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Evaluating the Impact of Neighborhood Trail Development on Active Travel Behavior and Overall Physical Activity

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Evaluating the Impact of Neighborhood Trail Development on Active Travel Behavior and Overall Physical Activity

A Dissertation submitted in partial satisfaction of the

requirements for the degree Doctor of Philosophy

in Geography

by

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Evaluating the Impact of Neighborhood Trail Development on Active Travel

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ABSTRACT

Evaluating the Impact of Neighborhood Trail Development on Active Travel Behavior and Overall Physical Activity

by

Shaunna Kay Burbidge

Many studies have examined the impact that the built environment has on physical activity. However, most have used cross-sectional methods which have allowed them to establish correlations but not behavioral causality. This research first uses a longitudinal design to perform a pilot study evaluating the impact neighborhood trail development has on active travel behavior and overall physical activity. A sample of suburban residents in West Valley City, Utah were surveyed both before and after the construction of a class-one trail in their neighborhood. Data collection methods include various individual and household surveys, as well as individual single-day fully annotated activity diaries completed at three pre-assigned time points before and after the trail‟s construction. Secondly, this research analyzes the suitability of the methods employed in the pilot study and provides a framework for future evaluations of built environment interventions. The pilot study found that installation of the new trail did not significantly increase overall physical activity or walking trips over the duration of the study. Residential proximity was not significantly correlated to walking behavior or physical activity, but over time an increase in nearness to a trail was correlated to a significant decrease in physical activity episodes and walking trips. Specific perceptions and attitudes about active modes, particularly those involving safety, were significantly correlated to behavior, and a preference for playing sports and ownership of exercise equipment was significantly correlated to physical activity and total walking trips. Residents moving to the area after the trail‟s construction were not drawn to the area by the trail, and report moving to the area for similar reasons to historic residents. A survey of the few existing trail users shows that the new trail may exhibit several negative characteristics which could limit any induced demand for physical activity and active travel behavior among other neighborhood residents. The analysis of this pilot study‟s methodology shows a need for future research which includes a separate control group, improved sampling, and an increased precision in data collection instruments. Future longitudinal studies should also delineate between trip utility (recreation/transportation) and provide a concurrent information/travel campaign.

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As overweight and obesity have become bigger issues in Americans" daily lives they have been widely attributed to the lack of physical activity in today"s society. This has spurred a research interest in this arena and many professionals now claim that current lifestyle patterns, such as the prolific reliance on personal vehicle use and a separation of land uses, have "engineered physical activity for non-exercise purposes out of many American"s lives" (Sallis, Frank, Saelens, and Kraft, 2004).

Analysis of data from the U.S. Department of Transportation"s 2001 National Household Transportation Survey showed that automobiles account for 86.5% of all trips taken, whereas walking and bicycling combined account for only 10.3% of trips (Bureau of Transportation Statistics, 2001). Additional analysis also found that approximately 25% of all trips in the Unites States are less than one mile in distance, but nearly 75% of these trips are made by automobile (Killingsworth and Schmid, 2001). This data shows that both short and long trips are utilizing the automobile as the primary mode of travel. These statistics however, are extracted from travel diaries that are known to have two biases: 1) Reporting persons forget short trips (i.e. walking the dog around the block), and they do not include access trips to modes other than transit (such as walking to a parking lot to drive a car back home from work) (Handy, 2005). 2) The survey does not include the travel behavior of children and has high non-response rates among the very young and the very old. Children and older adults are more likely to bike and walk than individuals in middle age groups (Burbidge, Goulias and Kim, 2006). These biases may result in consistent underestimation of the amount of active trips taken by US residents.

The personal choice or need to utilize the automobile for transportation along with work in employment sectors that require no physical activity, has kept U.S. residents from getting the minimum amounts of physical activity that were once accumulated through participation in a daily routine. National Household Travel Survey data show that between 1977 and 1995 the number of U.S. residents walking and cycling declined by about 40% (Bureau of Transportation Statistics, various years at www.bts.gov). In addition to this increase in reliance on automobiles for transportation, between 1980 to 2003 the United States experienced a 40% increase in the number of residents who are "overweight". The rates have compounded yearly leading to 65-73 percent of the U.S. population that is currently overweight or obese (Center for Disease Control and Prevention-CDC, 2004). This increase in overweight and obesity has been attributed to a lack of physical activity (Department of Health and Human Services-DHHS, 1996), and similar research shows that lack of physical activity has a far more pronounced effect on public health than obesity or overweight do in and of themselves. The Center for Disease Control and Prevention (CDC, 2004) has shown that increasing physical fitness plays the largest role in improving health regardless of other factors.

According to the surgeon General‟s report on physical activity and health 70% of U.S. adults currently do not obtain the recommended amount of physical activity, and approximately 25% of individuals report being completely inactive when not at work (DHHS, 1996). This phenomenon does not only affect adults but spills over to the very young as well. An analysis of the National Persona Transportation Survey showed that 40.7% of children walked to school. That proportion was down to only 12.9% in 2001, a 27.8% reduction in active mode share among school travelers (Environmental Protection Agency-EPA, 2003, McDonald, 2007).

Active transportation is one simple way that physical activity can be included in people‟s daily lives. "Active transportation" refers to the use of any mode that requires the use of human physical power (Saelens, Sallis, and Frank, 2003). However, for the purposes of this research the term will refer to walking and bicycling. The Surgeon General recommends both walking and bicycling as forms of physical activity (DHHS, 1996). Walking is the most regular physical activity for most people and can be done at any age for transportation, health, or leisure purposes. Walking is already an important part of human transportation, and Litman‟s review of existing travel survey data (2003a) discovered that although only 5-10% of trips are made completely by walking, 15-30% of urban trips involve at least one walking link. Walking and biking links are frequently ignored, but active modes often serve as connections to many other mode trips such as: home to transit, parking lot to destinations, and within airports and shopping centers. By increasing the walking and biking links used for transportation we may concomitantly see an increase in overall physical activity.

Many researchers assert that integrating additional walking and biking into daily routines may prove to be a better public health strategy than traditionally structured and organized programs (Litman, 2003b, Saelensminde, 2002). The basic assumption is that changing trip-making behavior to include more non-motorized trips can translate into favorable public health consequences (by increasing physical activity levels). Under this assumption, the US Public Health Service has included a national objective for the year 2010 of more than a 50% increase in walking trips made by adults for trips less than one mile (DHHS, 1996).

There are many difficulties inherent in promoting and planning for walking and bicycling however. For example, although the National Household Travel Survey (NHTS) provides estimates, it is not currently known exactly how much U.S. residents walk or bike in a day. Without an accurate baseline it becomes difficult to set a target for or ultimately to judge any improvement. Also, walking as a mode of transportation is often undervalued because it is difficult to measure, low cost, and many decision makers believe that walking will take care of itself since it is essentially possible to walk anywhere without specific facilities.

Numerous studies regarding promotion of physical activity through active transportation have produced data focusing on many possible connections, from time allocation and personal characteristics, to lifestyles and attitudes (discussed in detail in Chapter 2). Many key environmental variables and specific components of the built environment have also been identified as promoters or deterrents to active travel as well. These have given researchers as well as planners and policy makers guidance when trying to incorporate more bicycle and pedestrian travel opportunities in their communities. Ultimately, much of the existing research posits that if communities will provide and improve active infrastructure such as trails, sidewalks, and bike lanes, people will become more physically active (Task Force on Community and Preventive Services, 2002).

One drawback of a majority of these studies, however, is that they identify correlation but not causality, which often leads to spuriousness (attributing causality to a variable that correlates with another variable when it is not actually the cause) or confounding results (variables included in the study that are not intended to be a causal variable but affect one of the measured variables- Montello and Sutton, 2006). As described in Chapter 2, most studies relating to this topic are cross-sectional in design measuring only a sample of a population at one point in time, and most do not take into account time-order constraints or possible self selection issues. This includes but is not limited to residential self selection, which happens when an individual chooses to live in an area due to the presence of specific amenities or factors relating to physical activity. Additionally, although model development within the field of travel behavior as a whole continues today with more momentum than ever, active mode choice has largely been overlooked and left to a small fragment of transportation and public health researchers. Although many public health agencies have obesity and lack of physical activity on their radar screens and have begun to instigate programs relating to them, most transportation policies do not pay attention to the epidemic and the possible associations that exist between transportation systems and physical activity.

This research seeks first to identify if simply building new active infrastructure (infrastructure used for active transportation and recreation, i.e. sidewalks, bike paths, trails, etc.) is enough to change people‟s behavior or make people more active. Utilizing a longitudinal design, this pilot study first tests whether a causal relationship exists between the construction of active infrastructure, in this case a neighborhood trail, and increased active travel behavior. In Chapters 4-8 appropriate methods for longitudinal surveys are used to assess the impact of the installation by answering the following five questions:

- Will the installation of a neighborhood trail in an area not currently recognized for widespread physical activity trigger a change in the travel behavior and physical activity levels of neighborhood residents?
- Will changes in physical activity be maintained, increase, or decrease over time?

- Do residents living in closer proximity to the trail exhibit different behavioral patterns than those living further away?
- Do personal attitudes or perceptions about active modes of transportation actually impact active travel behavior or overall physical activity?
- Will new residents to the neighborhood be drawn to that specific area due to the presence of active infrastructure?

Following the evaluation of the built environment intervention, this research evaluates if the methods employed in the pilot study are sufficient for determining potential behavioral causality. Chapter 10 provides a description of future do‟s and don‟ts for this type of research and discusses the potential of alternative methodologies, with the ultimate goal of providing a framework for future researchers wishing to conduct evaluations of interventions to the built environment.

This research provides valuable insights into the potential impact that interventions to the built environment may have on physical activity and active travel behavior. By determining the level of influence that an intervention has over human behavior, planners and policy makers can be better informed when making critical land-use/transportation decisions in the future. This first of its kind longitudinal study of active behavioral change also lays the foundation for future research by exploring the methodology utilized in this pilot study and identifying the do‟s and don‟ts for future research.

2. Background and Theoretical Framework

As mentioned in the introduction, a great deal of research has been conducted concerning physical activity and public health, transportation, and the built environment as separate but somewhat intertwined components. However, researchers have used theories and methods from their specific fields to create different approaches. This research utilizes ideas gathered from a variety of fields including geography, transportation, urban planning, and public health. This chapter gives an overview of applicable research as well as proposing a conceptual model for active travel behavior.

Past research has proven that a variety of personal factors make one individual behave differently than another (Golledge and Stimson, 1997). These different factors also allow individuals to make personal decisions when it comes to their travel behaviors. Travel behavior can generally be defined as the study of what people do over space and how people use transportation (Hayes, 1993). Goulias (2000) gives a more comprehensive definition stating that the study of travel behavior is "the modeling and analysis of travel demand on the basis of theories and analytical methods from a variety of scientific fields. These include, but are not limited to, the use of time and its allocation to travel and activities, the use of time in a variety of time contexts and stages in the lives of people, and the organization and use of space at any level of social organization, such as the individual, the household, the community, and other formal or informal groups". The majority of travel behavior research to date, however, has focused on automobile travel rather than active travel (Handy, 2005).

2.1 Time Allocation

The initial concept of spatial and temporal capacities and constraints on individual behavior were proposed in the 1960"s within the field of Geography. Hagerstrand (1970) originally emphasized the importance of time in human activity. He noted that "time has a critical importance when it comes to fitting people and things together for functioning in socio-economic systems." Even if a given location is near an individual they may not be able to allocate enough time to travel to it. Spatial proximity alone may not inherently make a difference, but it is part of a bigger concept. Hagerstrand"s original research outlined the existence of a "time-space prism" which illustrates how individuals navigate through their spatial-temporal environments (1970). The space around an individual is reduced from a 3-D prism to a 2-D plane, on which the location and destination are represented as points (shown in Figure 2.1).

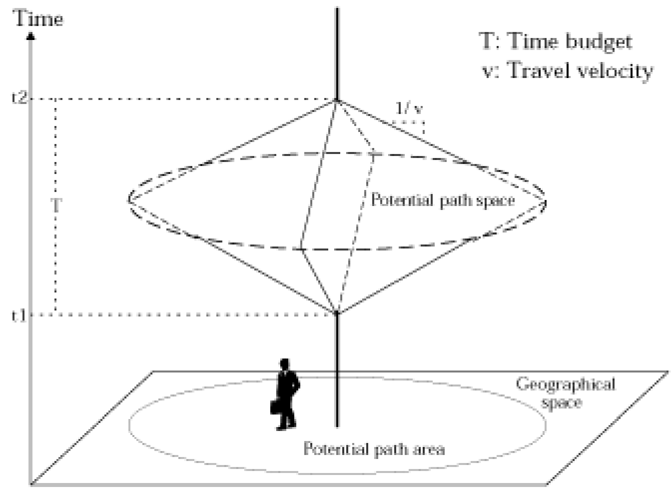

Figure 2.1 Time-Space Prism (BTS, various years)

Time is represented by a vertical axis which creates a three dimensional "aquarium" that represents a specific portion of space time (Corbett, 2005). The path of an individual appears as the vertical line between the starting and end times, and a conic area represents the potential path space.

These time-space paths have been used by transportation researchers to demonstrate how travel behavior is governed by limitations and not entirely by independent decisions (Cullen and Godson, 1975, Hagerstrand, 1970). These limitations or constraints can be classified in three distinct categories: capability constraints which limit human movement due to physical or biological factors; coupling constraints which create a need to be in one place for a given length of time, often interacting with others; and authority constraints which include the imposition and control of access by an outside individual or entity (i.e. hours of operation- Hagerstrand, 1970).

Temporal constraints play a large role in active mode choice. Transportation systems reduce the amount of time required for movement across space. A person must trade time for space through movement or communication, to participate in activities (Golledge and Stimson, 1997). Greater separations inherently imply a lower level of accessibility. This especially holds true with regards to active mode choice. When destinations are located further apart, the time required to reach those destinations increases. Choosing an active mode may not allow travel as quickly as other available modes resulting in a capability constraint. Janelle posits that there is a threshold at which time spent traveling may be perceived as no longer reasonable (approximately 30 minutes - 2004). This is especially relevant considering active trips generally require more time for travel, which may exceed any existing time threshold. Burbidge, Goulias, and Kim (2006) also showed that for active modes specific distances can act as thresholds. If a potential destination is located beyond this threshold it is likely that an inactive mode will be chosen.

Transportation researchers have noted that the choice of walking or cycling often depends on the importance of combining exercise with utilitarian travel, and not simply walking or cycling to reach a destination (Transportation Research Board, 2005). Most choices are made on the basis of their feasibility and the relative costs and benefits to the individual. With this in mind one would assume that people would be more likely to walk if walking trips were in any sense easier, if alternatives to walking became more difficult, or if the overall utility of walking was considered.

2.2 Demographic Characteristics

There are multiple demographic factors which have been proven to play a role in mode choice. These include age, economic status, sex, and education level. For both active and inactive mode choice, age is a significant correlate even in the presence of other demographic variables. Young people (under age 18) and older individuals (age 65+) are the groups most likely to utilize active modes of transportation (Burbidge, Goulias and Kim, 2006, Ewing et al, 2003, Pucher and Renne, 2003). One likely reason for this is that both the young and the elderly are often captive to specific modes of transportation. For example, prior to age 16 individuals in most of the United States cannot legally obtain a driver‟s license. Older individuals may lose the ability to operate an automobile as they age due to vision loss, decreased response reflex, or other degenerative conditions. This makes both groups reliant on other drivers, transit, or active modes for transportation.

Socio-economic status affects active mode choice as well. Giles-Corti and Donovan used a cross-sectional survey to study 1,803 adults near Perth, Australia, and found that survey respondents in low socio-economic areas had superior spatial access to many recreational facilities but were less likely to use them when compared with those living in high socio-economic areas (2002a). After adjustment, respondents living in low socio-economic areas (not explicitly defined in the article) were 36% less likely to undertake vigorous activity. Research has also shown that lower income individuals utilize active modes of transportation less than those with higher income, even when both groups live within the same neighborhoods with similar infrastructure available (Brownson et al, 2001, Pas and Koppelman, 1986). It is interesting that this phenomenon exists because Pucher and Renne‟s (2003) analysis of the 2001 National Household Travel Survey found that higher income households make more long trips covering almost twice the total mileage per day of lower income households. One would generally assume that lower income individuals traveling shorter distances would utilize active modes more often. This however, does not seem to be the case, even when considering low income individuals who are captive and may not have access to an automobile or do not have the ability to drive a car.

Sex has also proven to influence travel behavior. Brownson et al‟s (2000) cross-sectional survey of 1,269 adults in rural Missouri showed that women are significantly more likely to participate in physical activity and utilize neighborhood trails than men. When individuals do travel actively, women are more likely to walk for transportation, but men are more likely to utilize a bicycle for active travel (Pucher and Renne, 2003).

Also notable for its social affect on travel behavior is education level. Burbidge, Goulias, and Kim (2006), and Coogan (2003), showed that individuals with higher levels of education walk for transportation significantly more than those with lower levels of education. The Coogan study was based on National Household Travel Survey Data (the drawbacks of which are discussed previously), and the Burbidge study involved surveying individuals residing or working within Centre County Pennsylvania (home of the Pennsylvania State University), which could exhibit some representative bias for national inference due to geographic location and demographic make-up of the study group. These factors may cause some difficulty in generalizing these results to different populations.

2.3 Attitudes and Personal Characteristics

As defined by social psychologists, attitudes are "learned predispositions to respond in a consistently favorable or unfavorable way towards a given object, person, or event" (Hayes, 1993). A 2003 study by Beldon, Russonello, and Stewart surveyed 800 adults nationwide by telephone, and found that opinions about walking and cycling are generally positive, and the majority of the public recognize their virtues. A separate review by the Federal Highway Administration also showed that a majority of Americans stated that they would like to walk more than they currently do (USDOT-FHWA, 1992).

These stated preference surveys, however, only represent what an individual claims they would do in a given situation. They do not show what behavior a person would actually exhibit in that situation (Sanko, 2002). A wealth of research conducted over the past century has shown repeatedly that attitudes may not always determine behavior (Fishbein and Ajzen, 1974, LaPiere, 1934, and Weinstein, 1972). A number of other factors must be considered such as situational factors, characteristics of the attitudes themselves, personal factors, and habitual behavior (Wicker, 1969). Handy, Cao, and Mokhtarian, assert that residential location, attitudes and preferences, and walking behavior all interact with each other over time to create behavior (2006).

Habitual behavior and the role that personal habit plays on mode choice decisions is an important component of travel behavior research. Habits are "learned sequences of acts that have become automatic responses to specific cues, and are functional in obtaining certain goals or end states" (Verplanken and Aarts, 1999). In each transportation situation, individuals must choose how to get from their origin to their destination. Research has shown that eventually individuals may become so familiar with a situation and the accompanying decisions that they may not consider any alternatives but will automatically utilize whatever transportation mode they have used in the past (Bamberg, Rolle, and Weber, 2003, and Moller, 2002). The challenge of dealing with habits with regard to travel behavior and mode choice is that they happen without awareness. That is, many everyday choices and decisions are made without the decision maker being conscious of making the choices (Vanderplanken and Aarts, 1999). Moller (2002) concludes that any attempt to change travel mode choice will largely depend on the motivation behind the behavior, and that policies to change habits should focus on making individuals more conscious of their choices.

In addition to attitudes and habitual behavior, there are other personal characteristics which influence behavior as well. These can include a variety of internal factors such as disabilities or physical limitations, as well as external factors such as automobile or bicycle ownership, possession of a driver‟s license, and possession of other amenities, such as: exercise equipment, cell phone, internet, cable or satellite television, gym pass, etc (Burbidge, Goulias, and Kim, 2006).

All of the characteristics discussed above influence an individual‟s perception of travel utility (the benefit of travel). There are two types of travel utility: derived utility in which the traveler "derives" utility from the activity made possible by the travel (i.e. the joy of shopping after traveling to the mall), and intrinsic utility in which the utility is obtained from the travel itself (i.e. sense of speed, fresh air etc. - Janelle, 2004). Utility may change as an individual moves across their lifecycle stage or life-course. For example, a teenager with a new drivers‟ license may view a five hour road trip differently than someone who has been driving for many years. Technologies can also change the way that people experience travel utility. Driving in a luxury car with a nice stereo system, climate control, and heated seats may be more pleasurable than driving in an older vehicle with no heat or air conditioning. Mokhtarian and Salomon provide theoretical arguments and empirical evidence that travel is valued in its own right and not simply as a means to a destination (Mokhtarian and Salomon, 2001, and Mokhtarian et al, 2001). Their work specifically seeks to differentiate between intrinsic utility and derived utility. Handy (1996) also acknowledges that for walking or bicycling the trip itself might be the motivation for the trip. Additionally, Ratner and Kahn et al, showed that some individuals are "willing to sacrifice real-time enjoyment for the sake of variety" (1999). This finding shows that rather than always optimizing their utility, many individuals will change their routine simply to "change the scenery". Across societies there are variations in what is considered acceptable in terms of travel time, and Janelle (2004) argues that although there is no definitive proof that an optimal amount of travel time exists, the average value is relatively stable at approximately 30 minutes.

In addition to the utility associated with a specific trip, the purpose of the trip has been proven to impact whether an individual will choose an active or inactive mode. Burbidge, Goulias, and Kim (2006) showed that active modes are chosen for very specific trip purposes. Trips to and from school and for visiting or recreation were the most likely to utilize active modes; while work, shopping, escorting and delivery trips were most likely to utilize inactive motorized modes. This provides important insight into the decision making process as it helps delineate what is a reasonable response to a given stimulus. For example, not many individuals would choose to walk to the grocery store if they know that they will be buying a large quantity of items, because they most likely foresee having to walk home carrying those items. This also suggests that it may be presumptuous for policy makers to assume that all trips can incorporate active modes of transportation.

2.4 Infrastructure and the Built Environment

Cullen and Godson (1975) stated that "individual behavior patterns are an important element of urban structure, and their activities in time and space are at least as important as those which have been studied to date." This urban structure, or what is often referred to as the built environment, has long played a role in travel behavior decision making and should not be overlooked as a key element and determinant of active travel behavior. That being considered, this research specifically seeks to focus on the effect that a change in the built environment, in this case the construction of a neighborhood trail, has on the behavior and physical activity levels of neighborhood residents.

The built environment and its various components is one of the most important and most researched correlates associated with the decision to travel actively. The built environment is broadly defined to include land use patterns, the transportation system, and urban design features that altogether generate needs and provide opportunities for travel and physical activity (Transportation Research Board, 2005). The built environment has long been proven to affect the travel decisions that people make for their daily trips (Cullen and Godson, 1975). Development patterns also play a role in the physical activity level of residents. Killingsworth, De Nazell, and Bell (2003) posit that the automobile-dominant design of most suburban communities has contributed to unsafe environments for walking and bicycling. Sprawling land use has been correlated directly to overweight and obesity. Ewing (2005) utilized the metropolitan sprawl database to analyze elasticities of walking and transit-mode shares with respect to the metropolitan sprawl index. He found that an increase in sprawl was associated with a significant increase in chronic medical conditions and a decline in health related quality of life. Additionally, the 2001 National Household Travel Survey (NHTS) data found that individuals in urban environments are more likely to walk or bike than those in suburban or exurban areas (Coogan, 2003).

Accessibility is a direct result of the built environment or the layout of a community, and it unavoidably plays a role in mode choice and active travel. Accessibility reflects the ease of reaching necessary or simply desired activities and therefore reflects characteristics of both the land-use and transportation systems (Handy and Clifton, 2001a). There are many ways to measure accessibility, such as counting the number of opportunities reached within a given distance or travel time. Accessibility is affected not only by the basic land-use and transportation characteristics of an area, but also the scale at which a specific mode operates. For example, if a community is designed with land-uses completely separated and located far from one another accessibility may be severely restricted based on travel time, and mode choice will be affected. Research by Abreu de Silva, Golob, and Goulias, showed for commuters in Lisbon, Portugal that land-use patterns do significantly affect travel behavior, when considered as home-based and work-based and included in a system of equations that account for self-selection of location choices (2006). They also note that these same relationships affect commute distance and total travel time. Using the same overall method, similar strong connections between land-use and travel were found in the Seattle metropolitan area by Abreu de Silva and Goulias (2007). Handy and Clifton (2001a) however, state that many factors other than distance and travel time play a role in assessing accessibility. For bicycling and walking the availability of amenities and the quality of the travel environment may be just as important. Additional factors such as ease of street crossing, sidewalk continuity, local street connectivity, and topography, all affect accessibility for pedestrians and should not be overlooked. It is important to remember, however, that the relationship between the built environment and walking is different than the relationship between the built environment and driving. This key point is overlooked in the framework of many transportation models.

Other components of the built environment can facilitate or constrain physical activity, and built environment factors have had consistent associations with physical activity and active travel behavior. Past research agrees that certain community design factors play a role in active mode choice, and similar components appear in nearly every study. While all researchers agree that there is some level of impact, their conclusions vary regarding the measure of affect that the components have on active mode choice. The agreed upon components of active friendly communities include: density and intensity of development and mix of land uses, the functionality of destinations, connectivity of the street network, and aesthetic qualities of place (See Handy, 2005, Saelens and Handy, 2008, and Transportation Research Board, 2005). Communities that exhibit these characteristics are sometimes referred to as "walkable communities" while communities that do not, are referred to as "auto-oriented communities" (Burden, 2004). Many studies have shown that residents of pedestrian and bicycle-oriented neighborhoods make more walking, bicycling and public transportation trips than residents of automobile-oriented neighborhoods (Ewing, 2005, Ewing et al, 2003, Handy, 2004, Saelens, Sallis, and Frank, 2003). Abad (2005) argues that linked paths throughout the city should be available for exercise, recreation, transportation, and tourism to promote healthier lifestyles for the community. The Brownson et al, telephone survey of 1,818 adults nationwide found that approximately 66% of individuals indicated that they were most likely to engage in physical activity on neighborhood streets, or on walking and jogging trails (2001).

Table 2.1 provides additional information for the studies mentioned in above, including information on methodology and exact research findings. This is not intended to be a comprehensive or exhaustive review of travel behavior literature; the selected studies merely aim to represent the relevant literature as it applies to active mode choice for transportation and recreation.

Table 2.1 Summary of Findings from Prior Bicycle and Pedestrian Studies

Study	Methods	Findings
Bamberg, Rolle & Weber 2003	Quasi experimental survey of 241 adults in Stuttgart, Germany	-A strong car use habit makes travel mode choice script-based so that minimal information is needed to make it
Belden, Russonello, and Stewart 2003	Random telephone survey of 800 adults nationwide	-Opinions about walking and cycling are generally positive
Brownson et al 2000	Cross-sectional survey of 1269 adults in rural Missouri	-Women were more likely to report an increase in walking than men
Brownson et al 2001	Telephone Survey of 1818 adults nationwide	-66% of adults participate in physical activity on neighborhood streets or trails/paths -Lower income individuals are less likely to utilize active modes than higher income individuals
Burbidge, Goulias and Kim 2006	Activity Diary Panel Survey of 1471 adults and children from Centre County, PA	-Active travelers are generally younger than inactive travelers -Individuals with the higher levels of education walk significantly more than those with lower levels of education -Active modes are most likely to be used for school and visiting trips and recreation trips, while inactive modes are most likely to be used for work, escorting, and delivery trips.
Coogan 2003	Analysis of the 2001 NHTS Data	-Individuals with the lowest levels of education report "never walking" significantly more than those with the highest levels of education
Ewing 2005	Analysis of health using the metropolitan sprawl index	-Residents of sprawling counties weighed more, were more likely to be obese, and were more likely to have high blood pressure than their counterparts living in compact counties
Ewing et al 2003	Cross-sectional telephone survey of 382,601 adults from 448 counties and 83 metropolitan areas (BRFSS survey of 1998, 1999, & 2000)	-Adults age 65 and older are more likely to participate in leisure time walking than younger adults
Giles-Corti and Donovan 2002a	Cross-sectional survey of 1803 adults near Perth Australia	-Respondents in low socio-economic areas had superior spatial access but were less likely to use recreational facilities than those in high socio-economic areas

Litman 2003a	*Not Specified*	-15-30% of urban trips involve at least one walking link
Pas and Koppelman 1986	Five day record of travel for an unspecified number of adults in Reading England	-Individuals who have fewer financial constraints (high income) have higher levels of active trip making than those of lower income
Pucher & Renne 2003	Review and Analysis of the 2001 NHTS Data	-Not only do higher income households make more trips per day, but they also make longer trips, covering almost twice the total mileage per day of low-income households -Women are more likely than men to walk for transportation, but men are more likely to bike for transportation -Young individuals (under age 24) are the most likely to utilize active modes for transportation followed by individuals 65 years and over
USDOT-FHWA 1992	Report on existing research on walking and bicycling	-A majority of Americans would like to walk more than they currently do

As shown in this section, many studies have correlated physical activity and travel behavior to exogenous factors including time allocation, demographics, personal characteristics, and infrastructure and the built environment. However, there have been very few studies evaluating the impact of built environment interventions on active travel behavior and overall physical activity.

2.5 Theoretical Framework

This research proposes a conceptual model of active travel behavior which draws on components from the Theory of Planned Behavior (Ajzen, 1985) and Decision Field Theory (Busemeyer and Townsend, 1993). Additional components have been included based on the findings of the studies discussed in this chapter.

The Theory of Planned Behavior (TPB) asserts that human behavior is the direct result of an individual‟s intent. Intent, Ajzen claims, is informed by three main components: The “attitude toward the behavior” which reflects an individuals desire to participate in a behavior; the “subjective norm”, what others think of the behavior; and the “perceived behavioral control”, which describes the individual‟s perception of how hard it will be to adapt the behavior (Ajzen, 1985). As an individual makes a decision, they first form their intent from these three components. Their intent then informs their decision which is reflected in their revealed behavior. This research will utilize components of the Theory of Planned Behavior (shown in blue in Figure 2.2) to identify how a change to the built environment impacts the formation of intent and subsequently how that intent is manifest as behavior.

Decision Field Theory (DFT) was formed by combining two behavior theories from psychology: approach-avoidance theories of motivation, and information-processing theories of choice response time. DFT seeks to “understand the motivational and cognitive mechanisms that guide the deliberation process involved in making decisions” by integrating information that comes from the external environment with information coming from an individual. Decision Field Theory asserts that this “information” is used in a deliberation or “choice process” which weighs the potential consequences of actions. After deliberating, a preference state is created and a threshold is applied which includes all external “inhibitory criteria” (i.e. distance, time, topography, etc.) regarding a possible decision. The result of this process and threshold application is "revealed behavior" (Busemeyer and Townsend, 1993). Stern and Richardson (2005) expanded on this theory to incorporate situational dynamics of general travel behavior by including cultural and societal norms (included below as "subjective norm" similar to the TPB framework), type of trip (included as trip purpose in the model), and personality attributes. The conceptual model proposed in this research utilizes both the components of the original theory as well as the additions provided by Stern and Richardson (shown in green in Figure 2.2).

Past research (shown in Tables 2.1 and 2.3) has documented that each of the additionally included factors (shown in yellow) play a substantial role contributing to behavior. The process of the conceptual model and how each component relates to this pilot study are described below.

