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Understanding the Bicycling Behavior of a Student Population: A Case Study in the University
of Washington's College of Built Environments

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Abstract

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Bicycling behavior has proven to be related to a variety of factors, including the physical environment, social environment, trip characteristics, and individual attributes. The use of bikes therefore varies greatly across social groups. This thesis focuses on the bicycling behavior of students from University of Washington's (UW) College of Built Environments (CBE). This student group was selected because they are receiving an education that centers urban and natural environments. The study intends to articulate their bicycling patterns, understand factors that are related to their bicycling behavior, and investigate whether the CBE culture they are exposed to

shapes their bicycling choices. Based on findings from a survey (N=88¹) and in-depth interviews (N=17), this study examined the group's commuting and non-commuting bicycling behavior. This research found that the majority of respondents could be characterized as confident cyclists who are relatively comfortable bicycling in vehicular traffic and with less decent bike facilities, and the bicycling infrastructure in Seattle is not a barrier to their cycling. The study also identified factors that influenced respondents non-commuting bicycling, including the influence of family role models, family encouragement, companionship, and a sense of belonging to a cyclist group. The study identified several patterns of establishing regular cycling behavior among this student group, and suggests the importance of creating better cycling culture to encourage more biking trips.

¹ Eighty-eight is the total number of valid responses. For commuting trip analysis, the sample N is 66; for non-commuting trip analysis, N is 73.

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Chapter 1. INTRODUCTION

1.1 RESEARCH BACKGROUND

The benefits of bicycling have been well recognized and documented in recent years (Komanoff et al., 1993, Oja et al., 1998, Rabl & De Nazelle, 2012). As a physical activity, bicycling helps to decrease risks of health threats, such as cardiovascular mortality and obesity (Oja et al., 2011). As an affordable and economical transportation choice, bicycling improves mobility for a majority of the population (World Health Organization, 2002). Besides offering benefits for human beings, bicycling is good for the environment by reducing carbon emissions and traffic congestion (Woodcock et al., 2007).

There has been burgeoning advocacy for bicycling as an environmentally friendly travel mode and health behavior among built environment professionals and scholars in the past decades. In studies of bicycling, ecological models have served as useful frameworks. These models focus on people's connections with their physical and sociocultural environments and suggest that behaviors are influenced by multiple factors on different levels, including psychological, social, organizational, and physical environmental levels (Sallis et al., 2015). Abundant empirical evidence has been found in the literature, indicating that bicycling behavior is largely determined by environmental factors, intrapersonal factors (such as demographic characteristics and attitudes), interpersonal factors (such as social norm and others' behavior), and trip characteristics (such as the purpose and length of the trip) (Moudon & Lee, 2003).

Given the fact that physical environments can be influenced and improved by planning and design practices, environmental factors have received particular attention. Several characteristics of the built environment have shown to be related to transportation bicycling, such as street

connectivity (Badland et al., 2008; Titze et al., 2008), land-use patterns (Cervero & Kockelman, 1997), bike facilities (Nelson & Allen, 1997; Dill & Carr, 2003), and route types (Winters & Teschke, 2010). However, the measurements and results across studies are not always consistent. For example, some studies adopt objective measurements (e.g. Dill & Carr, 2003, Aultman-Hall et al., 1997, Cervero & Kockelman, 1997) of the built environments, some studies use people's perceived environment characteristics as measurements (e.g. Titze et al., 2008), and some studies combine both (e.g. Moudon et al., 2005). Most studies demonstrate a statistically significant relationship between certain environment factors and bike use, but some do not (e.g. land use diversity factor in Cervero & Duncan, 2003, and in Titze et al., 2008). Despite the inconsistency, previous research has provided great insights into bicycling advocacy for a variety of municipalities, organizations, and communities. Measures and policies, such as bike infrastructure and facility development, bike and public transit connections, and cyclist-friendly traffic regulations, have been adopted in many European and North American cities to improve the attractiveness, safety, satisfaction, and convenience of transportation bicycling (Pucher & Buehler, 2008, Pucher et al. 2011).

However, in a study that investigated both transportation activity and recreational activity, Hoehner et al. (2005) suggest that physical environments might affect transportation activity more so than recreational activity. In their study, transportation activity was associated with a wide range of objective and perceived environmental factors whereas recreational activity was found to be associated with very few.

Meanwhile, different psychological aspects of behavior are believed to play an important role in understanding and predicting bicycling as a travel behavior and leisure activity. In the theory of planned behavior (Ajzen, 1991), several components, such as attitudes (the degree to which

performance of the behavior is positively or negatively valued), subjective norms (the perceived social expectation to follow a certain behavior), and perceived control (the individual's perception of the possibility of engaging or not engaging in a certain behavior), are believed to explain travel intention and/or behavior (Steg & Nordlund, 2012).

From this behavioral intention point of view, a great number of scholars have explored the influence of peoples' cognitions (e.g. Claudy & Peterson, 2014), personality (e.g. Heesch et al., 2014), and social and cultural environments (e.g. de Geus et al., 2008) on bicycling behavior. The impacts of psychosocial factors such as a sense of self-efficacy, as well as perceived benefits, are well documented for certain types of bicycling trips (de Geus, 2008).

Meanwhile, demographic characteristics also have a great influence on people's cycling behavior. Literature suggests that bicycling is dependent on age and gender (Moudon et al., 2005). Younger adults have less fear of riding a bike and use bikes more often than older adults (Geller, 2006). Women are less likely to be regular cyclists than men and have a different route choice that values safety and physical comforts (Dill & Gliebe, 2008). In this respect, studying cyclists is equally important as investigating physical environments to guide social marketing programs and transportation policies for bicycling advocacy.

Guided by the ecological models, this research focuses on investigating the bicycling behavior of a specific population: Students at the University of Washington (UW) College of Built Environments (CBE).

There are two main reasons for studying this population. First, many studies suggest that college students seem to be an active group of bike users in the U.S. context. For instance, Baltes (1996) found that metropolitan statistical areas with larger student populations have higher rates of bicycling commuting. In a study that investigated 18 U.S. cities (Nelson & Allen, 1997), the top

four cities for bicycle commuting are college towns (Dill & Carr, 2003). In a study conducted on a university campus, Rodríguez and Joo (2004) found that the student population has higher odds of walking and bicycling to campus than faculty and staff. Understanding this leading group of bicycle users may provide insights into bicycling advocacy whereas inquiring about their abundant bicycling experience can support future bicycle planning. Second, the student sample selected for this study -- those enrolled in the UW College of Built Environments -- is receiving environment-related education. Being at the forefront of the global discourse of urbanization and sustainable development, CBE values human health, environmental resilience, social equity, and economic vitality in its environmental education (<http://be.washington.edu/about/>). The programs in this College cover the topics of climate change, urban environment, and transportation systems, which are closely related to individuals' transportation behavior. As a member of the CBE community myself, receiving education on human health and sustainable development has greatly influenced my travel choice. Inspired by this personal experience, this research project intends to inquire how and why this group bicycles, and whether the education and the cultural context make a difference in their bicycling behavior. With data obtained from survey and in-depth interviews, the study can be helpful for improving the bicycling experience for this specific group and for providing information for public cycling advocacy, especially for bike education programs.

1.2 RESEARCH QUESTIONS AND OBJECTIVES

This study combines quantitative and qualitative methods to comprehensively examine a specific group's biking behavior and consider factors related to their cycling. The study is conducted in the broader context of exploring how biking is affected by physical, social, and individual factors. It cannot and does not intend to provide generalizable conclusions, but it is valuable in terms of understanding CBE students bicycling behavior and the factors associated with their

choices, and in providing suggestions for bicycling advocacy from the users' perspectives. This study seeks to answer the following questions:

1. What patterns of bicycling are shown among CBE students?
2. What factors shape CBE students' bicycling behavior?
3. How might the CBE culture shape students' bicycling behavior?

The objectives of this research are to:

1. articulate the patterns and influential factors of CBE students' bike use.
2. generate insights for bicycling advocacy within the context of CBE and provide potential suggestions for public bike advocacy programs.

Chapter 2. LITERATURE REVIEW

Based on ecological models (Sallis et al. 2015), I explored the wide breadth of literature on the topic of bicycling conducted from transportation studies, the built environment and social psychology disciplines. The intention was to establish a theoretical framework that covers the environmental, social, and personal attributes relevant to bicycling. The framework would serve as a foundation for survey design and interview instruments.

2.1 OVERVIEW

In the literature, the factors that influence bicycling can be categorized into two types: “*Subjective factors*,” which have less to do with measurable conditions than with personal perception and interpretation of one's needs; and “*Objective, physical factors*,” which exist for everyone, though may not be weighed equally by everyone (Goldsmith, 1992, p.6). Subjective measurements are usually applied in studying social environment factors and psychological-related personal attributes, and sometimes in studying perceived environmental characteristics. Objective measurements oftentimes are applied in studying physical environment factors and demographic attributes. Given the fact that the data from this study would be collected by a survey and interviews, this literature review focused more on subjective measurements.

2.2 PHYSICAL ENVIRONMENTS, TRIP CHARACTERISTICS AND BICYCLING

Bicycling facilities are critical for safe and convenient cycling. Multiple research studies have demonstrated a correlation between the quantity and quality of bicycling facilities and bicycling rates. In a study conducted in 18 U.S. cities, Nelson and Allen (1997) found a correlation between the number of bikeway miles and bicycling commuting rates. They indicated that each mile of

bikeway per 100,000 residents was associated with a 0.069 percent increase in commuters using bicycles. Similarly, Dill and Carr (2003) found that each additional mile of on-street bike lanes per square mile was associated with roughly one percentage point increase in the sharing of bicycle commuting based on the data of 43 U.S. large cities. In a study conducted in King County, WA, Moudon et al. (2005) found that the presence of bike lanes and trails in cyclists' perception, and the objective distance to one's closest bike trail, have significantly positive associations with the odds of bicycling.

Besides being related to the overall bicycling rate, facility types and quality are important concerns for cyclists' route choices and biking experience. Dill and Gilebe (2008) found that more than half (52%) of the miles on bicycle traveled by regular cyclists were made on lanes, separate paths, or bicycle boulevards. In a study conducted on cyclists' commuting routes in Guelph, Canada, Aultman-Hall et al. (1997) found safe bicycling facilities with wide curb lanes and travel signals were one of the most important reasons for bicycling commuters' route choice. Similarly, in a study that evaluated the bicycling level of service of the existing street facilities, Harkey et al. (1998) indicated that the width of the bicycle lane or paved shoulder or the curb lane could increase the comfort levels for cyclists whereas higher vehicular traffic volume and motor vehicle speeds did the opposite.

Street connectivity, reflected by the degree to which one could bike conveniently, safely, and directly to their destinations, is one of the most common factors influencing commuting cyclists' route choice (Aultman-Hall et al., 1997). Dill and Gilebe (2008) found that utilitarian cyclists placed the highest priority on minimizing travel distance and avoiding high volume of street traffic when choosing their routes. Aultman-Hall et al. (1997) found that more than half of bicycling commuters chose the shortest routes, and most bicycling commuters preferred smooth routes with

slight grades and fewer turns. In a study conducted in an Australian city, Titze et al. (2008) found that perceived bike lane connectivity, as indicated by the existence of bike tracks and the possibility of taking shortcuts by bike, was positively associated with bicycling for transportation.

Steep topography and bad weather are two factors that not surprisingly discourage bicycling. The steepness of the topography, and the perceived steepness, increase cyclists' physical efforts. Most studies that use subjective measurements of physical environments reach a similar conclusion -- that steep slopes restrict bicycling and walking. For example, Rodríguez and Joo (2004) found that steep slopes between home and school significantly decreased students' and staff's propensity of bicycling and walking. However, in a few individual perception-based studies (e.g. Titze et al., 2008), the evaluation of steepness was positively related to bicycling for transportation. One possible explanation was that people who bicycled were more aware of the steepness than people who did not, therefore cyclists reported a greater presence of unfriendly topography. Bad weather, such as rain and snow, is inconvenient and raises safety concerns for most cyclists. In the study of people who bicycled regularly in Portland, Oregon, Dill and Gilebe (2008) found that only 8.8% of bicycling trips happened in fog or rainy weather, and only 1.2% of bicycling trips happened in heavy wind. These studies indicate that a city's natural characteristics are critical in overall bike usage.

Land-use diversity, oftentimes objectively measured by what is known as an Entropy Index² of the land-use mix or the proportion of total multi-use floorspace in buildings (Cervero & Kockelman, 1997), is proved to be positively associated with bicycling use in several studies. In a study that evaluated non-commuting trips under 5 miles in San Francisco Bay Area, Cervero and Duncan (2003) found that mixed land uses, and balances of residences, jobs, and retail services at

² The Entropy Index is a measure of land use mix which takes into account the relative percentage of two or more land use types within an area.

trip origins were in favor of bicycling (although not significantly). However, the influence of land-use diversity on bicycling was controversial in some study contexts. In a study that used subjective measurements, Titze et al. (2008) suggested that land-use diversity, indicated by perceived diversity along the path of travel and interestingness of shops and buildings along the route, had no significant relationship with cycling in non-discretionary trips. A possible reason for such conflict among studies is that, on the one hand, higher land-use diversity usually indicates more activity opportunities in a relatively short distance, encouraging bicycling and walking and decreasing vehicle use; but on the other, higher land-use diversity might also increase traffic volume and further raise safety risks for cyclists.

Distance is one deciding factor for bicycle use, especially for utilitarian purposes. In his study of 20 U.S. cities, Goldsmith (1992) found distance to work and safety en route were two major influential factors for bicycle commuting. The ideal distance for bicycling is subtle, as long trips will discourage people from bicycling whereas distances that are too short will render bicycle use unnecessary. A “suitable” bicycling distance might vary in different city contexts, and among different cyclists, but most research has shown that most bicycling trips, except those for exercising, are usually under 5 miles (Aultman-Hall et al., 1997, Dill & Gliebe, 2008). Meanwhile, cyclists’ perceived travel distance might be different from the actual difference based on the quality and comfort of the bike facility (Berney, 2018).

2.3 INDIVIDUAL FACTORS AND BICYCLING

Although physical environmental factors play an important role in facilitating cycling activity, many studies show that psychosocial factors, self-efficacy, and perceived benefits and barriers explain more variance in biking behavior, especially when decent bike infrastructure is in place (Bourdeaudhuij et al., 2005, de Geus et al., 2008).

Attitudes are defined by Ajzen (1991) as “the degree to which performance of the behavior is positively or negatively valued.” Attitudes towards both general physical activity (Heesch et. al, 2014, Bourdeaudhuij et al., 2005) and cycling activity are related to bicycling decisions, frequency, and distance in many studies. Heesch et. al (2014) found that habituated physical activity was one of the strongest positive correlates of utility cycling. Titze et al. (2010) found that positive attitudes toward cycling increased the odds of biking for transportation and for recreation among residents in an Australian city. Bopp et al. (2013) found that the positive attitudes towards active commuting, including the belief of its physical and mental health benefits, minimal environmental impacts, economic benefits, and work productivity-boosting, were positively related to cycling for commuting. Similarly, in a Dutch study, Heinen et al. (2011) found that bike commuters’ mode choice was closely related to their attitudes towards the direct benefit of cycling (in terms of time, comfort, and flexibility), and attitudes towards the long-term influence of cycling (in terms of getting environmental benefit, health benefit and mentally relaxing). These studies suggest that positive attitudes play a critical role in people’s cycling choices and in developing regular biking behavior.

Reasons for and against bicycling are adopted in some study to reflect the linkage between attitudes and behavior. Claudy and Peterson (2014) found that people’s reasons against bicycling, including inconvenience, bad weather, and danger, explained most of the variance in bicycling behavior among commuters in Dublin, Ireland. Similarly, de Geus et al. (2008) found that lack of time and lack of interest were two important barriers of bicycling for transportation. In terms of reasons for bicycling, enjoyment of the journey might be an important one. Gatersleben and Uzzell (2007) found that cyclists were more likely to feel they journey exciting compared to transit users and drivers. In a study conducted among University students, Titze et al. (2007) found that the

enjoyment of cycling was positively correlated with regular cycling. Environmentalism is also a strong reason for utility biking. In a qualitative study in London, Green et al. (2010) found that a feeling of “an obligation to travel in a way that minimizes impact on the environment and maximize potential health gains” (p.6) was an important criterion of cycling choices. Results from these studies suggest that reasons for and against biking are diverse and vary greatly in different contexts.

Self-efficacy is mostly developed from the concept of perceived behavioral control. It is defined as “how well one can execute courses of action required to deal with prospective situations.” (Bandura, 1982, p. 122) Self-efficacy plays a critical role in individuals’ biking choices (de Geus et al., 2008). Lois et al. (2015) found a strong association between bicycling commuting and self-efficacy of cycling, which was indicated by “feeling capable of performing tasks such as repairing a flat tire, cycling uphill, or cycling in car traffic.” In a survey on a UK population, Davies et al. (2001) found that non-cyclists seem to feel less self-efficacy than cyclists: of non-cyclists, the portion of people who would not feel comfortable on bikes, was almost four times that of cyclists. Similarly, in a Belgium study, de Geus et al. (2008) found that people reporting high levels of external self-efficacy (cycling even if the weather is bad, have to do shopping, etc.) were more likely to cycle for transportation. Cycling self-efficacy is also about the ways in which cyclists respond to perceived barriers of biking. Experienced cyclists have less fear of danger (Joshi and Senior, 1998) and accidents (AA, 1993) than those with less experience. Clearly the trend in the evidence suggests that self-efficacy can be the deciding factor of individuals’ cycling choices in certain types of trips.

Socio-demographic factors, especially age, gender, family status, and car ownership, are related to multiple dimensions of bicycling behavior. Many studies (e.g. Davies et al., 2001,

Bourdeaudhuij et al, 2005) found that older people (people over 55) were less likely to be cyclists. In most U.S. urban areas, females are less likely to regularly bicycle for utilitarian purposes compared to males (Dill and Gilebe, 2008). Females also have more cautious route choices compared to males. Garrard et al. (2008) found that women preferred using off-road paths and roads with bike lanes. Family status, especially the presence of children in the household, is also related to utilitarian bicycling. Skinner and Rosen (2016) pointed out that domestic responsibilities and gender roles are influential factors in bicycling use. For example, the responsibilities for transporting children might limit bike usage. Dill and Carr (2003) found that compared to all-types of commuters, fewer bicycle commuters had children at home. Car ownership is also negatively associated with the probability of an individual being a utilitarian cyclist in a lot of research (e.g. Heesch et. al 2014, Titze et al., 2010). In conclusion, the relationships between socio-demographic factors and bike usage reflect the characteristics of cycling, such as physical requirements, and suitability or unsuitability for certain trips.

2.4 SOCIAL ENVIRONMENT AND BICYCLING

In this study, the social environment refers to the influence that one's social networks and cultural context can have on an individual's cycling. Several factors are considered in this section – social norms, presence of role models, encouragement from others, and companionship while cycling,

A ***Social norm*** is the perceived social expectation to follow a certain behavior (Ajzen, 1991). Evidence from quantitative and qualitative research has shown the impacts of social norms on cyclists. Heinen et al. (2011) suggested that the perceived opinions of others influenced bike commuters' mode choice over short distances. In a qualitative study, Green et al. (2010) suggested that good social norms of biking in workplaces or residential areas, as reflected by

positive cycling culture, facilitated bicycling. Similarly, Bopp et al. (2013) suggested “active commuting culture” and tangible supports (e.g. bike racks, dress code) in workplaces were positively related to the active commuting. On the other hand, negative norms, such as the social pressure to avoid walking into the office in cycling clothes or co-workers’ negative comments on biking commuting, could exert negative pressure on cyclist commuters and discourage such behavior (Heinen & Handy, 2012). These studies suggest that bike culture in one’s social networks is important in shaping cycling behavior by creating social norms related to biking.

A Role model is a person whose behavior, example, or success is or can be emulated by others (Dictionary.com). Many studies have shown that seeing people in one’s social networks, such as coworkers (Campbell et al., 2013, Kaczynski et al., 2010), family members (Campbell et al., 2013, Bopp et al., 2013), and friends (Clark & Scott, 2013), engaging in walking and/or biking is significantly related to an individual’s choice of participation. Titze et al. (2007) found that the perception of peers cycling to the university was positively related to students’ regular cycling. The role model effect could also come from the general public beyond one’s close social networks. In a study conducted on college students, Rybarczyk and Gallagher (2014) found that seeing more bicyclists and having a greater number of bike racks on campus increased students’ bicycling.

