running into me
- [ ] Pedestrians stepping out in front of me without looking
- [ ] Stranger attacks
- [ ] Someone stealing my bike while it's parked
- [ ] None of the above
- [ ] Other (please specify)

Writing Women Back into Bicycling

27. What would cause you to start or increase your cycling (check all that apply)?

- [ ] More people cycling
- [ ] More bike lanes
- [ ] Wider lanes on the roads
- [ ] Completely separated off-road cycling paths
- [ ] Better connectivity/more direct routes
- [ ] Reduced traffic speeds/cars
- [ ] Better lighting along routes
- [ ] Showers and lockers at destination
- [ ] Incentives from my school
- [ ] More bike racks everywhere
- [ ] More bike racks at my transit station
- [ ] Secure bike parking
- [ ] Ability to bring bike on train or bus
- [ ] More fashionable
- [ ] More security and safety for cyclists
- [ ] Increased levels of other women cycling
- [ ] More encouragement from my friends and family
- [ ] Organized social cycling events
- [ ] Cycling with a buddy more often
- [ ] Starting-up cycling classes
- [ ] Ladies-only cycling class
- [ ] Work-place encouragement
- [ ] Tax breaks/financial incentives
- [ ] Bike repair class
- [ ] Friendlier bike shop employees
- [ ] Easy-to-read information explaining about bike parts and the cycling rules
- [ ] Good local bike maps or websites so I could check out and plan my routes
- [ ] Other (please specify)

Writing Women Back into Bicycling

28. When did you first have freedom to bicycle places alone?

- ○ Under 6
- ○ 7-10
- ○ 11-14
- ○ 14-17
- ○ Over 18

29. Have other family members ever bicycled for transportation (check all that apply)?

- ☐ Spouse
- ☐ Mother
- ☐ Father
- ☐ Siblings
- ☐ Grandparents
- ☐ Children

30. Has your bike ever been stolen?

- ○ Yes
- ○ No

Writing Women Back into Bicycling

Part 5: What would encourage more women to cycle?

31. What could your community do to encourage more women to bicycle for trips?

32. Could your community do anything different to encourage more teen girls to bicycle for trips?

33. What could your community do to specifically encourage more young girls to bicycle for trips?

34. Is there anything that you would like to add on the topic of women and bicycling:

Writing Women Back into Bicycling

Part 6: Can you let us know a little about you and your household?

35. What is your age group?

- ○ Under 20
- ○ 20-30
- ○ 31-40
- ○ 41-50
- ○ 51-60
- ○ 61-70
- ○ 70 and over

36. What is your highest educational level obtained?

- ○ Still in school
- ○ High school
- ○ College
- ○ Graduate

37. Cultural & Ethnic Background:

- ☐ American Indian and Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Hispanic or Latino
- ☐ Native Hawaiian and Other Pacific Islander
- ☐ Other
- ☐ White

38. May we get in touch with you again in the future to discuss this topic? If so please provide us with a contact e-address. We will not share this address for any other purpose.

Writing Women Back into Bicycling

Part 7: Thank you for your interest in our survey

To the gentlemen, while we definitely appreciate that you have valuable views about this topic, this particular survey is by women for women to capture a snapshot in time. In the future, we may construct a survey for the gentlemen as well.Do join us for a free webinar on this topic on March 31, 2010 at 3:00 p.m. Eastern Time, or view the archive later at your leisure.

Appendix B

COMPLETE LIST OF RESPONSES TO QUESTIONS 21-26 FROM SEATTLE SAMPLE

Table B.1: All Barriers Selected by Non-Daily Riders by Frequency

Barrier	**Number**	**%**
Distracted driving	84	79%
Parked cars opening doors	75	71%
Speed of cars	74	70%
Weather is not suitable (too wet/hot/cold)	73	69%
Vehicles turning right in front of me when I'm going straight	71	67%
Volume of cars	68	64%
I dislike aggressive/distracted drivers	67	63%
I don't like riding close to all the buses and trucks	67	63%
Motorists who run red lights and stop signs	62	58%
Too many hills in the area	61	58%
Moving trucks and buses	57	54%
I have to wear nice clothes and look well-groomed at my destinations	50	47%
Local roads are too busy for me to cycle on them	49	46%
I have personal safety/security concerns	48	45%
I don't like to ride after dark	47	44%
It's difficult bringing spare clothes	47	44%
Moving cars	47	44%
I have so much stuff to carry so I need my car	43	41%
I don't like being assertive with cars	39	37%
Clothing/grooming are a problem	38	36%