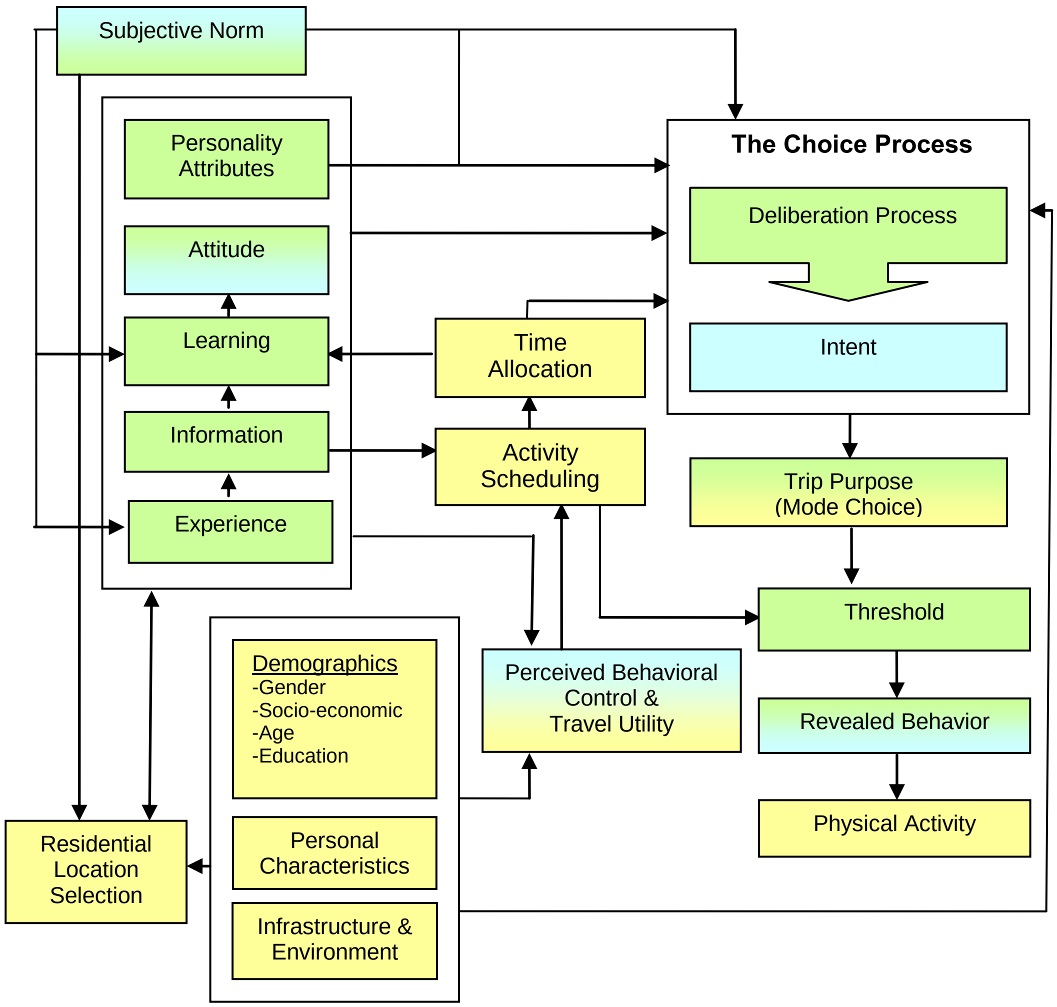

Figure 2.2 Conceptual Model of Active Travel Behavior
1-Blue shaded boxes taken from Ajzen‟s Theory of Planned Behavior (1985)
2-Green shaded boxes taken from Busemeyer and Townsend‟s Decision Field Theory (1993)
3-Yellow shaded boxes proposed by this research

The subjective norm refers to what others (friends, family, peers, etc.) think of a behavior or circumstance (Ajzen, 1985). This outside opinion impacts an individual‟s attitude directly as many individuals value the opinion of others (Gollege and Stimson, 1997). Subjective norm also contributes to learning and experience as outside opinions increase the amount of information available to the decision maker, thereby influencing their attitude and subsequently their choice process. Although this component is not examined directly by the pilot study, it is important to include it in the model as an exogenous factor.

Shown in one large box on the left, are the interrelated components of experience, information, learning, attitude, and personality attributes. Individuals acquire experience by living through different events. This experience provides them with new information, news, or knowledge (Gollege and Stimson, 1997). By processing information, individuals participate in a synthesis or learning which subsequently contributes to a formation of attitude. As previously defined in section 2.3, attitudes are "learned predispositions to respond in a consistently favorable or unfavorable way towards a given object (Hayes, 1993)". Not all individuals will respond the same to the learning process and individuals will inevitably develop different attitudes toward given stimuli. Additionally, individual personality attributes (i.e. insecure vs. confident, or impulsive vs. organized) couple with individual attitudes to inform the choice process (Collins and Chambers, 2005). In this pilot study, individual attitudes are measured regarding active modes of transportation and physical activity using several different survey instruments.

The second large box of components shown in the lower left quadrant of the model includes demographics, personal characteristics, and infrastructure and environment. Demographic characteristics include individual attributes such as age, sex, socio-economic status, education, etc. Personal characteristics include physical and emotional limitations (potential capability constraints), as well as additional things such as possession of a drivers‟ license, automobile ownership, bicycle ownership, or ownership of other amenities (i.e. cell phone, internet, cable television, exercise equipment, etc). The built environment includes land-use patterns, the transportation system, and urban design features that together generate needs and provide opportunities for travel and physical activity (Transportation Research Board, 2005). The connection between each of these components and active travel behavior/physical activity has been described in detail in Sections 2.2, 2.3, and 2.4. As shown in the model, these components work together to account for travel utility and perceived behavioral control, and subsequently provide for activity scheduling and time allocation, as well as the choice process. This pilot study takes each of these factors into account by measuring both demographics and personal characteristics and correlating them to active travel behavior and physical activity. Additionally one of the main goals of this research is to evaluate the impact that a change in the built environment (construction of a neighborhood trail) has on the choice process as it relates to active travel behavior and overall physical activity accumulation.

In the bottom left hand corner, the model includes a component identifying residential location selection, which encompasses the influence that neighborhood characteristics or residential decision making has on overall behavior (physical activity and travel). Residential location selection is impacted by a number of factors including demographics, personal characteristics, local infrastructure and environment, as well as experience, information, and attitude. Residential location decision is also somewhat based on the subjective norm. Additionally, residential location decision impacts the learning cycle by providing new experiences which contribute to new information. The pilot study examines if residential location selection has an impact on the choice process, as suggested by Handy (2005), Handy, Cao, and Mokhtarian (2006), and Dill (2003); by identifying if new residents choose to move to an area due to the presence of specific infrastructure or environmental characteristics. Additionally, the study evaluates differences between residents who lived in the area prior to the trail‟s construction and new residents who moved to the area after the trail‟s construction. Residential self-selection and its relationship to behavior are discussed in more detail in section 2.7.

The proposed model also incorporates perceived behavioral control and travel utility. Perceived behavioral control describes how difficult an individual perceives a change in behavior to be (i.e. how hard it would be to change from driving to walking or using transit). This perceived behavioral control is impacted by demographics, personal characteristics, and characteristics of the built environment, as well as experience, attitude, and personality. Also, as the research in Section 2.3 explained, behavior varies based on travel utility. Travel utility was described previously as the benefit derived from traveling. This is directly related to perceived behavioral control, as it is perception based. Travel utility differs based on the same characteristics which make perceived behavioral control unique for individuals. Therefore these components are included together. These components then provide input to individual and household activity scheduling and subsequently time allocation. This pilot study examines perceived behavioral control and travel utility by first by measuring these covariates through a number of survey questions. These responses are then correlated to active travel behavior data as well as reported physical activity.

The next model components are activity scheduling and time allocation. Activity scheduling describes the process by which households or individuals create a daily schedule of events (Gollege and Stimson, 1997). Activity scheduling includes coupling constraints (described in Section 2.1) which delineate all potential interactions that may restrict time allocation, such as the need to coordinate your schedule with other individuals both in and outside your own household (Arentze, Hofman, van Mourik, and Timmermans, 2000). Activity scheduling also incorporated details about scheduling such as departure time, activity duration, and interaction with others (Miller and Roorda, 2003, and Goulias, Kim, and Patten, 2004). As shown in the model, activity scheduling utilizes available information as well as perceived behavioral controls and travel utility to develop a schedule of subsequent time allocation. Time allocation refers to the way that individuals utilize their time or trade time for space in order to accomplish tasks over the course of the day. The time allocation component of the model is more general than activity scheduling and includes all potential temporal constraints (as described in Section 2.1). Activity scheduling is directly analyzed in the pilot study through the use of an activity diary. The use of an activity diary allows this research to examine each individual‟s activity scheduling and time allocation throughout the entire course of the entire day by putting active travel behavior and physical activity choices in context with other activities. Additionally, the pilot study examines time allocation using residential proximity as a construct. By evaluating the impact of residential proximity on the choice process, the pilot study can examine the relationship of trading time for space (i.e. individuals living further from the trail will require more time to travel to the trail than those living closer) which may ultimately impact behavior.

All of the above listed factors result in a choice process. The choice process first involves a deliberation process, in which each individual synthesizes all of the components described above in order to formulate their intent (referred to by Stern and Richardson (2005) as "preference state"). Intent describes what an individual expects or plans to do given the current situation (Ajzen, 1985, Verplanken and Aarts, 1999). An individual‟s intent informs a mode choice decision (based on trip/activity purpose) which may include a variety of options such as driving alone, getting a ride, taking transit, walking, bicycling, or some combination of modes (Moller, 2002). This pilot study provides a preliminary analysis of the relationship between intent and behavior by first asking residents about their intentions or plans for future behavior, and then measuring that future behavior and correlating the two.

After formulating an intended behavior and identifying the trip/activity purpose and mode choice, an individual then either consciously or unconsciously identifies any boundaries or thresholds which would restrict that intention from being carried out. Thresholds may include limitations such as distance, time, or lack of individual capacity (Jannelle, 2004). As shown in the model these thresholds are often directly impacted by time allocation, and reflect capability, temporal, and coupling constraints.

All of these components ultimately come together to produce a revealed behavior, which either consists of physical activity or does not. The pilot study does not specifically evaluate thresholds, however is does correlate revealed behavior to a variety of contributing covariates (as described above) while also evaluating factors which contribute to changes in physical activity over time.

Table 2.2 shows each of the above listed model components and provides sources for each.

Table 2.2 Source Theories of Specific Model Components

Model Component	Source
Subjective Norm	Ajzen, 1985
Experience, Information, and Learning	Busemeyer and Townsend, 1993 Gollege and Stimson, 1997
Attitudes	Ajzen, 1985 Bamberg, Rolle and Weber 2003 Beldon-Russenello 2003 Busemeyer and Townsend, 1993 Handy, Cao, and Mokhtarian 2006 Moller 2002 Pas and Koppelman 1986 *-To be determined through this research*
Personality Attributes	Busemeyer and Townsend, 1993 Collins and Chambers, 2005
Demographics	Brownson et al 2000 Burbidge, Goulias, and Kim 2006 Ewing et al 2003 Pas and Koppelman 1986 Pucher and Renne 2003 *-To be determined through this research*
Personal Characteristics	
Infrastructure and Environment	Brownson et al 2001 Dill 2004, EPA 2003 Evenson, Herring, and Huston 2005 Giles-Corti and Donovan 2002a *-To be determined through this research*
Residential Location Selection	Dill 2003 Handy 2005 Handy, Cao, and Mokhtarian 2006 *-To be determined through this research*
Perceived Behavioral Control and Travel Utility	Ajzen, 1985 Mokhtarian et al 2001 Mokhtarian and Salomon 2001 Ratner and Kahn 1999
Activity Scheduling	Arentze et al, 2000 Goulias, Kim, and Patten, 2004
Time Allocation	Hagerstrand 1970 Golledge and Stimson 1997 Sallis, Frank, Saelens, and Kraft 2004 Transportation Research Board 2005 Cervero and Radisch 1995 Golob, Bradley, and Polak 1995 *-To be determined through this research*
Deliberation Process	Busemeyer and Townsend, 1993
Intent	Ajzen, 1985 Verplanken and Aarts, 1999
Trip Purpose and Mode choice	Burbidge, Goulias, and Kim, 2006 Moller, 2002
Thresholds	Jannelle, 2004

While both the Theory of Planned Behavior and Decision Field Theory have been utilized separately, this conceptual model combines the components of each with additional components derived from active mode choice research to create a broad based framework that seeks to encompass the multifaceted nature of active travel behavior. The pilot study in this research will test the new model by directly analyzing a selection of the components described above. After directly testing these relationships, the conceptual model will be revisited and evaluated (Figure 11.1) with the study"s conclusions.

2.6 Determining Causality

As a part of a Transportation Research Board Special Report, Handy completed a thorough literature review of research studying the link between physical activity and the built environment (2005). Her literature review examined research in both the physical activity and travel behavior fields, and determined that the majority of the studies pertaining to physical activity and the built environment utilized cross-sectional methodologies (of the 50 studies that were examined, only one (1) was longitudinal in design). This leaves open the possibility that observed associations could be spurious in nature, and causality can not be adequately determined as explained below.

According to Briss, Fielding, et al (2000), "Cross sectional studies measure exposure and outcome in a single group at the same point in time creating a potential for significant threats to validity." Although cross-sectional data can tell us that there is a difference between behavior at two time points, it does not identify if a change has occurred, and if so why the change occurred; nor can we reliably estimate how change may occur in the future (Miller, 1999). Cross-sectional analysis can only provide a snapshot of a particular area or population at one particular point in time (Singer and Willet, 1996). Kitamura also stated that "behavioral relationships identified based on cross-sectional observation would not represent behavioral changes over time….longitudinal data and analysis are prerequisite for proper identification and prediction of behavior (1990)". In order for causality to be established, five criteria must be considered: empirical association, appropriate time order, nonspuriousness, causal mechanisms, and the context in which the effect occurs (Schutt, 2004).

Longitudinal data are obtained through panel surveys; and although many variations exist on the exact definition of a panel survey, general consensus defines a panel survey as a study conducted over time to evaluate the impact of change in an environment or change in behavior. Additional criteria by Singer and Willet (1996) suggest that a truly longitudinal panel should contain at least three waves of data collection. Literature differs regarding the number and typology of panel surveys. Miller (1999) identifies four types which focus on: auto ownership and usage, transit, special purpose (i.e. before and after), and general purpose (also mentioned by

Kitamura, 1990). Longitudinal and rotating panel designs are discussed by Tourangeau, Zimowski, and Ghadialy (1997).

When considering the analysis of panel data, Eccles, Grimshaw, Campbell, and Ramsay (2003) differentiate their focus from the others by emphasizing evaluative designs and non-randomized designs. Yafee (2003) also identifies six types of analysis strategies for panel data including: constant coefficient models, fixed effects models, and random effects models, as well as dynamic panel, robust, and covariance structure models. Additional methods for longitudinal data analysis are discussed in Section 2.9.

There are many benefits to utilizing a longitudinal research design. Panel surveys have the ability to identify temporal variation in travel behavior through direct observation (Kitamura, 1990). This observation reduces the effects of confounds and helps establish cause-effect relationships (Miller, 1999). Forecasting based on longitudinal data collection has shown improved predictive accuracy and increased statistical efficiency as well (Tourangeau, Zimowski, and Ghadialy, 1997). Additionally, Bandura (1986) observed that interactions between people, their environments, and behavior may not happen simultaneously and can play out over time. By establishing preliminary baseline data with regard to travel behavior and physical activity, data can then be gathered over time to identify if changes in behavior have occurred corresponding to changes in the built environment, rather than predicting causality based on comparative data collection.

2.7 Residential Self-Selection

Individual preference for physical activity may influence individual and household residential decision making. Current research tests hypotheses that individuals living in areas that support physical activity will be more physically active than those living in areas that do not support physical activity. In an alternative hypothesis, individuals who are more physically active may prefer to live in areas that support physical activity, while individuals who have a low preference for physical activity may self select to live in areas which do not support physical activity (Handy, 2005). The physical environment may simply reinforce a preferred behavior.

Studies by Handy and Clifton (2001b), Bagley and Mokhtarian et al (2002), and Greenwald and Boarnet (2001) provide strong evidence of self selection, although their cross-sectional nature allows for determination of correlation but not causality. Handy, Cao, and Mokhtarian (2006) used quasi-longitudinal methods to control for the potential of self-selection. By doing so they found a statistically significant association between a change in the built environment and change in walking or biking. However, their study methodology relied on respondents recalling their travel behavior over time (up to one year prior) rather than directly measuring it.

By using a longitudinal research design, such as the one performed in this pilot study, residential self-selection can be controlled for by studying travel behavior in the same group of residents both before and after an infrastructure change takes place. Self-selectors are easily identified through surveying individuals who move to the area after the change has occurred.

Although many current research projects show correlation exists between the built environment and physical activity, the nature of the methodologies cannot sufficiently establish a causal relationship. Additionally, innovation in travel behavior analysis provides state of the art capabilities for more robust modeling than has been traditionally exhibited in intervention research (further described in Section 2.9).

2.8 Trail Intervention Studies

A majority of studies correlating the built environment to physical activity have been designed not to look at specific infrastructure, but rather overall neighborhood design. Also, the majority are cross sectional in design which limits their ability to establish behavioral causality relating to a specific infrastructure‟s impact on active travel behavior or physical activity.

The only published study that documents a change in physical activity that can be attributed to the construction of a multi-use trail was conducted by Evenson, Herring, and Huston (2005). The research used a repeated cross-section methodology to study the impacts of a 2.8 mile multi-use trail in Durham, North Carolina. A random sampling of 2,125 households (based on households with telephone numbers in the white pages) were surveyed over the six months prior to the trail‟s opening. Follow-up surveys ranged from one year and seven months, to two years and four months post opening. Approximately 63% of the participants in the baseline survey participated in the follow-up survey. The study found no significant change in physical activity levels after the installation of the trail. The study also determined that participants who claimed to use the trail were less likely to increase their walking per week from baseline than those who had never heard of the trail.

Although this study is the closest existing research seeking to identify the impact of trail development on behavior, there are some drawbacks in the methodology. The sampling and survey technique included only households with working telephone numbers that were listed in the white pages. This would rule out all households who do not have a telephone (possibly a large number of low income), or households who choose not to have a landline telephone which is becoming more common with the prevalence of cell phone usage. The study claims it is "examining changes longitudinally", but is more correctly identified as a repeated cross-section. Respondents were randomly chosen in two stages: the first stage at the household level, and the second stage at the individual level (the person with the closest birthday). The study took into account the behavior of a household as a whole in phase one, and of one adult member of each household in phase two, which did not allow the researchers to identify changes in individual or household behavior over time. The Evanson, Herring, and Huston study methods rely on Behavioral Risk Factor Surveillance System (BRFSS) questions, and only one survey question directly addressed the trail being studied. There are several drawbacks to using the BRFSS questions as they only ask about walking for recreation, and do not incorporate the possibility of walking for transportation. It should be kept in mind that all walking, regardless of purpose or intent, provides physical activity and utilizes the same infrastructure. The majority of questions in this study related solely to recreational activity with only two questions addressing transportation. The analysis did not control for demographics or personal characteristics. In their conclusion the authors mention that this trail was a part of a larger trail network and that a "cleaner" evaluation may occur if the geographic area evaluated does not contain any other trails.

Brownson et al, provided the first study of community walking trails and the impact that they have on physical activity in 2000. A cross-sectional telephone survey was conducted in 12 counties in rural Missouri, to ask a population based sample of 1,269 residents (over 18 years of age) standard questions about walking behaviors, knowledge, and attitudes. This study was conducted by public health professionals, and utilized questions from the BRFSS including: walking behavior in the past month, access to walking trails, use of walking trails, and whether exercise behavior had changed due to walking trail use. The study also asked residents how they found out about trails, and what aspects of the trails they most liked. The study concluded that approximately 37% of respondents reported having access to walking trails in their area, and 45% stated that they had walked in the past month for exercise. The authors recommend building walking trails as an intervention to promote physical activity, but their research does not attempt to show that doing so would in fact increase physical activity.

By utilizing a telephone survey and asking about behavior over a one month time span, this study is open to participant errors in both recollection and self reporting. The questions used in this study were drawn from the Behavioral Risk Factor Surveillance System (BRFSS), the drawbacks of which are discussed previously. This study does not look at a specific geographical area and asks questions about trails in general terms, rather than collecting data about a specific trail.

Another study by Brownson et al (2004), examined creating a physical activity intervention program. Researchers sought to inspect changes in walking behavior in six intervention communities in Missouri, Arkansas, and Tennessee. Trail use data were collected (via electronic counting at trail heads), and trail users (over age 18) were asked to provide feedback to identify the best mechanisms for developing social and community support for physical activity. Intervention activities included having individuals fill out a brief one page questionnaire about issues such as perceived benefits or barriers, motivation, health related behaviors, resource availability, and preferences for walking. Brownson et al (2005) further examined the intervention issue from the 2004 work by utilizing a quasi-experimental design to quantify changes in walking behavior in the six intervention communities described above. This second phase of research included providing positive reinforcement to those who walked regularly and motivational and resource information to those who did not walk regularly. The researchers then measured changes in walking behavior in those who received the promotional materials versus those who did not receive promotional materials. The point of these interventions was to find ways to promote trail use and encourage citizens to become more physically active. It is important to note that all trails utilized in this study were at least 7 years old (built between 1975 and 1997) when the research was conducted, and of the residents surveyed only 8% actually used the trails. Also, the intervention discussed in this research was not an infrastructure intervention but rather a promotional intervention. Results from both studies lack statistical information regarding any change in behavior caused by the actual construction and implementation of the trails prior to their research.

Although not the main focus, a study by Giles-Corti and Donovan (2002b) addresses usage rates of local infrastructure by a cross-sectional survey of 1773 adults aged 18-59 years (one eligible respondent randomly selected from each contacted household) in Perth, Australia. Surveyors measured the individual, social, and physical environmental factors (not explicitly defined in the publication) that influence participation in physical activity. This study determined that 82.5% of survey respondents walked for either transportation or recreation, and that 100% of those who walked reported doing so on a facility near their home (i.e. sidewalk, trail, beach). The survey contained 255 questions and respondents were asked the frequency and duration of all types of physical activity undertaken in the previous two weeks. The unemployed, those who were physically active as part of a job, those with any medical condition likely to affect participation in recreational physical activity, those ages over 59, and those who had occupied the household for less than one year were intentionally excluded from the study.

Giles-Corti and Donovan (2002b) touch briefly on the impact of infrastructure on physical activity, but their focus is still well outside the domain of attempting to prove causality between the active infrastructure and the physical activity performed. The study‟s methodology could result in incomplete data as respondents are responsible for remembering all their physical activity episodes over a two week time period, and they may forget. There are also many strict restrictions placed on sample selection (by intentionally excluded unemployed individuals, those with medical conditions limiting mobility, and persons over age 59), created a sample population that is may not be representative of the public residing in that specific area as a whole, since it is likely that at least some percentage of residents would fall into at least one of the eliminated categories.

Troped et al (2001), examine associations between self-reported and objective physical environmental variables and the use of the Minuteman Bikeway in Arlington, Massachusetts. This cross-sectional community study surveyed a random sample of 413 adults (age 18 and over). The survey consisted of 53 questions aimed at assessing physical activity habits as well as factors potentially associated with the use of the Minuteman Bikeway. The survey attempted to measure recent participation in recreational physical activity, and stages of change for both recreational and transportation related physical activity. This study found that an increase in distance from the bikeway was correlated to a decreased likelihood of bikeway use, and the absence of busy streets and hill barriers were associated with bikeway use. The authors concluded that environmental barriers such as distance and hilly terrain should be considered when panning community trails. This survey relied on self reported behavioral data asking respondents to list their activity over the past two weeks. This research was cross-sectional in design and relied on respondents remembering all their physical activity episodes for the 14 days prior. No long term change was measured in the research. The average age of survey participants was 52 years, which may limit the generalizability and applicability of the study results.

A recent study conducted by Barnes, Thompson, and Krizek (2006), used census data to describe changes in bicycle commute mode share between 1990 and 2000 in Minneapolis-St. Paul, Minnesota. Their analysis specifically attempts to utilize longitudinal methods to analyze the impact of seven new facilities that were created during that decade. Their methods include an analysis of census journey to work data from 1990 and 2000, comparing bicycling commute rates over various parts of the city, and between specific origins and destinations taking into account their proximity to the above mentioned facilities. The authors assert that this method allows them to determine differences between geographic areas that existed prior to a trail"s construction. The study found that areas where bicycle facilities were built already had a very high commute share relative to the rest of the region, but these differences became even larger after the facilities were built. Mode share in the remainder of the region, where facilities were not built, remained constant. This methodology only took into account bicycle mode share for journey to work trips. Additionally, four of the seven paths analyzed were not constructed during the study time period; three were constructed prior to the 1990"s, and one was completed in the year 2000 (which would not have allowed any significant impact to be determined through the use of the 2000 census data). This analysis also notes purposefully not analyzing areas around new bike paths in the suburbs due to "low usage rates". However, if the authors" intentions were to determine the impact of bike path construction, that would best be accomplished by including all types of bike paths rather than only those they presumed would have a positive impact. This analysis may display some selectivity bias.

There continues to be a large gap in the existing research when it comes to physical activity levels in children as members of a household. It is very important to note that none of the previously described studies have taken into account the behavior of children (under age 18) who are likely to participate in walking as a mode of transportation. Although Evenson, Herring, and Huston noted that the trail they examined was located near two schools, no school aged children were surveyed (2005).

Table 2.3 below provides a summary of existing intervention research including methods, findings, and limitations.

Table 2.3 Summary of Existing Trail Intervention Research

Study	Methods	Findings	Limitations
Barnes, Thompson, and Krizek 2006	Comparison of census journey to work data from 1990 and 2000	-There was a statistically significant increase in bicycle mode share during the 1990's concentrated in the areas around facilities. -Long trips (over 5 miles) significantly increased to the University of Minnesota campus.	-Only takes into account journey to work trips - 4 of the 7 paths analyzed were not completed during the study time period (3 prior to the 1990's and 1 in the year 2000) -Analysis purposely ignored bike paths in the suburbs due to known "low usage rates"
Brownson et al 2000	Cross-sectional telephone survey of 1269 adults from 12 counties in rural Missouri including standard BRFSS questions about walking behaviors, knowledge, and attitudes	-37% of respondents reported having access to walking trails -45% had walked in the past month for exercise	-Cross-sectional methods -Recollection and self reporting errors over one month time span -BRFSS questions only ask about walking for recreation -No focus on geographical area or a specific trail
Brownson et al 2004	Intervention with data collection at six trail heads	Intervention included having individuals fill out	-No quantitative methodology or statistics

	in Missouri, Arkansas, and Tennessee – surveyed users regarding physical activity	a brief one page questionnaire about health, motivation, behavior, and preferences for walking	-All trails studied were over 7 years old which did not allow researchers to identify behavioral change caused by trail construction
Brownson et al 2005	Quasi-experimental design to quantify changes from Brownson et al 2004	-Provided positive reinforcement for walkers, and information for non-walkers	*-See Brownson et al 2004*
Evenson, Herring, & Huston 2005	Repeated cross sectional mail survey of 2125 households in Durham, NC; Data collected six months prior to, one year and seven months following, and two years and four months following a trail‟s construction	-No significant change in physical activity levels after the installation of the trail -Participants who used the trail were less likely to increase their walking per week from baseline than those who had never heard of the trail	-Repeated cross-sectional methods -Only included households with working telephone numbers -BRFSS questions -Only one question addressed the specific trail -Two different methodological techniques (households in wave one & individuals in wave two) -No follow-up data collection to determine causality
Giles-Corti and Donovan 2002b	Cross-sectional mail survey of 1773 adults in Perth, Australia – measured types and duration of physical activity within two prior weeks as well as other social, individuals, and environmental factors	-82% of respondents walked for transportation or recreation -100% of those who walked did so on a facility near their home	-Cross-sectional methods -Excluded unemployed individuals, those with medical conditions limiting mobility, persons over age 59, and those occupying household for < 1 year -Relied on memory of participants over 2 week duration
Troped et al 2001	Cross-sectional mail survey of 413 randomly sampled adults in Arlington, VA examining associations between self-reported and objective environmental variables relating to a local bikeway	-Age and female sex showed significant inverse associations with bikeway use -Increases in distance were associated with decreased likelihood of bikeway use -Absence of steep hill barriers and busy streets were associated with bikeway use	-Cross-sectional methods -Relied on memory of participants over 2 week duration -Bias due to age of respondents (Mean =52 years)

In addition to methodological shortcomings of the studies discussed above, there are several additional drawbacks to the analytical methods employed. A majority of the studies discussed provide only simplistic statistical analysis of the data. Brownson et al (2000, 2004, 2005) did not specifically identify which types of regression analysis were used in their studies, but output from the models suggests nothing more complex than simple linear regression estimated with ordinary least squares. Barnes, Thompson, and Krizek (2006) do not specifically identify their methods either, listing significance levels as only 1 or 2 with no further definitions. Troped et al (2001) recognize using logistical regression methods, but give no statistical diagnostics within the text allowing a determination of model performance to be made. These methods may not be multifarious enough to determine causality and correlation between the given variables and physical activity. Evenson, Herring, and Huston (2005) and Giles-Corti and Donovan (2002b) did acknowledge the use of multivariate statistics and 2 log-likelihood tests (chi-square) which suggests they used non-linear regression in their studies.

2.9 Analysis Methods

Until recently, traditional modeling of travel behavior and time allocation regarded trips as the primary focus of analysis. Travel diaries historically left out "trips" which began and ended in the same location with no stopping points in the middle (i.e. a recreation or exercise walk around the neighborhood), and trips which were used as feeders to other modes (i.e. walking to the bus stop). Since many survey participants in research did not consider recreation outings as “trips”, as outlined by the traditional research definition (Hanson and Giuliano, 2004), using this type of trip-based analysis left out a large number of active trips (which led to drastic underreporting). Traditional trip-based analysis also operated under the assumptions of standard economic theory (perfect rationality, perfect information, etc.), and failed to incorporate behavioral characteristics into models (Hanson and Giuliano, 2004). Many researchers analyzing time allocation were disappointed by the drawbacks of trip-based analysis and turned instead to a different type of measurement framework called activity-based. According to Ettema and Timmermans (1997) "activity-based approaches typically describe which activities people pursue, at what locations, at what times, and how these activities are scheduled given the location and attributes of destinations, the state of the transportation network, aspects of the institutional context, and their personal and household characteristics.” Activity-based approaches help researchers identify activity patterns that more accurately reflect how people plan and organize their days. This provides additional insight into transportation decision making by putting them in context, and catches many “trips” which would not have been recorded in a traditional travel survey.

According to Henson and Goulias (2006), the first models which incorporated behavioral processes were published in the late 1970‟s and early 1980‟s. Many of these utilized time-space prisms (described above) as constraints. Since these early beginnings, over 40 activity-based models have been created (a majority of which are comprehensively outlined and discussed by Henson and Goulias, 2006). These models incorporate measurements of individual travel behavior and focus on everything from daily household scheduling and mode choice decisions, to predicting land-use transportation interactions and estimating leisure and vacation activity. Substantial progress has been observed in the activity-based travel demand forecasting methods, but there are still many areas that require further improvement. For example, currently no activity-based models have been developed to predict pedestrian and bicycle mode choice (active travel behavior). In addition, one key understanding we have from activity-based approaches, is that mode choice should never be studied in isolation from human interactions, commitments, and constraints.