Encouragement from people in one’ close social networks is also a well-recognized factor that positively relates to physical activity (Darlow & Xu, 2011, Ball, 2006). For example, in a study on senior adults, Booth et al. (2000) found that encouragement from family and friends, such as giving reminders to be active, was strongly associated with physical activity level. However, evidence on the relationship between encouragement and specific biking behavior is not abundant. Still, some research (e.g. Bourdeaudhuij et al., 2005) investigated encouragement

as a component of social support and found a positive association with cycling and walking for transportation.

Companionship refers to bicycling with others instead of by oneself. In the physical activity literature, companionships from friends and family members (Ball, 2006, Clark & Scott, 2013, Campbell et al., 2013, de Geus et al., 2008), are closely related to walking and biking. Many studies suggested that being with others can remove barriers and provide incentives (Ball, 2006) for individuals' physical activity participation. Companionship can also make people less likely to quit in the future (Harley et al., 2009). Specific to bicycling, companionship has impacts on cyclists' route choice besides influencing the bicycling decision. Dill and Gilebe (2008) found that the cyclists valued more on route directness and less on avoiding traffic and riding on bike lanes when bicycling with other adults. However, when riding with children, cyclists would value more on route safety and avoiding hills (Dill & Gilebe, 2008).

Chapter 3. METHODS

This study combined surveys and interviews to comprehensively understand CBE students' bicycling behavior. First, a survey was distributed to get group-level information about students' biking behavior, cycling experience, attitudes towards biking, and socio-demographic information. In addition, the survey was a way to inquire about respondents' willingness to participate in a follow-up interview with open-ended questions for a deeper exploration of people's bicycling choices, attitudes, and behavior. Survey data were then analyzed using descriptive statistics. Interview data were analyzed through a qualitative data analysis process that explored key themes and identified detailed patterns of the group's bicycling experience. Each of these methods and procedures are described in greater detail in the sections below.

3.1 SURVEYS

3.1.1 *Questionnaire design*

Based on the literature review in Chapter 2, a list of potentially important aspects of built environments, social environments, trip characteristics, and individual attributes was generated to develop the survey questionnaire (See Appendix A). The questionnaire asked about commuting trips and non-commuting trips independently. For **commuting trips**, built environmental factors included perceived quality of bike facilities, types of facilities used, and street connectivity. Trip characteristic factors included travel modes combination and commuting time. Individual factors included bicycling self-efficacy, self-identified cyclist type, as well as reasons and barriers for commuting by bike. For **non-commuting trips**, the built environmental factor was bike facilities used; the trip characteristic factor

was travel destination. Individual factors included reasons for not commuting by bike (if the individual does not commute by bike), reasons for non-commuting bicycling, bicycling self-efficacy, and self-identified cyclist type. Social environmental factors were the same for both types of trips, including role model, encouragement, companionship, sense of belonging, and past experience. As one of the three major research questions is “How might CBE culture shape students’ biking behavior”, a few inquiries regarding CBE were also included in the survey. Questions that asked respondents to express their degree of agreement on a set of statements were assessed on five-point rating scales ranging from 1 (strongly agree) to 5 (strongly disagree). Bicycling frequencies were used as an indicator of bike usage. Table 3-1 and Table 3-2 describes the items and their measurements in detail for commuting and non-commuting trips.

Table 3-1. Survey items and measurements of commuting bicycling

Name of variables	How measured
<i>Dependent variable</i>	
Commuting bicycling frequency	Check one from the following: “< 1 trip per week”, “1-3 trips per week”, “4-7 trips per week”, “7+ trips per week”
<i>Independent variables</i>	
Physical environments	
Bike pathways used for commuting	Check all that apply from the following: “bike trails”, “protected bike lanes”, “sharrows”, “streets without designated bike lanes”. “Other, please specify” option was provided.
Route safety	Agreement on the statement “I think the bicycling infrastructure between home and school is good enough for safe commuting.”
Convenience of bike storage on campus	Agreement on the statement “I am satisfied with the parking facilities for bikes at school.”
Facilities used for bike storage on campus	Check all that apply from the following: “In a bike house”, “In a bike locker”, “At a bike rack”, “Anywhere allowed”, “In a building”. “Other, please specify” option was provided.
Street connectivity	Agreement on the statement “I think the bicycling infrastructure between home and school is good enough for safe commuting.”
Social environments	
Role model	Agreement on the statements: “One or more of my family members bicycle on a regular basis.”, “Seeing/Knowing member(s) of my family cycling makes me want to bicycle”, “My friend(s) bicycle on a regular basis”, “One or more of my friends bicycle on a regular basis.”, “Seeing/Knowing my friend(s) cycling makes me want to bicycle.”, “Many of my peers from CBE bicycle on a regular basis.”, “Seeing/Knowing my peers from CBE cycling makes me want to bicycle.”
Encouragement	Agreement on the statements: “My family member(s) encourage(s) me to bicycle.”, “My friend(s) encourage(s) me to bicycle.”, “My peers from CBE encourage me to bicycle.”
Companionship	Agreement on the statement: “There are people I can count on to bicycle with me on commuting bicycling trips.”
Sense of belonging	Agreement on the statement: “Bicycling makes me feel a sense of belonging to a cyclist community.”
Past experience	Agreement on the statement: “I grew up bicycling with my family on a regular basis.”
Individual factors	
Self-efficacy	Agreement on the statement: “I generally feel confident when bicycling (in terms of navigation, bicycling skills, etc.”
Cyclist type	Choose one of the following for the question “I would describe myself as a/an...”: “Strong and fearless cyclist”, “Enthusied and confident cyclist”, “Interested but concerned cyclist”, “No way, no how”. “Other, please specify” option was provided. (Explanation provided for each option)

Primary reasons for commuting bicycling	Check up to 3 answers from the following: “convenience”, “economic reasons”, “flexibility”, “lack of access to a car”, “physical health benefits”, “mental health benefits”, “climate change concern”, “nature contact”, “social contact”, “sense of belonging to a cyclist community”. “Other, please specify” option was provided.
Barriers faced for commuting bicycling	Check all that apply from the following: “Unsafe bicycling infrastructure”, “Lack of shower facilities on campus”, “Insufficient/Unsafe/Uncovered bike storage facilities on campus”, “Intimidation from other road users”, “Distance”, “Weather”, “Topography”, “N/A (no barriers)”. “Other, please specify” option was provided.
Influence from CBE	Agreement on the statement: “The education I’m receiving from the program(s) of study influences my bicycling behavior.”
Trip characteristics	
Mode combination	Check one from the following: “commute solely via bike”, “combine bike and other transportation mode(s)”, “don’t use a bike for commuting”
Other commuting modes combined in one trip	Check one from the following: “car”, “public transit”, “car and public transit”. “Other, please specify” option was provided
Time spent on the bike per commuting trip (one-way)	Check one from the following: “under 15 mins”, “15-30 mins”, “30-60mins”, “over an hour”
Time spent on the other mode per commuting trip (one-way)	Check one from the following: “under 15 mins”, “15-30 mins”, “30-60mins”, “over an hour”
Demographics	
Age range	Check one from the following: “under 19”, “20-24”, “25-29”, “30-34”, “35-39”, “40+”
Gender	Check one from the following: “Male”, “Female”, “Non-binary/gender fluid/non-conforming”. “Other, please specify” option was provided.
Ethnicity	Check one from the following: “White”, “Latinx”, “Black or African American”, “Native American or American Indian”, “Asian/Pacific Islander”. “Other, please specify” option was provided.
Department	Check one or more from the following: “Architecture”, “Construction Management”, “Landscape Architecture”. “Real Estate”, “Urban Design and Planning”.
Student status	Check one from the following: “Domestic student”, “International student”. “Other, please specify” option was provided.
Family status	Check one from the following: “Partnered with kid(s)”, “Partnered without kid”, “Divorced with kid(s)”, “Divorced without kid”, “Single”. “Other, please specify” option was provided.

Table 3-2. Survey items and measurements of non-commuting bicycling

Name of variables	How measured
<i>Dependent variable</i>	
Non-commuting bicycling frequency	Check one from the following: “Once per month/once every few months”, “2-3 times per month”, “Once per week”, “2-3 times per week”, “4+ times per week”
<i>Independent variables</i>	
Physical environments	
Bike pathways used for commuting	Check all that apply from the following: “bike trails”, “protected bike lanes”, “sharrows”, “streets without designated bike lanes”. “Other, please specify” option was provided.
Social environments	
Role model	Agreement on the statements: “One or more of my family members bicycle on a regular basis.”, “Seeing/Knowing member(s) of my family cycling makes me want to bicycle”, “My friend(s) bicycle on a regular basis”, “One or more of my friends bicycle on a regular basis.”, “Seeing/Knowing my friend(s) cycling makes me want to bicycle.”, “Many of my peers from CBE bicycle on a regular basis.”, “Seeing/Knowing my peers from CBE cycling makes me want to bicycle.”
Encouragement	Agreement on the statements: “My family member(s) encourage(s) me to bicycle.”, “My friend(s) encourage(s) me to bicycle.”, “My peers from CBE encourage me to bicycle.”
Companionship	Agreement on the statement: “There are people I can count on to bicycle with me on non-commuting bicycling trips.”
Sense of belonging	Agreement on the statement: “Bicycling makes me feel a sense of belonging to a cyclist community.”
Past experience	Agreement on the statement: “I grew up bicycling with my family on a regular basis.”
Individual factors	
Primary reasons for not commuting by bike, if don’t commute by bike	Check up to 3 answers from the following: “Feel unsafe”, “Distance too far/close for bicycling”, “It is tiring”, “Lack of satisfactory shower/bike storage facilities on campus”, “Got into a bike accident before”, “Bad weather/unfriendly bicycling topography in Seattle”, “Don’t own a bike”. “Other, please specify” option was provided.
Self-efficacy	Agreement on the statement: “I generally feel confident when bicycling (in terms of navigation, bicycling skills, etc.)”
Cyclist type	Choose one of the following for the question “I would describe myself as a/an...”: “Strong and fearless cyclist”, “Enthusied and confident cyclist”, “Interested but concerned cyclist”, “No way, no how”. “Other, please specify” option was provided. (Explanation provided for each option)
Primary reasons for non-commuting bicycling	Check up to 3 answers from the following: “Convenience”, “Economic reasons”, “Flexibility”, “Lack of access to a car”, “Physical health benefits”, “Mental health benefits”, “Climate change concern”, “Nature contact”, “Social contact”, “Entertainment”. “Other, please specify” option was provided.
Influence from CBE	Agreement on the statement: “The education I’m receiving from the program(s) of study influences my bicycling behavior.”

Trip characteristics	
Destinations for non-commuting bicycling trips	Check all that apply from the following: “Grocery stores”, “Social visits”, “Parks”, “Restaurants/bars/cafes”, “Farmers’ market or other outdoor community events”, “Gym or other workout location”, “No destinations, just bicycling around”. “Other, please specify” option was provided.
Demographic characteristics	
Age range	Check one from the following: “under 19”, “20-24”, “25-29”, “30-34”, “35-39”, “40+”
Gender	Check one from the following: “Male”, “Female”, “Non-binary/gender fluid/non-conforming”. “Other, please specify” option was provided.
Ethnicity	Check one from the following: “White”, “Latinx”, “Black or African American”. “Native American or American Indian”, “Asian/Pacific Islander”. “Other, please specify” option was provided.
Department	Check one or more from the following: “Architecture”, “Construction Management”, “Landscape Architecture”. “Real Estate”, “Urban Design and Planning”.
Student status	Check one from the following: “Domestic student”, “International student”. “Other, please specify” option was provided.
Family status	Check one from the following: “Partnered with kid(s)”, “Partnered without kid”, “Divorced with kid(s)”, “Divorced without kid”, “Single”. “Other, please specify” option was provided.

3.1.2 *Survey process and participants*

The survey questionnaire was created using Survey Monkey

(<http://www.surveymonkey.com>). An email with the survey link was sent to the CBE student electronic mailing list (be-students@uw.edu) on February 20, 2020. The email invited students who bicycle to fill out the survey. Two weekly follow-up emails were sent to the listserv and the survey was closed on March 09, 2020. The survey received 102 completed responses in total. Eighteen of the respondents indicated that they do not engage in any type of bicycling, therefore they were excluded from further analysis. Of the 88 participants who bicycle, 71 indicated that they commute by bike, among which five people were excluded for missing critical information, leaving a sample of 66 for commuting bicycling analysis. 75 people indicated that they do non-commuting bicycling, among which two people were excluded for missing critical information,

leaving a sample of 73 for non-commuting trip analysis. Table 3-3 and Table 3-4 show the demographic characteristics of the final sample for commuting and non-commuting trips, respectively.

Table 3-3. Demographic characteristics of commuting bicycling sample (N=66)

Characteristic	All N (%)	< 1 trip per week N (%)	1-3 trips per week N (%)	4-7 trips per week N (%)	7+ trips per week N (%)
Gender					
Female	29 (43.9)	3 (42.9)	14 (42.4)	11 (50.0)	1 (25.0)
Male	36 (54.5)	4 (57.1)	18 (54.5)	11 (50.0)	3 (75.0)
Non-binary/gender fluid/non-conforming	1 (1.5)	0 (0.0)	1 (3.0)	0 (0.0)	0 (0.0)
Age					
20-24	21 (31.8)	4 (57.1)	8 (24.2)	5 (22.7)	4 (100.0)
25-29	25 (37.9)	1 (14.3)	12 (36.4)	12 (54.5)	0 (0.0)
30-34	12 (18.2)	2 (28.6)	7 (21.2)	3 (13.6)	0 (0.0)
35-39	2 (3.0)	0 (0.0)	2 (6.1)	0 (0.0)	0 (0.0)
40+	6 (9.1)	0 (0.0)	4 (12.1)	2 (9.1)	0 (0.0)
Student status					
Domestic	60 (90.9)	6 (85.7)	31 (93.9)	19 (86.4)	4 (100.0)
International	6 (9.1)	1 (14.3)	2 (6.1)	3 (13.6)	0 (0.0)
Department					
Arch	14 (21.2)	2 (28.6)	6 (18.2)	5 (22.7)	1 (25.0)
Arch&LArch	2 (3.0)	0 (0.0)	1 (3.0)	1 (4.5)	0 (0.0)
CM	7 (10.6)	0 (0.0)	2 (6.1)	3 (13.6)	2 (50.0)
LArch	18 (27.3)	2 (28.6)	11 (33.3)	5 (22.7)	0 (0.0)
LArch&UDP	2 (3.0)	0 (0.0)	2 (6.1)	0 (0.0)	0 (0.0)
RE&UDP	1 (1.5)	0 (0.0)	1 (3.0)	0 (0.0)	0 (0.0)
UDP	22 (33.3)	3 (42.9)	10 (30.3)	8 (36.4)	1 (25.0)
Family status					
Partnered with kid(s)	5 (7.6)	0 (0.0)	5 (15.2)	0 (0.0)	0 (0.0)
Partnered without kid	18 (27.3)	2 (28.6)	9 (27.3)	6 (27.3)	1 (25.0)
Single	43 (65.2)	5 (71.4)	19 (57.6)	16 (72.7)	3 (75.0)
Ethnicity					
Asian/Pacific Islander	11 (16.7)	3 (42.9)	4 (12.1)	3 (13.6)	1 (25.0)
Black or African American	2 (3.0)	0 (0.0)	1 (3.0)	1 (4.5)	0 (0.0)
Latinx	3 (4.5)	0 (0.0)	3 (9.1)	0 (0.0)	0 (0.0)
White	50 (75.8)	4 (57.1)	25 (75.8)	18 (81.8)	3 (75.0)

Table 3-4. Demographic characteristics of non-commuting bicycling sample (N=73)

Characteristic	All N (%)	Once per month/once every few months N (%)	2-3 times per month N (%)	Once per week N (%)	2-3 times per week N (%)	4+ times per week N (%)
Gender						
Female	31 (42.5)	8 (47.1)	5 (26.3)	10 (66.7)	7 (46.7)	1 (14.3)
Male	40 (54.8)	8 (47.1)	14 (73.7)	4 (26.7)	8 (53.3)	6 (85.7)
Non-binary/gender fluid/non-conforming	2 (2.7)	1 (5.9)	0 (0.0)	1 (6.7)	0 (0.0)	0 (0.0)
Age						
20-24	24 (32.9)	6 (35.3)	7 (36.8)	3 (20.0)	5 (33.3)	3 (42.9)
25-29	24 (32.9)	4 (23.5)	5 (26.3)	8 (53.3)	6 (40.0)	1 (14.3)
30-34	15 (20.5)	4 (23.5)	4 (21.1)	2 (13.3)	3 (20.0)	2 (28.6)
35-39	3 (4.1)	1 (5.9)	1 (5.3)	0 (0.0)	1 (6.7)	0 (0.0)
40+	7 (9.6)	2 (11.8)	2 (10.5)	2 (13.3)	0 (0.0)	1 (14.3)
Student status						
Domestic	66 (90.4)	14 (82.4)	17 (89.5)	14 (93.3)	14 (93.3)	7 (100.0)
International	7 (9.6)	3 (17.6)	2 (10.5)	1 (6.7)	1 (6.7)	0 (0.0)
Department						
Arch	15 (20.5)	3 (17.6)	3 (15.8)	3 (20.0)	4 (26.7)	2 (28.6)
Arch&LArch	3 (4.1)	1 (5.9)	1 (5.3)	0 (0.0)	0 (0.0)	1 (14.3)
Arch&UDP	1 (1.4)	0 (0.0)	1 (5.3)	0 (0.0)	0 (0.0)	0 (0.0)
CM	6 (8.2)	0 (0.0)	3 (15.8)	1 (6.7)	1 (6.7)	1 (14.3)
LArch	19 (26.0)	6 (35.3)	4 (21.1)	3 (20.0)	3 (20.0)	3 (42.9)
LArch&UDP	2 (2.7)	0 (0.0)	0 (0.0)	1 (6.7)	1 (6.7)	0 (0.0)
RE&UDP	2 (2.7)	1 (5.9)	0 (0.0)	1 (6.7)	0 (0.0)	0 (0.0)
UDP	25 (34.2)	6 (35.3)	7 (36.8)	6 (40.0)	6 (40.0)	0 (0.0)
Family status						
Partnered with kid(s)	7 (9.6)	1 (5.9)	3 (15.8)	1 (6.7)	1 (6.7)	1 (14.3)
Partnered without kid	22 (30.1)	6 (35.3)	4 (21.1)	4 (26.7)	4 (26.7)	4 (57.1)
Single	44 (60.3)	10 (58.8)	12 (63.2)	10 (66.7)	10 (66.7)	2 (28.6)
Ethnicity						
Asian/Pacific Islander	13 (17.8)	5 (29.4)	2 (10.5)	1 (6.7)	3 (20.0)	2 (28.6)
Black or African American	1 (1.4)	0 (0.0)	0 (0.0)	0 (0.0)	1 (6.7)	0 (0.0)
Latinx	3 (4.1)	0 (0.0)	1 (5.3)	1 (6.7)	0 (0.0)	1 (14.3)
White	56 (76.7)	12 (70.6)	16 (84.2)	13 (86.7)	11 (73.3)	4 (57.1)

3.1.3 *Survey data analysis*

To understand CBE students' biking behavior and experience, I provided summary tables and/or histograms of several survey questions for both commuting and non-commuting trips. Those questions included biking frequency, facility used when cycling, primary reasons for cycling, agreements on statements of physical and social environments and individual attributes regarding bicycling. Information about mode combination, cycling distance, and barriers to biking in commuting trips, and cycling destinations in non-commuting trips was also presented in similar forms. Meanwhile, I used univariate linear regression models to examine the relationships between cycling frequency and each of the research item. I used ordered logit models to examine the relationships between bicycling frequency and the agreements on questions regarding cycling environments. The methods and analysis will be explained in greater detail in Chapter 4.

3.2 INTERVIEWS

3.2.1 *Interview protocol development*

Based on the research questions and literature review, I developed a basic interview protocol (see Appendix B). The protocol included open-ended questions regarding people's experience with biking, bike usage, cycling skills, as well as present bicycling experience and barriers faced. To address the research questions more specifically, I also asked whether any friends and family might have influenced their bicycling behavior and whether they think studying in CBE made a difference to their bicycling. The protocol served as a flexible guideline that was adjusted accordingly in different conversations. It also developed as the interview proceeded.

3.2.2 *Process and participants*

In the previous survey, respondents were asked to indicate their email addresses if they were willing to participate in further interviews. Thirty-three agreed to be interviewed. Interview invitation emails were then sent to the 33 respondents on April 3, 2020. I successfully scheduled interviews with 17 of them and conducted in-depth interviews using Zoom (<https://zoom.us/>) from April 4 to April 16, 2020. Each interview lasted about 20-50 minutes. Each conversation was recorded as a voice memo and transformed into texts via Otter, an audio transcription program (<https://otter.ai/>). Table 3-5 is the list of participants.