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Table B.1 – *All Barriers Selected by Non-Daily Riders by Frequency, continued from previous page*

Barrier	**Number**	**%**
Distance is too far	37	35%
I hate arriving anywhere all red and sweaty	36	34%
Vehicles hitting me from behind when I am cycling	35	33%
Crossing at intersections	34	32%
I have so many different errands that I need my car	33	31%
Helmets mess up my hair	33	31%
Someone stealing my bike while it's parked	32	30%
No bike lanes or bike paths in my area	27	25%
I don't have time	27	25%
Roads are in terrible shape, potholes, debris, etc.	26	25%
I dislike car fumes	24	23%
I am comfortable in my car and not on a bike	22	21%
Pedestrians stepping out in front of me without looking	21	20%
I'm not in shape to ride a bicycle	19	18%
I'm afraid that I'll get stranded with a flat tire somewhere	19	18%
Some of my routes are not well lit	17	16%
There are no facilities for locking bike/changing at my work	17	16%
I don't know how to carry stuff on my bike	17	16%
I need fenders	17	16%
Shoes are an issue	17	16%
Cycling has become too dangerous	14	13%
There are dangerous pinch points on my route	14	13%
I have to drop my kids everywhere so I need to drive	14	13%
I'm afraid of the bike breaking down	13	12%
Other cyclists running into me	12	11%
I don't know how to work the gears	11	10%
I don't like it when oil gets on my clothes from the chain	11	10%

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Table B.1 – *All Barriers Selected by Non-Daily Riders by Frequency, continued from previous page*

Barrier	**Number**	**%**
Stranger attacks	11	10%
I don't know cycling rules	10	9%
I had a scare/near-miss on my bike in the past	10	9%
All those other women look so fit	10	9%
My cycling skills are really poor	9	8%
I would like to ride with other people	9	8%
I would love to cycle again but I just don't know where to begin	8	8%
It's difficult to ride my bike to transit	8	8%
There is nowhere for me to park my bike	8	8%
All the clothes and gear look so complicated	8	8%
My hands get dirty when I have to do anything with the bike	7	7%
They don't clear the ice/snow from the bike facilities	6	6%
It's hard starting up from a stop	5	5%
It's so many years since I've cycled that I'm not sure that I can	5	5%
I'm afraid of negative comments about my appearance after cycling	5	5%
I can never get my brakes working right	3	3%
I would look silly on a bike	3	3%
No other women in my neighborhood cycle	2	2%
I don't know how to ride a bike	1	1%

Table B.2: All Barriers Selected by Daily Riders by Frequency

Barrier	**Number**	**%**
Distracted driving	217	84%
Vehicles turning right in front of me when I'm going straight	188	73%
Parked cars opening doors	182	70%
Weather is not suitable (too wet/hot/cold)	169	65%
Speed of cars	158	61%
Motorists who run red lights and stop signs	138	53%
Volume of cars	120	46%
Distance is too far	102	39%
I dislike aggressive/distracted drivers	102	39%
Roads are in terrible shape, potholes, debris, etc.	101	39%
Pedestrians stepping out in front of me without looking	94	36%
Someone stealing my bike while it's parked	94	36%
Moving trucks and buses	90	35%
Too many hills in the area	87	34%
I have to wear nice clothes and look well-groomed at my destinations	79	31%
I have so much stuff to carry so I need my car	73	28%
Vehicles hitting me from behind when I am cycling	69	27%
I don't like riding close to all the buses and trucks	64	25%
I don't have time	64	25%
Moving cars	60	23%
I have personal safety/security concerns	58	22%
Local roads are too busy for me to cycle on them	57	22%
There are dangerous pinch points on my route	56	22%
It's difficult bringing spare clothes	55	21%
Crossing at intersections	54	21%

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Table B.2 – *All Barriers Selected by Daily Riders by Frequency, continued from previous page*