As discussed in Section 2.6, it is important when addressing causality issues to utilize longitudinal or panel methodologies. Models analyzing panel data are typically referred to as "dynamic" models due to their recognition of time (Tourangeau, Zimowski, and Ghadialy, 1997). A common analysis mistake comes from utilizing cross-section methodologies on panel data (treating them as repeated cross-sections) which limits their predictive power and the other various opportunities that panel data provides. When it comes to quantitative methods for analyzing panel data, many different alternatives are available. Travel behavior researchers have long been adapting regression models for more complex analyses. Willet, Singer, and Martin (1998) stated that "familiar statistical techniques such as multiple regression and analysis of variance are ill-suited for addressing panel data", and Eccles, Grimshaw, Campbell, and Ramsay (2003) point out that "many published time series studies have been inappropriately analyzed; frequently resulting in an overestimation of the effect of [an] intervention". Because of this, a variety of more advanced regression methods are employed in this research. Although traditional Ordinary Least Squares (OLS) linear regression models are used to explore data correlations, most conclusions are drawn from models that are specifically tailored to the nature of the dependent variables. For example, to study the number of activities or trips, which often have a large amount of zeros in their distribution, Zero-Inflated Poisson Models are used. For categorical responses to survey questions, Probit Models are used to examine a variety of relationships in the data collected. Additionally, this research employs more complex paired t-tests and fixed effects panel regressions (with robust standard errors) to investigate impacts and correlations of a treatment (trail construction) as well as time variables within each individual case. These analysis methods are described further in the findings sections.

3. Study Approach and Data Collection

3.1 Study Goals and Objectives

The first component of this research, the pilot study, bridges methodologies of travel behavior and active living research by utilizing an innovative longitudinal design. This design incorporates fixed effects panel and other robust regression analyses to evaluate the impact that the installation of a neighborhood trail has on the active travel behavior and overall physical activity of neighborhood residents. Interventions involving changes in the built environment are relatively rare. This intervention technique performs a more direct test of causality than a traditional cross-sectional study, by providing before/after comparison data. By looking at the same group of residents over time and analyzing if a change in behavior occurs following an infrastructure change, this research determines if the "build it and they will come" argument is a reasonable expectation. This will be done by answering the following five questions:

- Will the installation of a neighborhood trail in an area not currently recognized for widespread physical activity trigger a change in the travel behavior and physical activity levels of neighborhood residents?
- Will changes in physical activity be maintained, increase, or decrease over time?
- Do residents living in closer proximity to the trail exhibit different behavioral patterns than those living further away?

- Do personal attitudes or perceptions about active modes of transportation actually impact active travel behavior or overall physical activity?
- Will new residents to the neighborhood be drawn to that specific area due to the presence of active infrastructure?

Following the evaluation of the built environment intervention, this research evaluates if the methods employed in the pilot study are sufficient for determining potential behavioral causality and discusses the potential of alternative methodologies with the ultimate goal of providing a framework for future researchers wishing to conduct evaluations of interventions to the built environment.

3.2 Study Area Overview

This pilot study highlights the residential Academy Park Neighborhood in West Valley City, Utah; a suburban area within the Salt Lake City, Utah Metropolitan Region where similar to most suburban locations in the country, active modes are rarely chosen. This location is ideal for this research due to the existence of a 1 mile (1600 meter) section of an irrigation canal owned by the Salt Lake-Utah Canal Company which runs through the center of the study area. The Salt Lake-Utah Canal Company has collaborated with Salt Lake County and West Valley City to construct a "class one" trail (two way multi-use trail separated from existing roads and sidewalks) on the existing canal right-of-way. The trail serves the public as both a transportation and recreation facility (shown in Figure 3.1). A key aspect of this proposed trail is its adjacency to 2 major schools and proximity to several small parks. Additionally, this trail will create a 2.5 miles loop connecting two currently existing sidewalks (shown in blue).

The study area consists of land between 4100 South and 4700 South, and 4000 West and 4800 West in West Valley City, Utah. This area is roughly 1.75 square miles (4.53 km) and contains approximately 3,500 households. The area is characterized by a moderately educated (78.4% of adults are high school graduates) moderate income (median annual household income of $45,773) population (U.S. Census, 2000a, 200b). The population is very diverse compared to other local municipalities and consists of 78.2% Caucasians, 18.5% Hispanic or Latinos (of which 95% of those households contain at least one fluent English speaker), and approximately 1% African Americans (U.S. Census, 2000e). U.S. Census figures (2000d) show that 6.7% of this location"s population is currently below the poverty level ($17,601 for a household of four), and 21.9% of the families received some type of public assistance income in 1999. With regards to current journey to work travel behavior; in the year 2000 the mode split for this area was 93.3% automobile, 2.2% public transit, 1.2% walking, and 0.2% bicycle, as well as 2.3% of the population who worked from home (U.S. Census, 2000c).

Figure 3.1 Academy Park Canal Right-of-Way* and Study Area
*Canal right-of-way is identified in red, local schools in green, and existing connecting sidewalks in blue/black hash

3.3 Research Design

This research consists of four waves of data collection: A preliminary household questionnaire, and three activity diary data collection waves. A new resident survey was administered concurrently with Activity Diaries 2 and 3. According to Curran and Hussong (2003), a minimum of three repeated measures are needed to identify a linear trajectory model, therefore the three activity diary data collection time points allow for flexible model testing. The activity diary wave increments in this study were also designed temporally close enough together to observe behavioral transitions as they occurred. This minimized many of the transition issues raised by Kitamura, Yamamoto, and Fujii (2003). Three waves of behavioral data collection allow for the analysis of behavior changes over time, and further reveal if physical activity levels are maintained over time.

3.4 Questionnaire and Activity Diary Design

The Academy Park Activity Diary Survey is loosely modeled after the CentreSim household activity diary (described in Patten and Goulias, 2004). This survey however, does not follow the CentreSIM format in some specific aspects. Due to a lack of resources and funding associated with a dissertation scale project, no follow-up was made with the non-respondents of the first group contacted. Second, this activity diary consists of only a single day, rather than the two day diary employed in the CentreSim project. Third, this sampling did not gather travel behavior information for children under age 5. Children under age five are not analyzed in this research as they are not of legal age to attend public school in Utah and would therefore have relatively few opportunities for travel outside those in which they are directly accompanied by a parent. Additionally, individuals under age five are highly unlikely to be making any of their own travel behavior decisions and therefore their behavior is not likely to reveal any changes in travel behavior through availability of new infrastructure (unless caused by the decisions of those who are being measured).

The preliminary household questionnaire sent in the Fall of 2006 began with instructions guiding participants through the appropriate ways to respond to each question. The questionnaire contained 14 questions formatted so that respondents were only required to check the appropriate box, rank/score, or fill in a number. For some questions an "other" option was given, and if selected the respondent was then given room to provide their own response. At the conclusion of the household questionnaire, respondents were informed that they could "check the box" and provide their mailing address if they would like to receive a summary of the results from the questionnaire analysis. The last page of the household questionnaire thanked participants for taking the time to assist with the research, and invited them to continue assisting with the project by participating in the activity diary portion of the research. Respondents were asked to indicate their willingness to participate by filling out a brief template which asked the names and ages of each family member, and their preferred mailing address. Immediately below the template respondents were informed that by completing the upcoming activity diaries, their household would automatically be entered into a drawing for a variety of prizes (i.e. gift certificates to local businesses, etc). They were also informed that at the conclusion of the research, households who participated in all waves of data collection would be entered into a drawing for a grand prize. The questionnaire concluded by reassuring all participants that their household and person specific information would be kept completely confidential. It was anticipated that for an average individual the questionnaire would take no longer than 10-15 minutes to complete. A complete version of the Household Questionnaire can be found in Appendix A.

For all activity diary waves each participating household received a packet of materials containing a household letter and personalized activity diary packets for each family member over age 5. Packets for Activity Diary 1 (AD1) included a cover page with a consent form, an individual survey, and a single day activity diary (copies of all items can be found in Appendix B). The cover page began by indicating which person in the household was to complete the diary (example: "To be completed by: John"). Below this identifier was a text box containing the consent agreement which focused on reinforcing the confidential nature of the project data to participants. The section also required the signature of a parent of guardian for all participants under age 18. Below the consent agreement box each participant was given detailed instructions on how to complete the activity diary including which day of the week it was to be completed and precise instructions on how to complete each box on the diary form. Participants were encouraged to include all activities and travel throughout the day no matter how small or inconsequential they may seem. At the bottom of the cover page participants were again given contact information for the project staff in case they had any questions or concerns.

The activity diary form resembled a typical day planner sheet (see copy in Appendix B). The top line reminded participants that their day was pre-selected stating "Please complete diary on:______" (specifying day of the week); and in order to determine any abnormalities the second line asked "Does this represent a typical day for you?" allowing the participant to circle either yes or no. Within the diary form the first column contained "begin and end time" where participants could list the start and end times for each activity throughout the day. The second column asked "What activity did you do" which allowed the participant to designate the activity type. Column three asked "did you do the activity with anyone" which provides information about group versus solo travel and activity participation, and column four asked “where did you do the activity” providing room for a destination or location. For transportation analysis, column five asked “did you travel” during the activity; column six followed-up by asking “how did you travel” (specification of mode choice); and column seven asked for an estimation of “approximate travel distance”.

The activity diary packets in Activity Diary 2 (AD2) and Activity Diary 3 (AD3) were identical to those completed in February 2007 for consistency, with the exception of the personal survey (copies of all items can be found in Appendices C and D). Participants were again encouraged to list all activities and travel throughout the day no matter how small or inconsequential they may seem, and at the bottom of the cover page contact information for the project staff was given in case participants had any questions or concerns.

The individual survey included in the packet for wave one (February 2007) consisted of five questions regarding physical activity and local infrastructure. Questions asked respondents to identify the total amount of time they spend in physical activity per day (estimated), what their preferred types of physical activity are, how many trails are located within walking distance of their home, would more trails benefit their area, and what activity types they would be most likely to walk for (i.e. work, school, shopping, etc.). The first question was used to compare estimated physical activity against reported physical activity (identified through activity diary). The other questions were used to better understand the individual behavior patterns which emerged as a result of the activity diaries. For example, if an individual reported that there are three trails within walking distance of their home when in reality there are none, this says something about their perception of what constitutes a trail (maybe they consider a sidewalk to be a trail). The final two questions were used to again identify attitudes and perception regarding active infrastructure and mode choice. By identifying if an increase in trails would be a good thing for their community, a respondent reveals their underlying attitude about trails. Additionally, individuals may have reported being most likely to walk or bicycle for shopping trips, but comparing that response to their reported travel behavior could identify if they actually do use active modes for shopping trips. These analyses are reported in Chapter 7.

The individual survey included in the packet for wave two (October 2007) consisted of six questions regarding each household‟s residential location and their perception of safety in the neighborhood. Respondent were initially asked to identify various reasons for choosing their home location, as well as the tenure at their current home location. Questions three and four identified perceived levels of safety (very safe, somewhat safe, etc.), and perceptions regarding the impact of safety on their behavior (i.e. Does the safety of your neighborhood impact the amount of walking you do?), and question six allowed respondents to identify specific characteristics which they feel would make their neighborhood safer. These questions were used to uncover correlations between perceptions of the environment and reported travel behavior (identified in the activity diary), and will be discussed in detail in Chapter 8. The complete survey can be found in Appendix C.

The individual survey included in the packet for AD3 consisted of two questions regarding each individual‟s change in physical activity over the past 12 months. Residents were first asked if they had become more physically active in the last twelve months. The survey then prompted "If you answered „yes‟ to question #1, please explain why you have become more physically active" or "If you answered „no‟ to question #1, please explain what has kept you from becoming more physically active." This open ended questionnaire was meant to provide an opportunity for individuals to be more specific about their physical activity patterns and provide controlled qualitative justification for the final conclusions of this research. This survey can be found in Appendix D.

3.5 Sampling Procedures

The Academy Park Survey pilot study consists of two populations: The first population consists of approximately 3,500 households currently living within 1 mile (800 meters) of the proposed canal trail. The second consists of residents who moved into the area after the construction of the canal trail was complete (September 2007). Research began by compiling a database of contact information for all residents living within the study area prior to the canal trails construction using assessor data from the Salt Lake County Clerk and West Valley City. For the second population, information was gathered through the West Valley City"s residential database by determining date of property acquisition (including all residents new to the area after September 2007). For rental units, the property owners were contacted to determine transition dates to new renters. Current renter contact information was established through this same methodology.

Following the creation of the above mentioned database, household information was merged with existing city parcel Geographic Information System (GIS) raster data. This allowed for spatial sampling of the population. Rather than utilize a simple random sampling technique which may disproportionately concentrate on some portions of the population at the expense of others, or a spatially systematic sampling technique which could inadvertently coincide with the grid street network that exists in this area, stratified random sampling was utilized (See Figure 3.2) to ensure maximum geographic coverage as outlined by Burt and Barber (1996) and Longley, Goodchild, Maguire, and Rhind (2001). Stratified sampling increases the precision of the estimates of variables that are related to the stratification variables and never harms the precision of sampling estimates (Fowler, 2002). Since one of the goals of this study was to determine if proximity to the trail affects physical activity levels, it is important to have a stratified sample of residents living both near the trail as well as further away. For this sample, stratification was based on random samples within local city blocks.

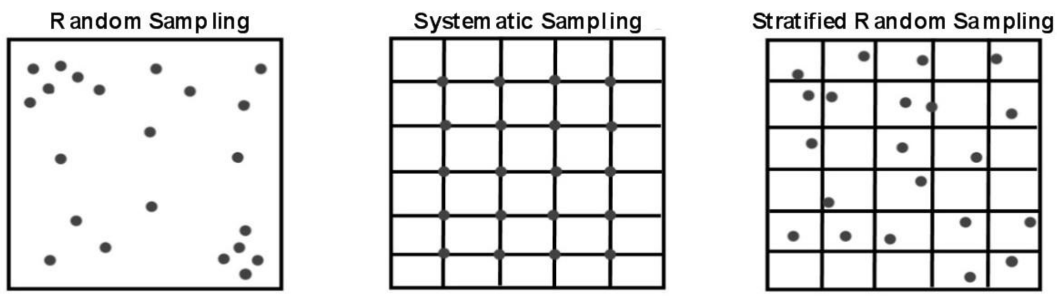

Figure 3.2 Spatial Sampling Techniques

The stratified random sampling was performed using ArcGIS software"s built in sampling technology to identify a sample of 2,211 households. Neighborhood blocks were identified as strata for the sampling procedure and the algorithm randomly selected representatives from each stratum. Due to the inherent potential for threats to validity that this type of sampling creates, the subsequent analyses included controls for distance, which encompass geographic sampling bias effects.

Figure 3.3 below shows the strata used for the sampling frame as well as the number of households selected within each strata (totaling 2,211).

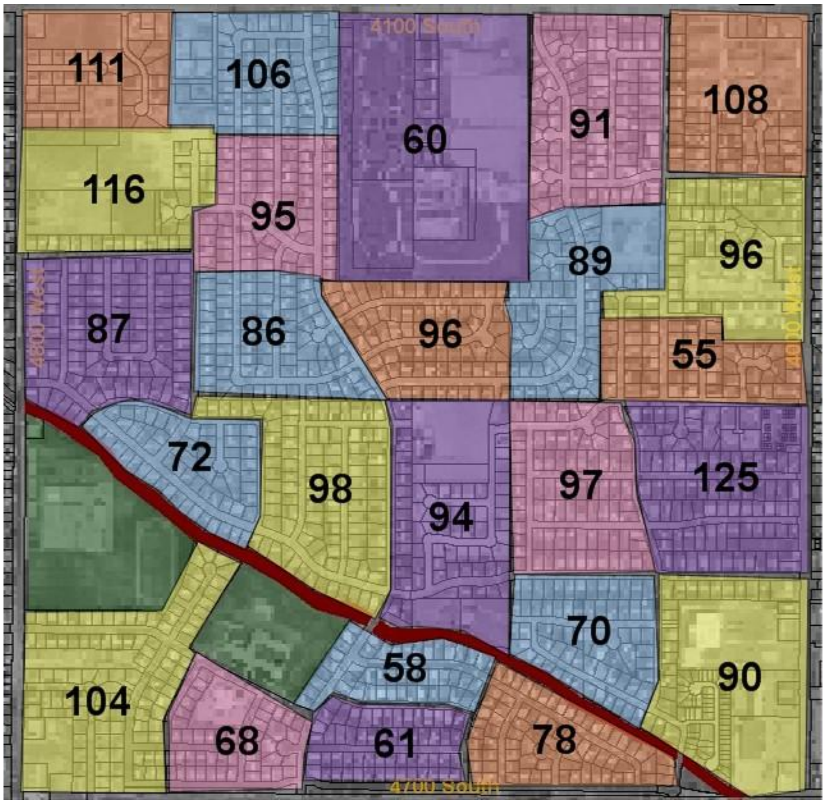

FIGURE 3.3 Sample Frame Strata and Sample Identification

Although Fowler notes an average of 70% response rates with mail only surveys (2002), this research sought to have a participating sample of at least 300 households and thus this sampling was based on a more conservative participation rate for multi-stage recruitment. The new resident sample is not strictly speaking a sample, but an entire population of the 206 households who moved into the study area after the trail‟s construction. All new households are included in the sample frame due to the smaller population size and potential for non-response. New residents are important for reasons other than exact geographic proximity to the trail, and therefore all should be included regardless of geographic location.

3.6 Methodological Bias

Three main threats to the internal and external validity of the pilot study have been identified. First, this study does not represent a truly experimental design. For this study to be truly experimental, a second study area would have been necessary in order to compare a non-trail sample to those households which were impacted by the trail"s construction. This would have proven extremely difficult as it would have required a second study area with demographics analogous to those within this study area. Additionally, in order to truly compare these two areas this second study area would be required to undergo identical transportation and land-use changes and similar household turnover. Although there are ways to control for a variety of exogenous factors and design that come closer to an experimental setting, they would exceed the resources available for this pilot project. The ascribed methodology was deemed adequate to fulfill the data requirements needed to answer the proposed research questions for this pilot study.

The second internal validity threat faced by this methodology is that of respondent self-selection, or the fact that only a percentage of individuals invited to participate will chose to do so. Inherent in any survey based study is the problem of response self-selection due to functions of personal and household characteristics. No matter how many surveys are sent out, the research staff cannot dictate the exact response rate. Since it would be nearly impossible to attain a 100% response or participation rate, all survey based research will have some inherent sampling bias.

The author therefore recognizes that those who chose to participate in this pilot study may have characteristically different behavior than those who chose not to participate. However, a comparison of the respondent demographics to the 2000 Census data (shown in Table 3.1) has established that the sample represented in this study is reasonably representative of the area"s population as a whole. This research includes control variables that are known to explain non-response behavior (age, sex, employment) as a tool known to decrease the potential for bias in findings.

The third and final identified threat to validity is that of generalizability. The author recognizes that no other area will be identical to the area studied in this research, and therefore no perfect generalization can be made from the behavior herein. This is an inherent threat to the external validity of the study. However, prior research has set precedent allowing generalizations to be made based on a majority of similar characteristics rather than identical circumstances.

The sample identification strategy seeks to minimize the impact of these three threats. By including the entire population of new residents and surveying them, we create a neighborhood level census of those moving to the area. The following contact and re-contact strategies are also beneficial to maintaining external validity.

3.7 Contact and Re-Contact

Before the initial research began, an announcement was posted in the West Valley City Newsletter which was delivered to each household within the city (September 2006). The announcement informed residents that a new and innovative research project is going to take place within their city and encouraged all those who are asked to participate to do so.

3.7.1 Household Questionnaire

The initial household questionnaire was mailed to the 2,211 sampled households. Each household received an introductory letter, the household questionnaire, and an addressed stamped envelope to return the questionnaire. The introductory letter described the nature of the study in general terms, and assured the participants that their personal information would be kept completely confidential, only being distributed in aggregate form. This introductory letter is included in Appendix A. The included return envelope was preprinted with the address of West Valley City Hall, in order to reinforce the credibility of the study to participants.

The household questionnaire mailing was sent out to the entire sample on November 15, 2006. The majority of completed questionnaires (85%) were returned by November 30, an additional 9% were returned by December 7th, and the last 6% were returned by December 22, 2006. In all, 290 Household Questionnaires were returned resulting in a 13.1% response rate (290 households; 796 individuals over age 5) from the original sample of 2,211 households (spatial distribution shown in Figure 3.4). Although the overall response rate is quite a bit lower than projected by previous research, 69% of respondents (199 households; 557 individuals over age 5) agreed to continue on and participate in the activity diary portion of the research which requires substantially more effort. Due to the projected high cost of sending a reminder mailing the decision was made not to re-contact the 1,922 households who failed to respond to the initial household questionnaire. However, a significant effort was made to re-contact and retain those households who agreed to continue in the process. It is of note that only two (2) of the original 2,211 questionnaires mailed were returned due to an incorrect address which suggests a highly accurate preliminary sample frame.

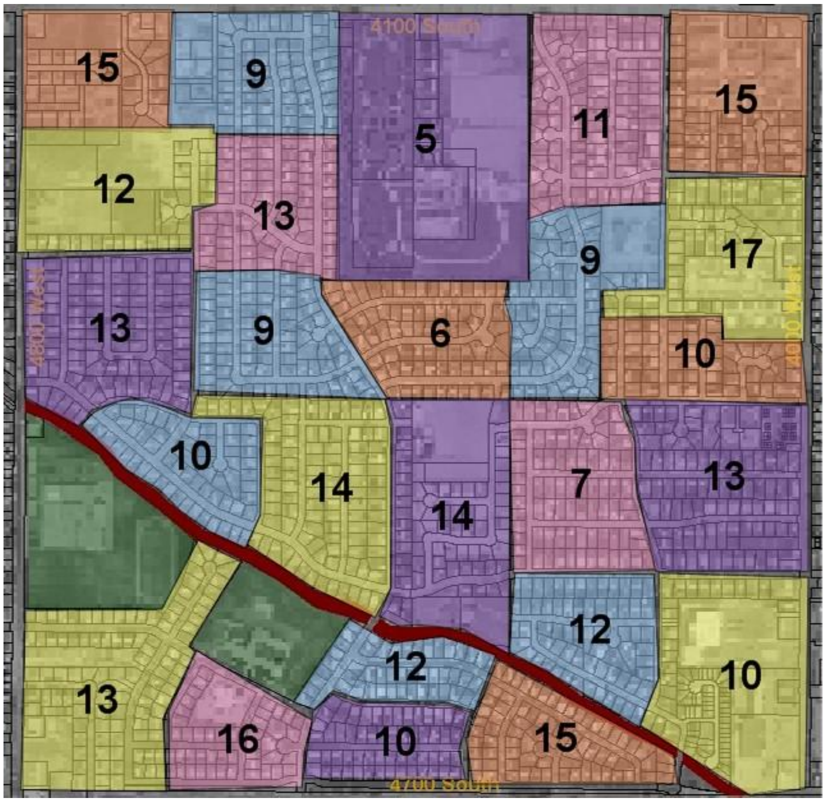

FIGURE 3.4 Spatial Distribution of Household Questionnaire Response

3.7.2 Activity Diaries

Following the analysis of the original household questionnaires 199 households were identified that were willing to continue participating in the data collection efforts. In order to acquire their behavioral data for analysis, single-day activity diaries were employed loosely based on the CentreSim project diary design (discussed in detail in Section 3.4).

The first wave of activity diary data collection occurred in February of 2007. Each household received a packet of materials containing a household letter, personalized activity diary packets for each family member over age 5 (as specified in the completed household questionnaires), and a postage paid return envelope. This first round of activity diary mailings was sent from the post office on February 6th 2007. By April 1st 2007, 65 households (consisting of 140 persons) had completed and mailed in their activity diary packets (resulting in a 33% response rate). The first participation drawing was held on March 30th, as designated in the household letter, and four households were selected to receive $25 gift cards to a local retail store. These households were subsequently acknowledged in the household letter accompanying the October 2007 activity diary to provide motivation for other households to continue their participation.

To raise the number of completed activity diaries and to ensure adequate participation in the subsequent data collection waves, the 134 households (417 persons) who had not returned their materials were sent duplicates of their original packets. These duplicate packets included another household letter similar to the first, but this resend letter (shown in Appendix B) contained a shaded text box that informed the household that their materials had not yet been received and that their input and participation were still very important. Each household was assigned to the same day of the week they had been in their initial mailing for consistency. Households were reminded of the available incentives (prize drawings) and encouraged to participate. By June 1, 2007 the activity diary resends had yielded responses from an additional 15 households (35 persons) which increased the wave‟s response rate to 40.8%. The spatial distribution of participants for Activity Diary 1 is shown in Figure 3.5.

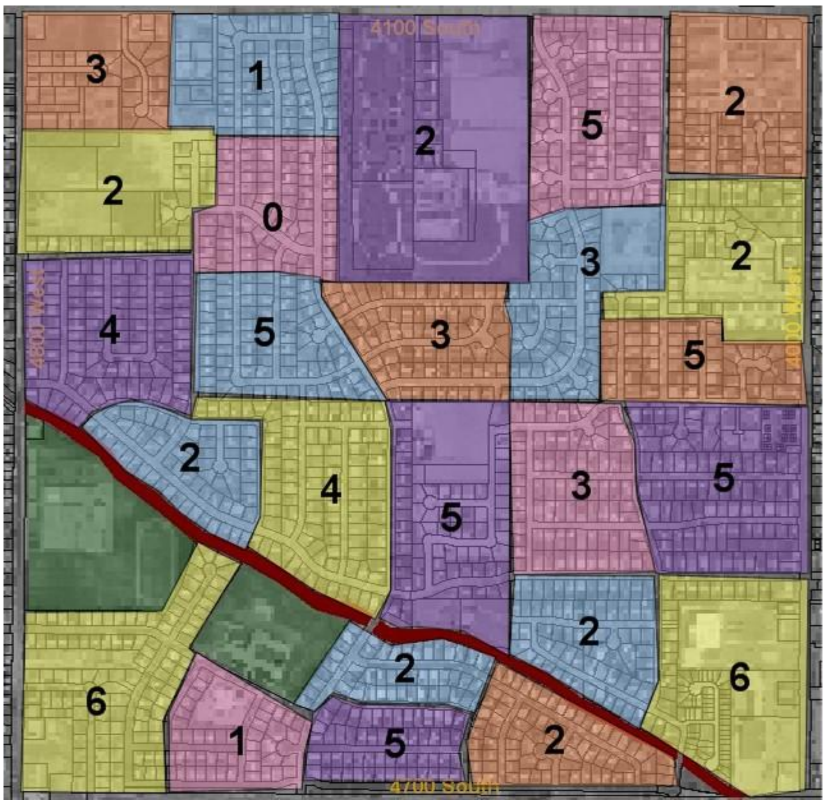

FIGURE 3.5 Spatial Distribution of Activity Diary 1 Response

Additionally, all of Activity Diary 1‟s responding households were complete households. That is, all members of the household over age 5 completed activity diary materials. Table 3.1 shows descriptive statistics for the respondents in Activity Diary Wave 1 (herein named AD1). The total number of activities in this and all subsequent tables includes trips as well.

In order to develop a rapport with the participants, each household was sent a hand written thank you note as soon as their activity diary packets were returned. The note consisted of the following notation:

> *Thank you for taking the time recently to participate in the West Valley City Travel Behavior Research Project. We appreciate your help.*
>
> *- Research Project Staff*

TABLE 3.1 Sample Characteristics for Activity Diary 1

<table>
<tr><th colspan="2">Sample Characteristics</th><th>Study Sample (Standard Deviation)</th><th>Academy Park Neighborhood*</th></tr>
<tr><td colspan="2">Number of persons in the sample (age 5+)</td><td>175</td><td>11,790</td></tr>
<tr><td colspan="2">Number of households in the sample</td><td>80</td><td>3,500</td></tr>
<tr><td colspan="2">Percent of males in the sample</td><td>46.8</td><td>48.5</td></tr>
<tr><td colspan="2">Number of persons per household</td><td>3.64</td><td>3.36</td></tr>
<tr><td colspan="2">Mean age of respondents</td><td>45</td><td>Not Available</td></tr>
<tr><td colspan="2">% of persons age 5-12</td><td>11.4</td><td rowspan="2">17.8</td></tr>
<tr><td colspan="2">% of persons age 13-15</td><td>2.2</td></tr>
<tr><td colspan="2">% of persons age 16-18</td><td>4.9</td><td>8.9</td></tr>
<tr><td colspan="2">% of persons age (18+)</td><td>81.5</td><td>66.3</td></tr>
<tr><td colspan="2">% of persons 65-85</td><td>22.3</td><td>5.0</td></tr>
<tr><td colspan="2">% of persons 85+</td><td>0.5</td><td>0.4</td></tr>
<tr><td colspan="2">Number of cars per household</td><td>2.50</td><td>2.66</td></tr>
<tr><td colspan="2">Number of bikes per household</td><td>2.01</td><td>Not Available</td></tr>
<tr><td colspan="2">% currently employed</td><td>54.2</td><td>72.5</td></tr>
<tr><td colspan="2">% possessing a driver‟s license</td><td>87.2</td><td>Not Available</td></tr>
<tr><td rowspan="3">Total Combined Household Income</td><td>≤$40,000</td><td>39.4%</td><td>41.2%</td></tr>
<tr><td>$40,001 to $80,000</td><td>40.4%</td><td>41.7%</td></tr>
<tr><td>≥ $80,001</td><td>20.2%</td><td>17.1%</td></tr>
<tr><td colspan="2">Number of trips per person</td><td>3.82 (2.22)</td><td rowspan="7"></td></tr>
<tr><td colspan="2">Number of activities per person</td><td>7.61 (3.30)</td></tr>
<tr><td colspan="2">Percentage of the sample reporting zero trips</td><td>9.7</td></tr>
<tr><td colspan="2">Mean physical activity time (minutes)</td><td>26.54 (40.17)</td></tr>
<tr><td colspan="2">Mean number of physical activity episodes</td><td>0.77 (1.09)</td></tr>
<tr><td colspan="2">Number of walking trips per person</td><td>0.54 (0.93)</td></tr>
<tr><td colspan="2">Number of biking trips per person</td><td>0.02 (0.21)</td></tr>
</table>

*U.S. Census Bureau (2000e)

Prior research (discussed previously) has suggested that personal contact through notes/cards makes participants feel more important and highly regarded, therefore making them more likely to participate through the extent of the project rather than drop out due to disinterest.

The second wave of activity diary data collection (AD2) occurred in October of 2007. Of the original 199 households which stated they were willing to continue participating in the data collection efforts, 196 were included (three households were removed due to relocation or death). Although 119 households from the sample did not participate in the first activity diary wave, their previous agreement to participate indicated that they may indeed be willing to participate during this second wave. It should also be noted that none of the 119 households at any time asked to be removed from the study sample when given the opportunity to do so. During this second activity diary wave each household received a packet of materials containing a household letter, personalized activity diary packets for each family member over age 5, and a postage paid return envelope.

The household letter thanked the household for participating in the data collection activities and encouraged those households who failed to return AD1, to participate in AD2. Additionally, winners from the previous wave‟s completion were recognized as a way to encourage additional participation and households were reminded about the incentives program for this wave as well as the grand prize. The letter once again described the contents of the packets and provided brief overview instructions for how to complete the materials. Each household was assigned to complete their diaries on the same day of the week specified in Wave 1, to eliminate selection bias and allow comparison of prior results. The household letter informed participants that a drawing would be held at the conclusion of the activity and 4 randomly selected households (who had returned completed activity diaries) would be awarded a variety of gift certificates to local West Valley City businesses. Households were again informed that if they participated in this wave, as well as the last remaining survey activity, they would be entered into a grand prize drawing at the conclusion of the project. The letter concluded by providing the household with contact information for the project staff (mailing address, phone number, and email). The household letter can be found in Appendix C.