Table 3-5. Demographic characteristics of interviewees (N=17)

NO.	Department	Cyclist type (Commuting=C, Non-commuting=NC)	Age range
1	UDP	C&NC	35-39
2	LArch & UDP	C&NC	25-29
3	UDP	C&NC	40+
4	LArch	C&NC	25-29
5	CM	C&NC	25-29
6	LArch	C&NC	25-29
7	LArch	C&NC	30-34
8	UDP	C&NC	25-29
9	Arch & LArch	NC	25-29
10	Arch	C&NC	30-34
11	UDP	C&NC	20-24
12	Arch	C&NC	30-34
13	LArch	C&NC	20-24
14	LArch	C	30-34
15	LArch	C&NC	30-34
16	UDP	C&NC	25-29
17	UDP	NC	25-29

3.2.3 *Thematic analysis*

To analyze the interview data, I followed Corbin and Strauss's (2008) thematic analysis approach. First, I read the interview transcripts several times. In this stage, concepts

mentioned by participants that were interesting, or reflecting individuals' uniqueness, or directly related to the interview questions, were labeled using in-vivo codes (p. 65). Second, I looked at those important concepts and traced them back to the original conversations to reflect on what the in-vivo codes were revealing. I tried to identify the connections and understand the inconsistency between concepts mentioned in different parts of one conversation. For example, some participants talked about the differences in bike usage in different life stages, and I looked deeper into why would the inconsistency happen and what the differences revealed. Then I grouped similar concepts into codes of a higher level. Meanwhile, I constantly compared the similarities and differences between concepts of the same levels across different individuals and developed coherent themes. Finally, I investigated the relationships of those landmark themes and integrated them into three analytical categories that collectively explain the similarities and heterogeneities of participants' bicycling.

Chapter 4. RESULTS

In this chapter, I will present the research results from the survey and interviews to answer the three research questions that drove this thesis. In my study, statistical data analysis was performed using R Statistical Software (version 3.6.3; R Foundation for Statistical Computing, Vienna, Austria). I analyzed the interview data using ATLAS.ti qualitative data analysis software (version 8.4.24.0; ATLAS.ti Scientific Software Development GmbH).

4.1 WHAT PATTERNS OF BICYCLING ARE SHOWN AMONG CBE STUDENTS

Based on the survey data, in this section I presented CBE students' cycling patterns, including bicycling frequency, commuting mode combination, cycling facilities used, primary reasons for cycling, non-commuting cycling trip destinations, and barriers faced for commuting cycling.

4.1.1 *Bicycling frequency*

Of the 66 bicycle commuters who completed the survey, seven (10.6%) commuted to school via bicycle less than once per week, 33 (50%) bicycled 1-3 times per week, 22 (33.3%) bicycled 4-7 times per week, and four (6.1%) bicycled more than 7 times per week.

The biking frequency for non-commuting purposes was distributed more evenly across the five frequency groups. Of the 73 respondents, 17 (23.3%) bicycled once per month/once every few months, 19 (26.0%) bicycled 2-3 times per month, 15(20.5%) bicycled once per week, 15(20.5%) bicycled 2-3 times per week, and seven (9.6%) bicycled more than four times per week. Figure 4-1 shows the distributions of the commuting and non-commuting biking frequencies among all survey respondents.

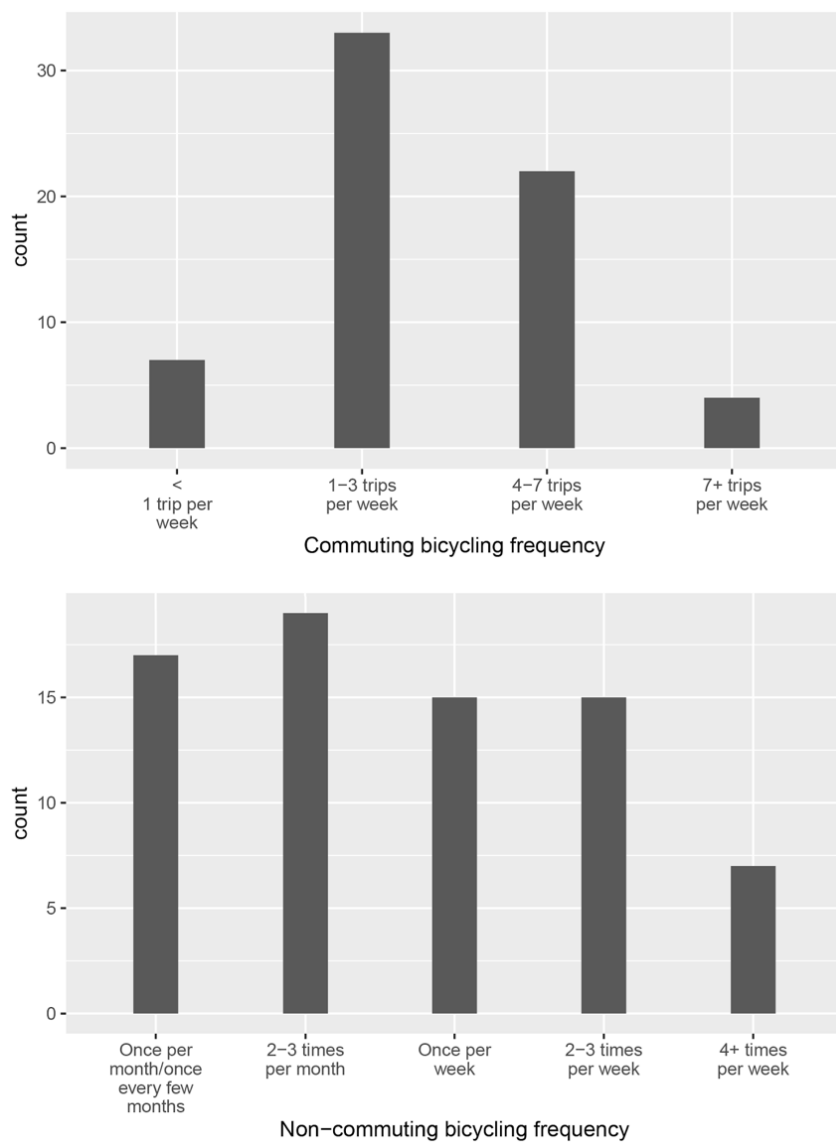


Figure 4-1. CBE students' commuting and non-commuting biking frequencies

4.1.2 *Commuting mode combination*

From the survey and interview results, I realized that the first question “Do you usually bicycle for commuting to school” should have included more options. There were more than one scenarios behind the phrase, “I combine bike and other transportation mode(s) for commuting:” an individual might solely commute by bike in some trips but solely use other transportation mode in other trips, or they might combine bike and other transportation mode in one trip for some or all of their commuting. The question was intended to ask about a typical commuting trip, but because of the differences in individuals’ understanding of this question, it failed to reflect the actual situation of whether and how the participants combine bicycling and other modes for commuting.

However, the results are still able to show the trend of the relationship between frequency of biking and mode combination (Table 4-1). The results show that more than half (57.6%) of respondents indicated that they used the certain combinations of bike and other transportation mode for commuting to campus. Of the 28 participants who reported commuting solely via bike, 17 (60.7%) spent 15-30 minutes in a one-way trip, nine (32.1%) spent under 15 minutes, and two (7.1%) spent 30-60 minutes. Of the 38 people who reported a mode combination, 30 (78.9%) combined public transit, five (13.2%) combined walking, two (5.3%) combined car and public transit, and one (2.6%) combined car in their commuting.

Table 4-1. Commuting mode combinations (N=66)

	< 1 trip per week N (%)	1-3 trips per week N (%)	4-7 trips per week N (%)	7+ trips per week N (%)
combine bike and other transportation mode(s)	6 (85.7%)	21 (63.6%)	10 (45.5%)	1 (25%)
solely via bike	1(14.3%)	12(36.4%)	12 (54.4%)	3 (75%)

4.1.3 *Bicycling facility used*

In the survey, participants were asked about the bike facilities they used for commuting and non-commuting trips independently. Participants were allowed to check all that apply from “bike trails” (paved rights-of-way completely separated from streets), “protected bike lanes” (on-street facilities designated for bicyclists using stripes and stencils), “sharrows” (on-street lane with paint on the pavement for cyclists but not separated from the car lane) and “street without designated bike lanes.” Figure 4-2 shows the facilities used by commuting cyclists with different bicycling frequencies. The original data is presented in Appendix C, Table 1.

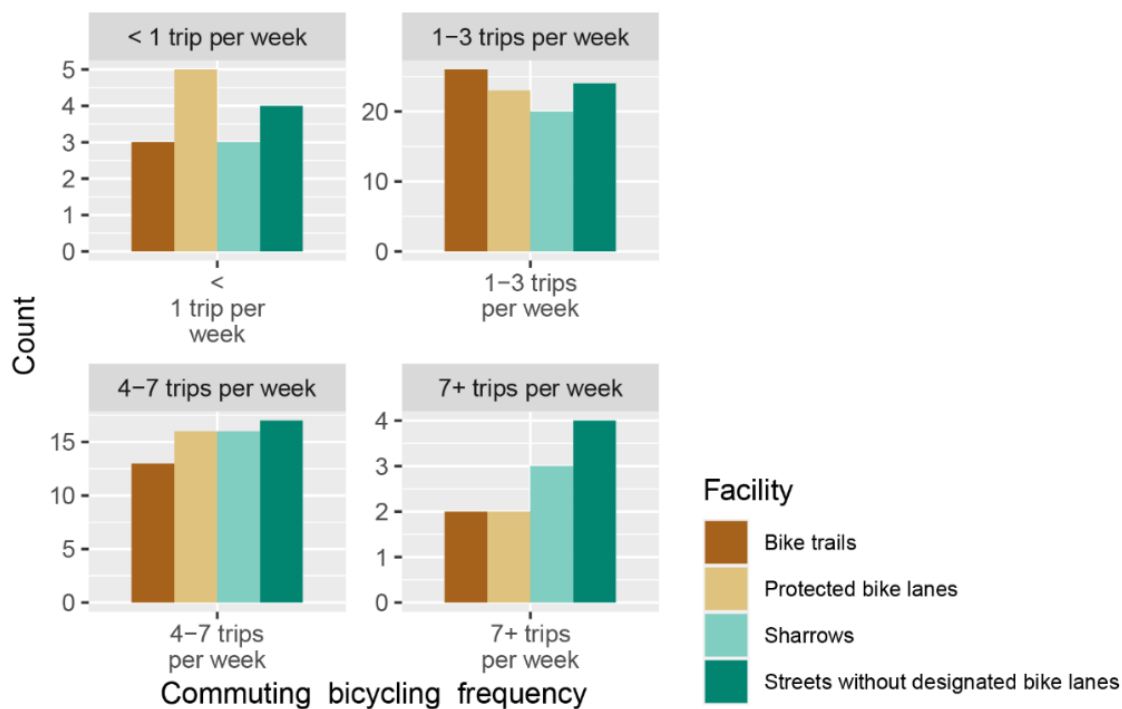


Figure 4-2. Bike facility used by commuting cyclists (N=66)

Respondents who reported bicycling less than 1 trip/week and 1-3 trips/week seemed to prioritize bike trails and protected bike lanes, whereas people who biked 4-7 trips per week and 7+ trips per week used sharrows and streets without designated bike lanes more

often. It suggests that participants who bike more often are more comfortable using shared facilities, and those who reported biking more often are likely in Geller (2006)'s more confident groups.

Four linear regressions were then applied to test the direction and strength of the relationships between bicycling frequency and facility of choice. Given the small number of the observations in the categories of "<1 trip/week" and "7+ trips/week," I merged "<1 trip/week" and "1-3 trips/week" as a new group "<4 trips/week", and merged the "4-7 trips/week" and "7+ trips/week" as "≥4 trips/week" to reduce the error.

Each regression model is specified as follows:

$$(1) Y = \alpha + \beta X + \varepsilon$$

where Y is a dummy variable of using/not using a certain type of bike facilities (bike trails, protected bike lanes, sharrows, and streets for the four models, respectively); X is a dummy variable of whether an individual's bicycling frequency is "≥ 4 trips/week" or not; α and β are intercept and regression coefficient to be estimated by the model; ε represents the unobserved error. Table 4-2 shows the regression results of the four models.

The results show that compared to those who bicycled less than four times per week, respondents who bicycled four or more times per week were less likely to use bike trails and protected bike lanes, but more likely to use sharrows and streets without designated bike lanes, but the results were not statistically significant.

Table 4-2. Four univariate linear regressions examine the relationships between bike facility used and commuting biking frequency (N=66)

	Dependent variable:			
	trail (1)	bike_lane (2)	sharrow (3)	street (4)
>=4trip/wk	-0.148 (0.119)	-0.008 (0.118)	0.156 (0.122)	0.108 (0.111)
Constant (<4 trips/wk)	0.725*** (0.075)	0.700*** (0.074)	0.575*** (0.076)	0.700*** (0.070)
Observations	66	66	66	66
R2	0.024	0.0001	0.025	0.014
Adjusted R2	0.008	-0.016	0.010	-0.001
Residual Std. Error (df = 64)	0.473	0.467	0.482	0.441
F Statistic (df = 1; 64)	1.544	0.004	1.643	0.940
Note:	*p<0.1; **p<0.05; ***p<0.01			

Table 4-3. Four univariate linear regressions examine the relationships between bike facility used and non-commuting biking frequency (N=73)

	Dependent variable:			
	trail (1)	bike_lane (2)	sharrow (3)	street (4)
2-3/wk	-0.014 (0.114)	0.091 (0.121)	0.196 (0.132)	0.498*** (0.150)
4+/wk	-0.090 (0.146)	-0.128 (0.155)	0.263 (0.169)	0.632*** (0.192)
<=1/mon	-0.065 (0.110)	0.040 (0.117)	-0.031 (0.127)	0.161 (0.145)
1/wk	-0.214* (0.114)	0.025 (0.121)	0.130 (0.132)	0.432*** (0.150)
Constant(2-3/mon)	0.947*** (0.076)	0.842*** (0.081)	0.737*** (0.087)	0.368*** (0.099)
Observations	73	73	73	73
R2	0.058	0.028	0.075	0.222
Adjusted R2	0.002	-0.029	0.021	0.176
Residual Std. Error (df = 68)	0.331	0.351	0.381	0.434
F Statistic (df = 4; 68)	1.039	0.494	1.384	4.850***
Note:	*p<0.1; **p<0.05; ***p<0.01			

Similar patterns were found in non-commuting trips. Respondents who bicycled less than once per week used bike trails and protected bike lanes more often, and people who bicycled once to three times per week seemed to use the four types of facilities more evenly, whereas people who bicycled more than four times per week used sharrows and streets more often, as shown in Figure 4-3. The original count and percentage are shown in Appendix C, Table 2.

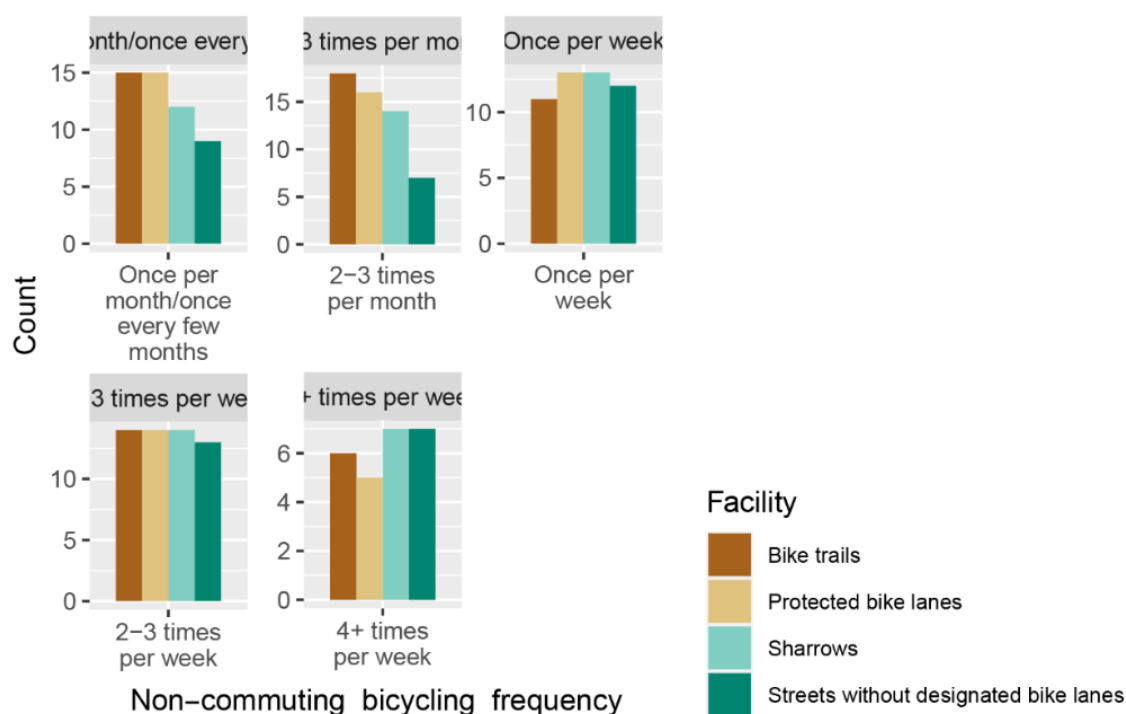


Figure 4-3. Bike facility used by non-commuting cyclists (N=73)

Similar regression models were applied to examine the statistical relationships:

$$(2) Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \varepsilon$$

In this model, Y still represents the facility dummy. X_i ($i=1, 2, 3, 4$) are four dummy variables of whether or not bicycling “once per month/once every few months” “once per week,” “2-3 times per week,” “4+ times per week.” And the “2-3 times per month” group served as a reference. Table 4-3 shows the regression results of the four models.

The results suggested that compared to the group who bicycled 2-3 times per month, respondents who bicycled once per week, 2-3 times per week, and more than 4 times per week, were more 43.2%, 49.8%, and 63.2% more likely to use streets without designated bike lanes, respectively. It might be because people who reported higher frequency might be bicycling for utilitarian purposes whereas those who bicycled less than once per week might mostly do recreational rides on bike trails.

4.1.4 Primary reasons for bicycling

For commuting trips, Figure 4-4 shows the primary bicycling reasons reported by different frequency groups (the original count and percentage are shown in Appendix C, Table 3). Convenience, flexibility, and physical health benefits were the top three reasons for all frequency groups.

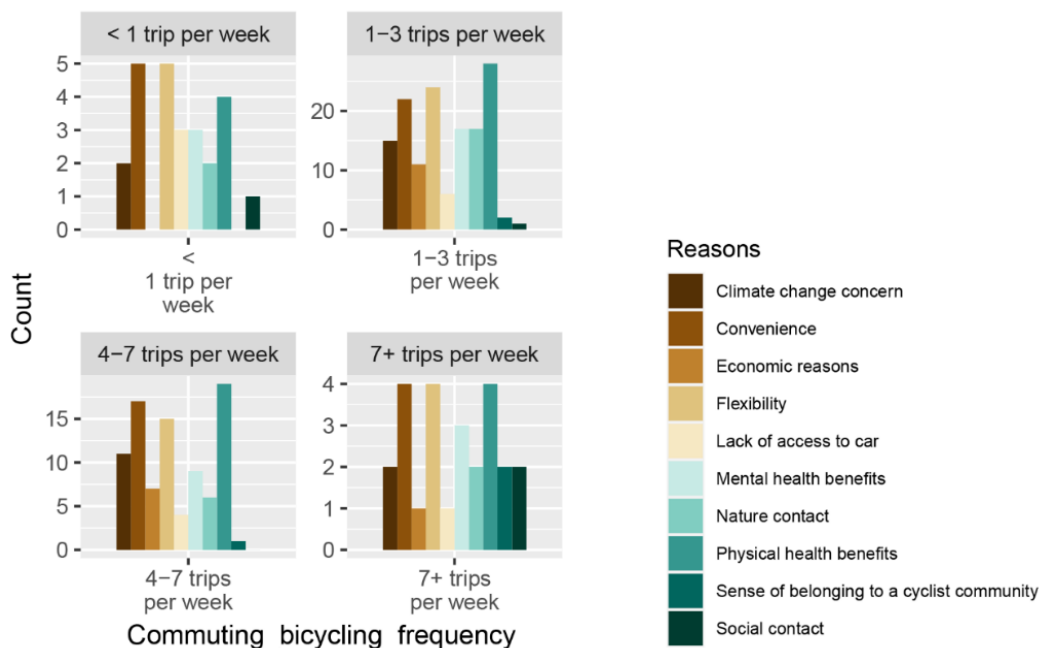


Figure 4-4. Primary biking reasons for commuting trips (N=66)

Ten univariate linear regression models were applied to examine the relationships between commuting cycling frequency and reasons for commuting by bike. Similar to the models in 4.1.3, each of the dependent variables of the ten models was a dummy of whether or not choosing a certain biking reason (climate change concern, convenience, economic reasons, flexibility, lack of access to car, mental health benefits, nature contact, physical health benefits, sense of belonging to a cyclists community, and social contact for the 10 models, respectively) and the independent variable was a dummy of whether or not bicycling more than four trips per week.