Barrier	**Number**	**%**
I hate arriving anywhere all red and sweaty	49	19%
Clothing/grooming are a problem	46	18%
I have so many different errands that I need my car	43	17%
Helmets mess up my hair	43	17%
I don't like to ride after dark	42	16%
Some of my routes are not well lit	42	16%
I dislike car fumes	40	15%
They don't clear the ice/snow from the bike facilities	36	14%
No bike lanes or bike paths in my area	35	14%
Shoes are an issue	35	14%
I had a scare/near-miss on my bike in the past	33	13%
Other cyclists running into me	30	12%
I don't like being assertive with cars	26	10%
Stranger attacks	26	10%
There is nowhere for me to park my bike	25	10%
I need fenders	23	9%
I'm afraid of the bike breaking down	20	8%
There are no facilities for locking bike/changing at my work	19	7%
I'm afraid that I'll get stranded with a flat tire somewhere	19	7%
I'm not in shape to ride a bicycle	18	7%
I have to drop my kids everywhere so I need to drive	18	7%
I don't like it when oil gets on my clothes from the chain	14	5%
I would like to ride with other people	12	5%
My hands get dirty when I have to do anything with the bike	9	3%
I am comfortable in my car and not on a bike	8	3%
I don't know how to carry stuff on my bike	8	3%
It's hard starting up from a stop	7	3%

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Table B.2 – *All Barriers Selected by Daily Riders by Frequency, continued from previous page*

Barrier	**Number**	**%**
I'm afraid of negative comments about my appearance after cycling	7	3%
I can never get my brakes working right	5	2%
All those other women look so fit	5	2%
Its difficult to ride my bike to transit	4	2%
I don't know how to work the gears	4	2%
I don't know cycling rules	3	1%
Cycling has become too dangerous	3	1%
I would love to cycle again but I just don't know where to begin	1	0%
All the clothes and gear look so complicated	1	0%
I would look silly on a bike	1	0%
No other women in my neighborhood cycle	1	0%
I don't know how to ride a bike	0	0%
My cycling skills are really poor	0	0%
It's so many years since I've cycled that I'm not sure that I can	0	0%

Appendix C

COMPLETE LIST OF RESPONSES TO QUESTIONS 21-27 FROM SEATTLE SAMPLE WITH SIGNIFICANCE VALUES AND RIDERSHIP GROUP COMPARISON

The following tables show all responses to Questions 21 to 27 in the order that the answer choices were displayed. The highest frequency values for each ridership group and question are displayed in bold. The Significance column shows the p values obtained from running a 2 by 2 Chi Square test for each possible response in SPSS. The Difference column shows the relative difference in frequency percentage for each answer choice within each question as a comparison of the daily and non-daily riders.

Table C.1: All Responses to Question 21: Cycling Skills and Confidence

Response	**Non-Daily Riders**		**Daily Riders**		**Significance**	**Difference**
	Number	*%*	*Number*	*%*	$p = .05$	
I don't know how to ride a bike	1	1%	0	0%	0.118	
Distance is too far	37	35%	102	39%	0.424	0.89
Weather is not suitable (too wet/hot/cold)	73	**69%**	169	**65%**	0.507	1.06
I have personal safety/security concerns	48	45%	58	22%	**0.000**	2.02
I'm afraid of the bike breaking down	13	12%	20	8%	0.170	1.59
I don't know cycling rules	10	9%	3	1%	**0.000**	8.14

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Table C.1 – *All Responses to Question 21, continued from previous page*

Response	**Non-Daily Riders**		**Daily Riders**		**Significance**	**Difference**
	Number	*%*	*Number*	*%*	$p = .05$	
I dislike aggressive/distracted drivers	67	**63%**	102	39%	**0.000**	1.60
I dont like being assertive with cars	39	37%	26	10%	**0.000**	3.67
It's hard starting up from a stop	5	5%	7	3%	0.327	1.75
I dont like to ride after dark	47	44%	42	16%	**0.000**	2.73
I had a scare/near-miss on my bike in the past	10	9%	33	13%	0.374	0.74
I'm not in shape to ride a bicycle	19	18%	18	7%	**0.002**	2.58
I would love to cycle again but I just don't know where to begin	8	8%	1	0%	**0.000**	**19.55**
My cycling skills are really poor	9	8%	0	0%	**0.000**	–
It's so many years since Ive cycled that I'm not sure that I can	5	5%	0	0%	**0.000**	–
None of the above apply to me	3	3%	39	15%	**0.001**	5.32