AD2 was sent from the post office on September 24, 2007. As of November 1st 2007, 42 households (consisting of 105 persons) had completed and mailed in their activity diary packets (resulting in a 21.5% response rate). The participation drawing was held November 1st, as designated in the household letter and six households were selected to receive an assortment of gift certificates from local area businesses.

Due to the dramatic drop in participation between the first and second activity diary waves, duplicate activity diary materials were resent to non-participating households on November 2nd, 2007. This provided those who had not yet returned their activity diaries with an additional opportunity to do so. Rather than sending additional materials to all 154 households who had not yet returned their materials, this resend effort focused on households who had completed the first activity diary wave but for one reason or another had not completed the second. Due to the nature of this study, gaining data from those specific households was deemed to be more valuable than gaining new data from households which had not participated in the prior activity diary data collection. Although that would have increased response rates, it would not have improved data quality due to a lack of baseline data (travel behavior data from before the trail"s construction) from those same households.

In order to entice these households to participate once again, the resend packet included a gift certificate to a local confection shop, an amended household letter, and individual surveys and activity diaries for all persons over age 5. The amended household letter thanked each household for participating in all project activities thus far and encouraged them to continue their participation. In this letter, a list of project activities was given in the form of a checklist with those they had already completed checked off as a way to graphically show them how much they had already accomplished and to serve as motivation to continue for the remaining project activities. Households were also reminded that there would be prizes for participation in all project activities as well as a grand prize drawing. A copy of this letter can be found in Appendix C.

The resend effort for AD2 was successful and by December 1st, 2007 the activity diary resends had yielded responses from an additional 14 households (39 persons) which increased the wave‟s response rate to 28.5%. Each participating household from Activity Diary Wave 2 was once again sent a hand written thank you note as soon as their activity diary packets were returned. The text of the thank you note was consistent with notes sent following AD1 however a gift certificate from a local merchant was included in each note.

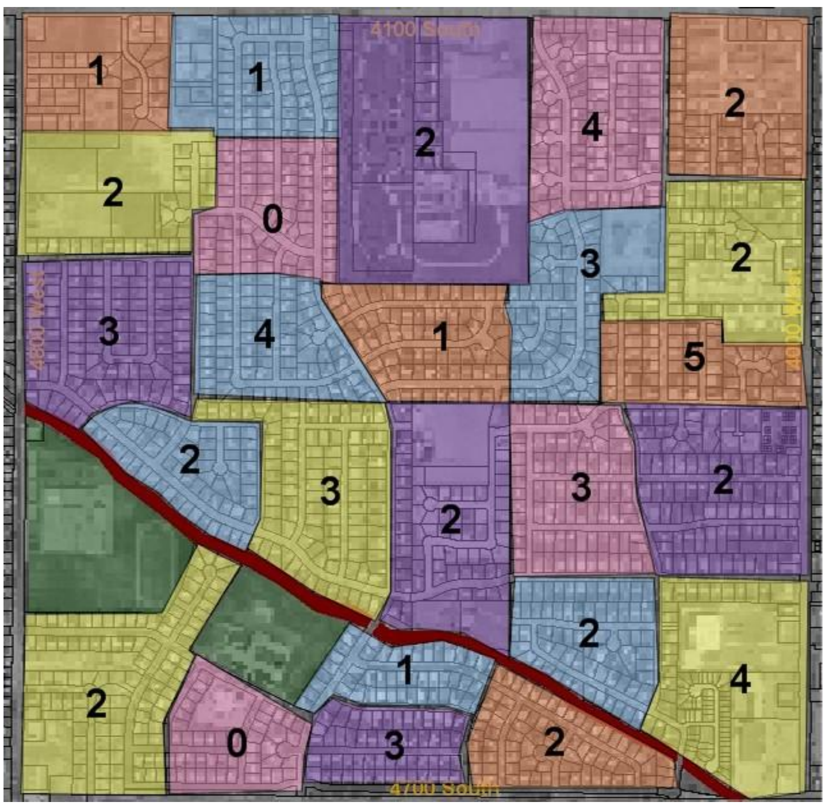

FIGURE 3.6 Spatial Distribution of Activity Diary 2 Response

Figure 3.6 above shows the spatial distribution of participation in Activity Diary 2, and Table 3.2 shows a summary of descriptive statistics for the same group.

TABLE 3.2 Sample Characteristics for Activity Diary 2

Sample Characteristics		Study Sample (Standard Deviation)	Academy Park Neighborhood*
Number of persons in the sample (age 5+)		144	11,790
Number of households in the sample		56	3,500
Percent of males in the sample		47.3	48.5
Number of persons per household		3.54	3.36
Mean age of respondents		47.5	*Not Available*
% of persons age 5-12		11.8	17.8
% of persons age 13-15		2.1	
% of persons age 16-18		3.5	8.9
% of persons age (18+)		82.6	66.3
% of persons 65-85		27.8	5.0
% of persons 85+		0.7	0.4
Number of cars per household		2.49	2.66
Number of bikes per household		1.97	*Not Available*
% currently employed		49.0	72.5
% possessing a driver‟s license		87.0	*Not Available*
Total Combined Household Income	≤$40,000	37.0%	41.2%
	$40,001 to $80,000	42.5%	41.7%
	≥ $80,001	20.5%	17.1%
Number of trips per person		3.81 (2.47)	
Number of activities per person		10.65 (4.53)	
Percentage of the sample reporting zero trips		10.4	
Mean physical activity time (minutes)		32.24 (58.15)	
Mean number of physical activity episodes		0.66 (1.12)	
Number of walking trips per person		0.44 (1.08)	
Number of biking trips per person		0.03 (0.20)	

*U.S. Census Bureau (2000e)

The third wave of activity diary data collection (AD3) occurred in January/February of 2008. This mailing concentrated on households who had participated in the prior activity diary data collections (88 households, 198 people). As mentioned above, gaining data from those specific households was deemed to be more valuable than gaining new data from households which had not participated in the baseline activity diary data collection (AD1). During this third activity diary wave each household received a packet of materials containing a household letter, personalized activity diary packets for each family member over age 5, and a postage paid return envelope.

The household letter thanked the household for continued participation in the data collection activities. Additionally, winners from AD2‟s prize drawing were recognized as a way to encourage additional participation. Household were reminded that this was the final project activity and that upon returning their activity diaries participating households would be entered in a Grand Prize drawing. The complete household letter can be found in Appendix D. This letter once again described the contents of the packets and provided brief overview instructions for how to complete the materials. This household letter also provided a check list of all project activities completed so far (including this last one) as a visual motivation informing participants that they were almost finished. Each household was assigned to complete their diaries on the same day of the week specified in Waves 1 and 2, to eliminate selection bias and allow comparison of prior results. The household letter informed participants that the Grand Prize drawing would be held on February 15th, 2008 and that randomly selected households (who had returned all completed activity diaries) would be awarded a variety of gift certificates to local West Valley City businesses as well a various large prizes (flat screen television, MP3 player, home stereo system, etc). The letter concluded by providing the household with contact information for the project staff (mailing address, phone number, and email).

The third wave of activity diaries was sent from the post office on January 7, 2008. As of February 15th 2008, 41 households (consisting of 107 persons) had completed and mailed in their activity diary packets (resulting in a 54% response rate). The final prize drawing was held on February 15th as designated in the household letter. A Grand Prize drawing was also held on February 15th for households who participated in all waves of data collection. Households were randomly selected to receive an assortment of prizes including: electronics (TV, DVD player, CD players), gift certificates from local area merchants and local restaurants, and other home amenities (scented candles and candle warmers).

Each participating household from AD3 was sent a thank you note as soon as their activity diary packets were returned. This thank you note included either their grand prize (if in gift certificate form) or instructions on when and where to pick-up their prize (City Hall). The letter once again thanked the household for their participation and provided contact information in case they had any remaining questions about the study.

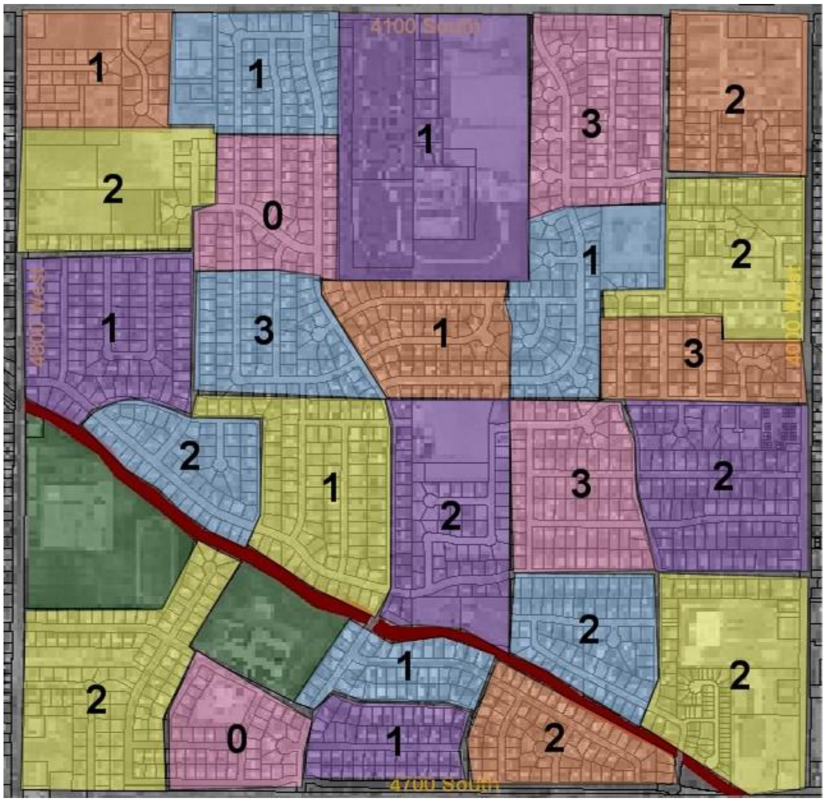

FIGURE 3.7 Spatial Distribution of Activity Diary 3 Response

Table 3.3 shows a summary of descriptive statistics for the respondents of Activity Diary 3 whose spatial distribution is shown above in Figure 3.7.

TABLE 3.3 Sample Characteristics for Activity Diary 3

Sample Characteristics	Study Sample (Standard Deviation)	Academy Park Neighborhood*
Number of persons in the sample (age 5+)	107	11,790
Number of households in the sample	41	3,500
Percent of males in the sample	45.8	48.5
Number of persons per household	3.49	3.36
Mean age of respondents	46.22	*Not Available*
% of persons age 5-12	10.7	17.8
% of persons age 13-15	1.0	
% of persons age 16-18	4.8	8.9
% of persons age (18+)	83.5	66.3
% of persons 65-85	24.2	5.0

% of persons 85+		1.0	0.4
Number of cars per household		2.29	2.66
Number of bikes per household		2.07	*Not Available*
% currently employed		51.4	72.5
% possessing a driver‟s license		88.8	*Not Available*
Total Combined Household Income	≤$40,000	39.3%	41.2%
	$40,001 to $80,000	40.1%	41.7%
	≥ $80,001	20.6%	17.1%
Number of trips per person		3.6 (2.01)	
Number of activities per person		11.05 (4.563)	
Percentage of the sample reporting zero trips		9.3	
Mean physical activity time (minutes)		30.69 (49.08)	
Mean number of physical activity episodes		0.65 (0.94)	
Number of walking trips per person		0.36 (0.86)	
Number of biking trips per person		0.01 (0.10)	

*U.S. Census Bureau (2000e)

3.7.3 New Resident Survey

The October 2007 and February 2008 waves of data collection also included a mailing to “new resident” households who had moved into the study area in the last 12 months) These households were identified through GIS data provided by West Valley City and Salt Lake County ownership records. This mailing included a letter to the household as well as a household survey. The household letter began by welcoming the household to the neighborhood and notifying them that they had been selected to participate in a survey to help city officials understand what draws new families to the area. Households were informed that their information would be kept completely confidential and would only be released in aggregate form, and that no third parties would contact them as a result of their participation in this study. They were informed that by returning this survey they would be entered into a drawing for local gift certificates. The letter closed by thanking them for their participation and providing contact information for the project staff. The included survey consisted of

20 questions focusing on characteristics that drew them to this particular neighborhood, and their household demographics. These households were asked to identify neighborhood characteristics which made them choose their current residence location, where they moved from, any other areas they looked for housing in, and their perception neighborhood safety. All questions were identical to those provided in the preliminary household survey and the individual surveys accompanying each activity diary (completed by all historical participants), in order to allow direct comparison between historical and new residents. A complete version of the new resident survey can be found in Appendix C.

The first wave of "new resident" surveys was mailed on September 24, 2007 and consisted of 120 households. As of November 1st, 2007 18 households (consisting of 75 persons) had completed and returned their "new resident" surveys (resulting in a 15% response rate). The second wave of "new resident" surveys was mailed in conjunction with AD3 on January 28, 2008, and consisted of 86 households. The materials sent to these household were identical to the materials sent to "new residents" in October 2007. As of March 1st, 2008 14 households (consisting of 42 persons) had completed and returned their "new resident" surveys (resulting in a 16.3% response rate). All together 32 new resident households consisting of 117 persons completed "new resident" surveys resulting in an 15.5% response rate. Table 3.4 shows sample characteristics for participating new residents.

TABLE 3.4 Sample Characteristics for New Residents

Sample Characteristics		Study Sample (Standard Deviation)	Academy Park Neighborhood*
Number of persons in the sample		117	11,790
Number of households in the sample		32	3,500
Number of persons per household		3.66	3.36
% of persons under age 5		18.8	10.6
% of persons age 5-12		15.4	17.8
% of persons age 13-15		2.6	
% of persons age 16-18		4.3	8.9
% of persons age (18+)		56.4	66.3
Number of cars per household		2.47	2.66
Number of bikes per household		1.84	*Not Available*
Total Combined Household Income	<=$40,000	13.7%	41.2%
	$40,001 to $80,000	81.2%	41.7%
	=> $80,001	5.1%	17.1%

*U.S. Census Bureau (2000e)

3.7.4 Trail Intercept Survey

At the conclusion of Activity Diary 3 following preliminary analysis of the data, it was deemed prudent to acquire additional qualitative data from individuals who were using the new trail (as opposed to just the sampled neighborhood residents). In order to gain information from trail users, an intercept survey was used. This exercise consisted of monitoring trail usage at three separate locations along the trail (one at each end and one point in the center) for four consecutive hours (to ensure an adequate sample) on two separate days (Saturday February 23, 2008 and Wednesday February 27, 2008). The research staff used a convenience sample to intercept individuals using the trail and invite them to answer a small number of questions. If the trail user consented they were asked about several key demographic variables including: age, possession of a driver‟s license, the number of cars owned in their household, their employment status, and sex (which was not asked, but rather identified by the researcher); additional questions provided information on trail usage. These questions were: how far from here do you live; how did you get to the trail today; why did you choose to use this trail; did you walk/jog/bike before this trail was constructed, and if so where; what do you like and dislike about this trail; and how frequently do you use this trail (times per week)? The researchers also noted what type of activity the individual was participating in (i.e. walking, jogging, biking, rollerblading, etc.). All questions were easily answered in 3-5 minutes, and participating individuals were then thanked for their time. Trail usage and intercept survey responses are shown below in Table 3.5 below.

TABLE 3.5 Trail Usage and Response for Intercept Survey

Data Collection Wave	Total Trail Users	Intercept Surveys Completed	Response Rate
Wednesday (1:00PM-5:00PM)	26	21	80.7%
Saturday (9:00AM-1:00PM)	17	10	58.8%
Total	43	31	72.1%

The response rate for individuals using the trail on Wednesday was relatively high (80.7%), most likely due to the larger number of young individuals who utilized the trail to travel home from school or other activities. The lower response on Saturday was due to a higher percentage of exercisers who were less willing to interrupt their activity to answer questions. Sample characteristics for trail users are shown below in Table 3.6.

TABLE 3.6 Sample Characteristics for Trail Users

Sample Characteristics	Sampled Trail Users	Academy Park Neighborhood*
Number of persons in the sample (age 5+)	31	11,790
Percent of males in the sample	38.7	48.5
Mean age of respondents	28.19	*Not Available*
% of persons under age 5	0.0	10.6
% of persons age 5-12	35.5	17.8
% of persons age 13-15	12.9	
% of persons age 16-18	6.4	8.9
% of persons age (18+)	45.2	66.3
% of persons 65-85	16.1	5.0
% of persons 85+	0.0	0.4
Number of cars per household	2.23	2.66
% currently employed	32.3	72.5
% possessing a driver‟s license	51.6	*Not Available*

*U.S. Census Bureau (2000e)

The trail users surveyed were for the most part very young (approximately 55% under age 18), however, there was a sizable percentage over age 65 as well (16.1%). That leaves slightly under 1/3 of trail users in the middle age category from 18-64. Because of this overrepresentation of young and old individuals, we see that only 32% of trail users were employed, and only 51.6% possessed a driver‟s license. The majority of trail users are female (61.3%), and the mean number of automobiles per household is fewer for trail users than for residents of the study area as a whole. These demographics will be revisited and discussed in Chapter 9.

With any data collection effort of this magnitude panel fatigue (as discussed previously) is expected. Table 3.7 shows the response for each wave of data collection.

The original household questionnaire was returned by 290 households consisting of 796 people. Of those 290 households, 196 (consisting of 557 people) agreed to participate in the activity diary portion of the study. Just over 40% of households who agreed to participate returned their first activity diary packet and 70% of those households continued their participation for Activity Diary 2 (as well as eight additional households who did not participate in Activity Diary 1). Activity Diary 3 yielded response from 41 households (107 people) representing 20.9% of the households who initially agreed to participate in the activity diary portion of the study.

TABLE 3.7 Response for All Waves of Data Collection

Data Collection Wave	# Households	# Persons
Household Questionnaire	290	796
Activity Diary 1	80	175
Activity Diary 2	56	144
Activity Diary 3	41	107
New Resident Survey	32	117
AD1 and AD2		121
AD2 and AD3		91
AD1 and AD3		98
AD1, AD2, and AD3	32	82

The bottom section of Table 3.7 shows the compound response for multiple waves. Some individuals, for whatever reason, chose to participate in only 2 of the 3 waves. Often times this trend consisted of half of a household participating but not the entire household (hence household totals are not shown). The response rate for individuals participating in various wave combinations throughout the study as well as the response for individuals and household who participated in all three activity diary waves. At the conclusion of the study 32 households containing 82 individuals participated in Activity Diaries 1, 2 and 3. This is a response rate of 16.3% from the original 196 households who agreed to participate, and 40% for households who began AD1. Table 3.8 below shows the sample characteristics for households who participated in all three activity diary waves as well as comparative population figures from the 2000 U.S. Census for the Academy Park neighborhood (U.S. Census Bureau, 2000e).

TABLE 3.8 Sample Characteristics for All Wave Respondents

Sample Characteristics		**Study Sample (Standard Deviation)**	**Academy Park Neighborhood***
Number of persons in the sample (age 5+)		82	11,790
Number of households in the sample		32	3,500
Percent of males in the sample		45.1	48.5
Number of persons per household		3.51	3.36
Mean age of respondents		47.77	*Not Available*
% of persons age 5-12		12.5	17.8
% of persons age 13-15		1.3	
% of persons age 16-18		3.7	8.9
% of persons age (18+)		82.5	66.3
% of persons 65-85		27.5	5.0
% of persons 85+		1.3	0.4
Number of cars per household		2.21	2.66
Number of bikes per household		2.06	*Not Available*
% currently employed		47.6 62.5**	72.5
% possessing a driver‟s license		86.6	*Not Available*
Total Combined Household Income	≤$40,000	37.8	41.2%
	$40,001 to $80,000	43.9	41.7%
	≥ $80,001	18.3	17.1%

*U.S. Census Bureau (2000e)
**Rate for sample adults age 18-65

As shown above, this sample is considerably different than the surrounding study area in specific areas. This reveals a need to control for exclusive differences in the analysis. It should be noted that a comparison between this sample and the Census 2000 data suffers from a difference in vantage and geography.

The average household size in the sample is relatively larger than the surrounding population with 0.15 more persons per household. The breakdown of ages within these households is also different. Sample households have more young children (under age 15) and seniors (over age 65) that the total population, suggesting the need to control for age in the analysis. This however, can be beneficial because previous research has shown that the very young and very old are most likely to utilize active modes of transportation and these groups are often underrepresented in research as described previously (Burbidge, Goulias, and Kim, 2006, Ewing et al 2003, and Pucher and Renne 2003). Due to the large number of very young and senior participants there is also a significant difference between the employment rate for the study sample and the study area, however, upon examining the employment rate for adults in the sample (ages 18-65), we find 62.5% currently employed which is notably closer to the study population rate. This sample shows nearly 0.4 fewer automobiles per household than the general population of the study area once again suggesting a need for controls. The income of the study area is very comparable to the study area as a whole suggesting a relatively representative economic sample.

3.8 Analysis of General Travel Behavior

The following section provides a preliminary breakdown of the general travel behavior of the sample including trip making frequencies, activity participation, weekday variation, duration, home based and linked trip information.

TABLE 3.9 Travel Behavior Characteristics for All Waves

	AD1	AD2	AD3
Number of trips per person	3.82 (2.22)	3.83 (2.46)	3.60 (2.10)
Number of activities per person	7.61 (3.30)	10.72 (4.45)	11.05 (4.56)
Mean physical activity time (minutes)	26.67 (40.17)	32.47 (58.15)	30.69 (49.08)
Mean number of physical activity episodes	0.77 (1.09)	0.67 (1.12)	0.65 (0.94)
Number of walking trips per person	0.53 (0.93)	0.43 (1.08)	0.36 (0.86)
Number of biking trips per person	0.02 (0.21)	0.03 (0.20)	0.01 (0.10)

*Standard deviation shown in parenthesis

Table 3.9 shows the general breakdown of general travel behavior, activity participation, physical activity, and active travel behavior across all waves of data collection. The total number of trips is stable across AD1 and AD2 with a slight decrease in trip making in AD3. Activity participation increased with each wave. The total time spent participating in physical activity was greater in AD2 than in AD1 or AD3, and the number of physical activity episodes was higher in AD1, but was comparable in AD2 and AD3. The mean number of walking trips decreased in each subsequent wave, while the mean number of biking trips was inconsequential in all waves.

For AD1, the frequency of trips varied across the spectrum. As shown in Figure 3.8, there was a high frequency of individuals reporting zero trips (27% of respondents). This is important to consider as it can skew the mean and standard deviation for the sample. The mean number of trips for AD1 is 3.82 (*SD = 2.22*).

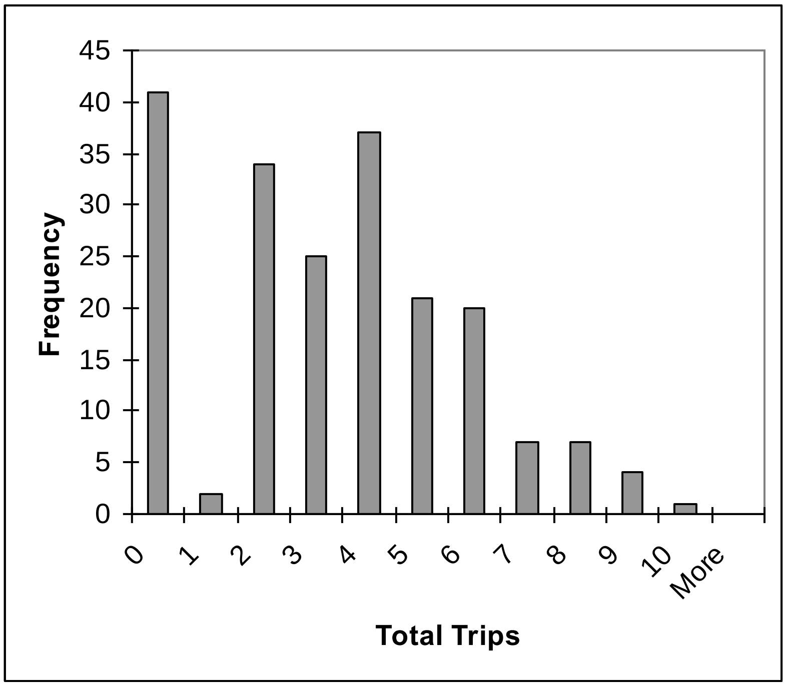

FIGURE 3.8 Activity Diary 1 Trip Frequency

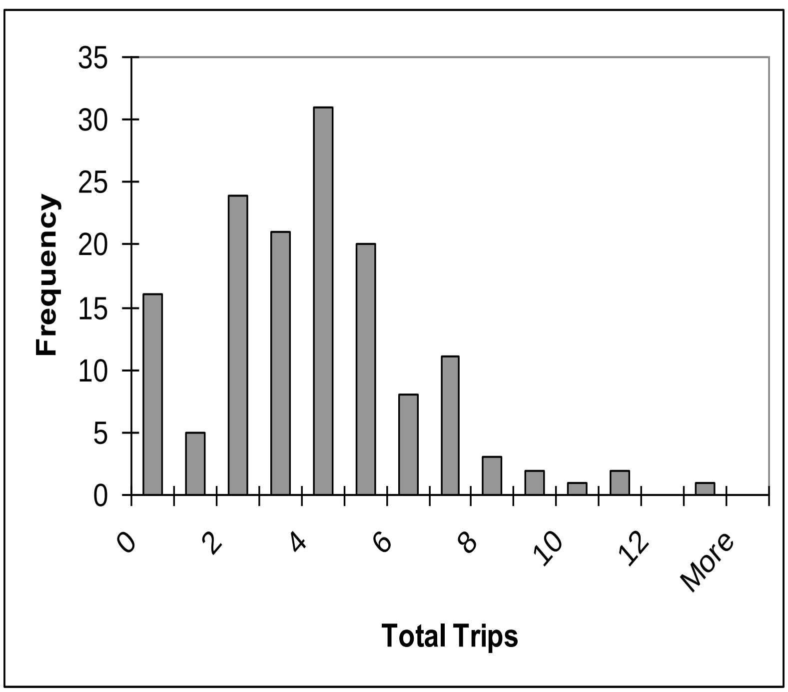

FIGURE 3.9 Activity Diary 2 Trip Frequency

The same pattern held true for Activity Diary Wave 2 (shown below in Figure 3.9). Fewer participants both numerically and proportionately (14%) reported taking zero trips than in AD1. The mean number of trips taken in AD2 is 3.83 (*SD = 2.46*).

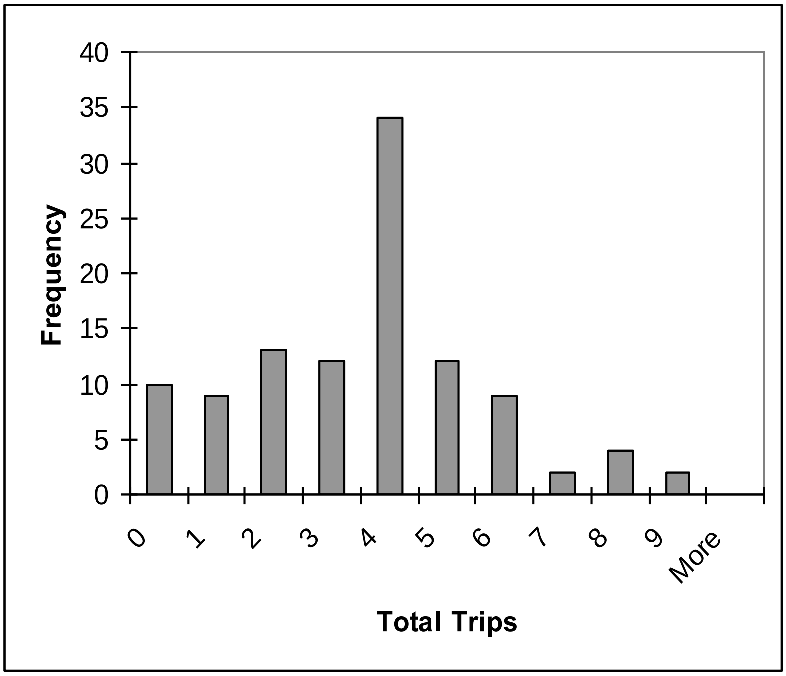

FIGURE 3.10 Activity Diary 3 Trip Frequency

AD3 saw a large drop off in the number as well as proportion of individuals taking zero trips (12%). Additionally, the trip distribution was relatively level with a spike at 4 trips per day (Figure 3.10). The mean number of trips taken in AD3 is 3.60 (*SD = 2.10*).

The pattern shown above for total trips did not hold true for activity participation. No respondents reported participating in zero activities (which would theoretically be impossible as even sitting idle all day would be considered one activity). To better compare the data for these three waves of data collection, the following table (3.10) shows the mean and standard deviation for total number of trips by wave; including those who reported zero trips, and excluding those who reported zero trips.

TABLE 3.10 Mean Total Trips by Activity Diary Wave

	Total Trips (Mean)	
	Including 0-Trip Persons	**Excluding 0-Trip Persons**
AD1	3.82 (2.22)	4.23 (1.93)
AD2	3.83 (2.46)	4.28 (1.29)
AD3	3.60 (2.10)	3.97 (1.84)

*Standard deviation is given in parenthesis

This table allows us to better understand variation between waves for individuals who did participate in trip making. Although the mean number of trips taken during AD1 and AD2 were comparable, the mean number of trips for AD3 was significantly lower. This is unexpected as AD1 and AD3 take place during almost the exact same week of the year (in 2007 and 2008 respectively) which would account for any seasonal variation. One explanation for this is that perhaps individuals who were likely to participate in higher levels of trip making found the task of completing an activity diary cumbersome and elected not to continue their participation in AD3. Eliminating individuals who took zero trips from the analysis brings the mean number of trips in AD1 and AD2 up to a level comparable with other areas across the nation (Hu and Reuscher, 2001), but AD3 remains considerably lower. All subsequent analyses regarding trips will include individuals who reported taking zero trips for completeness, however, zero trips and related selectivity (people that make no trips are qualitatively different than trip makers) will be accounted for using a zero-inflation Poisson regression models (described in detail later).

Table 3.11 below shows the breakdown of trip frequency for each wave by sex and employment characteristics. Employed women took significantly more trips than every other group of travelers in AD1 and AD2, but in AD3 employed males participated in the most trips. Also in AD3 the group participating in the fewest number of trips changed from unemployed men (in AD1 and AD2) to unemployed women. In all waves, employed individuals took more trips than unemployed individuals, but in AD3 employed women took nearly 1 trip less per day than they had in AD2. This information provides guidance in the coming analysis, as both sex and employment will need to be controlled for in all analyses of travel behavior.

TABLE 3.11 Mean Trip Frequency by Sex

	Men		**Women**	
	Employed	**Unemployed**	**Employed**	**Unemployed**
AD1	3.67 (1.99)	3.22 (1.90)	4.22 (2.13)	3.61 (2.87)
AD2	3.72 (1.92)	3.18 (2.33)	4.65 (2.23)	3.75 (2.95)
AD3	4.31 (1.85)	3.17 (2.04)	3.86 (1.89)	3.03 (2.41)

*Standard Deviation is given in parenthesis

As mentioned in the methodology section of this document, an equal number of households were systematically assigned to each day of the week for activity diary completion (discussed in detail in Section 3.4). As shown below, individuals were more likely to respond on certain days than on others.