Table 4-4 show the results of 10 regressions. The results suggested no statistically significant difference of biking reasons between cyclists of different cycling frequency.

For non-commuting trips, bicycling reasons varied across different frequency groups, as shown in Figure 4-5 (the original count and percentage are shown in Appendix C, Table 4). The top three of primary bicycling reasons were “physical health benefits,” “entertainment,” “nature contact,” for respondents who did non-commuting less than once per week. For respondents who bicycled once per week, the top three were “convenience,” “mental health benefits,” and “entertainment.” For respondents who bicycled 2-3 times per week, the top three were “physical health benefits,” “entertainment,” “flexibility”/ “nature contact.” For those who bicycled more than 4 times per week, the top three were “physical health benefits,” “entertainment,” and “convenience”/ “mental health benefits”/“lack of access to car.” Ten similar regression models were applied to examine the relationships between non-commuting bicycling reasons and frequency.

Table 4-4. Ten univariate linear regressions examine the relationships between primary biking reasons and commuting biking frequency (N=66)

	Dependent variable:									
	Conv (1)	Econc (2)	Flxb (3)	No car (4)	Physihlth (5)	Climchgeconcn (6)	Natrctct (7)	Sciactct (8)	Sensblng (9)	mentl hlth (10)
>=4 trips/wk	0.133 (0.113)	0.033 (0.116)	0.006 (0.114)	-0.033 (0.105)	0.085 (0.095)	0.075 (0.127)	-0.167 (0.124)	0.027 (0.061)	0.065 (0.067)	-0.038 (0.128)
Constant(<4 trips/wk)	0.675*** (0.071)	0.275*** (0.073)	0.725*** (0.072)	0.225*** (0.066)	0.800*** (0.059)	0.425*** (0.080)	0.475*** (0.078)	0.050 (0.038)	0.050 (0.042)	0.500*** (0.080)
Observations	66	66	66	66	66	66	66	66	66	66
R2	0.021	0.001	0.00004	0.002	0.012	0.005	0.028	0.003	0.015	0.001
Adjusted R2	0.006	-0.014	-0.016	-0.014	-0.003	-0.010	0.012	-0.013	-0.001	-0.014
Residual Std. Error (df = 64)	0.447	0.460	0.452	0.415	0.376	0.504	0.492	0.242	0.267	0.507
F Statistic (df = 1; 64)	1.386	0.080	0.003	0.098	0.798	0.349	1.820	0.195	0.947	0.091

Note: *p<0.1; **p<0.05; ***p<0.01

(1) convenience, (2) economic reasons, (3) flexibility, (4) lack of access to car, (5) physical health benefits, (6) climate change concern, (7) nature contact, (8) social contact, (9) sense of belonging to a cyclist community, (10) mental health benefits.

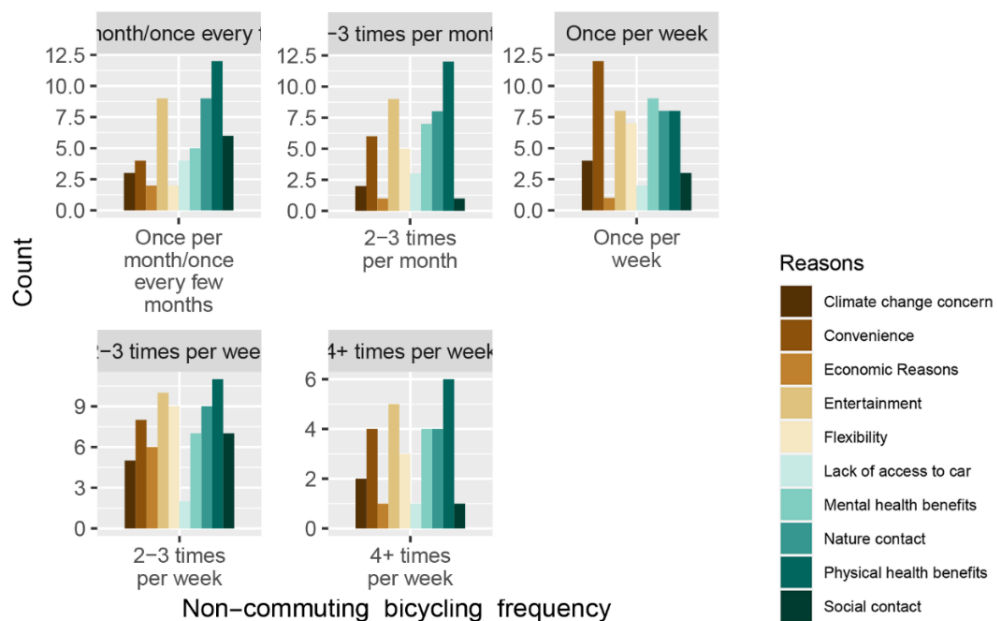


Figure 4-5. Primary biking reasons for non-commuting trips (N=73)

The results (Table 4-5) suggest that compared to those who bicycled 2-3 trips per month, respondents who bicycled once per month/once every few months were more likely to bicycle for social contact, respondents who bicycled once per week were more likely to bicycle for convenience, and respondents who bicycled 2-3 times per week were more likely to bicycle for economic reasons, flexibility, and social contact. One possible explanation would be that people in the “once or less per month” group might occasionally bicycle for recreation with other people, and those who bicycle 2-3 times per month might be bicycling for recreation or exercise by themselves on a regular basis. People who bicycle at a higher frequency reported more practical reasons, such as convenience, economic reasons, and flexibility, it might be because those groups bicycle for utilitarian purposes more often.

Table 4-5. Ten univariate linear regressions examine the relationships between primary biking reasons and non-commuting biking frequency (N=73)

	Dependent variable:									
	Conv (1)	Econc (2)	Flxb (3)	No car (4)	Physihlth (5)	Climchgeconcn (6)	Natrctct (7)	Scictct (8)	Entrnmt (9)	Mentl hlth (10)
2-3/wk	0.218 (0.162)	0.347*** (0.119)	0.337** (0.159)	-0.025 (0.132)	0.102 (0.165)	0.228 (0.145)	0.179 (0.177)	0.414*** (0.144)	0.193 (0.175)	0.098 (0.173)
4+/wk	0.256 (0.208)	0.090 (0.153)	0.165 (0.204)	-0.015 (0.169)	0.226 (0.211)	0.180 (0.185)	0.150 (0.227)	0.090 (0.184)	0.241 (0.224)	0.203 (0.221)
<=1/mon	-0.080 (0.157)	0.065 (0.115)	-0.146 (0.154)	0.077 (0.127)	0.074 (0.159)	0.071 (0.140)	0.108 (0.171)	0.300** (0.139)	0.056 (0.169)	-0.074 (0.167)
1/wk	0.484*** (0.162)	0.014 (0.119)	0.204 (0.159)	-0.025 (0.132)	-0.098 (0.165)	0.161 (0.145)	0.112 (0.177)	0.147 (0.144)	0.060 (0.175)	0.232 (0.173)
Constant(2-3/mon)	0.316*** (0.108)	0.053 (0.079)	0.263** (0.106)	0.158* (0.088)	0.632*** (0.109)	0.105 (0.096)	0.421*** (0.118)	0.053 (0.096)	0.474*** (0.116)	0.368*** (0.115)
Observations	73	73	73	73	73	73	73	73	73	73
R2	0.174	0.133	0.134	0.012	0.039	0.043	0.017	0.128	0.028	0.054
Adjusted R2	0.125	0.082	0.083	-0.046	-0.017	-0.013	-0.041	0.077	-0.029	-0.001
Residual Std. Error (df = 68)	0.470	0.345	0.462	0.382	0.477	0.419	0.513	0.417	0.507	0.500
F Statistic (df = 4; 68)	3.570**	2.601**	2.631**	0.203	0.698	0.765	0.289	2.505*	0.492	0.975

Note: *p<0.1; **p<0.05; ***p<0.01

(1) convenience, (2) economic reasons, (3) flexibility, (4) lack of access to car, (5) physical health benefits, (6) climate change concern, (7) nature contact, (8) social contact, (9) entertainment, (10) mental health benefits.

4.1.5 *Trip destination for non-commuting trips*

To better understanding how people used bikes for non-commuting purposes, the survey asked respondents about the destinations they usually biked to. The results are presented in Figure 4-6 (the original count and percentage are shown in Appendix C, Table 5). Not surprisingly, parks were the most popular destinations for groups who bicycled once or less per week. Parks were the second most frequent destinations for the other two groups – the 2-3 times per week group and the 4+ times per week group. Respondents in the once per month/once every few months and 2-3 times per month groups also biked for social visits and purely recreation (no destination, just bicycling around) very often. People who bicycled once per-week and 2-3 times per week reported more rides to social visits and restaurants/bars/cafes. People who bicycled more than 4 times per week reported those destinations more evenly.

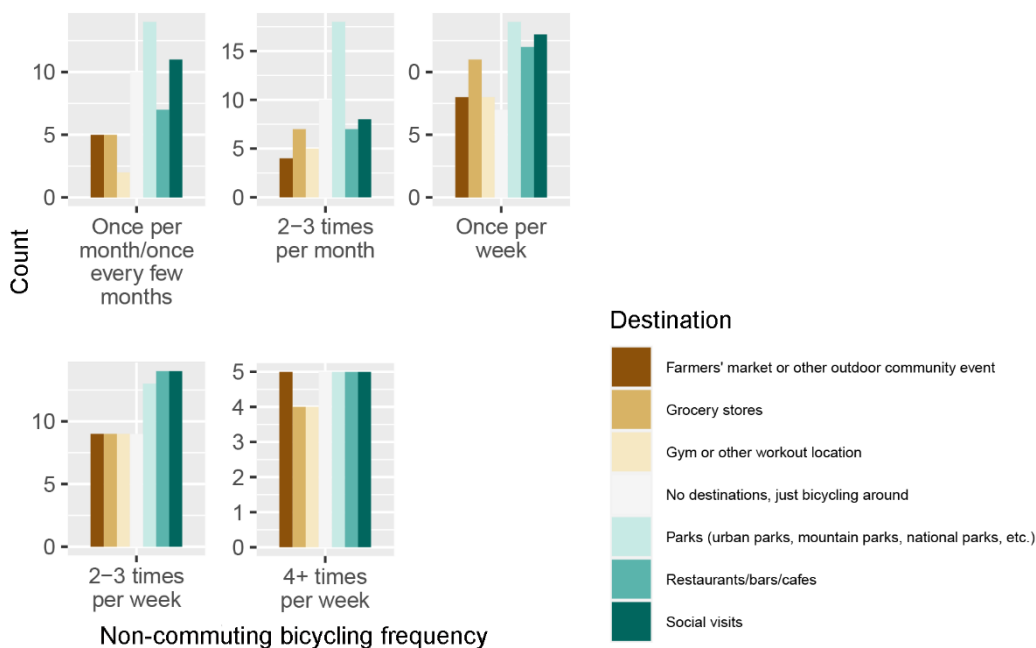


Figure 4-6. Destinations for non-commuting biking trips (N=73)

Similar univariate liner regression method was applied here:

$$(2) \quad Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \varepsilon,$$

where Y is a dummy variable of whether or not going to a specific biking destination (farmers' market or other outdoor community events, grocery store, gym or other workout location, no destinations, parks, restaurants/bars/cafes, social visits, for the seven models, respectively); X_i ($i= 1, 2, 3, 4$) are four dummy variables for the four of the five frequency groups.

The regression results are presented in Table 4-6. The results show that compared to those who bicycled 2-3 times per month, people who bicycled once per week had higher probability of going to grocery stores, social visits, and restaurants; people who bicycled 2-3 times per week had higher probability of going to social visits, restaurants/bars/cafes, farmers' markets or other outdoor community events, and gym or other workout locations; and people bicycled more than four times per week had higher probability of going to farmers' markets. Interestingly but not surprisingly, the results suggest that farmers' markets and other community outdoor events were popular among people who did non-commuting bicycling at a higher frequency.

Table 4-6. Seven univariate linear regressions examine the relationships between biking destinations and non-commuting biking frequency (N=73)

	Dependent variable:						
	Grcry (1)	Socivst (2)	Park (3)	Rstrnt (4)	Fmrmt (5)	Gym (6)	Nodesti (7)
2-3/wk	0.232 (0.169)	0.512*** (0.149)	-0.081 (0.115)	0.565*** (0.153)	0.389** (0.165)	0.337** (0.159)	0.074 (0.176)
4+/wk	0.203 (0.216)	0.293 (0.190)	-0.233 (0.147)	0.346* (0.196)	0.504** (0.211)	0.308 (0.204)	0.188 (0.225)
<=1/mon	-0.074 (0.163)	0.226 (0.144)	-0.124 (0.111)	0.043 (0.148)	0.084 (0.159)	-0.146 (0.154)	0.062 (0.170)
1/wk	0.365** (0.169)	0.446*** (0.149)	-0.014 (0.115)	0.432*** (0.153)	0.323* (0.165)	0.270* (0.159)	-0.060 (0.176)
Constant(2-3/mon)	0.368*** (0.112)	0.421*** (0.099)	0.947*** (0.076)	0.368*** (0.101)	0.211* (0.109)	0.263** (0.106)	0.526*** (0.117)
Observations	73	73	73	73	73	73	73
R2	0.112	0.180	0.048	0.229	0.134	0.160	0.020
Adjusted R2	0.060	0.131	-0.008	0.184	0.083	0.111	-0.038
Residual Std. Error (df = 68)	0.488	0.431	0.332	0.442	0.477	0.462	0.509
F Statistic (df = 4; 68)	2.150*	3.722***	0.854	5.061***	2.626**	3.241**	0.344

Note:

*p<0.1; **p<0.05; ***p<0.01

(1) Grocery stores, (2) Social visits, (3) Parks, (4) Restaurants/bars/cafes, (5) Farmers' market or other outdoor community events, (6) Gym or other workout locations, (7) No destinations, just bicycling around.

4.1.6 Barriers to bicycling commuting

In order to identify potential for encouraging more commuting rides, the survey inquired about commuting cyclists' barriers to biking more often (Figure 4-7). Meanwhile, for the 18 (24.7%) out of the 73 non-commuting cyclists who did not commute by bike, the survey also asked about the barriers they faced (Figure 4-8).

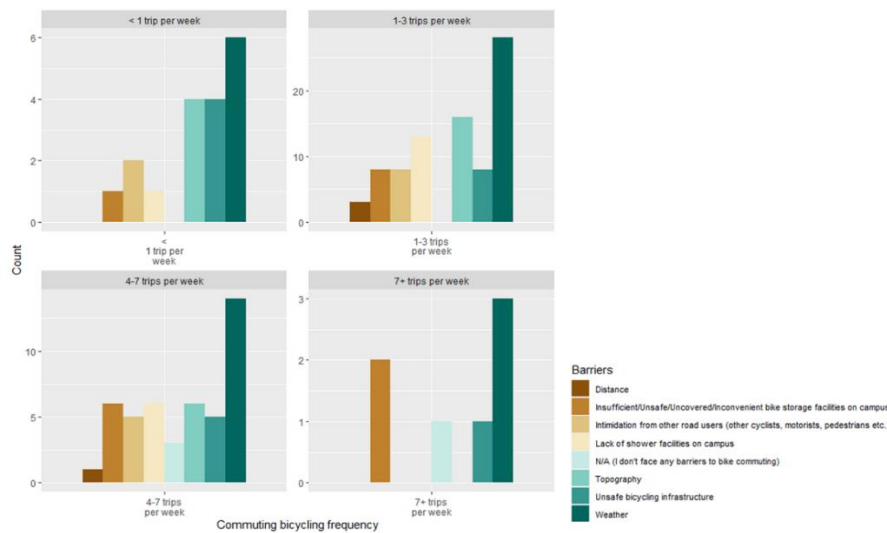


Figure 4-7. Barriers to bicycling more often reported by commuting cyclists (N=66)

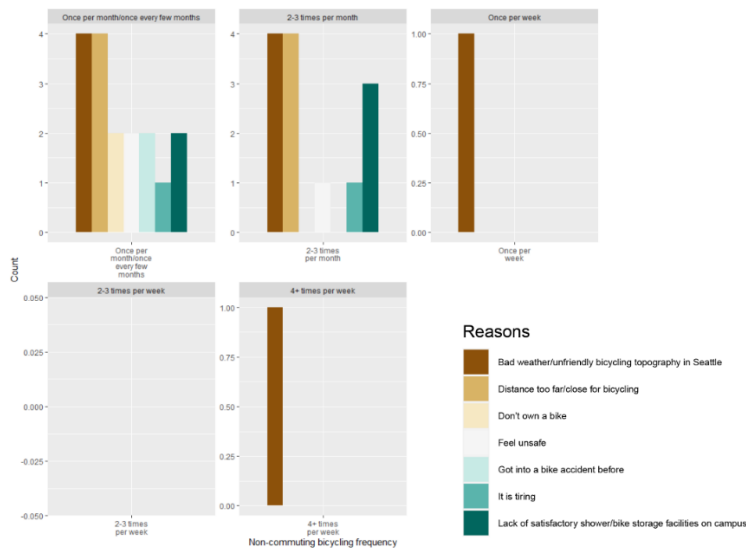


Figure 4-8. Barriers to commuting bicycling reported by non-commuting cyclists

For commuting cyclists, weather was the most common barrier for all frequency groups. 51 cyclists (77.3%) reported weather as a barrier to cycling more.

Of the 40 people who bicycled less than four times per week, 20 (50%) reported topography as a barrier to cycling more, and 14 (35%) reported the lack of shower facilities on campus as a barrier. For the 26 participants who bicycled four or more times per week, the second most reported (30.8%) barrier was insufficient/unsafe/uncovered/inconvenient bike storage facilities on campus.

For non-commuting cyclists, weather/topography was still the most common barrier (55.6%) to starting commuting by bike, whereas distance was the second most (44.4%). About one third (27.8%) participants also reported the lack of shower and/or bike storage facilities as a barrier to commuting biking.

4.1.7 *Perceived physical, social environments and individual factors*

In the survey, statements of perceived physical and social environments, and bicycling self-efficacy were assessed on five-point rating scales ranging from 1 (strongly disagree) to 5 (strongly agree). However, due to the small sample sizes, five categories might generate more errors in statistical analysis. Therefore, when examining the relationships between bicycling frequency and agreements on the items of interest, I merged “strong disagree” and “disagree” as a new group “Disagree”, and merged “strongly agree” and “agree” as “Agree”. Therefore, the new agreement scale had three ordered levels- “Disagree”, “Neither agree nor disagree”, and “Agree”. For the same reason, in commuting trip analysis, I merged the “< 1 trip per week” and “1-3 trips per week” groups as a new group “<4 trips per week”, and merged the other two groups as “>= 4 trips per week.” Similarly,

in non-commuting trips analysis, the five groups were regrouped as “< 1 trip per week” and “>=1 trip per week”.

I applied a series of ordered logit models (OLM) to analysis each of the survey questions.

The model is specified as:

$$(3) \quad \text{logit} (P (Y \leq j)) = \beta_{j0} - \eta X \quad (j=1,2),$$

where $P(Y \leq j)$ is the cumulative probability of Y less than or equal to a specific agreement category j ($j = 1,2$) of the specific question evaluated by the model; X is a dummy of whether or not bicycling “ ≥ 4 trips per week” and “>=1 trip per week” for commuting and non-commuting analysis, respectively, η represents the coefficient to be estimated by the model; β_{j0} represents the j^{th} cutpoint ($j=1,2$). To better interpret the results, I transferred the outcomes of log odds into odds ratio.

In commuting trip analysis, no statistically significant difference was found in the agreements to any of the statements between people in different cycling frequency groups, as shown in Table 4-7.