Table C.2: All Responses to Question 22: Facility Design and Maintenance Factors

Response	**Non-Daily Riders**		**Daily Riders**		**Significance**	**Difference**
	Number	*%*	*Number*	*%*	$p = .05$	
No bike lanes or bike paths in my area	27	25%	35	14%	**0.006**	1.88
Local roads are too busy for me to cycle on them	49	**46%**	57	22%	**0.000**	2.10
They don't clear the ice/snow from the bike facilities	6	6%	36	14%	**0.025**	0.41
It's difficult to ride my bike to transit	8	8%	4	2%	**0.004**	4.89
Too many hills in the area	61	**58%**	87	34%	**0.000**	1.71
I dislike car fumes	24	23%	40	15%	0.101	1.47
I don't like riding close to all the buses and trucks	67	**63%**	64	25%	**0.000**	2.56
There are dangerous pinch points on my route	14	13%	56	22%	0.064	0.61
Roads are in terrible shape, potholes, debris, etc.	26	25%	101	**39%**	**0.008**	0.63
There is nowhere for me to park my bike	8	8%	25	10%	0.524	0.78
Some of my routes are not well lit	17	16%	42	16%	0.966	0.99
There are no facilities for locking bike/changing at my work	17	16%	19	7%	**0.011**	2.19
None of the above apply to me	10	9%	62	24%	**0.002**	2.54

Table C.3: All Responses to Question 23: Lifestyle Factors

Response	**Non-Daily Riders**		**Daily Riders**		**Significance**	**Difference**
	Number	*%*	*Number*	*%*	$p = .05$	
I have to drop my kids everywhere so I need to drive	14	13%	18	7%	0.0550	1.90
I have so many different errands that I need my car	33	31%	43	17%	**0.0019**	1.88
I have so much stuff to carry so I need my car	43	**41%**	73	28%	**0.0211**	1.44
I don't have time	27	25%	64	25%	0.8787	1.03
I am comfortable in my car and not on a bike	22	21%	8	3%	**0.0000**	6.72
I have to wear nice clothes and look well-groomed at my destinations	50	**47%**	79	31%	**0.0025**	1.55
I would like to ride with other people	9	8%	12	5%	0.1508	1.83
None of the above apply to me	13	12%	96	**37%**	**0.0000**	3.02

Table C.4: All Responses to Question 24: Bikes and Equipment Factors

Response	**Non-Daily Riders**		**Daily Riders**		**Significance**	**Difference**
	Number	*%*	*Number*	*%*	$p = .05$	
I don't know how to work the gears	11	10%	4	2%	**0.000**	6.72
I can never get my brakes working right	3	3%	5	2%	0.594	1.47
I'm afraid that I'll get stranded with a flat tire somewhere	19	18%	19	7%	**0.003**	2.44
My hands get dirty when I have to do anything with the bike	7	7%	9	3%	0.185	1.90
I don't like it when oil gets on my clothes from the chain	11	10%	14	5%	0.088	1.92
I don" know how to carry stuff on my bike	17	16%	8	3%	**0.000**	5.19
I need fenders	17	16%	23	9%	**0.047**	1.81
None of these factors bother me	53	**50%**	196	**76%**	**0.000**	1.51

Table C.5: All Responses to Question 25: Culture and Fashion Factors

Response	**Non-Daily Riders**		**Daily Riders**		**Significance**	**Difference**
	Number	*%*	*Number*	*%*	$p = .05$	
Clothing/grooming are a problem	38	36%	46	18%	**0.000**	2.02
It's difficult bringing spare clothes	47	**44%**	55	21%	**0.000**	2.09
All the clothes and gear look so complicated	8	8%	1	0%	**0.000**	19.55
I would look silly on a bike	3	3%	1	0%	**0.042**	7.33
No other women in my neighborhood cycle	2	2%	1	0%	0.149	4.89
All those other women look so fit	10	9%	5	2%	**0.001**	4.89
I hate arriving anywhere all red and sweaty	36	34%	49	19%	**0.002**	1.80
Helmets mess up my hair	33	31%	43	17%	**0.002**	1.88
Shoes are an issue	17	16%	35	14%	0.531	1.19
I'm afraid of negative comments about my appearance after cycling	5	5%	7	3%	0.327	1.75
None of the above apply to me	30	28%	147	**57%**	**0.000**	2.01