TABLE 3.12 Sample Response by Day of the Week

Day	AD1		AD2		AD3	
	Count	%	Count	%	Count	%
Monday	38	21.7	31	21.5	29	27.1
Tuesday	30	17.1	21	14.6	7	6.5
Wednesday	28	16.0	25	17.4	23	21.5
Thursday	22	12.6	14	9.7	16	14.9
Friday	35	20.0	34	23.6	21	19.6
Saturday	12	6.9	7	4.9	9	8.4
Sunday	10	5.7	12	8.3	2	1.9
Total Persons	*175*	*100.0*	*144*	*100.0*	*107*	*100.0*

*"Temp" refers to the daytime high temperature for the day completed.

Although households were assigned to specific days to avoid possible bias toward personal selection of a specific day of the week, it seems that there may be some response bias with individuals selecting whether or not to respond based on the day of the week they were assigned (shown in Table 3.12).

Monday, Wednesday, and Friday seemed to be the preferred completion day as individuals assigned to those days were more likely to return their completed materials (especially through AD2 and AD3). For respondents assigned to the weekend days of Saturday and Sunday, response was especially low. This could be because households in the sample have set schedules on specific weekdays and are thus more willing to participate, while households assigned to weekends may see those days as having higher demand for recreational activities or relaxation, and thus they do not want to participate in something that feels like an assignment or work.

The following table (3.13) shows the differences in trip making and activity participation for each day of the week.

TABLE 3.13 Mean Trips and Activities by Day of Week

	AD1		AD2		AD3	
Day	Trips	Act.	Trips	Act.	Trips	Act.
Monday	3.35 (2.38)	7.00 (3.93)	4.23 (2.97)	12.32 (5.14)	3.62 (2.01)	11.79 (4.36)
Tuesday	3.06 (1.81)	7.38 (3.46)	3.38 (2.06)	8.86 (3.80)	2.43 (2.15)	11.29 (4.31)
Wednesday	3.66 (2.39)	6.22 (3.77)	4.56 (1.83)	10.72 (4.16)	3.96 (2.05)	11.00 (5.19)
Thursday	2.85 (1.96)	5.48 (3.57)	2.86 (1.75)	8.29 (3.26)	4.00 (1.79)	10.50 (4.62)
Friday	3.97 (2.76)	6.87 (4.21)	4.51 (2.56)	10.63 (4.50)	3.33 (2.63)	10.57 (5.10)
Saturday	4.77 (2.92)	8.46 (3.64)	3.57 (1.72)	13.71 (5.35)	3.78 (1.48)	10.67 (3.61)
Sunday	1.63 (2.22)	5.63 (5.25)	1.08 (1.44)	10.33 (3.75)	2.00 (2.82)	11.00 (0.00)

*Standard deviation shown in parenthesis
**Shaded boxes identify statistics with fewer than 10 observations

Trips are taken with higher frequency on Monday, Wednesday, Friday, and Saturday with fewer trips taken on Tuesday, Thursday, and Sunday. Monday, Tuesday, Friday, and Saturday, clearly show a higher frequency of activity participation than the middle of the week or Sunday. Weekend trips decreased between AD1 and AD2 while activity participation increased. Trip making between AD2 and AD3 decreased on every day except for Thursday (Saturday and Sunday are not representative in AD3 due to the low number of observations (<10)). Activity participation increased mid-week (Wednesday and Thursday) between AD2 and AD3, while decreasing through the weekend. This reinforces prior research by Pas and Koppelman which discussed day to day variability in travel behavior (1986). In order to control for any potential bias represented by response rates of different days (shown above), the day of completion will be added as a control variable in the analysis portion of this research.

In order to identify significant changes in specific behaviors in the later sections, it is first important to understand how the sample spent their time. Table 3.14 shows a complete breakdown of activity participation for each of the activity diary waves. This table includes the average amount of time individuals spent participating in each activity, as well as what percentage of their waking hours that time constituted.

TABLE 3.14 Mean Duration of Activities

	AD1		**AD2**		**AD3**	
Day	Mean*	%**	Mean	%	Mean	%
Work	292	32.66	179	20.95	224	24.22
Exercise	28	3.10	36	4.28	27	2.93
Errands	25	2.80	18	2.15	17	1.90
Visiting	12	1.34	20	2.40	13	1.40
Escorting	14	1.61	6	0.68	6	0.66
School	87	9.47	52	6.06	62	6.70
Shopping	23	2.54	18	2.17	17	1.88
Dining	59	6.58	72	8.52	79	8.50
Appointment	18	2.03	24	2.83	22	2.34
Traveling to Another Mode	1	0.09	1	0.13	1	0.14
Watching TV	79	8.79	87	10.14	116	12.53
Other Home Activities	181	20.17	250	29.37	212	22.91
Other Recreation	34	3.82	49	5.79	85	9.21
Returning Home	35	3.89	33	3.88	42	4.52
Religious Services	12	1.38	5	0.65	2	0.20
Total	900	100.00	850	100.00	925	100.00

*Time-use in minutes
**Percentage of average waking hours

Activity participation changed quite a bit from AD1 to AD2. The mean amount of time spent awake decreased slightly from 900 minutes to 850 minutes. The percentage of time spent at work decreased substantially from 32.66 in AD1 to 20.95 in AD2. There was an increase in the percentage of time spent visiting, dining, watching television, participating in other home activities, and participating in other recreation during that time, and a decrease in the amount of time spent at school, and at religious services. Between AD2 and AD3 there was an increase in the percentage of time spent at work and school, as well as time spent watching television and participating in other recreation. The data shows a decrease in the amount of time spent exercising, running errands, visiting, and shopping. This change in behavior from AD2 to AD3 seems to mirror an opposite change which took place between AD1 and AD2 suggesting some seasonal variability in time use. For example, the results above show that the average time spent at work is higher in the winter and lower in the summer, while time spent exercising is lower in the winter and higher in the summer.

Next, an analysis of trip-making behavior shows that individuals participated in the largest percentage of trips for work, followed by errands (and to return home from prior trips). Visiting, dining, and traveling to another mode resulted in the fewest number of trips. Table 3.15 shows that between AD1 and AD2 there was a slight decrease in the percentage of total trips related to work, school, and recreation, while there was a marked increase in the percentage of total trips related to errands, visiting, and traveling to another mode. From AD2 to AD3 there was an increase in work, shopping, escorting, appointment and recreation trips, and a decrease in trips for exercise, visiting, dining, religious services and returning home. There was very little change in trips for school or traveling to another mode. This data shows the same pattern described above alluding to some level of seasonal variation. AD1 and AD3 show relatively similar patterns with regard to behavior, while AD2 shows an up or downturn in the number of trips taken for specific purposes. Trips for exercise are more frequent in the summer than in the winter, while work trips, escorting, and shopping trips are more prevalent in the winter.

TABLE 3.15 Mean Trip Making Behavior by Activity Type*

Activity Type	AD1	AD2	AD3
Work	18.3	12.3	14.5
Exercise	6.4	7.1	3.1
Errands	8.8	12.7	10.1
Visiting	2.4	5.6	2.3
Escorting	5.7	4.0	5.7
School	8.6	3.6	3.9
Shopping	7.3	3.8	5.2
Dining	3.7	3.3	2.3
Appointment	3.7	4.5	9.6
Traveling to Another Mode	0.7	1.4	1.6
Other Recreation	7.0	2.7	3.4
Religious Services	1.6	1.3	0.3
Returning Home	25.6	37.7	27.9
Total Trips	100.00	100.00	100.00

*Numbers represent percentage of total trips by each trip type

After understanding the number of trips taken, it is important to identify how long each trip took on average. The average duration for all trips was around 30 minutes for all waves (see Table 3.16). This confirms Janelle"s assumptions regarding travel time thresholds (2004). Work trips were generally near the sample mean at about one half of an hour in length, comparable to trips for errands, visiting, and escorting someone. This time threshold was exceeded for traveling to other recreation (not considered exercise - with the exception of AD3), which would be expected because of the large recreational draw of the nearby Wasatch Mountains (skiing, mountain biking, hiking, fishing) which are located approximately a 60 minute drive from the study area.

TABLE 3.16 Mean Trip Duration by Activity Type*

Trip Type	AD1	AD2	AD3
Work	36.27 (40.11)	29.66 (26.78)	28.16 (25.61)
Exercise	54.86 (41.19)	41.28 (32.19)	57.08 (22.61)
Errands	26.44 (31.74)	29.07 (30.87)	37.54 (49.22)
Visiting	30.15 (29.37)	24.77 (32.21)	18.00 (9.91)
Escorting	38.52 (40.21)	35.59 (50.65)	27.55 (33.79)
School	16.22 (10.84)	17.40 (9.21)	13.87 (8.17)
Shopping	61.25 (66.37)	70.48 (88.33)	29.80 (24.30)
Dining	48.26 (16.77)	44.72 (29.83)	14.22 (7.45)
Appointment	40.10 (41.04)	35.80 (28.09)	18.24 (13.19)
Traveling to Another Mode	28.75 (6.29)	25.00 (13.36)	21.67 (14.72)
Other Recreation	93.55 (72.33)	102.67 (157.23)	23.08 (30.18)
Religious Services	6.88 (6.97)	7.86 (5.67)	5.00 (0.00)
Returning Home	23.66 (24.74)	23.14 (21.56)	29.52 (63.08)
All Trips	29.49 (37.04)	31.43 (42.90)	28.17 (35.37)

*Numbers represent mean trip length in minutes (standard deviation in parenthesis)

For the first two activity diary waves, shopping trips, dining trips, and appointments also took a bit longer than average, but in AD3 these trips are cut relatively short, as were recreation trips. The shortest trips were for religious purposes and traveling to school. This is also expected because school districts are arranged geographically with students assigned to local schools (generally in close proximity to their home). Also, the majority of residents in this study area who attend religious services noted attending a local neighborhood community church.

One important thing to note is that coinciding almost directly with AD3 was a slowdown in the national economy due to a mortgage financing crisis and the rising price of oil (approximately $100 per barrel at that time). Because of this, the local and national news spent a great deal of time discussing the potential for economic recession and financial downturn. Over the duration of the study we see a distinct change in travel times. Times were relatively stable in AD1 and AD2 and dropped substantially in AD3, which coincided almost directly with this economic downturn. Necessary trips such as work, school, traveling to another mode, and returning home, remain stable in their reported travel times, but optional trips such as shopping, dining, and other recreation, which may be considered extravagances, were cut short when compared to prior waves. This is potentially due to a fear of national economic problems which spurred individuals in the study (as well as the national population) to conserve spending on discretionary items, including unnecessary travel.

An important travel behavior concept to take into consideration for this research is the notion of trip chains. A trip chain is defined as a series of consecutive trips taken between a single origin and destination. In order to optimize efficiency in travel, individuals link their trips by pooling trip purposes into one chain (i.e. from home to store, store to appointment, appointment to dining, and dining to home) rather than taking multiple separate trips. Below, Table 3.17 shows the average number of trip chains taken over the course of the day per person. When this number is close to one it shows that individuals are chaining a large number of trips for efficiency in travel, which may explain the smaller number of overall trips per person. The higher the number of trip chains, the lower the number of trips per chain and vice versa.

TABLE 3.17 Average Linked Trips per Person

	AD1	AD2	AD3
Trips chains (per person)*	1.14 (1.98)	1.61 (1.77)	1.36 (1.84)
Mean Trips per trip chain	3.90 (2.32)	2.65 (3.27)	2.63 (3.18)

*Standard deviation shown in parenthesis.

Study respondents participated in an average of 1.14 trips chains per day in Activity Diary Wave 1 with a mean of 3.9 destinations or mini-trips per chain. This exhibits a high level of efficiency in travel with the number of trip chains being relatively close to 1 for the sample. This sample also shows a larger number of trips per trip chain which would be expected. In AD2 participants exhibited an average of 1.61 trip chains with 2.65 trips per chain. Activity Diary Wave 3 similarly shows 1.36 trip chains per person with an average of 2.63 trips per chain. The data above shows that as the number of trip chains increases in AD2 the number of trips per chain decreases also showing a decrease in travel efficiency. In AD3 we see fewer trip chains than in AD2, but a comparable number of trips per chain which is representative of fewer overall trips by participants in that wave.

Table 3.18 below shows mode choice by wave, and it is evident that a large majority of trips in this study utilized automobile transportation (over 80% per wave). Between AD1 and AD2 and again between AD2 and AD3 automobile mode share also increased while walking decreased; transit and bicycle use remained nearly the same. This data clearly shows that active mode choice in on the decline in this sample as time passes.

TABLE 3.18 Unlinked Mode Choice by Activity Diary Wave

Activity Type	AD1	AD2	AD3
Automobile	81.4%	86.1%	87.3%
Transit	4.4%	2.2%	2.3%
Walk	13.7%	11.1%	9.9%
Bike	0.6%	0.7%	0.5%

One of the benefits of an activity diary is the opportunity to classify non-travel time-use. By identifying activities that took place in a stationary location (herein referred to as home-based) we see that work, dining, watching television, and participating in "other home activities" represented the highest frequency of participation. Table 3.19 shows a breakdown by activity type for all non-travel activities as reported in the three activity diaries. This data helps to reveal the larger behavioral picture. For example, above we see that the amount of time spent in exercise increased between AD1 and AD2, but exercise as a percentage of total home-based activities decreased by 4% which suggests that during AD2 the exercise accumulated may have been a part of active trip making and not at home exercise. Likewise we see that other home activities as a percentage of total non-travel behavior (between AD1 and AD2) increased by nearly 7%, while the mean total time spent participating in other home activities during the same time period increased by 9%. Between AD2 and AD3 there are similar patterns, and the percentage of time spent in most activities remained relatively constant. There was a decrease in the percentage of activities spent visiting, and an increase in work, school, appointments, and other recreation. While "other home activities" make up 11% fewer of the total home-based activities, average time spent in other home activities decreased by only 7%.

TABLE 3.19 Average Home-Based Activities by Type*

Activity Type	AD1	AD2	AD3
Work	14.3	7.3	9.7
Exercise	7.2	3.0	4.2
Errands	0.3	1.5	1.1
Visiting	0.9	2.8	1.1
Escorting	0.5	0.1	0.1
School	6.3	2.3	3.5
Shopping	1.8	2.4	2.8
Dining	15.6	20.9	22.1
Appointment	3.0	1.7	3.3
Watching TV	10.4	12.3	13.1
Other Home Activities	33.8	39.4	28.0
Other Recreation	4.2	6.1	10.6
Religious Services	1.2	0.5	0.1

*Numbers represent percentage of non-travel activities

Finally, it is important to understand the impact of demographics on total trip and activity behavior before beginning any in-depth analysis. Using a Zero-inflated

Poisson Regression Model, the total number of trips for each wave was run against each individual‟s age, sex, household income, driver‟s license possession, number of children in the household, number of household cars, residential distance from the trail, employment status, and activity diary completion day.

A Poisson regression model is a nonlinear regression model for count data such as trips, activities, or any number of episode occurrence (Ma and Goulias, 1997). The Poisson regression model, "specifies that each y_i is drawn from a poisson distribution with parameter $\lambda_{i,}$ which is related to the exogenous regressors x_i. Greene (2003) shows that "the probability of making y trips is then:

$$\text{Prob}(Y_i = y_i | x_i) = \frac{e^{-\lambda_i} \lambda_i^{y_i}}{y_i!}, y_i = 0,1,2....$$

The most common formulation for $\lambda_{i,}$ is the loglinear model,

$$\ln \lambda_i = x_i' \beta .$$

The expected number of events per unit period is given by

$$\text{E}[y_i | x_i] = Var[y_i | x_i] = \lambda_i = e^{x_i' \beta} .$$

So

$$\frac{\partial \text{E}[y_i | x_i]}{\partial x_i} = \lambda_i \beta \quad ."$$

To recognize the presence of many observations with no events during the unit period, the zero-inflated Poisson model is formulated as a split population model which produces two sets of coefficients. The first set provides coefficients which predict the count of the dependent variable (as shown above). The second set runs a binary logit probability model which determines whether a zero or a nonzero outcome occurs. The model that "controls for excess zeros in the data (Greene, 2003)" is:

$$\text{Prob}\left(y_i = 0 \middle| x_i\right) = e^{-\theta}$$

$$\text{Prob}\left(y_i = j \middle| x_i\right) = \frac{\left(1 - e^{-\theta}\right) e^{-\lambda_i} \lambda_i^j}{j!\left(1 - e^{-\lambda_i}\right)}, j = 1,2,.....$$

To identify if a zero-inflation Poisson regression is appropriate, a Vuong test is run to identify if the sample is skewed by excess zeros. If the first iteration of the model does not pass the Vuong test a traditional Poisson model can be used. Within the zero-inflated portion of the model, the independent variables are identified with the maximum likelihood of producing a zero response.

Table 3.20a below shows that for AD1 the total number of trips was impacted significantly by sex, household income, automobile ownership, and completion day. Males and households with higher income were less likely to participate in trips, while households with two automobiles and those who completed their activity diaries on Wednesday, Friday and Saturday were significantly more likely to take trips. The zero-inflation analysis shows that having a driver‟s license is significant at determining zero trips, while those who are currently employed are significantly unlikely to take zero trips.

TABLE 3.20a Demographics and Total Trips for AD1

	AD1 Total Trips		
	Coefficients	**z-statistic**	p-value
Young (5-17)	-0.053	-0.20	**0.838**
Middle (18-64)	0.194	0.87	**0.384**
Male	-0.169	-2.17	**0.030**
# Children	0.046	1.48	**0.138**
HH Income	-0.458	-2.42	**0.016**
License	-0.078	-0.43	**0.669**
1 Car	0.167	0.53	**0.598**
2 Cars	0.610	1.94	**0.053**
3+ Cars	0.510	1.67	**0.096**
Distance to Trail	0.000	1.12	**0.261**
Employment	-0.027	-0.29	**0.771**
AD Monday	0.401	1.56	**0.119**
AD Tuesday	0.311	1.14	**0.255**
AD Wednesday	0.669	2.56	**0.011**
AD Thursday	0.395	1.49	**0.135**
AD Friday	0.765	2.79	**0.005**
AD Saturday	0.663	2.39	**0.017**
_Constant	0.512	1.14	**0.255**
Zero Inflate			
Employment	-3.195	-2.43	**0.015**
# Children	0.663	0.58	**0.516**
HH Income	-0.661	-0.74	**0.462**
License	21.013	16.85	**0.000**
_Constant	-20.939	-17.61	**0.000**
Number of Cases	***175***		

*Age 65+, 0 Cars, and Completion on Sunday, used as reference categories

For AD2, the same pattern held true, with age, number of children, automobile ownership, and completion day all holding significance (3.20b). Individuals age 18-64, and households with two or more cars were likely to take more trips, while completion on all days of the week (except Sunday) were significant for trip making. The zero-inflation analysis shows that individuals who are employed, have a large number of children in the home, and possess a driver"s license were significantly likely to participate in trip making (or significantly unlikely to make zero trips).

TABLE 3.20b Demographics and Total Trips for AD2

	AD2 Total Trips		
	Coefficients	**z-statistic**	p-value
Young (5-17)	0.204	1.01	**0.314**
Middle (18-64)	0.476	4.09	**0.000**
Male	-0.119	-1.58	**0.114**
# Children	0.132	4.08	**0.000**
HH Income	-0.033	-1.58	**0.114**
License	0.116	0.60	**0.551**
1 Car	0.263	1.47	**0.141**
2 Cars	0.464	2.34	**0.019**
3+ Cars	0.580	2.99	**0.003**
Distance to Trail	0.000	1.14	**0.256**
Employment	-0.040	-0.41	**0.684**
AD Monday	1.485	3.74	**0.000**
AD Tuesday	1.277	3.17	**0.002**
AD Wednesday	1.635	4.12	**0.000**
AD Thursday	1.250	3.06	**0.002**
AD Friday	1.527	3.90	**0.000**
AD Saturday	1.311	3.18	**0.001**
_Constant	-0.909	-1.88	**0.060**
Zero Inflate			
Employment	-19.653	-30.33	**0.000**
# Children	-11.110	-7.29	**0.000**
HH Income	-0.316	-1.12	**0.262**
License	-9.617	-4.99	**0.000**
_Constant	8.859	4.54	**0.000**
Number of Cases	***144***		

*Age 65+, 0 Cars, and Completion on Sunday, used as reference categories

Using a zero-inflated Poisson regression analysis of AD3, we see no significant correlation between demographics and total trips. However, the zero-inflated portion of the model revealed that age groups, employment, number of children per household, and number of cars per households were significant predictors for zero trips (Table 3.20c). Both young (5-17) and middle (18-64) age groups showed significance at predicting zero trips, while individuals who are currently employed, households with a larger number of children, and households owning one or more cars were significantly unlikely to take zero trips.

TABLE 3.20c Demographics and Total Trips for AD3

	AD3 Total Trips		
	Coefficients	**z-statistic**	p-value
Young (5-17)	0.313	1.32	**0.186**
Middle (18-64)	0.264	1.58	**0.115**
Male	0.058	0.61	**0.539**
# Children	0.037	0.88	**0.380**
HH Income	0.014	0.70	**0.485**
License	0.250	1.24	**0.215**
1 Car	0.347	1.62	**0.106**
2 Cars	0.131	0.56	**0.573**
3+ Cars	0.112	0.53	**0.599**
Distance to Trail	-0.000	-0.70	**0.484**
Employment	0.089	0.70	**0.481**
AD Monday	0.493	0.71	**0.479**
AD Tuesday	0.413	0.59	**0.556**
AD Wednesday	0.585	0.83	**0.404**
AD Thursday	0.552	0.80	**0.425**
AD Friday	0.487	0.70	**0.481**
AD Saturday	0.572	0.82	**0.413**
_Constant	0.094	0.12	**0.901**
Zero Inflate			
Young (5-17)	80.486	14.96	**0.000**
Middle (18-64)	56.376	21.90	**0.000**
Employment	-39.495	-12.27	**0.000**
# Children	-12.538	-11.34	**0.000**
1 Car	-58.185	-22.96	**0.000**
2 Cars	-40.649	-15.45	**0.000**
3+ Cars	-58.735	-23.60	**0.000**
_Constant	-16.516	-17.13	**0.000**
Number of Cases	***107***		

*Age 65+, 0 Cars, and Completion on Sunday, used as reference categories

Additional demographic analysis was run on the frequency of activity participation. This analysis was run using a regular Poisson distribution regression rather than the zero-inflated, because it is physically/physiologically impossible to have zero observations for the number of activities per day. Activity Diary 1 showed a significant correlation between the total number of activities and sex, car ownership, and employment. Table 3.21a shows that in AD1 females, persons in households with two or more cars, and individuals who are employed, have a higher likelihood of activity participation than the remainder of the sample.

TABLE 3.21a Demographics and Total Activities for AD1

	AD1 Total Activities		
	Coefficients	**z-statistic**	p-value
Young (5-17)	-0.193	-1.15	**0.251**
Middle (18-64)	-0.157	-1.49	**0.137**
Male	-0.217	-3.77	**0.000**
# Children	0.010	0.39	**0.700**
HH Income	-0.019	-1.47	**0.141**
License	-0.244	-1.67	**0.096**
1 Car	0.663	1.78	**0.076**
2 Cars	0.952	2.62	**0.009**
3+ Cars	0.878	2.44	**0.015**
Distance to Trail	0.000	0.74	**0.457**
Employment	0.179	2.07	**0.039**
AD Monday	-0.143	-1.07	**0.284**
AD Tuesday	-0.044	-0.34	**0.734**
AD Wednesday	-0.061	-0.47	**0.638**
AD Thursday	-0.241	-1.87	**0.061**
AD Friday	-0.057	-0.43	**0.670**
AD Saturday	0.039	0.29	**0.774**
_Constant	1.643	4.10	**0.000**
Number of Cases	***175***		

*Age 65+, 0 Cars, and Completion on Sunday, used as reference categories

AD2 yielded very different significance for the correlation of demographics and total activities (table 3.21b). In AD2, the only demographic which proved to be significantly correlated to total activities was number of children. Households with more children were more likely to participate in activities than those with fewer children.

TABLE 3.21b Demographics and Total Activities for AD2

	AD2 Total Activities		
	Coefficients	**z-statistic**	p-value
Young (5-17)	-0.883	-0.55	**0.585**
Middle (18-64)	0.102	1.20	**0.232**
Male	-0.019	-0.32	**0.747**
# Children	0.638	2.12	**0.034**
HH Income	0.008	0.68	**0.497**
License	-0.018	-0.12	**0.902**
1 Car	-0.235	-0.90	**0.371**
2 Cars	-0.036	-0.13	**0.893**
3+ Cars	-0.165	-0.62	**0.533**
Distance to Trail	0.000	1.30	**0.193**
Employment	-0.079	-1.01	**0.315**
AD Monday	0.204	1.11	**0.266**
AD Tuesday	-0.125	-0.65	**0.517**
AD Wednesday	0.091	0.47	**0.640**
AD Thursday	-0.206	-1.04	**0.298**
AD Friday	0.029	0.17	**0.868**
AD Saturday	0.195	1.08	**0.279**
_Constant	2.237	6.07	**0.000**
Number of Cases	***144***		

The demographics analysis for AD3 shows significant positive correlations for distance to the trail, and completion day, with individuals living further from the trail, and individuals completing their diary on Monday or Friday being more likely to participate in activities (Table 3.21c). These results regarding completion day validate, in an active travel behavior context, prior travel behavior day of the week research showing that individual days of the week are treated differently by travelers and that there is no one size fits all formula for weekdays versus weekends (Pas and Koppelman, 1986). In the following analyses, this day of the week analysis will be further identified and explained.

TABLE 3.21c Demographics and Total Activities for AD3

	AD3 Total Activities		
	Coefficients	**z-statistic**	p-value
Young (5-17)	-0.303	-1.11	**0.267**
Middle (18-64)	-0.018	-0.17	**0.866**
Male	0.019	0.28	**0.777**
# Children	0.008	0.25	**0.805**
HH Income	0.014	0.86	**0.389**
License	-0.236	-0.94	**0.347**
1 Car	0.029	0.06	**0.953**
2 Cars	0.006	0.01	**0.991**
3+ Cars	-0.002	-0.00	**0.997**
Distance to Trail	0.000	2.75	**0.006**
Employment	0.051	0.57	**0.571**
AD Monday	0.349	2.23	**0.025**
AD Tuesday	0.305	1.62	**0.106**
AD Wednesday	0.272	1.64	**0.102**
AD Thursday	0.159	0.99	**0.324**
AD Friday	0.270	2.09	**0.037**
AD Saturday	0.240	1.37	**0.170**
_Constant	2.105	3.30	**0.001**
Number of Cases	***107***		

The time-use analysis above shows that each wave of data collection had similar travel behavior characteristics. For each wave there was a specific portion of the sample which took zero trips, but the mean fell near 3.7 trips per day (4.1 trips per day, for individuals who took one or more trips). Employed individuals took significantly more trips in all activity diary waves, with employed females participating in the most trips in AD1 and AD2, and employed males participating in the most trips in AD3. Also in AD3, the group which took the fewest number of trips changed from unemployed men (in AD1 and AD2) to unemployed women (in AD3).

The pre-assigned day of the week for completion revealed an inherent bias (if only in response rate) with the most individuals responding on Monday and Friday and the fewest respondents on Saturday and Sunday. By looking at mean trips per completion day we see that participants took more trips on Monday, Wednesday, Friday, and Saturday, with the fewest trips taken on Sunday.

The mean amount of time spent in each type of activity varied form one wave to another. Activity participation changed from AD1 to AD2, with the mean amount of time spent awake decreased slightly from 900 minutes to 850 minutes. The percentage of time spent at work decreased substantially. There was an increase in the percentage of time spent visiting, dining, watching television, participating in other home activities, and participating in other recreation, and a decrease in the amount of time spent at school, and at religious services. Between AD2 and AD3 there was a resurgence of time spent at work and school. There was also an increase in the percentage of time spent watching television and participating in other recreation. The change in behavior from AD2 to AD3 mirrored an opposite change which took place between AD1 and AD2 suggesting some seasonal variability in time use. For example, the results above show that the average time spent at work is higher in the winter and lower in the summer, while time spent exercising is lower in the winter and higher in the summer.

Trip making patterns in the data show that the majority of trips are taken for work, school, and errands. The fewest trips were taken traveling on visits, to religious services, and to travel to other modes. Trip duration differs depending on trip type as well. The longest trips involved traveling to other recreation, and the shortest trips were for raveling to school and religious services. The average amount of time per trip was approximately 30 minutes with work trips being the most common in this time period. Data for AD3 was different from AD1 and AD2 which could be due to the behavioral impact of a potential economic crisis as described above. AD3 showed a reduction in travel time for discretionary trips while mandatory trips such as work and school remained constant.

The analysis showed that the majority of the sample optimized their travel time by improving travel efficiency through trip chains. This sample participated in between 1 and 2 trip chains per person per wave, with analysis confirming that the greater the number of trip chains per person, the lower the number of trips per chain and vice versa. AD3 showed a similar number of trip chains to AD2 but with fewer trips per chain, likely due to the economic uncertainty described above.

The transportation mode choice breakdown confirms the high rate of auto dependence. Over 80% of trips utilized automobile transportation with 10-13% utilizing walking, less than 5% using transit, and less than 1% using a bicycle in all waves. This heavy reliance on automobile transportation creates an interesting predicament for the local transportation system. Also, the low level of transit mode share reduces some potential for active transportation, as walking and cycling are frequently considering appropriate feeder modes for transit. One unexpected trend was the large reduction in walking mode choice across each consecutive wave. Although walking showed a mode share of 13.7% in AD1, by AD3 it was down to 9.9% (at a similar time of year) suggesting a considerable decrease in the number of walking trips taking place in the area. This is analyzed in detail in Chapter 4.

For home-based activities, work, dining, watching television, and participating in other activities, are consuming the majority of the participant"s time. This is shown by both frequency and duration above. The amount of time spent in exercise increased between AD1 and AD2 but exercise as a percentage of total home-based activities decreased by 4%, which suggests that during AD2 any exercise accumulated was more likely as a part of active trip making and not at home exercise. Likewise we see that other home activities as a percentage of total non-travel behavior (between AD1 and AD2) increased by nearly 7. Between AD2 and AD3 we see similar patterns with the percentage of time spent in most activities remaining relatively constant. There was a decrease in the percentage of activities spent visiting, and an increase in work, school, appointments, and other recreation.

Lastly, the regression analysis of total trips and total activities shows unique demographic correlations in different activity diary waves. In AD1, females and households with lower income were more likely to participate in trip making while households owning two cars, and those who completed their activity diary on Wednesday, Friday or Saturday, were more likely to participate in trips.

Additionally, individuals taking zero trips in AD1 were unlikely to be currently employed, but were highly likely to have a driver‟s license. For AD2, individuals age 18-64 and households with two or more cars were more likely to take trips, and completion on each day of the week (except Sunday) was significant for trip making. Individuals who took zero trips during AD2 were significantly unlikely to be currently employed, have children in the home, or have a driver‟s license (opposite of AD1). Participants in AD3 only showed significance in the zero-inflated portion of the model. Both young (5-17) and middle (18-64) age groups showed significance at predicting zero trips, while individuals who are currently employed, households with a larger number of children, and households owning one or more cars were significantly unlikely to take zero trips.