Table 4-7. Ordered logit models examine how physical, social environment and self-efficacy relate to commuting bicycling frequency (N=66)

	OR	2.5 % CI	97.5 % CI	Disagree		Neither disagree nor agree				Agree					
				<4tpwk	>=4tpwk	<4tpwk	>=4tpwk	<4tpwk	>=4tpwk						
				N	%	N	%	N	%	N	%	N	%		
Physical Environment															
Good bike infrastructure	2.95	0.93	9.34	13	19.7	3	4.5	3	4.5	2	3	24	36.4	21	31.8
Route directness ^a	0.99	0.38	2.62	12	18.2	8	12.1	5	7.6	3	4.5	23	34.8	15	22.7
Good parking facility at school	0.87	0.34	2.22	11	16.7	10	15.2	10	15.2	3	4.5	19	28.8	13	19.7
Social environment															
Family members bicycling	1.25	0.63	2.51	25	37.9	14	21.2	2	3	2	3	13	19.7	10	15.2
Growing up bicycling with family	1.35	0.69	2.64	24	36.4	12	18.2	4	6.1	5	7.6	12	18.2	9	13.6
Family role model	1.98	0.94	4.13	9	13.6	3	4.5	11	16.7	4	6.1	20	30.3	19	28.8
Family encouragement	1.74	0.85	3.56	8	12.1	6	9.1	15	22.7	2	3	17	25.8	18	27.3
Friends bicycling	1.47	0.44	4.96	3	4.5	1	1.5	2	3	1	1.5	35	53	24	36.4
Friends role model	1.31	0.52	3.27	1	1.5	2	3.1	8	12.3	2	3.1	30	46.2	22	33.8
Friends encouragement	1.31	0.65	2.61	4	6.1	4	6.1	17	25.8	6	9.1	19	28.8	16	24.2
CBE peers bicycling	0.63	0.3	1.32	3	4.5	4	6.1	7	10.6	6	9.1	30	45.5	16	24.2
CBE peers role model	0.56	0.26	1.23	1	1.5	3	4.5	7	10.6	6	9.1	32	48.5	17	25.8
CBE peers encouragement	0.85	0.43	1.67	3	4.5	4	6.1	16	24.2	9	13.6	21	31.8	13	19.7
Commuting trip companionship	1.94	0.87	4.34	33	50	17	25.8	4	6.1	4	6.1	3	4.5	5	7.6
Sense of belonging to a cyclist group	1.42	0.74	2.71	18	27.3	8	12.1	10	15.2	8	12.1	12	18.2	10	15.2
CBE education	0.63	0.33	1.22	9	13.6	9	13.6	9	13.6	7	10.6	22	33.3	10	15.2
Self efficacy															
Confidence in cycling skills	3.31	0.72	15.2	3	4.5	0	0	4	6.1	1	1.5	33	50	25	37.9

Note: OR= odds ratio; CI= confidence interval; tpwk= trips/week

a. This questions ask route indirectness: "To travel safely by bicycle, I cannot always take the shortest or the most direct path when commuting to school"

However, in non-commuting trip analysis, a few social environment factors were proved related to biking frequency, as shown in Table 4-8. For people who bicycled more than one trip per week, the odds of being more likely to agree that “family role model”, “family encouragement”, “companionship” and “a sense of belonging to a cyclist group” have influence on their bicycling behavior is two to three times that of those who bicycled less than once per week. The predicted probability of agreements for each frequency group on the four questions as shown in Appendix C, Table 6.

OLS regression was also applied to examine the relationships between agreement on the statements and bicycling frequency. The results are presented in Appendix C, Table 7 and Table 8 (commuting trips), and Table 9 (non-commuting trips). For commuting trips, the results were similar to the ordered logit model, and no significant results were identified. For non-commuting trips, the results of the OLS and OLM were also similar, except that in the OLS model with “a sense of belonging to a cycling group” as the dependent variable, the coefficient was not significant.

Table 4-8. Ordered logit models examine how social environment and self-efficacy relate to non-commuting bicycling frequency (N=73)

	OR	2.5 % CI	97.5 % CI	Disagree		Neither disagree nor agree				Agree		
				<1tpwk	>=1tpwk	<1tpwk	>=1tpwk	<1tpwk	>=1tpwk			
				N %	N %	N %	N %	N %	N %	N %	N %	
<i>Social environment</i>												
Family members bicycling	1.37	0.73	2.6	21 28.8	18 24.7	3 4.1	2 2.7	12 16.4	17 23.3			
Growing up bicycling with family	0.96	0.51	1.78	17 23.3	19 26	5 6.8	3 4.1	14 19.2	15 20.5			
Family role model	2	1.04	3.81	11 15.1	5 6.8	9 12.3	7 9.6	16 21.9	25 34.2			
Family encouragement	2.47	1.29	4.72	14 19.2	7 9.6	10 13.7	5 6.8	12 16.4	25 34.2			
Friends bicycling	3.91	0.84	18.16	1 1.4	1 1.4	5 6.8	0 0	30 41.1	36 49.3			
Friends role model	2.27	0.93	5.54	3 4.1	1 1.4	7 9.6	3 4.1	26 35.6	33 45.2			
Friends encouragement	1.8	0.95	3.4	6 8.2	3 4.1	16 21.9	12 16.4	14 19.2	22 30.1			
CBE peers bicycling	1.08	0.54	2.18	5 6.8	3 4.1	6 8.2	8 11	25 34.2	26 35.6			
CBE peers role model	1.2	0.61	2.38	3 4.1	3 4.1	10 13.7	8 11	23 31.5	26 35.6			
CBE peers encouragement	1.3	0.71	2.4	10 13.7	4 5.5	10 13.7	16 21.9	16 21.9	17 23.3			
Non-commuting trip companionship	2.64	1.34	5.24	13 17.8	7 9.6	9 12.3	2 2.7	14 19.2	28 38.4			
Sense of belonging to a cyclist group	2.01	1.08	3.74	20 27.4	12 16.4	9 12.3	10 13.7	7 9.6	15 20.5			
CBE education	1.01	0.54	1.86	12 16.4	10 13.7	5 6.8	9 12.3	19 26	18 24.7			
<i>Self efficacy</i>												
Confidence in cycling skills	2.32	0.85	6.32	4 5.5	1 1.4	4 5.5	2 2.7	28 38.4	34 46.6			

Note: OR= odds ratio; CI= confidence interval; tpwk= trips/week
 Bold numbers: confidence intervals did not cross 1.

4.1.8 Self-identified cyclist types

Based on Geller's (2006) four types of cyclists, the survey asked respondents to select one of the cyclist identities to indicate their attitudes towards cycling in different situations. The four types are: "Strong and fearless cyclist: I'm willing to bicycle with limited or no bicycle-specific infrastructure," "Enthusied and confident cyclist: I'm willing to bicycle if some bicycle-specific infrastructure is in place," "Interested but concerned cyclist: I'm willing to bicycle if high-quality bicycle infrastructure is in place," and "No way, no how: I'm unwilling to bicycle even if high-quality bicycle infrastructure is in place." Figure 4-9 and 4-10 display CBE students' cyclist identities according to commuting and non-commuting frequencies, respectively. The results show that most of the CBE cyclists were self-identified as "enthusied and confident cyclist" or "strong and confident cyclist."

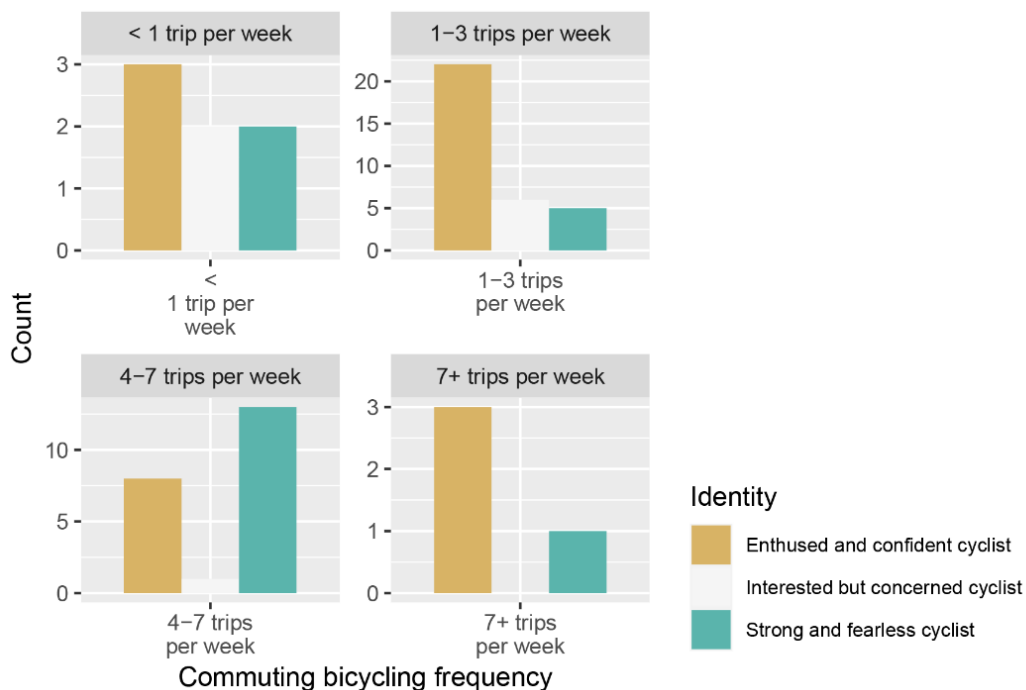


Figure 4-9. Self-identified cyclist type and commuting frequency (N=66)

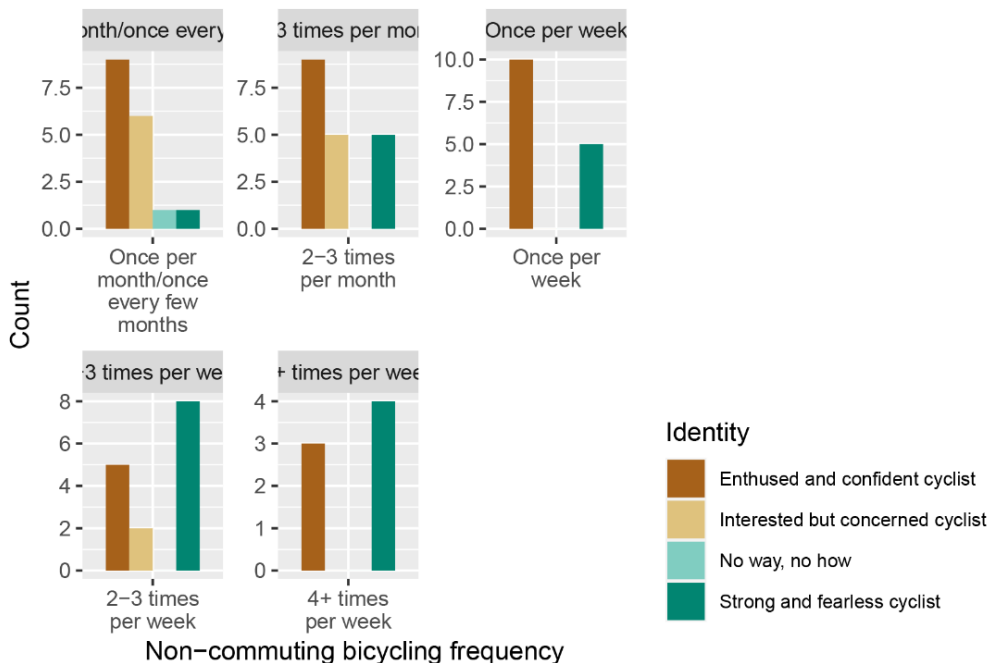


Figure 4-10. Self-identified cyclist type and non-commuting frequency (N=73)

4.2 WHAT FACTORS SHAPE CBE STUDENTS' BICYCLING BEHAVIOR

In this study, this question was answered by interview and qualitative analysis. This section discusses about how CBE students' bicycling behavior developed and was shaped.

Despite individual differences, a common course of establishing regular bicycling emerged in talking with the participants about their bicycling experience. The course includes three stages- having triggers that initiate regular bicycling, factors related to sustaining and reinforcing bicycling behavior, and establishing one's own perception of bicycling (Table 4-9). These stages served as three analytical categories under which common themes and trends were identified from the interview data.

The positional characteristic of the participants - students who were at a younger age and lived in different cities primarily for short-term education or working - played an essential role in initiating their regular bicycling. Meanwhile, the bike culture and related

social opportunities, as well as the physical characteristics of the environments that respondents live in, were closely linked with their enduring bicycling behavior. Last, although interviewees shared many commonalities of reasons for bicycling, great differences were found in their bike usages and the barriers they faced according to individuals' perceptions of bicycling. In the following sections, I will describe the main themes and individual differences in detail.

Table 4-9. Analytic categories and themes of CBE students' bicycling behavior

Analytic	Themes	Sub-themes	
Triggers that initiate regular bicycling	1 Getting into a context where bicycling is reasonable	1-1) Change of physical environment	
		1-2) Exposure to a bicycling culture	
		1-3) Change of available transportation options	
		1-4) Being in a situation where bicycling is possible	
	2 Getting good cycling experience	2-1) Getting suitable bikes/gears	
		2-2) Engaging in enjoyable bicycling trips	
Sustaining and reinforcing bicycling behavior	3 Bicycling surpassing other transportation modes		
		4 Bicycling bringing extra benefits	4-1) Getting health benefits
			4-2) Having good emotional experience
			4-3) Building social connections
4-4) Connecting with environments			
Establishing the perception of bicycling	5 Cycling as a source of internal happiness		
	6 Cycling as a part of individuals' identities		
	7 Cycling merely a practical transportation mode		

4.2.1 *Analytic category 1: triggers that initiate regular bicycling*

Almost all interview participants were regular cyclists and bike commuters. They typically learned how to ride a bike in their childhoods and many had occasionally cycled over the years before using bikes on a regular basis in the present. In the interviews, I found that participants shared certain patterns of how regular bicycling started. I call these “triggers that initiated regular bicycling.” Before explaining different themes within this category, I should point out that many people started bicycling under the influence of multiple factors, i.e. the themes sometimes co-exist to initiate biking.

Theme 1: Getting into a context where bicycling is reasonable

1-1) Change of physical environment

A change of environment is a common trigger for behavior change. When interviewees talked about how they became a cyclist, many described their experience of moving to a place that was physically suitable for biking. This pattern was common among individuals who moved to an urban context from suburban or rural areas. For those participants, biking became more attractive in the compact urban environment because of the suitable travel distance, better bike infrastructure, and the inconvenience of transit or driving due to traffic congestion and parking. It is interesting that such a change of the environment could also alter how they feel about bicycling, besides initiating the cycling action. As one participant, Tim³, suggested:

I grew up in a small town where bicycling is stigmatized, something that is either for kids or for people who have a lower income. My first biking experience in a city was 2010 in Philadelphia. And I loved it. It was much more efficient than taking public transit. The bus would be stuck in the traffic and on a bike, it was twice as fast. Plus, you've got physical exercise in the city. (Tim, male, graduate student, 30-34 years old)

³ Names of the interview participants are all pseudonyms to protect participants' privacy.

Another participant, Walter, talked about a similar experience of starting biking after moving to a new city:

I had a car when I lived in the suburbs. Biking wasn't until I lived in a city which was a much denser environment where it became a legitimate way of getting to places. Before I moved to the city, I remember thinking that biking was not cool. It was something that you would do in high school and get looked down upon. But then I came to Chicago and biking was cool. It was a faster way of getting. (Walter, male, graduate student, 25-29 years old)

For many people who started cycling after moving to a new city, bicycling was also a helpful way to get familiar with new surroundings. As Tim pointed out:

Biking is also one of the things that helped me learn new places. I just built out mental maps quickly and familiarize myself with my surroundings. Whereas if I were only using public transit, I wouldn't be paying attention to the surroundings as much. (Tim, male, graduate student, 30-34 years old)

Sometimes the natural characteristics of the new environment, such as better weather, were also an important reason that made participants started biking. For example, Leah talked about her experience of starting bicycle when moving to Seattle:

I started bicycling this year moving to Seattle, as a method of transportation but also as a form of entertainment. The reason I think I wanted to bike more is partly because the weather. I'm from Texas and I don't like biking in the heat. So, when the weather is nice in Seattle, it's the perfect reason for biking. (Leah, female, graduate student, 25-29 years old)

Besides moving to new cities, starting college was also one common trigger of regular biking. It is mostly because the daily travel distance in a college town or on campus is suitable for cycling, and the affordability and convenience of biking make it a good option for students. For example, Kelly described a lifelong experience bicycling but felt that it was especially easy to cycle to school and around campus:

I learned to ride a bike as a kid. And then, when I was in college, I got around with a bike, because that's what the campus was set up for. In the

core of campus, cars weren't allowed anywhere, and everything was good and flat. My house was never more than a mile from anywhere else that I had to go, so I biked everywhere. (Kelly, female, graduate student, 30-34 years old)

Similarly, Renee talked about her experience of starting cycling in college:

I became a regular cyclist in 2007. I went to undergrad, and I moved to a college town where everybody biked. And I got a bike, and I started biking everywhere. It was wonderful. I didn't have a car until I was 23. And before that, I just biked everywhere. (Renee, female, graduate student, 30-34 years old)

Another participant, Wong, also started biking in college because of the suitable cycling distance:

I started biking when I was in college. Because the campus was huge. If I walked to school or to the cafeterias, it would take me much more time, so I rode a bike. It was a more convenient way. (Wong, male, graduate student, 20-24 years old)

1-2) Exposure to a bicycling culture

A change of physical context is one important catalyst that helps people start bicycling, but sometimes the influence comes from the cultural or social atmosphere in the new environment. Many participants were inspired by other people around them and started biking based on their influence. Such influence could come from people in their personal social network, as Walter noted:

Another reason I started biking is because my colleagues biked to work. They're also the ones who told me that biking was cool. I think that led me to a little bit of peer pressure to join in the group mentality. I had a boss that I really respected who biked every day no matter what the weather was. And I thought he was a cool and macho dude for doing that. So, there was also a level of respect that came from that. (Walter, male, graduate student, 25-29 years old)

Similarly, Abby also felt an influence from her sister who was a regular bicycle commuter:

I started biking when I moved to Boston. I was inspired by my sister who lives in Boston. And she bikes to get to work. She introduced me to biking in the city and showed me how to pass cars on the right and get in front of

them at the stoplights and how to use the hand signals. (Abby, female, graduate student, 25-29 years old)

The social and cultural influence could also come from the general public such as a great number of cyclists on the streets, as Leah suggested:

When I first came to Seattle, I realized a lot of people commuted by bike. I think just knowing that a lot of people do it is one reason that got me involved in doing it. (Leah, female, graduate student, 25-29 years old)

In some cases, the participants were influenced by other cultural experiences, such as having a bike-related job that helped them get familiar and feel comfortable with biking, as Luke said:

I've had a bike ever since I was a child, but I have been a cyclist basically for the past year. I moved to Olympia, and I helped running a volunteer bike shop. I taught kids how to ride bikes safely on the streets and how to ride around cars. Because I spent all my day working with bikes, I biked to work every day. (Luke, male, undergraduate student, 20-24 years old)

1-3) Change of available transportation options

For many individuals, travel choice is made by comparing available modes. Participants under this theme started biking because they did not have an alternative mode, or they emotionally disliked other available modes. Biking for these participants was almost the most convenient choice, as David suggested:

At first, I didn't have a car before, and so bike was just a means of transportation. The buses were very inconvenient. So it (the reason that I started biking) is convenience. (David, male, 30-34 years old)

Similarly, Mark talked about his experience of starting biking because of the discomfort of using other modes of travel:

I started biking mostly because I just hate driving, I hate being in traffic. I don't like having to find parking, it's just convenient to bike around. (Mark, male, graduate student, 25-29 years old)

1-4) Being in a situation where bicycling is possible

For many participants, bicycling may not be the best choice of transportation, but it was a possible choice, i.e. the external situation makes bicycling feasible. Being in a situation where bicycling is possible, enables regular cycling behavior to develop in combination with other factors, such as a good cycling experience, specific travel needs, or a desire to get daily physical exercise. For example, one participant, Drake, bicycled nine miles per trip for commuting to school. One of the most critical reasons he mentioned was that he was able to use the Burke-Gilman Trail⁴ the entire time:

I started biking to school right from the start (of his graduate studies). My apartment is right on the Burke-Gilman Trail, so I won't be on a road the entire time, which is helpful. I think if I didn't live in a city that cared as much about bike infrastructure, or if I didn't have as easy access to the bike infrastructure, I would be much less likely to use it, especially if my commute was as long. (Drake, male, graduate student, 25-29 years old)

Another participant, Chloe, talked about a similar experience of starting biking in middle school because of the suitable distance and the bike-friendly neighborhood she lived in:

I started regular biking in middle school. The school was a little too far to walk, but a little too close to bus. Biking is the perfect way to get there. It was also because I grew up in Ballard, the neighborhood in Seattle, where you can bike to everything you need. It is a convenient way for the location that I live. (Chloe, female, graduate student, 25-29 years old)

⁴ UW is linked with the Burke-Gilman Trail, which is a popular recreational, off-road trail of high quality.

Theme 2: Getting good cycling experience

If suitable contexts initiated bicycling by making it an attractive transportation mode, having a good cycling experience helps to develop the habit by providing positive feelings.