Table C.6: All Responses to Question 26: Safety Concerns about Bicycling

Response	**Non-Daily Riders**		**Daily Riders**		**Significance**	**Difference**
	Number	*%*	*Number*	*%*	$p = .05$	
Volume of cars	68	**64%**	120	46%	**0.002**	1.38
Speed of cars	74	**70%**	158	**61%**	0.112	1.14
Moving cars	47	44%	60	23%	**0.000**	1.91
Distracted driving	84	**79%**	217	**84%**	0.301	0.95
Motorists who run red lights and stop signs	62	**58%**	138	53%	0.364	1.10
Moving trucks and buses	57	**54%**	90	35%	**0.001**	1.55
Parked cars opening doors	75	**71%**	182	**70%**	0.927	1.01
Vehicles turning right in front of me when I'm going straight	71	**67%**	188	**73%**	0.284	0.92
Vehicles hitting me from behind when I am cycling	35	33%	69	27%	0.220	1.24
Crossing at intersections	34	32%	54	21%	**0.023**	1.54
Other cyclists running into me	12	11%	30	12%	0.943	0.98
Pedestrians stepping out in front of me without looking	21	20%	94	36%	**0.002**	1.83
Stranger attacks	11	10%	26	10%	0.922	1.03
Someone stealing my bike while its parked	32	30%	94	36%	0.265	0.83
None of the above	4	4%	5	2%	0.303	1.95

Table C.7: All Responses to Question 27: What would cause you to start or increase your cycling?

Response	**Non-Daily Riders**		**Daily Riders**		**Significance**	**Difference**
	Number	*%*	*Number*	*%*	$p = .05$	
More people cycling	25	24%	75	29%	0.296	0.81
More bike lanes	64	**60%**	162	**63%**	0.698	0.97
Wider lanes on the roads	39	37%	106	41%	0.464	0.90
Completely separated off-road cycling paths	74	**70%**	119	**46%**	**0.000**	1.52
Better connectivity/more direct routes	60	**57%**	141	**54%**	0.706	1.04
Reduced traffic speeds/cars	25	24%	91	35%	**0.031**	1.49
Better lighting along routes	29	27%	72	28%	0.932	0.98
Showers and lockers at destination	35	33%	80	31%	0.691	1.07
Incentives from my school	6	6%	20	8%	0.487	0.73
More bike racks everywhere	31	29%	91	35%	0.279	0.83
More bike racks at my transit station	5	5%	16	6%	0.586	0.76
Secure bike parking	30	28%	87	34%	0.326	0.84
Ability to bring bike on train or bus	13	12%	48	19%	0.145	0.66
More fashionable	11	10%	14	5%	0.088	1.92
More security and safety for cyclists	28	26%	71	27%	0.846	0.96

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Table C.7 – *All Responses to Question 27, continued from previous page*

Response	**Non-Daily Riders**		**Daily Riders**		**Significance**	**Difference**
	Number	*%*	*Number*	*%*	$p = .05$	
Increased levels of other women cycling	16	15%	31	12%	0.418	1.26
More encouragement from my friends and family	9	8%	10	4%	0.071	2.20
Organized social cycling events	15	14%	19	7%	**0.042**	1.93
Cycling with a buddy more often	20	19%	32	12%	0.106	1.53
Starting-up cycling classes	13	12%	2	1%	**0.000**	15.88
Ladies-only cycling class	12	11%	5	2%	**0.000**	5.86
Work-place encouragement	19	18%	42	16%	0.691	1.11
Tax breaks/financial incentives	34	32%	121	**47%**	**0.010**	1.46
Bike repair class	21	20%	44	17%	0.522	1.17
Friendlier bike shop employees	12	11%	38	15%	0.398	0.77
Easy-to-read information explaining about bike parts and the cycling rules	15	14%	25	10%	0.212	1.47
Good local bike maps or websites so I could check out and plan my routes	28	26%	57	22%	0.366	1.20