The demographic analysis on total activities revealed that in AD1 females, households with two or more cars, and individuals who were currently employed had a higher likelihood of activity participation than the remainder of the sample. Activity Diary 2 yielded very different significance for the correlation of demographics. The only demographic which proved to be significantly correlated to total activities in AD2 was number of children, with households having a larger number of children being likely to participate in more activities. Activity participation in AD3 showed significant correlations between total activities and distance to the trail and diary completion date. Individuals living further form the trail, as well as those who completed their diary on Monday or Friday were significantly likely to participate in more activities than the remainder of the sample.

4. Infrastructure Impact Over Time

4.1 Data Analysis

The central aspect of this research is the identification of the impact of the trail construction on total physical activity and active travel behavior. Before identifying any change in specific trip types or physical activity, it is important to first identify if there was a change in total travel behavior over time. A preliminary comparison of means was conducted to identify any significant differences between before-trail behavior and after-trail behavior. The paired-samples t-test procedure compares the means of two variables (total trips and total activities- in this case) for a single group by computing the differences between values of the two variables for each case and testing whether the average significantly differs from zero.

As shown below in Table 4.1, the total number of trips did not significantly change between AD1 and AD2, but significantly decreased between Activity Diaries 2 and 3.

TABLE 4.1 Change in Travel and Activity Behavior-Mean Test

	AD1*	AD2	t-statistic	p-value
Total Trips	4.05 (2.33)	3.98 (2.39)	-0.296	0.768
Total Activities	7.84 (3.21)	10.87 (4.41)	7.166	0.000
	AD2*	**AD3**	**t-statistic**	**p-value**
Total Trips	4.31 (2.59)	3.47 (2.11)	-3.492	0.001
Total Activities	11.78 (4.61)	11.18 (4.82)	-1.310	0.194
	AD1*	**AD3**	**t-statistic**	**p-value**
Total Trips	3.86 (2.42)	3.59 (2.16)	-1.086	0.280
Total Activities	7.80 (3.39)	11.00 (4.61)	6.666	0.000
Number of Cases	*AD1-AD2=144*	*AD2-AD3= 91*	*AD1-AD3=98*	

*Includes only cases that also participated in the group being compared (i.e. 1 & 2, 2 & 3, and 1 & 3).

Any change in travel behavior between AD1 and AD2 or AD2 and AD3 could also be due to seasonal variation, as Activity Diaries 1 and 3 were completed during the winter, and Activity Diary Wave 2 was completed in late summer/early fall. An additional Mean Test was run between AD1 and AD3. This test identified no significant change in trip making when controlling for seasonal variation. Additionally, the total number of activities significantly increased between AD1 and AD2 and also between AD1 and AD3. This could indeed imply an increase in activity participation, or could also be attributed to respondents becoming more experienced with the activity diary format. By AD3 they could simply have been including more detail regarding their daily behavior which would show up as an increase in activity participation.

Seasonal variation was qualitatively analyzed by examining the daytime high temperature and precipitation levels for each of the completion dates for Activity Diaries 1,2, and 3. This information provides an additional explanation of the significant difference between the waves occurring during different seasons. In Activity Diaries 1 and 3, the temperature was quite a bit colder than during AD2 which likely impacted travel behavior (Table 4.2). Often, individuals will take fewer trips or participate in fewer activities when the weather is cold, compared to times when the weather is warmer (Nankervis, 1999). As a reminder, individuals were pre-assigned to the same day of the week throughout all waves of data collection which controlled for behavior variation based on changing completion day.

TABLE 4.2 Activity Diary Wave Temperature and Precipitation Data

Assigned	AD1		AD2		AD3	
Completion Day	Temp*	Precip**	Temp	Precip	Temp	Precip
Monday	47	0.07	76	0.03	33	0.00
Tuesday	45	0.00	64	0.00	31	0.01
Wednesday	42	0.00	79	0.00	20	0.00
Thursday	38	0.02	76	0.00	24	0.01
Friday	52	0.03	69	0.21	28	0.01
Saturday	52	0.00	43	0.32	35	0.00
Sunday	60	0.00	53	0.00	30	0.00

*Temperature is given in degrees Fahrenheit
**Precipitation is given in inches

For added robustness and complexity, subsequent to the preliminary comparison of means a fixed effects panel analysis was conducted to incorporate the time effect (AD1, AD2, AD3) and the treatment effect (presence of the trail in AD2 and AD3) into analysis of individual behavior change.

When using a panel regression model to isolate the "effect of the independent variable for time period T shown by

$$y_{it} = x_{it}\beta + c_i + u_{it}, (t = 1,...T)$$

it is important to including a fixed effects estimator

$$\ddot{y}_{it} = \ddot{x}_{it}\beta + \ddot{u}_{it}$$

where

$$\ddot{y}_{it} = (y_{it} - \bar{y}_i), \ddot{x}_{it} = (x_{it} - \bar{x}_t), \ddot{u}_{it} = (u_{it} - \bar{u}_i)$$

which analyzes individual changes across all time periods with regard to the included regression coefficients (Wooldridge, 2002).

Although the change in the total number of activities remains significant, the change in total number of trips taken drops below the 0.05 significance level (0.068). This follow-up panel analysis shows that there was indeed a significant change in activity behavior between AD1 and AD2, as well as between AD1 and AD3. There was also a nearly significant change in trip making between AD1 and AD2 (at between the 6-7% level), but not between AD1 and AD3.

TABLE 4.3 Change in Travel and Activity Behavior-Panel Analysis

AD1-AD2	**Coefficients**	**t-value**	**p-value**	**R-square**
Total Trips	0.448	1.84	0.068	0.007
Total Activities	4.037	8.95	0.000	0.182
AD1-AD3	**Coefficients**	**t-value**	**p-value**	**R-square**
Total Trips	-0.265	-1.09	0.280	0.012
Total Activities	3.204	6.67	0.000	0.314
Number of Cases	*AD1-AD2=144*		*AD1-AD3=98*	

Similar tests were utilized to identify any significant changes to active trip making or total physical activity. A paired t-test of total physical activity (total time and episodes) and active trips (walking and bicycling) showed no significant change between AD1 and AD2 at the 0.05 level as shown in Table 4.4 below.

TABLE 4.4 Change in Active Trips and Physical Activity- Mean Test

	AD1	**AD2**	**t-statistic**	**p-value**
Total Physical Activity (Episodes)	0.86 (1.14)	0.74 (1.19)	-0.899	0.370
Total Physical Activity (Minutes)	29.75 (40.00)	35.70 (60.61)	0.944	0.347
Total Walking Trips	0.59 (0.99)	0.50 (1.16)	-0.763	0.447
Total Biking Trips	0.03 (0.26)	0.03 (0.22)	-0.000	1.000
	AD1	**AD3**	**t-statistic**	**p-value**
Total Physical Activity (Episodes)	0.90 (1.17)	0.65 (0.96)	-2.126	0.036
Total Physical Activity (Minutes)	32.48 (44.64)	30.65 (50.49)	-0.330	0.742
Total Walking Trips	0.64 (0.98)	0.38 (0.89)	-2.710	0.008
Total Biking Trips	0.00 (0.00)	0.01 (0.10)	1.00	0.320
Number of Cases	*AD1-AD2=144*		*AD1-AD3=98*	

From before the trail‟s construction to after (AD1 to AD3), there was a significant decrease in both the number of physical activity episodes, as well as the total number of walking trips taken. This implies that the trail had no positive impact on active travel behavior. The change in behavior did not appear immediately (during AD2), but the significant decrease in total physical activity episodes and walking trips appeared 5 months after construction during AD3.

A subsequent fixed effects panel analysis was conducted on active trip making and physical activity covariates as well. The installation of the trail did not have a significant impact on active travel behavior or physical activity in sample in the short term (from AD1 to AD2), however between AD1 and AD3 there was a significant decrease in the total number of physical activity episodes as well as a significant reduction in the number of walking trips taken (Table 4.5).

TABLE 4.5 Change in Active Trips and Physical Activity –Panel Analysis

AD1-AD2	Coefficients	t-value	p-value	R-square
Total Physical Activity (Episodes)	-0.052	-0.45	0.655	0.001
Total Physical Activity (Minutes)	8.806	1.53	0.129	0.008
Total Walking Trips	-0.059	-0.55	0.581	0.001
Total Biking Trips	-4.14 e-18	-0.00	1.000	0.000
AD1-AD3	**Coefficients**	**t-value**	**p-value**	**R-square**
Total Physical Activity (Episodes)	-0.245	-2.13	0.036	0.045
Total Physical Activity (Minutes)	-1.826	-0.33	0.742	0.001
Total Walking Trips	-0.265	-2.71	0.008	0.070
Total Biking Trips	0.010	1.00	0.320	0.010
Number of Cases	*AD1-AD2=144*		*AD1-AD3=98*	

By controlling for age, sex, household income, driver‟s license possession, number of children in the household, number of household cars, residential distance from the trail, employment status, and completion day within the model, we were able to determine if any specific exogenous characteristics proved to be significantly correlated to a change in behavior overtime. This analysis determined that individuals between the ages of 18 and 64 significantly increased their total number of physical activity episodes between AD1 and AD3 (B=0.56, p=0.024). This may be considered noteworthy because prior research has shown that the very young and the very old are the most likely to participate in physical activity (Ewing et al 2003) and active transportation (Burbidge, Goulias, and Kim, 2006, Pucher and Renne, 2003). By controlling for age covariates this research shows that the installation of the trail was in fact correlated to a significant increase in physical activity episodes for members of this age group. A more detailed discussion of demographics covariates as they correlate to a change in behavior is included in Chapter 6.

4.2 Summary of Findings

This analysis shows that in this case, the construction of a trail in a suburban neighborhood setting did not have a significant positive impact on the active travel behavior or physical activity levels of neighborhood residents in the short term. The mean test and panel analyses both show that construction of the trail was correlated to active transportation and physical activity but it was significantly negative rather than the predicted positive correlation. These results do not discredit the existence of alternative external benefits created by installing a trail in such a location (aesthetics, crime reduction, etc). They simply prove that the construction is not guaranteed to produce an immediate short term induced demand for physical activity or active travel behavior in all local residents.

Adults age 18-64 did show a significant increase in physical activity episodes over the measured time period, but no significant change in total physical activity (time), or walking and biking trips. This suggests that perhaps building the trail did not impact those who were already predisposed to participate in physical activity (the very young or very old), but may have impacted individuals who were less likely to participate in physical activity and active travel behaviors to begin with. Additionally, by controlling for day of the week it was identified that between AD1 and AD3 individuals who completed their activity diaries on Tuesday significantly decreased the number of physical activity episodes they participated in (B=-2.12, p=0.052), but significantly increased the total time they spent being physically active by nearly 100 minutes (B=98.13, p=0.037). This suggests that individuals who completed their activity diaries on Tuesday changed from participating in several short episodes of physical activity, to fewer large blocks of physical activity.

Approximately 63.1% of sample respondents stated that "an increase in neighborhood trails would be a positive thing" (discussed in Chapter 7). Though only small significant changes in behavior occurred as a result of the trail, it is notable that the majority of residents viewed the construction of a neighborhood trail as a positive addition. That suggests that this specific trail must not possess all the necessary characteristics to induce a behavioral change. For example, this trail segment was only 1 mile long meaning that these results are context dependent. Perhaps a longer segment would be necessary in order to directly impact physical activity or create a larger behavioral change. A lack of information may also be impacting the trail"s usage. For example, there is a three mile loop crated by the trail and adjoining sidewalks (shown in Figure 3.1), but a lack of adequate signage delineating the existence of this loop may be limiting the trail‟s effectiveness. Additionally, many prior studies have expressed the necessity of “destinations” to promote active transportation (Burden, 2004, and Handy, 2004). This location may not be close enough in proximity to adequate destinations (i.e. shopping, parks, etc.) to promote physically active transportation. Additional analysis discussing potential triggers for the above changes in behavior (or lack thereof) will be discussed in detail in Chapter 6.

5. Residential Proximity

As it was hypothesized in the introduction to this research that individuals living closer to the trail would take more walking trips or be more physically active than individuals living further from the trail, the following analysis sought to identify the impact that residential distance from the trail had on active trip making and total physical activity.

5.1 Data Analysis

An initial analysis was performed using a regular Poisson regression model (as the data did not pass the Vuong test for zero-inflation) regressing impact of residential proximity to the trail (in feet) on total physical activity episodes. As shown in Table 5.1a, AD2 showed no significant correlation between proximity to the trail and likelihood of physical activity. Of the control variables, age, sex, and completion day proved to be significant indicators of physical activity (episodes). Young individuals (age 5-17) and individuals completing their diaries on Wednesday, Friday, and Saturday, were significantly more likely to report participation in physical activity episodes, while males were significantly less likely to report participating in physical activity episodes.

TABLE 5.1a Impact of Residential Proximity on PA Episodes in AD2

	AD2-Total Physical Activity (Episodes)		
	Coefficients	**z-statistic**	p-value
Proximity to Trail	0.000	0.99	**0.320**
Young (5-17)	1.237	2.87	**0.004**
Middle (18-64)	-0.094	-0.32	**0.747**
Male	-0.436	-2.02	**0.043**
# Children	0.008	0.10	**0.921**
HH Income	0.022	0.45	**0.650**
License	0.597	1.58	**0.114**
1 Car	-0.748	-1.03	**0.303**
2 Cars	0.108	0.15	**0.878**
3+ cars	-0.261	-0.37	**0.709**
Employment	0.256	1.12	**0.262**
AD Monday	2.057	1.81	**0.070**
AD Tuesday	1.979	1.75	**0.080**
AD Wednesday	2.393	2.10	**0.036**
AD Thursday	0.527	0.37	**0.712**
AD Friday	2.274	2.02	**0.043**
AD Saturday	2.517	2.29	**0.022**
_Constant	-3.428	-2.37	**0.018**
Number of Cases	***144***	***Pseudo R^2=0.182***	

*Age 65+, 0 cars, and completion on Sunday, used as reference categories

TABLE 5.1b Impact of Residential Proximity on PA Episodes in AD3

	AD3-Total Physical Activity (Episodes)		
	Coefficients	**z-statistic**	p-value
Proximity to Trail	0.000	1.15	**0.251**
Young (5-17)	0.026	0.03	**.0975**
Middle (18-64)	0.033	0.10	**0.923**
Male	0.144	0.46	**0.646**
# Children	-0.919	-0.75	**0.454**
HH Income	-0.016	-0.34	**0.737**
License	-0.985	-1.10	**0.272**
1 Car	0.946	0.77	**0.443**
2 Cars	1.225	1.05	**0.295**
3+ cars	1.25	1.09	**0.275**
Employment	0.448	1.43	**0.153**
AD Monday	14.310	16.08	**0.000**
AD Tuesday	13.796	12.90	**0.000**
AD Wednesday	14.002	14.24	**0.000**
AD Thursday	14.356	16.38	**0.000**
AD Friday	14.438	16.34	**0.000**
AD Saturday	13.382	13.47	**0.000**
_Constant	-15.453	-8.22	**0.000**
Number of Cases	***107***	***Pseudo R^2=0.076***	

*Age 65+, 0 cars, and completion on Sunday, used as reference categories

In AD3, proximity to the trail had no significant affect on total physical activity episodes. When taking into account the control variables, day of the week proved significant for all included days which suggests that the likelihood of participating in physical activity episodes is higher on Monday through Saturday than it is on Sunday (Table 5.1b).

An Ordinary Least Squares (OLS) regression model with robust standard errors was used to regress proximity to the trail (in feet) on each individual‟s total physical activity time (in minutes). A simple specification model for this type of OLS regression can be written as

$$Y_i = \alpha + \beta x_i + \varepsilon_i$$

with the "ordinary least squares (OLS) estimator (Greene, 2003)"

$$b = (X'X)^{-1}X'y = \beta + (X'X)^{-1}X'\varepsilon$$

and "robust standard errors (heteroskedasticity-robust variance matrix estimator) of

$$A\hat{\text{var}}(\hat{\beta}) = (X'X)^{-1}\left(\sum_{i=1}^{N}\hat{u}_i^2 x_i' x_i\right)(X'X)^{-1}$$

(Wooldridge, 2002)".

A correlation coefficient in an OLS model measures the strength of the linear association between variables. "The correlation coefficient *r*, is obtained by

$$r = \frac{S_{XY}}{S_X S_Y} = \frac{\sum_{i=1}^{n}(X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum_{i=1}^{n}(X_i - \bar{X})^2}\sqrt{\sum_{i=1}^{n}(Y_i - \bar{Y})^2}}$$

By calculating r^2, a goodness-of-fit is established for the model (Burt and Barber, 1996)."

TABLE 5.2a Impact of Residential Proximity on PA Time in AD2

	AD2-Total Physical Activity (Time)		
	Coefficients	**z-statistic**	p-value
Proximity to Trail	0.000	0.15	**0.877**
Young (5-17)	-3.283	-0.11	**0.909**
Middle (18-64)	-1.044	-0.10	**0.919**
Male	3.165	0.33	**0.744**
# Children	5.188	1.14	**0.158**
HH Income	-1.544	-0.81	**0.420**
License	-34.283	-1.04	**0.302**
1 Car	3.268	0.10	**0.924**
2 Cars	6.646	0.22	**0.826**
3+ cars	15.677	0.51	**0.614**
Employment	1.778	0.19	**0.851**
AD Monday	27.389	2.14	**0.035**
AD Tuesday	55.529	2.70	**0.008**
AD Wednesday	36.942	2.32	**0.022**
AD Thursday	19.159	1.24	**0.217**
AD Friday	43.273	2.56	**0.012**
AD Saturday	51.624	1.60	**0.113**
_Constant	17.873	0.37	**0.715**
Number of Cases	***144***	***R^2=0.166***	

*Age 65+, 0 cars, and completion on Sunday, used as reference categories

Table 5.2a shows that for Activity Diary 2, proximity to the trail was not significantly correlated to total time spent participating in physical activity. Of the included control variables, completion day was the only variable which proved to be significantly correlated to total physical activity time. Individual"s completing their diary on Monday, Tuesday, Wednesday, and Friday reporting significantly more physical activity time than the remainder of the sample.

TABLE 5.2b Impact of Residential Proximity on PA Time in AD3

	AD3-Total Physical Activity (Time)		
	Coefficients	**z-statistic**	p-value
Proximity to Trail	0.002	0.69	**0.493**
Young (5-17)	17.489	0.46	**0.647**
Middle (18-64)	-21.988	-1.631	**0.106**
Male	15.818	1.52	**0.131**
# Children	2.003	0.44	**0.659**
HH Income	1.888	1.27	**0.207**
License	45.803	0.98	**0.330**
1 Car	25.238	0.93	**0.355**
2 Cars	19.093	0.70	**0.483**
3+ cars	19.306	0.76	**0.450**
Employment	5.831	0.57	**0.572**
AD Monday	68.322	3.16	**0.002**
AD Tuesday	76.604	1.58	**0.118**
AD Wednesday	45.879	2.05	**0.044**
AD Thursday	55.876	2.35	**0.021**
AD Friday	66.716	3.15	**0.002**
AD Saturday	39.543	1.51	**0.134**
_Constant	-106.949	-1.60	**0.113**
Number of Cases	***107***	***R^2=0.174***	

*Age 65+, 0 cars, and completion on Sunday, used as reference categories

Additional analysis showed that proximity to the trail had no significant impact on total time spent in physical activity during AD3, however, individuals who completed their diaries on Monday, Wednesday, Thursday or Friday, participated in significantly more physical activity time than individuals who completed their diaries on Tuesday, Saturday, or Sunday (shown in Table 5.2b).

Next, a regular Poisson regression model was used to regress residential proximity (in feet) on total walking trips. This model found that residential proximity to the trail had no significant impact on the likelihood of participating in walking trips for participants in AD2. Additionally, age, sex, and employment status control variables yielded a significant correlation; with men being less likely to participate in walking trips, while young individuals (age 5-17) and those who are currently employed were more likely to participate in walking trips (Table 5.3a).

TABLE 5.3a Impact of Residential Proximity on Walking Trips in AD2

	AD2-Total Walking Trips		
	Coefficients	**z-statistic**	p-value
Proximity to Trail	-8.79 e-06	-0.05	**0.958**
Young (5-17)	1.336	2.44	**0.015**
Middle (18-64)	-0.189	-0.42	**0.677**
Male	-0.964	-2.78	**0.005**
# Children	-0.107	-0.95	**0.345**
HH Income	0.094	1.42	**0.155**
License	1.054	1.68	**0.094**
1 Car	0.197	0.21	**0.836**
2 Cars	0.790	0.88	**0.381**
3+ cars	0.228	0.25	**0.805**
Employment	0.809	2.31	**0.021**
AD Monday	0.964	0.70	**0.484**
AD Tuesday	1.107	0.86	**0.388**
AD Wednesday	1.654	1.28	**0.202**
AD Thursday	-0.116	-0.08	**0.937**
AD Friday	1.559	1.21	**0.227**
AD Saturday	2.169	1.87	**0.061**
_Constant	-4.342	-2.30	**0.021**
Number of Cases	***107***	***Pseudo R^2=0.277***	

*Age 65+, 0 Cars, and completion on Sunday, used as reference categories for AD2

Additional Poisson analysis of AD3 yielded similar results. Residential proximity was not significant in determining physical activity events. However, when controlling for distance, employment status and completion day were significant. Individuals who are currently employed and individuals who completed their diary on Thursday were more likely to participate in walking trips than the remainder of the sample. It is important to note that to maximize the model for AD3, different controls were used as reference categories (described in the footnote below table 5.3b).

TABLE 5.3b Impact of Residential Proximity on Walking Trips in AD3

	AD3-Total Walking Trips		
	Coefficients	**z-statistic**	p-value
Proximity to Trail	-4.14 e-07	-0.00	**0.998**
Young (5-17)	-16.702	-0.00	**0.996**
Middle (18-64)	-0.048	-0.09	**0.929**
Male	-0.156	-0.45	**0.650**
# Children	-0.157	-0.98	**0.327**
HH Income	-0.088	-1.14	**0.256**
License	-18.531	-0.01	**0.996**
1 Car	-15.613	-0.00	**0.998**
2 Cars	-.429	0.87	**0.385**
3+ cars	-.163	0.38	**0.705**
Employment	1.173	2.46	**0.014**
AD Monday	-0.554	-0.51	**0.612**
AD Tuesday	0.444	0.84	**0.400**
AD Wednesday	1.014	2.12	**0.034**
AD Thursday	0.680	1.13	**0.260**
AD Friday	-17.016	-0.01	**0.996**
AD Saturday	-17.413	-0.00	**0.998**
_Constant	16.781	0.00	**0.996**
Number of Cases	***107***	***R^2=0.201***	

*Age 65+, 3+cars, and completion on Monday, used as reference categories

Additional regression models were run using categorical (dummy) variables for residential proximity (potentially allowing for greater accuracy). These categories identify residential proximity as: less than ¼ mile (0-400 meters), between ¼ and ½ mile (401-800 meters), between ½ and ¾ miles (801-1,200 meters) and over ¾ mile (1,200+ meters).

Using a zero-inflated Poisson regression model the categorical residential proximity constructs were regressed on the total number of physical activity episodes. Similar to the prior analysis, the categorical distance constructs were not significantly correlated to the total number of physical activity episodes acquired in AD2 (Table 5.4a).

Age, sex, and completion day, were significantly correlated to total physical activity episodes (regardless of residential proximity). Young individuals (age 5-17) and individuals who completed their activity diary on Saturday were more likely to participate in physical activity episodes, while males were less likely to participate in physical activity episodes. The zero-inflate portion of the model for AD2 shows that individuals who were currently employed, or live within one quarter mile (400 meters) of the canal trail were significantly unlikely to report zero physical activity episodes.

TABLE 5.4a Categorical Proximity and Total PA Episodes in AD2

	AD2-Total Physical Activity (Episodes)		
	Coefficients	**z-statistic**	p-value
Less than ¼ mile	-0.825	-1.24	**0.217**
¼ to ½ mile	-0.476	-0.83	**0.404**
½ to ¾ mile	-0.901	-1.25	**0.211**
Young (5-17)	1.414	4.07	**0.000**
Middle (18-64)	0.052	0.18	**0.860**
Male	-0.519	-2.35	**0.019**
# Children	0.004	0.06	**0.954**
HH Income	0.015	0.25	**0.804**
License	0.478	1.59	**0.111**
1 Car	-0.913	-1.12	**0.261**
2 Cars	-0.042	-0.05	**0.956**
3+ Cars	-0.369	-0.51	**0.607**
Employment	-0.086	-0.35	**0.725**
AD Monday	2.165	1.61	**0.108**
AD Tuesday	1.795	1.44	**0.150**
AD Wednesday	2.300	1.76	**0.079**
AD Thursday	0.437	0.29	**0.770**
AD Friday	2.239	1.82	**0.069**
AD Saturday	2.279	2.08	**0.037**
_Constant	-2.051	-1.72	**0.086**
	Zero-Inflate		
Employment	-14.249	-5.67	**0.000**
License	-2.073	-1.15	**0.250**
Less than ¼ mile	-20.388	-14.85	**0.000**
¼ to ½ mile	0.799	0.68	**0.495**
½ to ¾ mile	-1.581	-0.74	**0.459**
_Constant	0.647	0.48	**0.632**
Number of Cases	***144***		

*>3/4 mile, age 65+, 0 cars, and completion on Sunday, used as reference categories

The categorical proximity constructs were also not significantly correlated to total physical activity (episodes) in AD3 (Table 5.4b). Controls for demographics revealed that completion day showed significance as individuals completing their diary Monday through Saturday had a significantly higher likelihood of participating in physical activity than those who completed their diaries on Sunday. The zero-inflation portion of the model illustrates that possession of a driver‟s license, employment status, and zero household cars, are significant predictors of zero physical activity episodes.

TABLE 5.4b Categorical Proximity and Total PA Episodes in AD3

	AD3-Total Physical Activity (Episodes)		
	Coefficients	**z-statistic**	p-value
Less than ¼ mile	1.365	1.05	**0.293**
¼ to ½ mile	0.695	0.61	**0.539**
½ to ¾ mile	1.477	1.20	**0.231**
Young (5-17)	0.485	0.43	**0.668**
Middle (18-64)	-0.033	-0.07	**0.942**
Male	0.148	0.54	**0.586**
# Children	-0.269	-1.80	**0.072**
HH Income	-0.078	-1.71	**0.088**
License	-0.579	-0.94	**0.347**
1 Car	-0.460	-0.35	**0.723**
2 Cars	-0.245	-0.22	**0.823**
3+ Cars	-0.603	-0.52	**0.601**
Employment	1.066	2.99	**0.003**
AD Monday	14.812	13.00	**0.000**
AD Tuesday	14.413	10.79	**0.000**
AD Wednesday	14.527	14.35	**0.000**
AD Thursday	16.296	18.50	**0.000**
AD Friday	15.477	13.87	**0.000**
AD Saturday	14.156	11.13	**0.000**
_Constant	-15.21	-8.97	**0.000**
Zero-Inflate			
Employment	16.225	16.78	**0.000**
License	16.806	12.29	**0.000**
Young (5-17)	-0.525	-0.31	**0.757**
Middle (18-64)	-0.286	-0.27	**0.788**
0 Cars	50.606	32.02	**0.000**
_Constant	-33.034	-23.05	**0.000**
Number of Cases	***107***		

*>3/4 mile, age 65+, 0 cars, and completion on Sunday, used as reference categories

Next, utilizing an Ordinary Least Squares (OLS) regression model, categorical distance constructs were once again regressed on the total amount of time spent participating in physical activity (in minutes). For AD2, the only distance construct that was significantly correlated to total physical activity (time) was for households living one half to three quarters of a mile from the trail. Individuals from these households participated in nearly 45 fewer minutes of physical activity than the remainder of the sample, which suggests that to some degree as residential location distance from the facility increases physical activity decreases.

TABLE 5.5a Categorical Proximity and Total PA Time in AD2

	AD2-Total Physical Activity (Time)		
	Coefficients	**z-statistic**	p-value
Less than ¼ mile	-13.591	-0.62	**0.536**
¼ to ½ mile	-25.001	-1.36	**0.177**
½ to ¾ mile	-44.313	-2.08	**0.040**
Young (5-17)	-1.737	-0.06	**0.952**
Middle (18-64)	3.134	0.28	**0.777**
Male	3.084	0.32	**0.748**
# Children	5.146	1.13	**0.260**
HH Income	-1.277	-0.65	**0.519**
License	-34.904	-1.06	**0.291**
1 Car	-12.666	-0.39	**0.697**
2 Cars	0.124	0.00	**0.997**
3+ Cars	10.232	0.35	**0.729**
Employment	0.439	0.05	**0.962**
AD Monday	45.181	2.76	**0.007**
AD Tuesday	61.799	2.95	**0.004**
AD Wednesday	51.163	2.88	**0.005**
AD Thursday	24.044	1.47	**0.145**
AD Friday	49.199	2.81	**0.006**
AD Saturday	75.398	2.11	**0.037**
_Constant	34.699	0.85	**0.396**
Number of Cases	***144***	***R^2=0.194***	

*>3/4 mile, age 65+, 0 cars, and completion on Sunday, used as reference categories

Completion date was the only control which was significantly correlated to total time spent in physical activity. Individuals who completed their activity diary on Monday, Tuesday, Wednesday, and Friday participated in significantly more minutes of physical activity per day than those who completed their diaries on Thursday and Saturday (Table 5.5a).

Categorical residential proximity had no significant impact on total time spent participating in physical activity during AD3. However, when controlling for distance, individuals in this sample participated in significantly more physical activity on week days than on the weekend.

TABLE 5.5b Categorical Proximity and Total PA Time in AD3

	AD3-Total Physical Activity (Time)		
	Coefficients	**z-statistic**	p-value
Less than ¼ mile	-8.164	-0.25	**0.799**
¼ to ½ mile	-24.543	-0.77	**0.441**
½ to ¾ mile	-0.867	-0.02	**-0.981**
Young (5-17)	11.973	0.33	**0.744**
Middle (18-64)	-28.282	-1.82	**0.072**
Male	16.331	1.58	**0.118**
# Children	2.698	0.58	**0.563**
HH Income	1.059	0.70	**0.484**
License	50.932	1.08	**0.281**
1 Car	13.441	0.43	**0.670**
2 Cars	11.834	0.47	**0.639**
3+ Cars	12.745	0.53	**0.597**
Employment	4.774	0.47	**0.642**
AD Monday	75.142	3.25	**0.002**
AD Tuesday	92.373	2.11	**0.038**
AD Wednesday	51.535	2.34	**0.021**
AD Thursday	65.327	2.92	**0.004**
AD Friday	70.649	3.42	**0.001**
AD Saturday	41.349	1.64	**0.104**
_Constant	-81.282	-1.20	**0.233**
Number of Cases	***107***	R^2***=0.200***	

*>3/4 mile, Age 65+, 0 Cars, and Completion on Sunday, used as reference categories

Regular Poisson regression models were next used to regress categorical proximity constructs on the total number of walking trips (the data did not pass the Vuong test for zero-inflation). Table 5.6a below shows that residential proximity to the trail had no significant impact on the likelihood of participating in walking trips during AD2. After controlling for residential proximity, the model found age, sex, and employment status significantly impact the likelihood of taking walking trips. Acquiescent to previously discussed results, males were less likely to take walking trips, while individuals ages 5-17 and those who are currently employed were more likely to participate in walking.