2-1) Getting suitable bikes/gears

A good cycling trip sometimes requires a suitable bike. Some participants mentioned that they started regular bicycling because they got an appropriate bike, which made frequent trips possible and helped them experience the beauty of cycling. As Drake noted:

The first time I commuted by bike was when I was living Bellingham, Washington. I only had a mountain bike for many years. Then I got a road bike from a friend. So, having that made me start biking to work. (Drake, male, graduate student, 25-29 years old)

Similarly, Walter talked about how a suitable bike helped him get into biking:

I remember when I first got a bike that fit me, my right size, I was like, oh, this is what it's supposed to be, a road bike. It was a totally different experience than when I was growing up. Trying a road bike for the first time that was a big change and it made it a lot more fun just realizing how fast you could go. (Walter, male, graduate student, 25-29 years old)

2-2) Engaging in enjoyable bicycling trips

Although many people became a cyclist from biking for transportation, some participants' stories of biking started from enjoyable recreational trips. The positive feelings about biking made individual continue bicycling for both commuting and non-commuting purposes. As Don suggested:

I started on a whim. I was training for a triathlon. I bought the gear that I needed and worked with a cycling coach, and ended up being pretty good

at it. I just really took to it, and started cycling to school and undergrad and work. And it just never stopped. (Don, male, graduate student, 35-39 years old)

4.2.2 *Analytic category 2: sustaining and reinforcing bicycling behavior*

After getting started, people need certain reinforcements that make biking reasonable and beneficial for them to become long-term cyclists. Different from the triggers that initiate cycling as a novel experience, the reasons that sustain and reinforce individuals' long-term biking influence decisions by rationalizing their choices over time. There were two themes - bicycling surpassing other transportation modes, and bicycling bringing extra benefits- that were identified from the interviews as reasons which helped participants continue biking.

Theme 3: Bicycling surpassing other transportation modes

As mentioned earlier, a great number of people chose a bike as a transportation mode because of its comparative advantages over other modes in their daily life. Similar to the literature, such advantages of bikes identified in the interviews primarily include speed, affordability, flexibility, and convenience. Along these lines, participants mostly talked about their current commuting biking to school. As mentioned before by a participant, the Burke-Gilman Trail (Figure 4-11) is an important factor that makes bike commuting safer and faster for many UW students. Renee talked about her convenient and fast cycling experience:

For me, biking to UW is by far the fastest way to get there from everywhere that I've lived. I've lived in four different places in Seattle. And it's always about twice as fast as the bus. And obviously much faster than walking, and it's probably faster than driving but free because you don't have to pay for parking. (Renee, female, graduate student, 30-34 years old)



Figure 4-11. Location of UW campus and Seattle bike map

(Source: Author, based on Seattle DOT, Bike Web Map

<https://www.seattle.gov/transportation/projects-and-programs/programs/bike-program/bike-web-map>)

Another participant, Leah, mentioned that one of her commuting biking reasons is the inconvenience and unreliability of the bus:

I have a bus stop very close to my house that goes directly to Gould Hall. But the problem with the bus is it's always delayed. And it takes more time. The bus takes about 20 to 25 minutes total, whereas the bike can be as little as 15 minutes and that's door to door. (Leah, female, graduate student, 25-29 years old)

Meanwhile, the flexibility of bike allows people to change schedules more easily, as Connor noted:

Bike gives me more freedom if I don't know what's gonna happen after school. If I'm going out with friends or meet up with my girlfriend, on a bike it's easy to be last minute and be flexible about where you're going. (Connor, male, graduate student, 25-29 years old)

For some of the non-commuting utility trips, participants oftentimes chose biking for its convenience. Parking challenges in Seattle were one common reason that made driving less competitive than biking. As Mia pointed out:

I personally do not like driving. For grocery shopping in the neighborhood, driving to park is stressful and it's not worth it. I should say biking is easier. I also don't have a secure parking spot at my apartment so I don't like to move the car unless I have to. (Mia, female, graduate student 25-29 years old)

Another participant, David also mentioned that the inconvenience of driving made him bicycle for some utility trips:

For running errands, bike is more convenient because it's usually hard to find parking in Seattle, so bike is probably faster. It's too stressful to find parking. (David, male, graduate student, 30-34 years old)

Theme 4: Bicycling bringing extra benefits

Besides the practical advantages, most participants valued the extra benefits of biking. For utilitarian trips, those benefits made people stick to biking even when other travel options are available. For purely recreational trips, the benefits were the dominant reasons for biking.

4-1) Getting health benefits

Both physical and mental health benefits were greatly valued by most interviewees. Especially when people were occupied by studying and working, biking for commuting became a time-efficient workout and stress reliever. As Kelly said:

In part, it is because I knew I was getting at least 10 minutes of fresh air and movement. And when things get busy at school, I often counted it as my workout. (Kelly, female, graduate student, 30-34 years old)

Another participant, Chole, mentioned the reasons of getting exercise and being less stressed via biking commuting:

With biking, I am being able to get exercise twice a day. I like being able to be outside as much as possible. And I also think that it makes me less stressed out or anxious. Those are probably the main reasons. (Chole, female, graduate student, 25-29 years old)

Similarly, Mark suggested:

I just think it improves quality of life for a lot of people. Certainly, it is convenient, but also the physical and mental health aspects that you get from it. Commuting and getting a workout from that, not sitting in a car and getting stuck in traffic and getting stressed about finding parking. (Mark, male, graduate student, 25-29 years old)

4-2) Having a good emotional experience

Some participants enjoyed biking, not only because it helped to release stress, but also because the sensory experience and momentary feeling on a bike were wonderful. When talking about their bicycling experience, participants vividly described some specific moments when biking was enjoyable. For example:

Expanding on getting physical exercise, it's just nice to get your mind go on and your blood flow before you're going into the day. It's a joyful thing because you're zipped by winds blowing on your face. I think I just really like the feeling. (Connor, male, graduate student, 25-29 years old)

4-3) Building social connections

For many participants, bicycling was an important way to build social connections. People engaging in group cycling shared many special feelings, which were helpful for developing or maintaining social relationships. Meanwhile, being a cyclist also provided a cultural identity that helps people start a conversation and bond with each other very quickly. As Don noted:

I do social biking with groups and organizations and I've really enjoyed that. There's an element of a shared suffering and exhilaration. Sharing that type of experience is something that you don't do with very many people. There's a sense of camaraderie. And knowing that there are other people that are enjoying mobility the way that you enjoy it, it's a gateway to a conversation and friendships. (Don, male, graduate student, 35-39 years old)

Similarly, Joey suggested that biking was a good way to build connections with his peers:

There are people that are in my program cycle. It hasn't necessarily built a really strong community around cycling per se, but it's definitely one component of my community that we can bond over. It brings us a little bit closer together as we have those things that we can share experiences and that we have in common, and plan for going on bike rides together. (Joey, male, graduate student, 40+ years old)

Meanwhile, a transportation mode, bike benefited social meetings with its flexibility and convenience. As Tim suggested:

Biking was special because it was so easy, responsive, and adaptable. When you have friends who bike, it's a little easier for you to vote (for meetings) and change plans. Like our favorite place to go in Chicago, my friends and I never ever plan that. It was always spontaneous. And biking allows for that spontaneity. So I would absolutely say that biking played a really special role in building special friendship and memories. (Tim, male, graduate student, 30-34 years old)

4-4) Connecting with the environment

Some of the participants mentioned connecting with environments as one of the reasons that they bicycle. Such a connection was not limited to getting nature contact as some literature suggested, but also included knowing more about their surroundings and engaging oneself in the living environment. As mentioned before, biking benefited wayfinding for many participants, and it also helped cyclists know more about public life and establish multi-dimensional mental maps of the city. As Connor described:

When I bicycle the same route every day going slow enough, I can see what's happening, what's changing in the neighborhood. I can see little instances of public life that you would miss in a bus or a car. So that's part of why it's fun. (Connor, male, graduate student, 25-29 years old)

Besides knowing more about their surroundings, some participants also bicycled to take advantage of or to fully enjoy the physical characteristics of the city they lived in, such as good bike infrastructure, as Renee commented on Seattle:

I was excited to get to bike in Seattle. I moved here from California and knew that Seattle was a city where people biked and had decent infrastructure for biking. So, I brought my bike here and it has been the only mode of transportation, for me pretty much for the past three years. (Renee, female, graduate student, 30-34 years old)

For non-commuting trips, many participants mentioned that they did recreational biking in Seattle partly was because the natural landscape along the bike trail was stunning and interesting. Biking and enjoying the views were a good combination for exploring the city and for recreation, as Leah mentioned:

I love using my bike as a form of recreation and exercise, I think Seattle has a lot of natural beauty and a lot of its best scenes on a bike trail like the Burke-Gilman Trail. (Leah, female, graduate student, 25-29 years old)

Similarly, Tim described how the stunning landscape along the bike trail encouraged him to cycle for recreation:

A greater number of people that do recreational biking here in Seattle. It is sort of rewarding along the way and at the end because we're just in such a stunning natural landscape. Biking and going into a natural landscape or a post-industrial landscape, there's a lot of a great sense of mystery. (Tim, male, graduate student, 30-34 years old)

Sometimes this connection between biking and the environment came from the environmentalism perspective. Biking as a carbon-neutral activity helped individuals minimize the impacts on the environment and further build a closer connection with nature. For example, Joey mentioned his opinions of bicycling for better environment:

I don't own a car, and I have chosen not to own a car. I love bicycling because it is a sustainable transport. I believe in the biocentric model and the connection between humans and the natural world. It needs to develop in a way that it's homeostatic that we are in balance. We can do more things like walking, cycling, and less driving or use of combustion engine. (Joey, male, graduate student, 40+ years old)

4.2.3 Analytic category 3: establishing the perception of bicycling

Although most of the reasons for cycling were not mutually exclusive, I found that for many interviewees, there was a primary driver for biking that they valued the most. As individuals were developing their behavior and being influenced by multiple factors, those primary drivers evolved, got reinforced, or changed over time to coordinate with people's needs and values, and eventually helped them establish their unique perceptions of bicycling. Those perceptions varied across individuals and distinguished their bicycling behavior from one another. In other words, how people perceived bicycling varied greatly and it largely explained the individual differences of how they use bikes and the barriers of biking they faced. I identified three patterns of individuals' perceptions of bicycling.

Theme 5: Cycling as a source of internal happiness

Participants who perceived bicycling as a source of internal happiness valued the positive emotions linked with bicycling per se. They loved the experience and feelings of bicycling. The following quotes from four participants perfectly illustrate how this type of cyclist perceives bicycling and enjoys the feeling of bicycling:

I really enjoy biking. It's a pure enjoyment and a stress reliever for me. Being out on a bike is a bit of a liberating feeling and you're able to enjoy your surroundings a little bit more... (Don, male, graduate student, 35-39 years old)

I think biking is essential for my happiness and my health, and for getting around the city. And it has led to a lot of friendships and a lot of adventures, and a lot of opportunities. I think it shaped the way that I view the world... (Chloe, female, graduate student, 25-29 years old)

I would say bicycling is one of the most important things in my life. I enjoy it, and I depend on many things that are related to bicycling. I love this feeling of thinking into turns when I'm on my bicycle. I love the feeling of pushing up the hill. Coming downhill and just feeling that, you know, the wind across your face and the speed... (Joey, male, graduate student, 40+ years old)

I think there's a lot of different things kind of layered on top of it that make cycling a significant thing for me. Not the least of which being that I love biking. I love the feeling of it. It'd be hard to give it up... (Drake, male, graduate student, 25-29 years old)

This group of cyclists, especially commuting cyclists, usually had bicycled for a long time and were very confident about their bicycling skills. Typically, their commuting choices were likely to be influenced by weather conditions. These cyclists were one group among the “strong and fearless cyclists” (Geller, 2006). Some of the commonly believed biking barriers, such as hilly topography, traffic, and long distances, were not big challenges for them. As Don suggested:

I'm a pretty confident cyclist. Just to be a little anecdotal, I enjoy the topography. When I would ride on my way home after I had been done with the day, spending so much time sitting down, I could put some effort in heading back home going back up hill. So really it works for me... (Don, male, graduate student, 35-39 years old)

Similarly, Joey and Chloe mentioned that they would commute to school by bike regardless of the weather:

I consider myself a very confident biker. I can bike up hills and I can bike in a street, it's totally manageable... There might be one day or two days during the quarter that I won't commute, if it's either just the biggest downpour or I feel a little sick, but other than that I commute by bike every day. (Chloe, female, graduate student, 25-29 years old)

Yeah, I don't stop. I mean there are certainly times like last year when the snow got really bad. I had to take a couple days off from biking because at the time my bike was a road bike, and it didn't do so great in the snow. I have a thicker wheeled bike now, and it's more of like a mountain bike so I did it this year in the snow. (Joey, male, graduate student, 40+ years old)

Besides commuting bicycling at a very high frequency, this type of cyclists also did purely recreational and exercising bicycling a lot, as Drake suggested:

Mountain biking is probably the biggest thing for my recreation. Sometimes in the evening when the weather's nice, my wife and I will go for a ride on the path. That's the most we've done in the past. (Drake, male, graduate student, 25-29 years old)

Meanwhile, some of the cyclists who perceived biking as a source of internal happiness would also use bike for utility trips very often, as Joey said:

I also ride my bike, or every single one of my errands. Get my haircut, or groceries, or go to the bank... I make sure I ride my bike (Joey, male, graduate student, 40+ years old)

Theme 6: Cycling as part of individuals' identities

Besides providing happiness and enjoyment, bicycling helps develop individuals' identities and is projecting some external public images of cyclists.

There are many types of external identities that biking is included. A most intuitive one is that as a pro-environmental behavior, bicycling could indicate care for the environment, as David suggested:

Culturally I prefer a built environment that is more geared towards lower environmental impact transportation. I spent a lot of time in different European cities where there's a lot of bicycling and then I kind of identify with that culturally. So I don't like to drive, even though I can drive. I prefer to use a bicycle. I feel like the way that it affects the built environment is important to me. And I prefer to see a city that's built around bicycles and pedestrians than one it's built around cars. (David, male, graduate student, 30-34 years old)

Meanwhile, as biking helps with wayfinding, being a cyclist is linked with individual's closeness with the city, and suggests a better knowledge of their surroundings, as Abby and Walter noted:

I think it's an important part of my identity. I think that biking commuting has become an important strategy for me to feel at home, and rooted in my location. Because it helps me better understand the layout of the roads. It makes me feel more mobile, able to reach different locations... (Abby, female, graduate student, 25-29 years old)

It was super important; it was part of my identity. It is like you identify yourself as a bicyclist, you know the city. Because it forces you to know where you are and you see the city at a different speed. It's a much more visceral interaction with the city that I wasn't getting with other transportation modes... (Walter, male, graduate student, 25-29 years old)

There is another layer of cyclists' identity- being included in a cyclist community. It was not a very common theme, but it played an important role for some of the participants, especially when many people in their close social networks bicycled or were interested in bikes, as Luke and Walter suggested:

Bike is a way that I connect with a lot of people. Everybody knows me as somebody who knows and enjoys bikes. So it changes how people see me and changes how they interact with me. It's like a public-facing image that I project, and that I enjoy. (Luke, male, undergraduate student, 20-24 years old)

old, who had work experience with bikes and commute by bicycle every day.)

There's also something with bikers where there's this language like "oh I took this route because it's a little flatter right there", or like "the streets are really good for bikers because they have a lane". You kind of create this different language of speaking with other bikers and that creates a community. And I had a lot of friends who bike so it kind of became a thing. (Walter, male, graduate student, 25-29 years old)

Although most of the participants who primarily valued the identities related to biking still found cycling enjoyable, they are usually less dedicated to cycling than cyclists who perceived biking as a source of internal happiness are. Their commuting bicycling choices were more influenced by weather and topography and could be more easily changed when biking became less convenient, or when other modes became more competitive. The following quotes from three participants illustrated how their bicycle commuting was influenced by other available modes and the weather:

But now I don't bike to school anymore, because the transit just where I am. The bus is super convenient and takes me right to the campus. And I'm usually working late hours, so I almost don't bike to school now. (Walter, male, graduate student, 25-29 years old)

I bike a little less now. Because I moved to Capitol Hill. It's about a 10 minutes' walk to the Capitol Hill light rail station from where I'm living. And with the UPASS, I don't have to spend money on transit. So I would say because I have a more convenient option, or I'm tired, or when the weather it's really bad. (Tim, male, graduate student, 30-34 years old)

I mean, the weather is not always very good for biking, and that's topography that makes it challenging. So yeah, it (whether biking for commuting) is (depending on) a combination of the weather, or I'm tired and have too much stuff to do. (David, male, graduate student, 30-34 years old)

Participants in this group often used bikes as a transportation mode to get to recreational destinations, such as parks, but they did less purely recreational cycling than the first group

did. It mostly because they did not think cycling was as fun as other recreational activity, as Luke and Abby suggested:

I haven't really gone on that many recreational rides. I had other stuff to do or something I thought was more interesting. I usually hiked more. I wouldn't say it (recreational biking) was a very big part of my life. (Luke, male, undergraduate student, 20-24 years old)

I actually haven't used bike very much for recreation. I think the biggest reason is that I've been so incredibly busy as a graduate student, that I don't feel I have the time to go on recreational rides. Another reason is that, when I do have free time, I prioritize going running, as I generally enjoy that more than biking. (Abby, female, graduate student, 25-29 years old)

Theme 7: Cycling merely as a practical transportation mode

For some participants, there was little value in bicycling beyond practical uses. They biked primarily because it was the most convenient or most feasible transportation mode, as John and Wong said:

I think that it's a transportation for me, because I don't really use it as an exercise. I just use it to get from point A to point B. (John, male, graduate student, 30-34 years old)

Bike is important to me. As I mentioned before, the parking fee was so expensive in UW. So biking is much cheaper. (Wong, male, graduate student, 20-24 years old)

For this group of cyclists, bikes were primarily and very frequently used for certain utility purposes. Some participants didn't necessarily feel satisfied with the bicycling infrastructure and weather conditions or topography, but they still cycled for commuting for the lack of other options, such as John and Wong suggested:

Of course, it's so much nicer to bike on a sunny day, but I still bike despite the weather. Because for me it's still more convenient than having to wait for the bus. (John, male, graduate student, 30-34 years old)

My commuting biking is not very good, because Seattle is so hilly. The good thing is that I can put the bike the bus. The terrible thing is the topography. Sometimes the slope is quite steep, and I'd be exhausted to ride my bike uphill and downhill. (Wong, male, graduate student, 20-24 years old)

Meanwhile, some participants' choices of bicycling were largely based on the high quality of infrastructure and the convenience of biking, as Kelly suggested:

I'm lucky because I live two blocks from the Burke-Gilman Trail. I think if I live another 10 minutes farther away, then I would be sweating by the time I got to school. And it is really safe. I've tried going other places and sometimes, I get a little nervous about that without enough bike lanes. (Kelly, female, graduate student, 30-34 years old)

4.3 HOW MIGHT THE CBE CULTURE SHAPE STUDENTS' BICYCLING BEHAVIOR

4.3.1 *Insights from the survey*

Among the 66 commuting cyclists, about half (48.5%) agreed or strongly agreed that the education they were receiving from the program(s) of study influenced their bicycling behavior, 27.3% disagreed or strongly disagreed, and 24.2% had a neutral attitude. However, the response to this question was not significantly related to biking frequency, as proved in section 4.1.7.

Among the 32 respondents who strongly agreed or agreed that studying in CBE influenced their biking, 24 (75%) reported that the education increased their concern for climate change, 14 (43.8%) suggested that it increased the awareness of engaging in physical activity for health benefits, and 17 (53.1%) reported more awareness of getting nature contact.

4.3.2 *Insights from the interviews*

The survey indicated no strong influence of CBE culture on respondents' bicycling. However, from the interviews, I found that it was because many students were already "die-hard" cyclists who did not need direct influences from external environments to support their bicycling. Rather, most interviewees pointed out that many components of the CBE culture **reinforced** their choices of cycling and changed some of their biking patterns. In this section, I will explain how the reinforcements happen with three themes identified from the interviews: CBE social experience mutually reinforcing bicycling, studying in CBE changing the perceptions of the outward contributions of bicycling, and studying in CBE changing the perceptions of the inward benefits of bicycling.

Theme 1: CBE social experience mutually reinforcing bicycling

In the interviews, most people agreed that a large number of their peers in CBE were commuting cyclists. In this sense, bicycling as a shared activity brought many social opportunities, which in turn bolstered students' bicycling choice.

Such social opportunities could be group activities with biking as a transportation mode. These group activities would provide companionship for cycling trips. For example, Renee talked about her experience of engaging in more rides after she biked with other students and formed a "cyclist group:"

For me, it (biking) was solidified during Plant Identification (a course). We formed a biker gang, people in that class who would bike over there from Gould Hall and back every day. And after that, whenever there's any biking going on, we contact each other and try to bike together. So I have gone on a lot of bike rides with some of the die-hard cyclists, that I otherwise would have probably just taken the bus. (Renee, female, graduate student, 30-34 years old)

Meanwhile, bicycling could make social meetings more flexible and exert a sense of “peer pressure” to students when it became a necessary mode for them to be included in some social activities, as Kelly suggested:

I felt like there were times when I didn't bring a bike, and if we wanted to go to the park or a brewery after school, I would be left out. So there was a point where I would think ahead and be like, I'm gonna ride my bike today because I know I want to do something after school, and it's easier if everyone has them. Yeah, I feel like that has been a good type of peer pressure... (Kelly, female, graduate student, 30-34 years old)

Besides encouraging participants to engage in more rides, having peers who shared similar interests also provided good social experience centered around bicycling and helped people bond with each other, as Connor suggested:

I'm not sure that I would say it (CBE culture) influences me to do it (biking) more just because I've already been doing it, but it supports what I'm doing. It puts me in touch with more friends, like classmates, who also like biking. For example, last year for my birthday, I got a big group of people, a lot of people from school as well as other friends from earlier on, we did a big bike ride out to the Golden Gardens (a park in Seattle). It's really fun to have people who are like-minded. (Connor, male, graduate student, 25-29 years old)

Biking not only benefited students' group activity but also connected cyclists via shared experience. For example, Chloe talked about feeling a sense of belonging to a cycling community when parking her bike at the bike rack:

To some extent, I think that we have a connection. I like showing up to the bike rack and walking my bike up next to people's, or trying to figure out whose bike is who, and observing what type of setup they have. That's a fun game. (Chloe, female, graduate student, 25-29 years old)

In another example, Leah talked about her experience of getting help from peers with locking a bike correctly:

I also was able to ask my peers questions about routes and biking culture in Seattle and that kind of made me more comfortable with biking. I actually

had a friend teach me the proper way to lock my bike up because I was doing it wrong. (Leah, female, graduate student, 25-29 years old)

In conclusion, the social experience related to biking, such as group activity and shared experience, brought students closer and encouraged them to engage in more rides.

Theme 2: Studying in CBE changing the perceptions of the outward contributions of bicycling

Besides offering social experiences related to bicycling as many collectives would do, CBE provided environment-related education that served as a special reinforcement of biking, as many interviewees suggested.

Knowing the trends of promoting active transportation in the urban planning field, and being more aware of the outward benefits of biking and the ongoing bike infrastructure developments, many students indicated they became more willing to bicycle. For example, Tim mentioned his feeling of contributing to infrastructure developments when cycling:

I'm more aware of the organizations and the studies that are being done on building better bike infrastructure. I think that has been reinforcing. I've been biking on streets where people were counted in videos. I've noticed that several times. And I feel like, cool, I'm doing something that is actually being recognized and measured in the quantitative data that is being done here in Seattle. (Tim, male, graduate student, 30-34 years old)

For another example, Don talked about his experience of recognizing the social benefits of cycling and feeling an obligation to do more of it:

Having gone through a program like urban design or planning, I think you would recognize the societal benefits towards a more cyclist-friendly community and really need to lead by example, by getting involved and taking advantage of what's out there. (Don, male, graduate student, 35-39 years old)

Similarly, Walter talked about the influence of receiving environmentalism education on his perceptions of biking:

I think it was a feeling that you got to back up what you're talking about, in all these things that you're studying. So for me, biking was an action I can take to be more environmentally responsible. And doing that, I can say that at least I'm trying to do something. (Walter, male, graduate student, 25-29 years old)

Theme 3: Studying in CBE changing the perceptions of the inward benefits of bicycling

Although the health gain and environmental contribution of biking have been widely recognized by the majority of cyclists, many interviewees pointed out that the education they were receiving in CBE brought an extra layer of awareness of the benefits of biking. First, many interviewees suggested that the systematic learning of the impacts of built and natural environment on health reinforced their beliefs of biking and encouraged more utility biking, as Joey mentioned:

Principally I've taken a handful of classes that are very explicit on exploring health impacts. When you look at things like infrastructure planning, like the history of Landscape Architecture, the connection between the urban and natural environment and our health is made very clear. I would say that it has quite directly reinforced my belief in the need for cycling, and not merely as a recreational sport, but as a means of transportation. (Joey, male, graduate student, 40+ years old)

Similarly, for many non-commuting cyclists, the knowledge that they were exposed to in their education in CBE made them more likely to change behavior when the situation arose, as Mia suggested:

I think it's the nature of the program. You learn a lot more about the health impacts of the built environment, which influences your decision-making on a daily level. I think that it (biking) hasn't become daily commuting for me just based on the topography and late hours, but I think having that education makes you more likely to make that choice when the time comes. (Mia, female, graduate student 25-29 years old)

Second, learning how the transportation systems work also helped CBE students understand how to make full use of the infrastructure to support their cycling and affected their cycling routes, as Don mentioned:

Prior to this program, I would just seek out routes with less traffic for cycling. But in going through this program and recognizing that there's intentional infrastructure integrating cycling with all other forms of mobility, I started doing a lot more mixed-mode travel. I would take the train downtown and ride where I needed to go, and also try different routes and go on more congested streets and be more involved with the flow of traffic. A lot of that had to do with having a better understanding of how cycling infrastructure was integrated into the overall transportation infrastructure and how it's meant to be used. (Don, male, graduate student, 35-39 years old)

Third, several courses in CBE engaged students in cycling by creating a good biking experience. For example, Chloe mentioned that after a study abroad program related to bike infrastructure in Copenhagen, many people started biking when coming back to Seattle:

I think that after the Scan/Design Copenhagen program, there are always people who end up buying bikes, or biking more because that program introduced us to biking to get around. And when we're doing it in such a safe environment in Copenhagen that it really allows people to become comfortable. We've got good memories and associations with biking, and I think that's a critical element. (Chloe, female, graduate student, 25-29 years old)

Chapter 5. CONCLUSION

5.1 CBE STUDENTS' BIKING BEHAVIOR AND RECOMMENDATIONS FOR BIKE FACILITY BUILDING

To better understand CBE students' cycling behavior, I should briefly introduce Seattle's biking environment.

The City of Seattle approved and implemented the Seattle Bicycle Master Plan (BMP) since 2007. The BMP outlines an infrastructure plan that includes 100 miles of protected bicycle lanes⁵ and 250 miles of neighborhood greenways⁶ from 2014 to 2033 (Seattle DOT, 2019). By the year 2017, 30% of the goals have been met. Since the implementation of the plan, the city's ridership has been overall improved, especially in the year of 2017-2018 where the ridership increased by 12% (Seattle DOT, 2019). However, the city is still overly dependent on sharrows and unprotected bike lanes, and many meteorological and geographical characteristics, such as the frequently rainy conditions and hilly topography, are constraining cycling (Berney, 2018).

In this study, bad weather and distance were the most common reasons for non-commuting cyclists not going to campus by bike. For example, the weather was reported as the most common barrier (51 reports from 66 commuting cyclists) to biking more. Other frequently reported barriers by commuting cyclists were topography, insufficient shower facilities, and bike storage facilities.

⁵ Facilities physically separated from motor vehicle traffic and distinct from the sidewalk; they may be one-way or two-way, and may be at street level or raised several inches above (Seattle DOT, 2019).

⁶ Neighborhood streets with enhanced crossings of busy streets, low motorized traffic volumes and speeds that are designated and designed to give bicycle and pedestrian safe and pleasant travel priority (Seattle DOT, 2019).

In reporting their biking experience, most commuting cyclists (68.2%) agreed or strongly agreed that the bike infrastructure was good enough for safe commuting. Compared with that, only 18 (27.3%) commuting cyclists reported unsafe bike infrastructure as a barrier. The use of bike trails, protected bike lanes, sharrows, and streets without bike lanes was reported quite evenly- respectively 44, 46, 42, and 49 times- by the 66 commuting cyclists.

Meanwhile, most respondents (54.5% of commuting cyclists and 49.2% of non-commuting cyclists) were self-identified as “enthused and confident cyclists” who would bicycle if some infrastructure is in place. The second largest group (31.8% of commuting cyclists and 31.5% of non-commuting cyclists) was “strong and fearless cyclists” who would bicycle with limited or no bike-specific infrastructure. The results correspond with Dill and McNeil (2013)’s finding that younger adults are less concerned about bike infrastructure.

These results indicate that the bike infrastructure in Seattle is not a big constraint for most CBE students commuting cycling. One reason, as suggested by students’ self-reported cyclist type, is that the group is less afraid to use lower quality bike facilities or to ride in traffic. Another reason, as shown in the interviews, is that the bike trail provides smooth and safe cycling. However, more than half (57.5%) commuting cyclists agreed or strongly agreed that they could not always take the shortest or the most direct path to campus to guarantee safe commuting, indicating that many cyclists might detour to use the trails.

The results suggest that to encourage more students to commute by bike, more actions need to be taken from other perspectives different from improving bike pathway quality. End-of-trip facilities, for example, should be taken into consideration by CBE to create a

better cycling environment for the community. At present, there are several bike racks (Figure 5-1) near Gould Hall and Arch Hall, which are the two main buildings of CBE. And more of the bike racks are uncovered. Meanwhile, there are no shower facilities in this area.

In the survey, 17 (25.8%) commuting cyclists reported that lack of good bike storage on campus was a barrier to biking more, whereas 20 (30.3%) commuting cyclists reported lack of shower facilities on campus as a barrier. It suggests that CBE could consider providing more end-of-trip facilities, especially shower facilities and changing rooms.

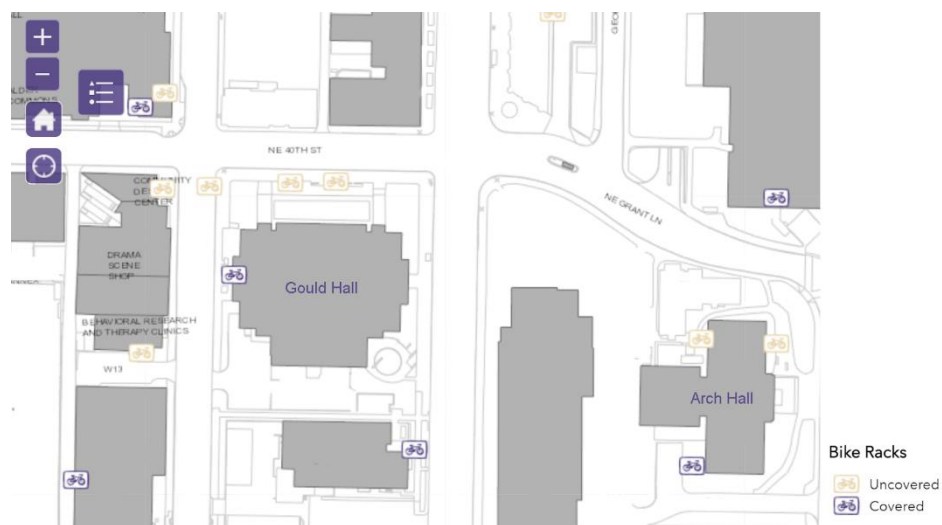


Figure 5-1. Bike rack near Gould Hall and Arch Hall
(Source: author, based on UW Transportation Services,
<https://transportation.uw.edu/maps/bike-parking>)

When investigating non-commuting trips, I found that parks were the most popular destinations for almost all frequency groups. Social and commercial destinations, especially restaurants and farmers' markets, were also related to non-commuting cycling frequency. Meanwhile, in the interviews, most participants mentioned that the “stunning

natural landscape in Seattle” and “the diversity of the scenes along the routes” makes recreational bicycling “enjoyable and rewarding.”

These results suggest a possibility of encouraging non-commuting biking by connecting bike facilities to parks, places that frequently hold outdoor community events, and dense commercial areas.

5.2 CBE STUDENTS’ BIKING EXPERIENCE AND RECOMMENDATIONS FOR CYCLING CULTURE CREATING

Information from both the survey and the interviews revealed the importance of building a better cycling culture. In this study, I identified three cultural factors that have an impact on the bike usage of CBE students: bike knowledge and accessibility to suitable cycling gear, social activity related to cycling, and familiarity with the built environments as a cyclist.

First, accessibility to bike and cycling gear were more important than I expected. Many of the interviewees started regular cycling when getting suitable bikes. Meanwhile, for many of the less experienced cyclists, the lack of bike knowledge, cycling gear or just a feeling of lacking, could be barriers to biking more. Several interviewees mentioned that they always needed help from others for bike maintenance. Some interviewees who just started cycling suggested the biking culture in Seattle could be “intimidating” because most cyclists on the streets had “fancy gear.” The findings demonstrate the importance of cycling knowledge and equipment.

These results also correspond with the literature. Edmiston and Tuttle (2012) described several cultural components that distinguished people who use bikes at a lower frequency (“interested but concerned” cyclists). These components, such as not owning special bike

gear and limited knowledge on bike maintenance and bike technology, could help identify the targeting population for biking advocacy. These results suggested that helping CBE students get connected to affordable and suitable bike equipment, and education projects on bike knowledge, might encourage more cycling.

Second, many social environment factors, such as companionship and a sense of belonging to a cyclist group, were related to CBE students' cycling frequency, specifically for non-commuting trips. In the interviews, many participants mentioned that social activities in CBE mutually reinforced their cycling choice. The results suggest that providing group cycling events in the CBE community could help build social connections and encourages students to cycle.

Third, familiarity with the built environments was a motivator for some students' cycling but could be a barrier to others. By providing opportunities for cycling, such as group trips and encouraging students to cycle together for school activities outside campus, such as site visits, could help some of them get familiar and become more comfortable with cycling in the city.

Meanwhile, by inquiring how studying in CBE shaped students' cycling behavior, I identified a few factors that reinforced their biking. In summary, those factors included being more appreciative of the ongoing infrastructure developments for cyclists and pedestrians, being more aware of the contributions of their own cycling behavior to the infrastructure building, and being more concerned about the environmental impacts of their transportation behavior.

The results could serve as a reference for public cycling advocacy programs. The City of Seattle has been encouraging citizens to bicycle via a variety of programs. These

programs include special events (such as “Bicycle Sundays” and “May Bike to Work Day”), bicycle safety programs targeting public schools, and encouragement materials that inform the public about the updates of cycling infrastructure (Seattle DOT, 2019). Besides these efforts, this research suggests that it is important to let people know that cycling and infrastructure building are mutually reinforcing. It also suggests that helping people better understand the integration of the bike system and transit system, as well as providing more information about available bike shops, could be included in the encouragement programs.

5.3 LIMITATIONS OF THE STUDY

The major limitation of the study is the survey sample size. Most of the statistical models not showing significant results might be because of the small number of observations, indicating that many factors that are related to CBE students’ cycling might not be identified. In addition, the survey respondents in this study are self-selected to participate. Without being able to get the CBE students’ demographic information, and without knowing the exact number of cyclists in CBE, the research sample might have limited ability to reflect all CBE students’ cycling situation. Meanwhile, due to the time and resource limitations, I was not able to include a control group, such as a student group from another college, in this study. Having a control group would have provided more information and made the results more convincing.

5.4 IMPORTANCE OF THE STUDY AND NEXT STEP

During this time of the study, facilitating walking and bicycling as transportation modes is becoming more important. As the global pandemic COVID-19 is posing a necessity for social distance, public transportation ridership is down by 50-90% from pre-crisis levels in

major cities in the U.S., Europe, and China (Levy & Goldwyn, 2020). For people who do not have access to a car or are not able to drive, active transportation becomes critical for their mobility. As a response, the City of Seattle has initiated the Stay Healthy Streets⁷ project to help improve people's adaptability to the pandemic situation that might linger for a long time (Seattle DOT, 2020).

Meanwhile, the pandemic has been reshaping urban lifestyles and might exert profound impacts on the future urban transportation systems. For instance, the shifting trends of working from home might greatly reduce the long-distance commuting trips for people of many occupations in the future.

With this background, understanding people's bicycling behavior could be a good strategy to facilitate active transportation development in addition to creating better infrastructure. Many studies have categorized cyclists according to their cycling characteristics, such as attitudes towards bike facilities (Geller, 2006), and whether cycling in winter or in summer (Bergström & Magnusson, 2003). Most of the research is conducted on population level. This study shows that specific social groups might have particular motivators, barriers, and facilitators of cycling. It also indicates that studying the behavior of a smaller social group could be helpful to address their needs more specifically.

Future research could focus on social group of a larger scale, such as employees that have similar working environment, and people that share similar demographic characteristics, to investigate how their cycling behavior are influenced by the multiple factors and to provide more specific recommendations.

⁷ The "stay health streets" are portions of the neighborhood greenways that are closed to thru-traffic, and help connect people to essential services and recreational amenities by walking, rolling, and biking (SDOT, 2020).

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APPENDIX A

Survey questionnaire and raw responses, not including skip logics and invalid responses exclusion.

1. Do you usually bicycle for commuting to school?		
Answer Choices	Responses	
Yes, I commute solely via bike.	22.61%	26
Yes, I combine bike and other transportation mode(s) for commuting.	42.61%	49
No, I don't use a bike for commuting.	34.78%	40
Other (please specify)		0
2. For what reason do you not bicycle to school (check up to 3 answers):		
Answer Choices	Responses	
Feel unsafe	22.50%	9
It is tiring	12.50%	5
Got into a bike accident before	10.00%	4
Bad weather/unfriendly bicycling topography in Seattle	55.00%	22
Distance too far/close for bicycling	37.50%	15
Physical challenges	0.00%	0
Lack of satisfactory shower/bike storage facilities on campus	17.50%	7
Don't own a bike	37.50%	15
Insufficient/Unsafe/Uncovered/Inconvenient bike storage facilities	0.00%	0
Other	0.00%	0
Other (please specify)		4
3. Please estimate the time you spend commuting on your bike from home to school (one-way).		
Answer Choices	Responses	
under 15 minutes	37.04%	10
15-30 minutes	55.56%	15
30-60 minutes	7.41%	2
over an hour	0.00%	0
4. What transportation mode(s) do you usually combine with biking for commuting to school (in one trip)?		
Answer Choices	Responses	
Car	4.44%	2
Public transit	71.11%	32
Car and public transit	4.44%	2
Other (please specify)		11
5. Please estimate the time you spend commuting on your bike from home to school (one-way).		
Answer Choices	Responses	
under 15 minutes	41.30%	19
15-30 minutes	41.30%	19
30-60 minutes	17.39%	8
over an hour	0.00%	0
6. Please estimate the time you spend commuting on your other transportation mode(s) from home to school (one-way).		
Answer Choices	Responses	
under 15 minutes	28.89%	13
15-30 minutes	42.22%	19
30-60 minutes	26.67%	12
over an hour	2.22%	1
7. How many times do you bicycle roundtrip for commuting to school per week, on average? (One roundtrip between home and school counts for one time)		
Answer Choices	Responses	
< 1 trip per week	11.27%	8
1-3 trips per week	49.30%	35
4-7 trips per week	32.39%	23
7+ trips per week	7.04%	5

8. Which of the following is/are your primary reason(s) of commuting to school by bicycle? (check up to 3 answers)

Answer Choices	Responses	
Convenience	73.24%	52
Economic reasons	26.76%	19
Flexibility	71.83%	51
Lack of access to car	21.13%	15
Physical health benefits	81.69%	58
Mental health benefits	49.30%	35
Climate change concern	46.48%	33
Nature contact	40.85%	29
Social contact	5.63%	4
Sense of belonging to a cyclist community	7.04%	5
Other (please specify)		5

9. What type(s) of biking pathways do you use for commuting to school? (check all that apply)

Answer Choices	Responses	
Bike trails (paved rights-of-way completely separated from streets)	67.61%	48
Protected bike lanes (on-street facilities designated for bicyclists using signage)	69.01%	49
Sharrows (on-street lane with paint on the pavement for cyclists but not a designated lane)	63.38%	45
Streets without designated bike lanes	74.65%	53
Other (please specify)		4

10. Where do you store your bike on campus when commuting (check all that apply)?

Answer Choices	Responses	
In a bike house (a garage to store bikes)	0.00%	0
In a bike locker	4.23%	3
At a bike rack	92.96%	66
In a building	11.27%	8
Other (please specify)		2

11. To what extent do you agree with the following statements:

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree	Total	Weighted Average
I think the bicycling infrastructure between home and school is good enough for safe commuting.	2.82%	22.54%	16	7.04%	52.11%	37	15.49%
To travel safely by bicycle, I cannot always take the shortest or the most direct path when commuting to school.	4.23%	32.67%	19	11.27%	83.80%	27	19.72%
I am satisfied with the parking facilities for bikes at school.	8.45%	623.94%	17	21.13%	1536.62%	26	9.86%
						7	71