TABLE 5.6a Categorical Proximity and Total Walking Trips in AD2

	AD2-Total Walking Trips		
	Coefficients	**z-statistic**	p-value
Less than ¼ mile	-0.196	-0.20	**0.840**
¼ to ½ mile	0.005	0.01	**0.995**
½ to ¾ mile	-0.486	-0.51	**0.613**
Young (5-17)	1.257	2.19	**0.028**
Middle (18-64)	-0.224	-0.49	**0.629**
Male	-0.947	-2.66	**0.008**
# Children	-0.072	-0.55	**0.581**
HH Income	-0.121	1.58	**0.114**
License	1.024	1.62	**0.106**
1 Car	0.133	0.73	**0.463**
2 Cars	0.688	0.78	**0.438**
3+ Cars	0.142	0.15	**0.878**
Employment	0.795	2.27	**0.024**
AD Monday	1.136	0.73	**0.463**
AD Tuesday	1.168	0.87	**0.384**
AD Wednesday	1.788	1.29	**0.198**
AD Thursday	-0.058	-0.04	**0.968**
AD Friday	1.544	1.19	**0.233**
AD Saturday	2.482	1.78	**0.075**
_Constant	-4.402	-3.25	**0.001**
Number of Cases	***144***	***Pseudo R^2=0.280***	

*>3/4 mile, age 65+, 0 cars, and completion on Sunday, used as reference categories

For analysis of AD3 a zero inflated Poisson model was used, and although in AD3 we see that residential proximity to the trail once again had no significant impact on total walking trips, this model reveals additional correlations for the demographic control variables (Table 5.6b). Young individuals (age 5-17), licensed drivers, and members of households with one or more vehicles were significantly more likely to participate in walking trips during AD3, while males were significantly less likely to participate in walking trips.

TABLE 5.6b Categorical Proximity and Total Walking Trips in AD3

	AD3-Total Physical Activity (Episodes)		
	Coefficients	**z-statistic**	p-value
Less than ¼ mile	2.459	1.42	**0.154**
¼ to ½ mile	0.971	0.71	**0.479**
½ to ¾ mile	1.503	0.85	**0.396**
Young (5-17)	-16.615	-14.07	**0.000**
Middle (18-64)	-0.476	-0.70	**0.481**
Male	-0.222	-0.74	**0.457**
# Children	-0.406	-1.63	**0.102**
HH Income	-0.206	-2.61	**0.009**
License	-17.861	-16.98	**0.000**
1 Car	15.427	13.29	**0.000**
2 Cars	16.099	15.77	**0.000**
3+ Cars	15.53	20.13	**0.000**
Employment	2.183	3.19	**0.001**
AD Monday	13.893	8.40	**0.000**
AD Tuesday	12.849	6.37	**0.000**
AD Wednesday	14.214	7.71	**0.000**
AD Thursday	16.429	14.10	**0.000**
AD Friday	14.793	9.38	**0.000**
AD Saturday	-24.961	-13.10	**0.000**
_Constant	-13.919	-8.64	**0.000**
Zero-Inflate			
Employment	18.555	25.03	**0.000**
_Constant	15.934	9.20	**0.000**
Number of Cases	***107***		

*>3/4 mile, age 65+, 0 cars, and completion on Sunday, used as reference categories

Additionally, household members who completed their activity diaries Monday through Saturday were significantly more likely to walk than those who completed their diaries on Sunday. In the zero-inflated portion of the model, employment was the only significant predictor of zero trips.

Because there were so few bicycle trip observations in the sample (AD2=3, AD3=2) neither regular nor categorical residential proximity regression analysis was run on total bicycle trips.

Prior to the Academy Park Trail‟s construction the closest trail was located approximately three miles from the study area (specific distances were calculated for each residence for precision of analysis). For increased complexity and predictive power the following fixed effects panel regression analysis was conducted analyzing this change in residential proximity to the nearest trail (from before construction to after). This panel analysis identifies what impact the change in proximity, brought about by the trail‟s construction, had on active trip making and physical activity covariates overall (Table 5.7).

This analysis found that residential proximity remained insignificantly correlated in the panel regression model for AD2. However, during AD3 we see that the change in proximity was significantly correlated to total physical activity episodes and total walking trips. These results imply that when the new trail was built it was located closer in proximity to the majority of residents. The change in proximity was significantly correlated to a decrease in total physical activity episodes and walking trips. This runs contradictory to the proposed hypothesis of this research that an increase in trail proximity (nearness) would result in an increase in physical activity and active trip making.

TABLE 5.7 Impact of Residential Proximity-Panel Analysis

	Total Physical Activity (Episodes)			
	Coefficients	**t-value**	**p-value**	**R-square**
AD2-Proximity	0.000	0.88	0.383	0.001
AD3-Proximity	0.000	2.28	0.025	0.051
	Total Physical Activity (Minutes)			
	Coefficients	**t-value**	**p-value**	**R-square**
AD2-Proximity	-0.001	-1.02	0.312	0.005
AD3-Proximity	0.000	0.28	0.783	0.001
	Total Walking Trips			
	Coefficients	**t-value**	**p-value**	**R-square**
AD2-Proximity	7.29 e-06	0.68	0.500	0.001
AD3-Proximity	0.000	2.83	0.006	0.076
	Total Biking Trips			
	Coefficients	**t-value**	**p-value**	**R-square**
AD2-Proximity	-5.60 e-07	-0.24	0.814	0.001
AD3-Proximity	-7.81 e-07	-1.05	0.297	0.011
Number of Cases	*AD2=144*	*AD3=107*		

5.2 Summary of Findings

The above analysis leads to the conclusion that overall residential proximity to the local trail has rather limited significant correlation to total physical activity and active travel behavior. Although households living one half to three quarters of a mile from the trail participated in significantly fewer minutes of physical activity (nearly 45) than the remainder of the sample. Additionally, the change in distance to the closest trail (from before the trail"s construction to after) significantly impacted the total number of physical activity episodes and walking trips conflicting with the expected outcome. As the residential distance from a local trail decreased, the total number of physical activity episodes and walking trips significantly decreased as well. This is exactly opposite of the hypothesized change in behavior that was expected to occur after a change in local trail proximity.

After controlling for distance to the trail (which was done in all previous analyses as well), several demographic variables proved to be significantly correlated to physical activity and total walking trips in AD2. Age, sex, and employment remained significant indicators of both total walking trips and physical activity, and completion day also proved to have a significant impact on physical activity alone. Individuals who completed their diaries on Wednesday, Friday, and Saturday participated in more physical activity episodes and accumulated more physical activity time. Additionally, individuals who reported no physical activity episodes were not likely to be employed and were unlikely to live within one quarter of a mile of the canal trail. Analysis of behavior from AD3 yielded similar demographic correlations for total physical activity and active trip making. Completion day was significantly correlated to total physical activity (episodes and time) and walking trips, with individuals who completed their diary on a weekday reporting more physical activity than those who completed their diary on a weekend (especially Sunday). Individuals who are currently employed reported more physical activity episodes and walking trips than the remainder of the sample. When controlling for distance, young individuals (age 5-17), licensed drivers, and members of household with one or more vehicles, were significantly likely to participate in walking trips.

This data suggests that although distance did not always prove to be significant, residential location plays a small role in contributing to or detracting from physical activity and active trip making. Counter intuitively however, this research shows that in this case a reduction in distance to the nearest facility significantly coincides with a reduction in physical activity episodes and total walking trips.

6. Analysis of Change

As described in Chapter 5, the construction of the trail did not have a significant impact on the active travel behavior or total physical activity of the sample as a whole. The one exception was a significant increase in physical activity episodes for individuals age 18-64 over time. The analysis in this section seeks to identify which additional factors (other than the trail) may have significantly impacted active travel behavior and physical activity constructs. In other words, are any specific personal characteristics correlated to specific active behaviors? These characteristics were included as controls in the prior models, but are discussed in additional detail here.

6.1 Analysis of Personal Characteristics

By creating two binary sets of variables representing walking or not walking and exercising or not exercising for each activity diary wave, personal characteristics were regressed on participation in those categories using marginal effects binary Probit regression models.

Discrete dependent variable Probit analysis measures the relationship between the strength of a stimulus and the proportion of cases exhibiting a certain response to the stimulus. The dependent variable y_i can be only one or zero, and the coefficients of the independent variables x_i are estimated in

$$\Pr(y_i = 1) = F(x_i b)$$

Here b is a parameter to be estimated, and F is the normal cumulative distribution function. The dependent variable y is coded as 1 for yes to the question of walking more and 0 for no. "The marginal effects for the independent variable are noted as:

$$\text{Marginal effect} = \Pr\left(Y = 1 \mid \bar{x}_{(d)}, d = 1\right) - \Pr\left(Y = 1 \mid \bar{x}_{(d)}, d = 0\right)$$

where $\bar{x}_{(d)}$ denotes the means of all the other variables in the model (Greene, 2003)." The marginal effect coefficients are reported below.

The correlation coefficient or goodness-of-fit is calculated differently for a binary response model than for traditional OLS regression. The "pseudo R^2" measure is calculated by $1 - \ell_{ur} / \ell_o$ where ℓ_{ur} is the log-likelihood function for the estimated model, and ℓ_o is the log-likelihood function in the model with only an intercept. "Because the log likelihood for a binary response model is always negative, $|\ell_{ur}| \leq |\ell_o|$, the pseudo R-squared is always between zero and one (McFadden, 1974)." It is important to note that "for binary response models the goodness-of-fit is not as important as statistical and econometric significance of the explanatory variables (Wooldridge, 2002)".

Personal characteristics included in the model are: age, sex, household income, driver"s license possession, number of children in the household, number of household cars, residential distance from the trail, employment status, and completion day. The marginal effects coefficients are reported below for all waves.

TABLE 6.1a Personal Characteristics and Walking Behavior in AD1

	Participated in Walking Trips (AD1)		
	Coefficients	**z-statistic**	**p-value**
Middle (18-64)	0.070	0.52	0.604
Old (65+)	-0.076	-0.53	0.597
Male	-0.025	-0.39	0.697
# Children	-0.008	-0.28	0.777
HH Income	0.001	0.09	0.930
License	-0.272	-1.45	0.146
2 Cars	0.999	810.35	0.000
3+ Cars	0.994	141.26	0.000
Distance to Trail	0.000	1.44	0.150
Employment	-0.039	-0.48	0.629
AD Monday	-0.086	-0.69	0.487
AD Tuesday	-0.009	-0.06	0.949
AD Wednesday	-0.067	-0.49	0.628
AD Thursday	0.131	0.73	0.468
AD Friday	0.259	1.27	0.206
AD Saturday	-0.024	-0.15	0.879
_Constant	0.005	0.01	0.994
Number of Cases	*175*		
Log Likelihood at convergence	*-91.607*		
Pseudo R^2	*0.165*		
Chi-Square	*23.21*		
P>Chi-Square	*0.080*		

*Young (5-17), 1 car, and completion on Sunday used as reference categories

Owning an automobile was very highly significant for predicting walking trips within this sample. Individuals from households with 2 or 3 cars were 99% likely to participate in walking trips. All individuals from households reporting zero cars reported zero walking trips for AD1 (perfectly correlated); for this reason 1 car was used as reference category in this analysis.

Table 6.1b shows the Probit regression results for walking behavior in AD2. Employment was the only significant predictor of walking behavior; with individuals who are currently employed being 24% more likely than those who are unemployed to participate in walking trips.

TABLE 6.1b Personal Characteristics and Walking Behavior in AD2

	Participated in Walking Trips (AD2)		
	Coefficients	**z-statistic**	**p-value**
Middle (18-64)	-0.275	-1.72	0.085
Old (65+)	-0.066	-0.43	0.670
Male	-0.119	-1.76	0.079
# Children	-0.016	-0.58	0.560
HH Income	0.019	1.31	0.189
License	0.152	1.49	0.137
1 Car	0.172	0.56	0.577
2 Cars	0.231	0.85	0.395
3+ Cars	0.046	0.19	0.848
Distance to Trail	2.51e-07	0.01	0.994
Employment	0.238	2.78	0.005
AD Monday	0.125	0.49	-0.379
AD Tuesday	0.352	1.17	0.243
AD Wednesday	0.479	1.71	0.088
AD Thursday	-0.102	-0.63	0.532
AD Friday	0.315	1.19	0.233
AD Saturday	0.315	1.19	0.233
_Constant	-0.625	-1.99	0.046
Number of Cases	*144*		
Log Likelihood at convergence	*-63.177*		
Pseudo R^2	*0.206*		
Chi-Square	*34.24*		
P>Chi-Square	*0.008*		

*Young (5-17), 0 cars, and completion on Sunday used as reference categories

When analyzing data from AD3, a few idiosyncrasies arose. Individuals from households reporting zero cars also reported zero walking trips (perfect correlation). Additionally, during AD3 there were no walking trips reported on the weekend (Saturday and Sunday), and possession of a driver"s license was perfectly correlated to zero household cars (all individuals from households with zero cars possessed a drivers license). Therefore for the analysis reported in Table 6.1c these variables are omitted, and young (age 5-17), 1 household car, and completion on Friday are used as reference categories. The analysis of the remaining personal characteristics showed no significant correlations to walking behavior.

TABLE 6.1c Personal Characteristics and Walking Behavior in AD3

	Participated in Walking Trips (AD3)		
	Coefficients	**z-statistic**	**p-value**
Middle (18-64)	-0.091	-0.72	0.471
Old (65+)	-0.019	-0.14	0.890
Male	-0.047	-0.62	0.533
# Children	-0.014	-0.44	0.656
HH Income	-0.003	-0.28	0.780
2 Cars	0.070	0.60	0.546
3+ Cars	-0.114	-1.11	0.266
Distance to Trail	0.000	0.40	0.686
Employment	0.059	0.71	0.480
AD Monday	0.029	0.26	0.797
AD Tuesday	-0.053	-0.38	0.701
AD Wednesday	0.040	0.30	0.761
AD Thursday	0.244	1.40	0.160
_Constant	-0.874	-1.04	0.299
Number of Cases	*107*		
Log Likelihood at convergence	*-48.339*		
Pseudo R^2	*0.088*		
Chi-Square	*9.87*		
P>Chi-Square	*0.705*		

*Young (5-17), 1 car, and completion on Friday used as reference categories

Additional analysis was conducted to determine any possible correlation between personal characteristics and likelihood of participating in physical activity (PA) episodes. Tables 6.2a,b, and c show the results for each of the activity diary waves.

In AD1, the middle age category (18-64), drivers license possession, and completion on Thursday were all significantly correlated to participation in physical activity episodes (Table 6.2a). Individuals in the middle age range were 29% more likely; and while individuals completing AD1 on Thursday were 34% more likely to participate in physical activity than the remainder of the sample, persons possessing a driver‟s license were 32% less likely to participate in physical activity than individuals without a driver‟s license.

TABLE 6.2a Personal Characteristics and PA Participation in AD1

	Participated in Physical Activity (AD1)		
	Coefficients	**z-statistic**	**p-value**
Middle (18-64)	0.294	1.92	0.055
Old (65+)	0.290	1.59	0.111
Male	0.056	0.70	0.481
# Children	0.027	0.77	0.441
HH Income	0.025	1.50	0.133
License	-0.320	-2.00	0.045
1 Car	0.136	0.50	0.616
2 Cars	0.384	1.55	0.122
3+ Cars	0.181	0.69	0.488
Distance to Trail	0.000	1.84	0.065
Employment	-0.111	-1.12	0.264
AD Monday	0.206	1.13	0.260
AD Tuesday	0.075	0.38	0.707
AD Wednesday	0.219	1.14	0.254
AD Thursday	0.348	2.21	0.027
AD Friday	0.324	1.80	0.071
AD Saturday	-0.004	-0.02	0.986
_Constant	-1.916	-2.23	0.025
Number of Cases	*175*		
Log Likelihood at convergence	*-105.504*		
Pseudo R^2	*0.127*		
Chi-Square	*34.42*		
P>Chi-Square	*0.007*		

*Young (5-17), 0 cars, and completion on Sunday used as reference categories

Physical activity participation in AD2 was significantly predicted by activity diary completion day (shown in Table 6.2b). Individuals who completed their activity diaries on Monday, Tuesday, Wednesday, and Friday, were over 40% more likely to participate in physical activity episodes than individuals who completed their diary on Sunday.

TABLE 6.2b Personal Characteristics and PA Participation in AD2

	Participated in Physical Activity (AD2)		
	Coefficients	**z-statistic**	**p-value**
Middle (18-64)	-0.053	-0.26	0.795
Old (65+)	0.164	0.69	0.489
Male	-0.071	-0.79	0.427
# Children	0.014	0.36	0.721
HH Income	0.004	0.20	0.845
License	-0.217	-0.92	0.359
1 Car	-0.013	-0.05	0.963
2 Cars	0.206	0.72	0.471
3+ Cars	0.061	0.21	0.831
Distance to Trail	-0.000	-0.29	0.769
Employment	0.130	1.24	0.214
AD Monday	0.425	2.01	0.044
AD Tuesday	0.506	2.88	0.004
AD Wednesday	0.539	3.08	0.002
AD Thursday	-0.081	-0.29	0.769
AD Friday	0.560	3.25	0.001
AD Saturday	0.503	2.85	0.004
_Constant	-1.336	-1.28	0.202
Number of Cases	*144*		
Log Likelihood at convergence	*-82.629*		
Pseudo R^2	*0.151*		
Chi-Square	*29.69*		
P>Chi-Square	*0.029*		

*Young (5-17), 0 cars, and completion on Sunday used as reference categories

In AD3 activity diary completion on Sunday was perfectly correlated to participation in physical activity episodes (all individual‟s who completed AD3 on Sunday participated in 0 PA episodes). Therefore, completion on Saturday was used as a reference category for the following analysis (Table 6.2c). Regression coefficients proved significant for residential distance to the trail and completion on Monday or Friday. Individuals living further from the trail were more likely to participate in physical activity episodes in AD3. Additionally, individuals who completed their activity diary on Monday or Friday were more than 40% more likely to participate in physical activity episodes than those who completed their activity diary on the weekend.

TABLE 6.2c Personal Characteristics and PA Participation in AD3

	Participated in Physical Activity (AD3)		
	Coefficients	**z-statistic**	**p-value**
Middle (18-64)	-0.148	-0.65	0.518
Old (65+)	-0.086	-0.34	0.732
Male	0.175	1.72	0.086
# Children	-0.071	-1.63	0.103
HH Income	0.012	0.65	0.518
License	-0.249	-0.90	0.371
1 Car	0.007	0.02	0.982
2 Cars	0.284	0.92	0.356
3+ Cars	0.203	0.65	0.513
Distance to Trail	0.000	2.08	0.037
Employment	0.019	0.17	0.868
AD Monday	0.496	3.13	0.002
AD Tuesday	0.115	0.41	0.684
AD Wednesday	0.227	1.09	0.275
AD Thursday	0.259	1.27	0.203
AD Friday	0.401	2.14	0.032
_Constant	-0.505	-1.46	0.145
Number of Cases	*107*		
Log Likelihood at convergence	*-63.039*		
Pseudo R^2	*0.138*		
Chi-Square	*21.82*		
P>Chi-Square	*0.149*		

*Young (5-17), 0 Cars, and Completion on Saturday used as reference categories

6.2 Analysis of Behavioral Change Across Waves

The following analyses reveals additional behavioral patterns in the data by showing the likelihood of participation in an activity based on individual participation in a prior wave. Each cross-classification table below shows participation in walking over two waves of data collection. This allows for easy identification of consistency or inconsistency within individual behavior.

Also shown in each table is the chi-square statistic. Chi-square provides a likelihood ratio that an event will occur given a specific factor. For Tables 6.3a-c this provides the likelihood that a person who walked in one activity diary wave will also walk in a subsequent activity diary wave, and for Tables 6.4a-c this provides the likelihood that a person who participated in physical activity in one activity diary wave will also participate in physical activity in a subsequent activity diary wave. This goodness-of-fit test compares the observed and expected frequencies in each category to determine if all categories contain the expected proportion of values (which equals a null hypothesis). The higher the chi-square statistic, the higher the failure of the null hypothesis (Green, 2003).

TABLE 6.3a Walking Participation in AD1 and AD2

	Walked (AD2)	**Did not Walk (AD2)**	**Total**
Walked (AD1)	19	23	42
Did not Walk (AD1)	14	65	79
Total	33	88	121
Chi-Square =10.468	*P= 0.001*		

In Table 6.3a we see that for AD1 there was not a random distribution of observations for walking in AD2. The occurrence of walking in AD1 did significantly predict the occurrence of walking in AD2, with 19 individuals walking in both waves (15.7%), 65 individuals neglecting to walk in both waves (53.7%), and 37 individuals changing behavior from one wave to another (30.6%). This cross-tabulation reveals that 11 individuals (11.6%) began walking between AD1 and AD2, and 23 individuals (19.0%) stopped walking between AD1 and AD2.

TABLE 6.3b Walking Participation in AD2 and AD3

	Walked (AD3)	Did not Walk (AD3)	Total
Walked (AD2)	10	18	28
Did not Walk (AD2)	5	58	63
Total	15	76	91
Chi-Square =10.865	*P= 0.001*		

Table 6.3b also shows a correlation between behavior in AD2 and AD3. The occurrence of walking in AD2 significantly predicted the occurrence of walking in AD3, with 10 individuals walking in both waves (10.9%), 58 individuals neglecting to walk in both waves (63.7%), and 25 individuals changing behavior from one wave to another (25.3%). This table also shows that 5 individuals (5.5%) who had not walked in AD2 began walking in AD3, while 18 individuals (19.8%) stopped walking between AD2 in AD3.

TABLE 6.3c Walking Participation in AD1 and AD3

	Walked (AD3)	Did not Walk (AD3)	Total
Walked (AD1)	17	20	37
Did not Walk (AD1)	3	58	61
Total	20	78	98
Chi-Square =23.867	*P=0.000*		

Lastly, Table 6.3c shows that the occurrence of walking in AD1 significantly predicted the occurrence of walking in AD3, with 17 individuals walking in both waves (17.3%), 58 individuals neglecting to walk in both waves (59.1%), and 23 individuals changing behavior from one wave to another (23.5%). Between AD1 and AD3, 3 individuals (3.1%) began walking and 20 individuals (20.4%) stopped walking.

A similar analysis was conducted looking at participation in physical activity over the three waves of behavioral data collection. Table 6.4a below shows that there was a significant correlation between participation in physical activity (exercise) in AD1 and AD2, AD2 and AD3, and AD1 and AD3.

TABLE 6.4a Physical Activity Participation in AD1 and AD2

	Exercised (AD2)	**Did not Exercise (AD2)**	**Total**
Exercised (AD1)	34	28	62
Did not Exercise (AD1)	20	39	59
Total	54	67	121
Chi-Square =5.365	*P= 0.021*		

Participating in physical activity in AD1 significantly predicted the occurrence of participating in physical activity in AD2, with 34 individuals exercising in both waves (28.1%), 39 individuals neglecting to exercise in both waves (32.2%), and 48 individuals changing behavior from one wave to another (39.7%). This cross-tabulation reveals that between AD1 and AD2, 20 individuals (16.5%) began exercising and 28 individuals (23.1%) stopped exercising.

TABLE 6.4b Physical Activity Participation in AD2 and AD3

	Exercised (AD3)	**Did not Exercise (AD3)**	**Total**
Exercised (AD2)	26	19	45
Did not Exercise (AD2)	12	34	46
Total	38	53	91
Chi-Square =9.393	*P= 0.002*		

Participating in physical activity in AD2 significantly predicted the occurrence of participating in physical activity in AD3, with 26 individuals exercising in both waves (28.6%), 34 individuals neglecting to exercise in both waves (37.4%), and 31 individuals changing behavior from one wave to another (34.1%). This cross-tabulation reveals that between AD2 and AD3 12 individuals (13.2%) began exercising and 19 individuals (20.9%) stopped exercising.

TABLE 6.4c Physical Activity Participation in AD1 and AD3

	Exercised (AD3)	Did not Exercise (AD3)	Total
Exercised (AD1)	32	18	50
Did not Exercise (AD1)	9	39	48
Total	41	57	98
Chi-Square =20.607	*P= 0.000*		

Lastly, participating in physical activity in AD1 significantly predicted the occurrence of participating in physical activity in AD3, with 32 individuals exercising in both waves (32.7%), 39 individuals neglecting to exercise in both waves (39.8%), and 27 individuals changing behavior from one wave to another (27.6 %). This cross-tabulation reveals that between AD1 and AD3 9 individuals (9.2%) began exercising while 18 individuals (18.4%) stopped exercising.

6.3 Analysis of Physical Activity Levels

The analysis in Section 6.2 shows that individuals from the sample can be classified in three distinct categories: 1-Individuals who were consistently active in all waves of data collection (hereafter referred to as “Active”), 2- Individuals who were inactive in all waves of data collection (hereafter referred to as “Inactive”), and 3- Individuals who changed there behavior across waves of data collection (hereafter referred to as “Flip-Flop”). Table 6.5 below shows a complete breakdown of participant membership in each of these categories.

TABLE 6.5 Participant Physical Activity Levels

Level of Activity	Number of Participants	Percentage of Sample
Active	45	22.7
Inactive	82	58.6
Flip-Flop	71	35.9
Total	198	100.0

We see that the majority of the sample was inactive across all waves of data collection (58.6%). Although a higher than expected percentage of respondents reported being physically active in all waves (22.7%), a larger percentage of respondents reported changing their behavior between waves (35.9%).

In order to identify which personal characteristics delineate membership in each of these activity level categories, a binary Probit model was run regressing the following personal characteristics against membership in each activity level group: age, sex, household income, driver"s license possession, number of children in the household, number of household cars, residential distance from the trail, employment status, and completion day. These models include all individuals who participated in at least one activity diary (*N=198*). This eliminates the possibility of analysis bias in categorization associated with attrition from the panel. The marginal effects results for each model are shown below.

Membership in the active category (individuals who were active in all waves of data collection) was only significantly correlated to completion of the activity diary on Friday (shown in Table 6.6). Participants who completed their activity diary on Friday were 44% more likely than those who completed their diary on other days to be physically active across all waves of data collection. No demographic characteristics significantly impacted membership in the active group.

TABLE 6.6 Personal Characteristics of Active Participants

	Active Participants		
	Coefficients	**z-statistic**	**p-value**
Middle (18-64)	-0.066	-0.51	0.610
Old (65+)	0.038	0.24	0.807
Male	0.013	0.23	0.820
# Children	-0.002	-0.06	0.951
HH Income	0.002	0.17	0.865
License	-0.124	-0.73	0.465
1 Car	0.068	0.30	0.766
2 Cars	0.205	0.91	0.363
3+ Cars	0.101	0.51	0.610
Distance to Trail	-4.86e-06	-0.20	0.839
Employment	0.047	0.67	0.501
AD Monday	0.327	1.65	0.098
AD Tuesday	0.213	1.03	0.305
AD Wednesday	0.299	1.44	0.151
AD Thursday	0.280	1.33	0.183
AD Friday	0.438	0.199	0.027
AD Saturday	0.189	0.78	0.435
_Constant	-0.745	-1.96	0.050
Number of Cases	*198*		
Log Likelihood at convergence	*-98.002*		
Pseudo R^2	*0.074*		
Chi-Square	*15.99*		
P>Chi-Square	*0.525*		

*Young (5-17), 0 cars, and completion on Sunday used as reference categories

Membership in the inactive category was not categorized by the presence of specific variables, but rather by the absence of specific categories. For example,

Table 6.7 shows that auto ownership and completion day were significantly correlated (negatively) to being inactive. Households owning 1 or more cars were at least 31% less likely to be inactive than households owning zero cars. Additionally, individuals who completed their activity diaries on Monday through Saturday were at least 25% less likely to be inactive than individuals who completed their diary on Sunday.

TABLE 6.7 Personal Characteristics of Inactive Participants

	Inactive Participants		
	Coefficients	**z-statistic**	**p-value**
Middle (18-64)	-0.127	-0.79	0.432
Old (65+)	-0.116	-0.66	0.509
Male	-0.059	-0.78	0.433
# Children	-0.002	-0.05	0.959
HH Income	0.002	0.13	0.900
License	0.205	1.42	0.156
1 Car	-0.312	-2.17	0.030
2 Cars	-0.493	-3.12	0.002
3+ Cars	-0.364	-1.90	0.057
Distance to Trail	-0.000	-1.26	0.207
Employment	0.065	0.71	0.475
AD Monday	-0.295	-2.41	0.016
AD Tuesday	-0.356	-3.53	0.000
AD Wednesday	-0.414	-4.64	0.000
AD Thursday	-0.328	-3.11	0.002
AD Friday	-0.399	-3.92	0.000
AD Saturday	-0.251	-1.93	0.053
_Constant	0.852	2.51	0.012
Number of Cases	*198*		
Log Likelihood at convergence	*-120.977*		
Pseudo R^2	*0.093*		
Chi-Square	*0.145*		
P>Chi-Square	*23.14*		

*Young (5-17), 0 cars, and completion on Sunday used as reference categories

Membership in the flip-flop category was characterized by completion day as well (shown in Table 6.8). Individuals who completed their activity diaries on

Tuesday and Wednesday were nearly 40% more likely to change their activity level between waves than participants who completed their activity diaries on Sunday. Auto ownership was significant at the 0.10 level, with members of households owning 1 or 2 cars being significantly more likely to change their activity over time than individuals from households with zero cars.

TABLE 6.8 Personal Characteristics of Flip-Flop Participants

	Flip-Flop Participants		
	Coefficients	**z-statistic**	**p-value**
Middle (18-64)	0.228	1.28	0.200
Old (65+)	0.117	0.55	0.586
Male	0.045	0.64	0.520
# Children	-0.001	-0.02	0.983
HH Income	-0.004	-0.23	0.819
License	-0.118	-0.58	0.563
1 Car	0.389	1.67	0.096
2 Cars	0.414	1.78	0.075
3+ Cars	0.339	1.51	0.131
Distance to Trail	0.000	1.40	0.162
Employment	-0.116	-1.32	0.187
AD Monday	0.157	0.98	0.326
AD Tuesday	0.360	2.39	0.017
AD Wednesday	0.388	2.46	0.014
AD Thursday	0.268	1.63	0.104
AD Friday	0.205	1.22	0.223
AD Saturday	0.255	1.34	0.180
_Constant	-0.277	-2.81	0.005
Number of Cases	*198*		
Log Likelihood at convergence	*-120.348*		
Pseudo R^2	*0.065*		
Chi-Square	*17.51*		
P>Chi-Square	*0.420*		

*Young (5-17), 0 cars, and completion on Sunday used as reference categories

6.4 Summary of Findings

In each activity diary wave different personal characteristics significantly impacted walking behavior and physical activity participation. In AD1, individuals from households owning 2 or 3 cars were 99% likely to participate in walking trips, while 100% of individuals from households with zero cars took zero walking trips. The middle age category (18-64), and completion on Thursday were positively correlated to participation in physical activity episodes, while drivers license possession was negatively correlated to participation in physical activity episodes during AD1.

Employment was the only significant predictor of walking behavior during AD2, with individuals who are currently employed being 24% more likely than those who are unemployed to participate in walking trips. Also during AD2, individuals completing their activity diary on Monday, Tuesday, Wednesday, and Friday were over 40% more likely to participate in physical activity episodes than individuals who completed their diary on Sunday.