12. What is/are the barrier(s) that prevent you from bike commuting to school more often (check all that apply)?

Answer Choices	Responses	
Unsafe bicycling infrastructure	26.76%	19
Lack of shower facilities on campus	30.99%	22
Insufficient/Unsafe/Uncovered/Inconvenient bike storage facilities on campus	26.76%	19
Intimidation from other road users (other cyclists, motorists, pedestrians)	21.13%	15
Distance	8.45%	6
Weather	77.46%	55
Topography	38.03%	27
N/A (I don't face any barriers to bike commuting)	5.63%	4
Other (please specify)		5

13. Do you bicycle for non-commuting purposes?

Answer Choices	Responses	
Yes, I bicycle for non-commuting purposes.	72.22%	78
No, I don't bicycle for non-commuting purposes.	27.78%	30

14. How often do you bicycle for non-commuting purposes (either for recreational or utilitarian trips/errands)?

Answer Choices	Responses	
Once per month/once every few months	23.38%	18
2-3 times per month	25.97%	20
Once per week	22.08%	17
2-3 times per week	19.48%	15
4+ times per week	9.09%	7

15. Which of the following is/are your primary reason(s) for bicycling for non-commuting purposes? (check up to 3 answers)

Answer Choices	Responses
Convenience	47.37% 36
Economic Reasons	15.79% 12
Flexibility	35.53% 27
Lack of access to car	15.79% 12
Physical health benefits	68.42% 52
Mental health benefits	46.05% 35
Climate change concern	23.68% 18
Nature contact	53.95% 41
Social contact	25.00% 19
Entertainment	55.26% 42
Other (please specify)	3

16. What type(s) of biking pathways do you use when bicycling for non-commuting purposes? (check all that apply)

Answer Choices	Responses
Bike trails (paved rights-of-way completely separated from streets)	86.67% 65
Protected bike lanes (on-street facilities designated for bicyclists using signs and pavement markings)	85.33% 64
Sharrows (on-street lane with paint on the pavement for cyclists but not a designated lane)	82.67% 62
Streets without designated bike lanes	64.00% 48
Other (please specify)	7

17. Which is/are your destination(s) for bicycling for non-commuting purposes? (check all that apply)

Answer Choices	Responses
Grocery stores	50.67% 38
Social visits	68.00% 51
Parks (urban parks, mountain parks, national parks, etc.)	88.00% 66
Restaurants/bars/cafes	61.33% 46
Farmers' market or other outdoor community event	42.67% 32
Gym or other workout location	38.67% 29
No destinations, just bicycling around	56.00% 42
Other (please specify)	2

18. To what extent do you agree with the following statements

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree	N/A	Total	Weighted Average
One or more of my family members bicycle on a regular basis.	30.69%	31 24.75%	25 5.94%	6 15.84%	16 18.81%	19 3.96%	4 101	2.66
I grew up bicycling with my family on a regular basis.	19.61%	20 27.45%	28 11.76%	12 27.45%	28 12.75%	13 0.98%	1 102	2.86
Seeing/Knowing member(s) of my family cycling makes me want to bicy	8.82%	9 9.80%	10 25.49%	26 34.31%	35 11.76%	12 9.80%	10 102	3.34
My family member(s) encourage(s) me to bicycle.	11.76%	12 17.65%	18 23.53%	24 31.37%	32 12.75%	13 2.94%	3 102	3.16
One or more of my friend(s) bicycle on a regular basis.	1.96%	2 5.88%	6 6.86%	7 38.24%	39 46.08%	47 0.98%	1 102	4.22
Seeing/Knowing my friend(s) cycling makes me want to bicycle.	3.92%	4 5.88%	6 16.67%	17 41.18%	42 31.37%	32 0.98%	1 102	3.91
My friend(s) encourage(s) me to bicycle.	4.90%	5 11.76%	12 35.29%	36 30.39%	31 16.67%	17 0.98%	1 102	3.43
Many of my peers from CBE bicycle on a regular basis.	4.95%	5 9.90%	10 17.82%	18 39.60%	40 25.74%	26 1.98%	2 101	3.73
Seeing/Knowing my peers from CBE cycling makes me want to bicycle.	1.96%	2 10.78%	11 23.53%	24 40.20%	41 17.65%	18 5.88%	6 102	3.65
My peers from CBE encourage me to bicycle.	5.88%	6 16.67%	17 34.31%	35 23.53%	24 16.67%	17 2.94%	3 102	3.29
There are people I can count on to bicycle with me on commuting bicycl	30.39%	31 42.16%	43 14.71%	15 5.88%	6 2.94%	3 3.92%	4 102	2.05
There are people I can count on to bicycle with me on non-commuting b	11.88%	12 21.78%	22 18.81%	19 35.64%	36 10.89%	11 0.99%	1 101	3.12
Bicycling makes me feel a sense of belonging to the cycling community	7.92%	8 30.69%	31 30.69%	31 18.81%	19 4.95%	5 6.93%	7 101	2.81

19. To what extent do you agree with the following statement: The education I'm receiving from the program(s) of study influences my bicycling behavior.

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree	Total	Weighted Average
1	9.80%	10 21.57%	22 26.47%	27 34.31%	35 7.84%	8 102	3.09

20. In what way do you think that the program of study you are in influences your bicycling behavior? (check all that apply)

Answer Choices	Responses
Increases my concern for climate change.	79.07% 34
Increases my awareness of the health benefits of physical activity.	46.51% 20
Increases my desire to have contact with nature.	55.81% 24
Other (please specify)	10

21. To what extent do you agree with the following statement: I generally feel confident when cycling (in terms of navigation, bicycling skills, etc).

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree	Total	Weighted Average
1	0.00%	0 11.90%	10 11.90%	10 53.57%	45 22.62%	19 84	3.87

22. I would describe myself as a/an...

Answer Choices	Responses
Strong and fearless cyclist: I'm willing to bicycle with limited or no bicycl	23.53% 24
Enthusied and confident cyclist: I'm willing to bicycle if some bicycle-spe	48.04% 49
Interested but concerned cyclist: I'm willing to bicycle if high-quality bicy	23.53% 24
No way, no how: I'm unwilling to bicycle even if high-quality bicycle infra	4.90% 5
Other (please specify)	3

23. Please indicate the department you are in (dual degree students please check both of your departments):

Answer Choices	Responses				
Architecture	26.00%	26			
Construction Management	12.00%	12			
Landscape Architecture	34.00%	34			
Real Estate	2.00%	2			
Urban Design and Planning	36.00%	36			

24. Please indicate your age range

Answer Choices	Responses				
Under 19	0.00%	0			
20-24	31.37%	32			
25-29	36.27%	37			
30-34	19.61%	20			
35-39	4.90%	5			
40+	7.84%	8			

25. Please indicate your gender

Answer Choices	Responses				
Male	52.43%	54			
Female	44.66%	46			
Non-binary/gender fluid/non-conforming	2.91%	3			
Other (please specify)		0			

26. Please specify your ethnicity

Answer Choices	Responses				
White	65.69%	67			
Latinx	4.90%	5			
Black or African American	1.96%	2			
Native American or American Indian	0.00%	0			
Asian/Pacific Islander	23.53%	24			
Other (please specify)		5			

27. Are you a domestic or an international student?

Answer Choices	Responses				
I'm a domestic student.	82.35%	84			
I'm an international student	17.65%	18			
If neither of these applies, please specify your student status.		0			

28. Please indicate your family status:

Answer Choices	Responses				
Partnered with kid(s)	8.91%	9			
Divorced with kid(s)	0.99%	1			
Partnered without kid	28.71%	29			
Divorced without kid	0.00%	0			
Single	60.40%	61			
Other (please specify)		1			

29. Would you be willing to be interviewed (for my thesis) to talk further about your bicycling values? If so, please indicate your email:

Answered	43				
Skipped	72				

APPENDIX B

Interview protocol

1. How long have you been a regular cyclist?
2. How did you start bicycling at the first place?
3. When you first came the CBE for study, did you plan to commute by bicycle? Can you tell me why do you commute to school by bike?
4. How do you feel about your commute bicycling experience in Seattle?
5. How do you feel about bicycling? Do you think bicycle is important to you?
6. Do you know other people who commute by bike? I'm curious to know Whether any people around you, like your family, friends, peers, influence you bicycle or decision to bicycle at all, do you think they do?
7. Are there any factors that prevent you from bicycling more for commuting to school?
8. How do you usually use a bicycle for non-commuting purposes?
9. Can you tell me why do you bicycle for those purposes?
10. Do you bicycle by yourself or with other people in those trips?
11. How do you feel about those bicycling experience?
12. Do you know other people who bicycle for those purposes? Do you think they influence or inspire you in any way?
13. How do you feel about your bicycling skills?
14. Do you think studying in CBE makes a difference to your bicycling?

APPENDIX C

Table 1.
Count and percentage of bicycling facility used for commuting bicycling (N=66)^a

Bike facility	< 1trip per week		1-3 trips per week		4-7 trips per week		7+ trips per week		Total	
	N	%	N	%	N	%	N	%	N	%
Bike trails	3	6.8	26	59.1	13	29.5	2	4.5	44	99.9
Protected bike lanes	5	10.9	23	50	16	34.8	2	4.3	46	100
Sharrows	3	7.1	20	47.6	16	38.1	3	7.1	42	99.9
Streets without designated bike lanes	4	8.2	24	49	17	34.7	4	8.2	49	100.1
Other ^b	0	0	2	66.7	1	33.3	0	0	3	100

Note: a. Each respondent could check all that apply.

b. Included: Sidewalk (3).

Table 2.
Count and percentage of bicycling facility used for non-commuting bicycling (N=73)^a

Bike facility	Once per month/once every few months		2-3 times per month		Once per week		2-3 times per week		4+ times per week		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
Bike trails	15	23.4	18	28.1	11	17.2	14	21.9	6	9.4	64	100
Protected bike lanes	15	23.8	16	25.4	13	20.6	14	22.2	5	7.9	63	99.9
Sharrows	12	20	14	23.3	13	21.7	14	23.3	7	11.7	60	100
Streets without designated bike lanes	9	18.8	7	14.6	12	25	13	27.1	7	14.6	48	100.1
Other ^b	0	0	2	40	2	40	0	0	1	20	0	0

Note: a. Each respondent could check all that apply.

b. Includes: Sidewalk (2), mountain trails (3)

Table 3.
Count and percentage of reasons for commuting bicycling (N=66)^a

Reasons	< 1trip per week		1-3 trips per week		4-7 trips per week		7+ trips per week		Total	
	N	%	N	%	N	%	N	%	N	%
Convenience	5	10.4	22	45.8	17	35.4	4	8.3	48	99.9
Economic reasons	0	0	11	57.9	7	36.8	1	5.3	19	100
Flexibility	5	10.4	24	50	15	31.2	4	8.3	48	99.9
Lack of access to car	3	21.4	6	42.9	4	28.6	1	7.1	14	100
Physical health benefits	4	7.3	28	50.9	19	34.5	4	7.3	55	100
Climate change concern	2	6.7	15	50	11	36.7	2	6.7	30	100.1
Nature contact	2	7.4	17	63	6	22.2	2	7.4	27	100
Social contact	1	25	1	25	0	0	2	50	4	100
Sense of belonging to a cyclist community	0	0	2	40	1	20	2	40	5	100
Mental health benefits	3	9.4	17	53.1	9	28.1	3	9.4	32	100
Other ^b	0	0	2	50	2	50	0	0	4	100

Note: a. Each respondent was allowed to check up to 3 reasons.

b. Including: Faster than other modes (3), For fun(1)

Table 4.
Count and percentage of reasons for non-commuting bicycling (N=73)^a

Reasons	Once per month/once every few months		2-3 times per month		Once per week		2-3 times per week		4+ times per week		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
Convenience	4	11.8	6	17.6	12	35.3	8	23.5	4	11.8	34	100
Economic Reasons	2	18.2	1	9.1	1	9.1	6	54.5	1	9.1	11	100
Flexibility	2	7.7	5	19.2	7	26.9	9	34.6	3	11.5	26	99.9
Lack of access to car	4	33.3	3	25	2	16.7	2	16.7	1	8.3	12	100
Physical health benefits	12	24.5	12	24.5	8	16.3	11	22.4	6	12.2	49	99.9
Climate change concern	3	18.8	2	12.5	4	25	5	31.2	2	12.5	16	100
Nature contact	9	23.7	8	21.1	8	21.1	9	23.7	4	10.5	38	100.1
Social contact	6	33.3	1	5.6	3	16.7	7	38.9	1	5.6	18	100.1
Entertainment	9	22	9	22	8	19.5	10	24.4	5	12.2	41	100.1
Mental health benefits	5	15.6	7	21.9	9	28.1	7	21.9	4	12.5	32	100
Other ^b	0	0	1	33.3	1	33.3	0	0	1	33.3	0	99.9

Note: a. Each respondent could check up to 3 reasons.

b. Including: Sports and competition (1), Convenient for neighborhood trips (1), Faster than driving (1).

Table 5.
Count and Percentage of Commuting Bicycling Destination (N=73)^a

Destination	Once per month/once every few months		2-3 times per month		Once per week		2-3 times per week		4+ times per week		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
Grocery stores	5	13.9	7	19.4	11	30.6	9	25	4	11.1	36	100
Social visits	11	21.6	8	15.7	13	25.5	14	27.5	5	9.8	51	100.1
Parks (urban parks, mountain parks, national parks, etc.)	14	21.9	18	28.1	14	21.9	13	20.3	5	7.8	64	100
Restaurants/bars/cafes	7	15.6	7	15.6	12	26.7	14	31.1	5	11.1	45	100.1
Farmers' market or other outdoor community events	5	16.1	4	12.9	8	25.8	9	29	5	16.1	31	99.9
Gym or other workout location	2	7.1	5	17.9	8	28.6	9	32.1	4	14.3	28	100
No destinations, just bicycling around	10	24.4	10	24.4	7	17.1	9	22	5	12.2	41	100.1

Note: a. Each respondent could check all that apply.

Table 6.
Predicted probability of agreement on questions of interest (N=73)

	OR	2.5 % CI	97.5 % CI	Disagree		Neither disagree nor agree		Agree	
				<1tpwk>=1tpwk	<1tpwk	>=1tpwk	<1tpwk>=1tpwk		
<i>Social environment</i>				Prob	Prob	Prob	Prob	Prob	Prob
Family role model	2	1.04	3.81	0.30	0.14	0.26	0.18	0.44	0.67
Family encouragement	2.47	1.29	4.72	0.41	0.16	0.24	0.17	0.36	0.66
Non-commuting trip companionship	2.64	1.34	5.24	0.40	0.14	0.18	0.12	0.42	0.74
Sense of belonging to a cyclist group	2.01	1.08	3.74	0.56	0.32	0.24	0.28	0.20	0.40

Note: OR= odds ratio; CI= confidence interval; tpwk= trips/week; Prob=Predicted probability.
Bold numbers: confidence intervals did not cross 1.

Table 7.

OLS examine the relationship between agreement on built environment questions and commuting bicycling frequency (N=66)

	Dependent variable:		
	ifrgd1 (1)	drct1 (2)	pkfci1 (3)
frq.L	0.295* (0.150)	-0.004 (0.162)	-0.060 (0.159)
Constant	2.484*** (0.106)	2.272*** (0.115)	2.158*** (0.112)
Observations	66	66	66
R2	0.057	0.00001	0.002
Adjusted R2	0.042	-0.016	-0.013
Residual Std. Error (df = 64)	0.843	0.911	0.893
F Statistic (df = 1; 64)	3.859*	0.001	0.141

Note:

*p<0.1; **p<0.05; ***p<0.01

(1) Good bike infrastructure (2) Route indirectness, (3) Good parking facility at school

Table 8.

OLS examine the relationship between agreement on social environment and individual attribute questions and commuting bicycling frequency (N=66)

	Dependent variable:													
	fambk1 (1)	grwbk1 (2)	kwfmbk1 (3)	fmecrg1 (4)	frdbk1 (5)	kwfrbk1 (6)	fregrg1 (7)	cbebk1 (8)	kwcbebk1 (9)	cbeecrg1 (10)	compny1 (11)	blggrp1 (12)	beedu1 (13)	cnfisk11 (14)
frq.L	0.103 (0.169)	0.131 (0.162)	0.241* (0.137)	0.167 (0.143)	0.060 (0.092)	0.014 (0.095)	0.061 (0.126)	-0.151 (0.120)	-0.167 (0.103)	-0.073 (0.122)	0.204* (0.122)	-0.073 (0.122)	-0.203 (0.151)	0.150* (0.085)
Constant	1.773*** (0.120)	1.792*** (0.115)	2.445*** (0.097)	2.343*** (0.101)	2.842*** (0.065)	2.760*** (0.067)	2.418*** (0.089)	2.568*** (0.085)	2.657*** (0.073)	2.398*** (0.086)	1.394*** (0.086)	2.398*** (0.086)	2.182*** (0.106)	2.856*** (0.060)
Observations	66	66	66	66	66	66	66	66	66	66	66	66	66	66
R2	0.006	0.010	0.046	0.021	0.007	0.0003	0.004	0.024	0.040	0.006	0.042	0.006	0.028	0.046
Adjusted R2	-0.010	-0.005	0.031	0.006	-0.009	-0.015	-0.012	0.009	0.024	-0.010	0.027	-0.010	0.012	0.032
Residual Std. Error (df = 64)	0.950	0.910	0.772	0.805	0.516	0.532	0.705	0.676	0.579	0.682	0.684	0.682	0.845	0.475
F Statistic (df = 1; 64)	0.373	0.648	3.064*	1.362	0.423	0.021	0.237	1.572	2.632	0.365	2.801*	0.365	1.810	3.121*

Note:

*p<0.1; **p<0.05; ***p<0.01

(1) Family members bicycling, (2) Growing up bicycling with family, (3) Family role model, (4) Family encouragement, (5) Friends bicycling, (6) Friends role model, (7) Friends encouragement, (8) CBE peers bicycling, (9) CBE peers role model, (10) CBE peers encouragement, (11) Commuting trip companionship, (12) Sense of belonging to a cyclist group, (13) CBE education, (14) Confidence in cycling skills

Table 9.

OLS examine the relationship between agreement on social environment and individual attribute questions and non-commuting bicycling frequency (N=73)

	Dependent variable:													
	fambk (1)	grwbk (2)	kwfmbk (3)	fmeorg (4)	frdbk (5)	kwfrbk (6)	freorg (7)	cbebk (8)	kwcbebk (9)	cbeorg (10)	compny (11)	blggrp (12)	beedu (13)	cnfiskl (14)
frq> =1tpwk	0.223 (0.225)	-0.025 (0.223)	0.402** (0.187)	0.542*** (0.195)	0.140 (0.094)	0.226* (0.126)	0.291* (0.161)	0.066 (0.161)	0.066 (0.151)	0.185 (0.179)	0.540*** (0.197)	0.185 (0.179)	0.022 (0.208)	0.225* (0.129)
Constant	1.750*** (0.160)	1.917*** (0.159)	2.139*** (0.133)	1.944*** (0.139)	2.806*** (0.067)	2.639*** (0.090)	2.222*** (0.114)	2.556*** (0.115)	2.556*** (0.108)	2.167*** (0.127)	2.028*** (0.140)	2.167*** (0.127)	2.194*** (0.148)	2.667*** (0.092)
Observations	73	73	73	73	73	73	73	73	73	73	73	73	73	73
R2	0.014	0.0002	0.061	0.098	0.030	0.043	0.044	0.002	0.003	0.015	0.096	0.015	0.0002	0.041
Adjusted R2	-0.0003	-0.014	0.048	0.086	0.017	0.030	0.031	-0.012	-0.011	0.001	0.083	0.001	-0.014	0.028
Residual Std. Error (df = 71)	0.962	0.952	0.800	0.832	0.403	0.539	0.687	0.688	0.646	0.764	0.840	0.764	0.887	0.551
F Statistic (df = 1; 71)	0.980	0.012	4.594**	7.747***	2.214	3.207*	3.285*	0.168	0.191	1.067	7.541***	1.067	0.011	3.047*

Note:

*p<0.1; **p<0.05; ***p<0.01

(1) Family members bicycling, (2) Growing up bicycling with family, (3) Family role model, (4) Family encouragement, (5) Friends bicycling, (6) Friends role model, (7) Friends encouragement, (8) CBE peers bicycling, (9) CBE peers role model, (10) CBE peers encouragement, (11) Commuting trip companionship, (12) Sense of belonging to a cyclist group, (13) CBE education, (14) Confidence in cycling skills