There were many idiosyncrasies when analyzing Activity Diary 3. For example, in AD3 activity diary completion on Sunday was perfectly correlated to participation in physical activity episodes (individual‟s who completed AD3 on Sunday participated in zero physical activity episodes). Additionally, individuals from households owning zero cars also reported zero walking trips (perfect correlation). There were no reported walking trips on the weekend (Saturday and Sunday) and possession of a driver‟s license was perfectly correlated to zero household cars (all individuals from households with zero cars possessed a drivers license). The analysis of the remaining personal characteristics showed no significant correlations to walking behavior, but individuals living further from the trail were more likely to participate in physical activity episodes in AD3. Individuals who completed their activity diaries on Monday and Friday were more than 40% more likely to participate in physical activity episodes than those who completed their activity diary on the weekend.

Participation in walking or physical activity significantly predicted walking or physical activity behavior in a subsequent wave. By analyzing the above data we see that a large percentage of the population remained consistent in their behavior with a smaller segment changing their behavior between waves. Approximately 11.6% of individuals who did not walk in AD1 began walking in AD2 and 3.1% began walking in AD3. Of individuals who were initially inactive in AD1, 16.5% became physically active in AD2 and 9.2% became physically active in AD3. However, 19.0% of individuals who walked in AD1 stopped walking in AD2 and 20.4% stopped walking in AD3. Additionally, 23.1% of exercisers in AD1 stopped exercising in AD2 and 18.4% stopped exercising in AD3. This shows that although there was some increase in physical activity and walking after the trail was constructed, a larger percentage of individuals stopped walking or participating in physical activity during the same time periods.

Lastly, individuals from the sample can be classified in three distinct categories: 1-Individuals who were consistently active in all waves of data collection (Active), 2- Individuals who were inactive in all waves of data collection (Inactive), and 3- Individuals who changed there behavior across waves of data collection (Flip-Flop). The majority of the sample was inactive across all waves of data collection (58.6%). Although a higher than expected percentage of respondents reported being physically active in all waves (22.7%), a larger percentage of respondents reported changing their behavior between waves (35.9%).

A regression of personal characteristics on membership in each of these activity level categories revealed that participants who completed their activity diary on Friday were 44% more likely than others to be physically active across all waves of data collection. No demographic characteristics significantly impacted membership in the active group. Auto ownership and completion day were significantly correlated (negatively) to being inactive. Households owning 1 or more cars were at least 31% less likely to be inactive than households owning zero cars, and individuals who completed their activity diaries on Monday through Saturday were at least 25% less likely to be inactive than individuals who completed their diary on Sunday. Membership in the flip-flop category was characterized by day of completion, with individuals completing their activity diaries on Tuesday and Wednesday being nearly 40% more likely to change their activity level between waves. Household auto ownership was significant at predicting membership in the flip-flop category at the 0.10 level, with owners of 1 or 2 cars being significantly more likely to change their activity over time than individuals from households with zero cars.

Although this analysis shows that personal characteristics significantly impact walking and physical activity participation, the identified characteristics are not consistent across waves of data collection. Although there is some consistency in behavior, a large percentage of participants change their behavior over time, even when holding the completion day of the week as a constant. After further analyzing which personal characteristics are most likely to determine a participant"s physical activity level, we see that traditional demographics are not significant at predicting activity level. The only two predictors which were significantly correlated to physical activity level were auto ownership and completion day. Different days of the week yielded different behavioral characteristics and households owning an automobile were likely to change their physical activity over time and unlikely to remain consistently inactive.

7. Perceptions, Attitudes, Lifestyles and Behavior

Participants completed various surveys in addition to the activity diaries, in order to provide more information about their perceptions and attitudes regarding specific aspects of transportation and physical activity.

The following analysis uses active travel behavior data from AD2 to identify the impact that individual perceptions, attitudes, and lifestyle characteristics have on reported behavior (total walking trips and total time spent in physical activity). All of the models included in this section control for age, sex, household income, driver‟s license possession, number of children in the household, number of household cars, residential distance from the trail, employment status, and completion day. As the correlation of these demographics and personal characteristics to walking was addressed in Chapter 5, it will not be readdressed here. All walking trips reported by participants are included in this analysis. These models do not incorporate the total number of biking trips as a separate dependent variable, due to the small number of biking trips reported (3 total).

7.1 Data Analysis

The preliminary household questionnaire asked various questions regarding perceptions and attitudes about active transportation. Participants were asked to rank modes of transportation according to their individual preference for using them.

When comparing mean ranking between modes, as well as the number of households who ranked each mode as their #1 choice, automobile proved to be the most popular mode followed by walking. Bicycling received the fewest "1" rankings as a preferred transportation mode as shown in Table 7.1.

TABLE 7.1 Mean Rank by Transportation Mode (1= most likely, 5 = least likely)

Mode	Mean Rank	% Households that ranked this mode as "1"
Automobile	1.35	86.0
Walking	2.48	9.9
Public Transportation	3.05	6.6
Bicycling	3.61	4.3

To determine if an individual‟s rank of specific transportation modes had a significant impact on their actual travel behavior, the stated rank for each mode was run in a zero-inflated Poisson regression model against each individual‟s total walking trips; using age, sex, household income, driver‟s license possession, number of children, number of cars, distance from the trail, employment status, and completion day as control variables.

As shown in Table 7.2, stated preference for walking (1= most preferred, 5= least preferred) was significantly correlated to the total number of walking trips taken.

TABLE 7.2 Impact of Mode Preference Ranking on Total Walking Trips

	Total Walking Trips		
	Coefficients	**z-statistic**	p-value
Automobile Pref.	-0.351	-0.81	**0.417**
Walking Pref.	0.750	2.59	**0.010**
Transit Pref.	0.195	0.97	**0.330**
Biking Pref.	-0.142	-0.63	**0.529**
Young (5-17)	1.500	2.52	**0.012**
Middle (18-64)	0.301	0.50	**0.618**
Male	-0.978	-2.94	**0.003**
# Children	-0.011	-0.08	**0.937**
HH Income	-0.114	-1.16	**0.247**
License	1.442	2.87	**0.004**
1 Car	-1.187	-1.60	**0.110**
2 Cars	1.123	1.36	**0.175**
3+ Cars	0.626	0.71	**0.480**
Distance to Trail	-0.000	-0.56	**0.574**
Employment	-0.898	-1.33	**0.182**
AD Monday	0.732	0.49	**0.624**
AD Tuesday	0.565	0.45	**0.654**
AD Wednesday	1.265	0.90	**0.369**
AD Thursday	-0.257	-0.18	**.861**
AD Friday	1.462	1.03	**0.302**
AD Saturday	1.322	1.03	**0.302**
_Constant	-1.924	-0.95	**0.241**
Zero Inflate			
Employment	-9.284	-2.36	**0.018**
# Children	1.883	1.68	**0.093**
1 Car	-20.759	-3.03	**0.002**
2 Cars	2.429	1.33	**0.184**
3+ Cars	0.979	0.46	**0.648**
HH Income	-1.386	-2.47	**0.014**
License	3.456	1.58	**0.115**
_Constant	3.560	1.49	**0.137**
Number of Cases	***144***		

*Age 65+, 0 cars, and completion on Sunday, used as reference categories

However, contrary to the original hypothesis, individuals who ranked walking as a less preferred mode of transportation were significantly more likely to take walking trips than those who viewed walking favorably. This is highly peculiar considering its contradictory nature, and runs contrary to results from other studies (Handy, 2004). Rankings for other modes of transportation were not significantly correlated to the total number of walking trips acquired.

To identify underlying perceptions of safety for each transportation mode, respondents were asked to rank their perception regarding the likelihood of each transportation mode being involved in a traffic accident.

TABLE 7.3 Perceived Likelihood of Traffic Accident by Mode

Mode	Very Low	Low	Moderate	High	Very High
Walking	2.8*	30.0	44.4	18.9	1.1
Bicycle	2.8	22.8	37.2	27.8	6.7
Automobile	0.0	4.3	36.8	43.3	14.4

*Percent of Responses from household questionnaire

Table 7.3 above shows that over 75% of respondents perceived pedestrians risk of accident to be very low (2.8%), low (30%) or moderate (44.4%), with only 20% ranking the risk as high or very high. Bicyclists‟ responses were spread evenly between low (22.8%), moderate (37.2%), and high (27.8%), but maintained the perception of a higher risk than pedestrians (34.5% high or very high). This is not surprising as many suburban households may see the risk of pedestrians being involved in an accident as low since they are not generally traveling in the right-of-way of other vehicles, whereas bicycles in the area are required to ride adjacent to the flow of automobile traffic which would inherently increase their risk of accident. Subsequently, however, 40% of questionnaire respondents stated that they would walk more if they "felt safer" (show in Table 7.5), suggesting that although they may not see pedestrians as facing a high risk for traffic accidents, there are additional safety/security factors that play a role in their decision to walk for transportation or recreation (shown in Table 7.4 below). The perception of automobile risk is clearly higher than all other modes.

Using demographics and personal characteristics as control variables, a binary dependent variable Probit Model was used to regress perception of safety on total walking trips. As reported below, perception of safety played a significant role in predicting walking behavior. For every single point increase in an individual‟s view of risk (1=very low, 5=very high) the probability of that individual walking went down by 12%.

TABLE 7.4 Impact of Safety Perceptions on Total Walking Trips

	Total Walking Trips (AD2)		
	Coefficients	**z-statistic**	**p-value**
Pedestrian Risk	-0.124	-2.88	0.004
Sidewalk Safety	0.098	0.343	0.343
Age	-0.000	-0.20	0.839
Male	-0.122	-1.79	0.073
# Children	-0.018	-0.63	0.527
HH Income	0.002	0.19	0.850
License	0.043	0.31	0.754
HH Cars	0.012	0.31	0.759
Distance to Trail	-0.000	-0.71	0.477
Employment	0.160	2.01	0.045
AD Monday	0.057	0.28	0.783
AD Tuesday	0.262	0.99	0.320
AD Wednesday	0.300	1.18	0.240
AD Thursday	-0.139	-1.26	0.209
AD Friday	0.295	1.30	0.192
AD Saturday	0.403	1.43	0.154
_Constant	-0.211	-0.18	0.861
Number of Cases	*144*		
Log Likelihood at convergence	*-63.355*		
Pseudo R^2	*0.198*		
Chi-Square	*37.52*		
P>Chi-Square	*0.002*		

*Age 65+, 0 cars, and completion on Sunday, used as reference categories

Next, participants were asked under what circumstances or situations would they would walk more than they currently do. Nearly half of respondents stated that they would walk more if there were better destinations to walk to (49.4%), which inherently implies that they do not view their current environment as having many high quality destinations (shown in Table 7.5). This may be a direct result of their residential location in a bedroom community with little mixing of land uses. Infrastructure quality also had an impact with a large number of respondents identifying a lack of trails (40.6%) or inadequate sidewalks (33.9%) as factors. A complex combination of intentions contributes to mode choice decisions. The second most cited reason for not walking more (48.3%) was the need for more time. Perhaps even if residents claim that a trail would make them walk more, they may not have enough time to do so (time allocation - perceived behavioral control), or they may not feel safe on the trail. Some individuals make no presupposition for their lack of physical activity, shown by the fact that 7.4% of respondents claimed that nothing would make them walk more.

Using a Poisson regression model (the model did not pass the Vuong test for zero-inflation), stated incentives for increased walking were regressed on total walking trips using demographics and personal characteristics as control variables (results shown in Table 7.5). Stated motivations for increased walking had no significant impact on total walking trips.

TABLE 7.5 Stated Incentives and Total Walking Trips

I would walk more if…	% HH	Total Walking Trips		
		Coefficients	**z-statistic**	p-value
There were better destinations	49.4	0.235	0.35	**0.727**
I had more time	48.3	0.072	0.17	**0.863**
There were more paths/trails	40.6	-0.164	-0.25	**0.803**
It were safer	40.0	-0.527	-1.16	**0.244**
There were better sidewalks	33.9	-0.331	-0.57	**0.565**
The weather were better	22.2	0.013	0.03	**0.974**
Nothing would make me walk more	7.2	-1.514	-1.49	**0.137**
Young (5-17)		1.23	2.06	**0.040**
Middle (18-64)		-0.175	-0.32	**0.750**
Male		-0.895	-2.57	**0.010**
# Children		-0.199	-1.24	**0.214**
HH Income		0.132	1.54	**0.123**
License		0.912	1.47	**0.142**
1 Car		0.351	0.33	**0.740**
2 Cars		0.512	0.54	**0.591**
3+ Cars		-0.211	-0.22	**0.829**
Distance to Trail		4.33 e-06	0.02	**0.988**
Employment		0.719	1.91	**0.056**
AD Monday		1.476	0.76	**0.450**
AD Tuesday		1.379	0.74	**0.457**
AD Wednesday		1.820	1.16	**0.247**
AD Thursday		0.244	0.14	**0.886**
AD Friday		1.740	1.10	**0.270**
AD Saturday		2.383	1.48	**0.139**
_Constant		-4.041	-1.87	**0.062**
Number of Cases	***144***	***Pseudo R^2 = 0.295***		

*Age 65+, 0 Cars, and Completion on Sunday, used as reference categories

As a follow-up to the above analysis, the 40.6% of individuals who stated that they would walk more if their neighborhood had more paths/trails were revisited. Using an Ordinary Least Squares (OLS) linear regression model (estimating α and β in order to minimize the sum of the squared deviations) with robust standard errors to control for heteroskedasticity, this attitudinal response was regressed on the change in the total number of walking trips acquired from before the trail was developed to after (shown in Figure 7.1) using the same demographic and personal controls discussed previously.

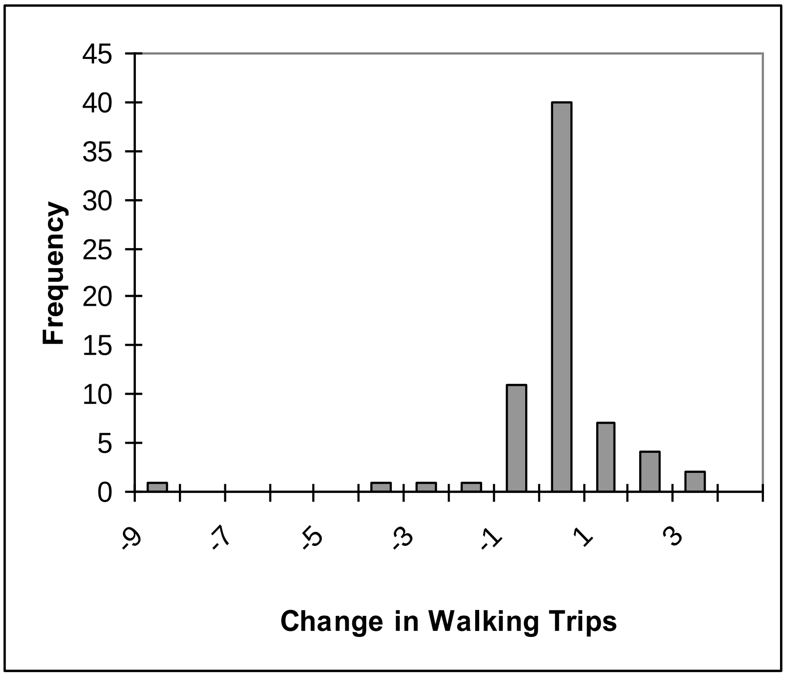

FIGURE 7.1 Change in Walking Trips AD1 to AD2

TABLE 7.6 Impact of Trail Perceptions on Behavioral Change

	Change in Total Walking Trips		
	Coefficients	**t-statistic**	p-value
Motivation-Trails	0.250	1.16	**0.248**
Young (5-17)	1.379	1.09	**0.278**
Middle (18-64)	-0.668	-2.41	**0.018**
Male	-0.406	-1.81	**0.073**
# Children	0.075	1.02	**0.309**
HH Income	0.015	0.26	**0.793**
License	2.457	1.90	**0.060**
1 Car	-0.319	-0.60	**0.550**
2 Cars	-0.373	-.076	**0.447**
3+ Cars	-0.149	-0.29	**0.773**
Distance to Trail	1.06 e-06	0.01	**0.992**
Employment	0.420	1.63	**0.107**
AD Monday	1.011	1.58	**0.116**
AD Tuesday	1.331	2.19	**0.031**
AD Wednesday	0.987	2.01	**0.047**
AD Thursday	0.987	1.46	**0.148**
AD Friday	0.511	0.79	**0.434**
AD Saturday	2.184	1.89	**0.062**
_Constant	-3.138	-1.98	**0.050**
Number of Cases	***144***	***R^2 =0.303***	

*Age 65+, 0 cars, and completion on Sunday, used as reference categories

The model (shown in Table 7.6) reported no significant impact between an individual‟s stated motivations and an increase in walking trips. Individuals who stated that an increase in trails would make them walk more did not take significantly more walking trips once a trail was indeed in place, even when controlling for a variety of demographic and lifestyle factors. This establishes in an active travel behavior context that an individual‟s stated intent ("I would walk more if there were more trails") does not significantly translate into revealed behavior.

The next portion of this analysis focuses on lifestyle factors as they relate to walking trips and total physical activity. Many different individual factors can impact behavior significantly as discussed in Chapter 2.

Utilizing a regular Poisson regression model (the model did not pass the Vuong test for zero-inflation) automobiles and bicycle ownership (per household) were regressed on the total number of walking trips that participants accumulated over the course of the measured day (after the trail was installed) using demographics and personal characteristics as control variables.

TABLE 7.7 Car and Bike Ownership and Walking Trips

	Total Walking Trips		
	Coefficients	**z-statistic**	p-value
1 Automobile	-0.224	-0.20	**0.841**
2 Automobiles	0.617	0.65	**0.517**
3+ Automobiles	-0.005	-0.01	**0.996**
Total Bikes	0.161	1.10	**0.272**
Young (5-17)	1.239	2.18	**0.029**
Middle (18-64)	-0.266	-0.55	**0.581**
Male	-0.938	-2.67	**0.008**
# Children	-0.117	-1.62	**0.106**
HH Income	0.068	1.04	**0.298**
License	1.053	1.66	**0.087**
Distance to Trail	-0.000	-0.07	**0.945**
Employment	0.849	2.49	**0.013**
AD Monday	0.877	0.63	**0.530**
AD Tuesday	1.225	1.02	**0.307**
AD Wednesday	1.42	1.11	**0.266**
AD Thursday	-0.052	-0.04	**0.971**
AD Friday	1.532	1.23	**0.218**
AD Saturday	2.033	1.74	**0.082**
_Constant	-4.135	-2.22	**0.026**
Number of Cases	***144***	***Pseudo R^2 = 0.283***	

*Age 65+, 0 cars, and completion on Sunday, used as reference categories

Additionally, using an Ordinary Least Squares (OLS) linear regression model with robust standard errors to control for heteroskedasticity, automobile and bicycle ownership were regressed on the total amount of time spent in physical activity (while controlling for demographics and personal characteristics).

Table 7.8 shows that neither automobile nor bicycle ownership proved to significantly impact the total amount of physical activity (time) accumulated over the measured day.

TABLE 7.8 Car and Bike Ownership and Total Physical Activity

	Total Physical Activity (Minutes)		
	Coefficients	**t-statistic**	p-value
1 Automobile	3.955	0.12	**0.905**
2 Automobiles	7.074	0.24	**0.812**
3+ Automobiles	16.126	0.51	**0.609**
Total Bikes	-0.314	-0.09	**0.932**
Young (5-17)	-3.054	-0.11	**0.916**
Middle (18-64)	-0.845	-0.08	**0.933**
Male	3.175	0.33	**0.745**
# Children	5.333	1.06	**0.292**
HH Income	-1.500	-0.76	**0.450**
License	-34.206	-1.04	**0.302**
Distance to Trail	0.001	0.16	**0.875**
Employment	1.655	0.17	**0.863**
AD Monday	27.509	2.14	**0.034**
AD Tuesday	55.075	2.74	**0.007**
AD Wednesday	37.289	2.34	**0.021**
AD Thursday	18.988	1.22	**0.224**
AD Friday	43.267	2.54	**0.012**
AD Saturday	51.652	1.59	**0.114**
_Constant	17.432	0.37	**0.714**
Number of Cases	***144***	R^2**=0.166**	

*Age 65+, 0 cars, and completion on Sunday, used as reference categories

It is hypothesized that individual preference for physical activity type may impact total physical activity as well. For example, individuals who enjoy lifting weights may spend more time being physically active than someone who prefers riding a stationary bike or taking an aerobics class. The following analysis sought to identify if individual preference for a specific type of physical activity was correlated to their actual accumulation of physical activity. Using an Ordinary Least Squares (OLS) Table 7.9 shows the results of a linear regression model with robust standard errors to control for heteroskedasticity, correlating preference for different types of physical activity against total amount of time spent in physical activity (in minutes) using demographics and personal characteristics as controls.

TABLE 7.9 Expressed Exercise Preference and Total Physical Activity

	Total Physical Activity (Minutes)		
	Coefficients	**t-statistic**	p-value
Running/Jogging	-8.180	-0.36	**0.716**
Cycling	2.371	0.13	**0.900**
Aerobics	4.128	0.31	**0.759**
Aerobic Machine	1.239	0.08	**0.937**
Walking	-3.734	-0.23	**0.816**
Lifting Weights	22.482	1.12	**0.267**
Playing Sports	39.748	2.07	**0.041**
No Regular PA	-11.968	-0.74	**0.462**
Young (5-17)	-9.934	-0.35	**0.724**
Middle (18-64)	-5.513	-0.45	**0.657**
Male	-6.218	-0.54	**0.592**
# Children	4.707	0.97	**0.337**
HH Income	-0.774	-0.39	**0.700**
License	-27.741	-0.90	**0.372**
1 Car	12.041	0.25	**0.802**
2 Cars	19.860	0.47	**0.636**
3+ Cars	26.099	0.59	**0.557**
Distance to Trail	0.003	0.48	**0.632**
Employment	3.456	0.32	**0.750**
AD Monday	36.065	1.15	**0.252**
AD Tuesday	64.398	1.86	**0.067**
AD Wednesday	47.654	1.34	**0.185**
AD Thursday	16.422	0.45	**0.655**
AD Friday	45.531	1.38	**0.171**
AD Saturday	20.199	0.53	**0.597**
_Constant	-12.563	-0.18	**0.858**
Number of Cases	***144***	R^2***=0.258***	

*Age 65+, 0 cars, and completion on Sunday, used as reference categories

Only one activity preference proved to be significant. Individuals who reported preferring participation in sports/games acquired significantly more physical activity that the sample as a whole. These individuals accumulated 40 more minutes of physical activity per day than individuals who did not prefer playing sports/games. It is of note that this analysis controlled for age and sex (both showing no significance), which may be intuitively identified as potential explanations for these results with younger males typically being seen as more likely to play sports. One simple explanation for the correlation is that participating in sports may take more time than participating in other non-organized activities such as walking or lifting weights. If an individual works out on an elliptical machine the time spent on that machine is generally self-motivated (i.e. I plan to spend 30 minutes exercising but if I am tired I will cut it short) whereas someone playing in a basketball game has most certainly committed to participate for the entire game. Typically sporting events have a designated length (i.e four timed quarters) which may create longer participation durations.

TABLE 7.10 Sample Characteristics for Individuals that Prefer Sports

Sample Characteristics		Individuals who enjoy sports	Study Sample (AD2)
Number of persons in the sample (age 5+)		41	144
Percent of males in the sample		58.5	47.3
Number of persons per household		4.76	3.54
Mean age of respondents		25.28	47.5
% of persons age 5-12		33.3	11.8
% of persons age 13-15		7.7	2.1
% of persons age 16-18		10.3	3.5
% of persons age (18+)		48.7	82.6
% of persons 65-85		7.7	27.8
% of persons 85+		0.0	0.7
Number of cars per household		2.37	2.49
Number of bikes per household		3.12	1.97
% currently employed		41.5	49.0
% possessing a driver‟s license		63.4	87.0
Total Combined Household Income	<=$40,000	39.0%	37.0%
	$40,001 to $80,000	34.2%	42.5%
	=> $80,001	26.8%	20.5%

Table 7.10 shows a side by side demographic comparison of individuals who prefer playing sports and the Activity Diary 2 sample (previously shown in Table 3.2). The 28% of that sample who preferred playing sports were more frequently young males from larger households. Those preferring sports also came from households with fewer automobiles and a larger number of bikes than the sample as a

whole. The economic characteristics for these individuals are similar to the sample, with a slightly higher likelihood of having a household income over $80,000 per year.

As a follow-up it was also important to identify if specific exercise preferences (the type that may utilize a trail) impact attitudes/opinions about trails.

TABLE 7.11 Expressed Exercise Preference and Attitude Regarding Trails

	I would walk more if my neighborhood had more trails/paths		
	Coefficients	**z-statistic**	**p-value**
Running/Jogging	-0.095	-0.83	0.409
Cycling	0.089	0.80	0.423
Walking	0.026	0.28	0.779
Young (5-17)	0.263	1.08	0.280
Middle (18-64)	0.163	1.31	0.191
Male	0.048	0.58	0.564
# Children	-0.056	-1.60	0.111
HH Income	0.056	3.45	0.001
License	0.149	0.80	0.422
1 Car	-0.431	-4.65	0.000
2 Cars	-0.430	-2.23	0.026
3+Cars	-0.605	-3.81	0.000
Distance to Trail	0.000	1.24	0.216
Employment	-0.109	-0.56	0.574
AD Monday	0.004	0.02	0.984
AD Tuesday	-0.109	-0.56	0.574
AD Wednesday	-0.328	-2.42	0.015
AD Thursday	-0.229	-1.47	0.142
AD Friday	-0.277	-1.71	0.088
AD Saturday	0.184	0.79	0.429
_Constant	0.204	0.22	0.829
Number of Cases	*144*		
Log Likelihood at convergence	*-98.325*		
Pseudo R^2	*0.174*		
Chi-Square	*40.30*		
P>Chi-Square	*0.046*		

*Age 65+, 0 Cars, and Completion on Sunday, used as reference categories

The above analysis sought to determine if exercise preferences for running/jogging, biking, or walking, had an impact on whether or not participants saw an increase in trails as a motivation for walking more (shown above in Table 7.11). Using demographics and personal characteristics as control variables, a Probit Model with marginal effects was used to regress exercise preference on the stated motivation that trails would increase individual walking. The marginal effects coefficients are shown in Table 7.11.

Exercise preference did not have a highly significant impact on whether or not an individual would identify a trail as a walking stimulus. It is possible that the surveyed individuals may not be inclined to run/jog on a trail, but rather prefer running/jogging on local sidewalks or even on a treadmill as will be discussed in the following analysis. Of the control variables, household income, auto ownership, completion day, and employment status were all significantly correlated to identification of the trail as a walking stimulus. Every $10,000 increase in household income resulted in a 5.6% increase in the likelihood of stating that neighborhood trails would motivate walking. Likewise households owning one or more automobiles were 43-60% more likely, and employed individuals were nearly 11% more likely to identify trails as a motivation for more walking. Individuals completing their activity diary on Wednesday were 32% less likely than the rest of the sample to state that a trail would make them walk more.

In addition to individual preference for the specific types of exercise analyzed above, it is also important to identify the impact of exercise equipment in the home or ownership of exercise equipment. This information becomes critical in this study, because the presence or absence of exercise equipment may impact an individual‟s observed behavior. Using a regular Poisson regression model (the model was unable to maximize using zero-inflation) ownership of different types of exercise equipment was regressed on total walking trips, using demographics and personal characteristics as control variables.

TABLE 7.12 Exercise Equipment Ownership and Walking Trips

	% HH Ownership	Total Walking Trips		
		Coefficients	**z-statistic**	p-value
Stationary Bike	31.1	-0.742	-0.94	**0.348**
Free Weights	29.4	-0.374	-0.61	**0.543**
Treadmill	28.9	0.000	0.00	**1.000**
Weight Machine	10.0	-0.258	-0.30	**0.763**
Elliptical	9.4	-2.699	-2.00	**0.046**
Stair Climber	5.0	-0.591	-0.41	**0.684**
Rowing Machine	2.2	-9.733	-6.99	**0.000**
Young (5-17)		1.252	2.24	**0.025**
Middle (18-64)		-0.222	-0.50	**0.618**
Male		-0.835	-2.50	**0.013**
# Children		0.029	0.018	**0.858**
HH Income		0.117	1.37	**0.170**
License		0.993	1.49	**0.137**
1 Car		0.382	0.36	**0.718**
2 Cars		0.839	0.78	**0.434**
3+ Cars		0.354	0.33	**0.738**
Distance to Trail		0.000	0.70	**0.484**
Employment		0.840	2.46	**0.014**
AD Monday		1.501	0.97	**0.333**
AD Tuesday		1.199	0.90	**0.369**
AD Wednesday		2.022	1.43	**0.152**
AD Thursday		-0.632	-0.43	**0.668**
AD Friday		1.772	1.37	**0.171**
AD Saturday		2.027	1.71	**0.087**
_Constant		-4.856	-2.40	**0.016**
Number of Cases	***144***	***Pseudo R^2=0.0.332***		

*Age 65+, 0 Cars, and Completion on Sunday, used as reference categories

Table 7.12 above shows both the response frequency for each type of exercise equipment as well as the regression coefficients. Owners of Elliptical machines (9.4% of the sample) and owners of rowing machines (2.2% of the sample) were significantly less likely to take walking trips than the remainder of the sample. This may be because these individuals feel that they are accumulating enough physical activity without adding walking to their routine. Or perhaps individuals who dislike walking are prone to purchasing elliptical or rowing machines. Additionally, a small percentage of respondents noted having exercise equipment other than the types listed above (5.6%). These residents identified items such as: exercise videos, yoga paraphernalia, abdominal equipment, exercise ball, trampoline, and aerobic rider, and 4% of questionnaire respondents reported having a membership at a gym or athletic club. The owners of "other" exercise equipment were significantly more likely to participate in walking trips than the remainder of the sample.

If owners of exercise equipment are not significantly more likely to participate in walking trips (or less, as in the exceptions mentioned above), they could potentially be substituting these walking trips with usage of their at home exercise equipment. People today are becoming much busier than ever before, making it difficult to insert additional activities into their already overcrowded days. This is what Couclelis (2000) referred to this time allocation dilemma as "lifestyle fragmentation". With this fragmentation of time individuals may become more focused on accumulating a specific amount of physical activity at one time when it can be scheduled into their busy lifestyle. For example, it may be more convenient to walk on the treadmill inside the home for 30 minutes while watching the evening news, than to systematically acquire 30 minutes of walking throughout the course of the day. This creates a research dilemma, and begs the question: if households are using home exercise equipment instead of accumulating physical activity in their neighborhoods and other environments, what can then be done to increase usage of local sidewalks, trails and pathways; and should that even be considered as an issue?

Lastly this analysis seeks to examine if individual perceptions regarding daily accumulation of physical activity are consistent with the physical activity they reported in their activity diary. In Activity Diary Wave 3 participating individuals were asked specific open ended questions regarding their decision to participate in walking trips or use the new trail.

TABLE 7.13 Stated Change in Physical Activity

How has your physical activity changed in the last 12 months?	% of Residents
My physical activity has increased	**46.7**
I want to improve my health	14.0
I am participating in new activity	14.0
I want to lose weight	8.4
I have an active job	7.5
I want to have more energy	1.8
I have more time	1.0
My physical activity decreased	**28.0**
I have health problems	11.2
I have a lack of time or energy	8.4
I lack motivation	5.6
The weather has not been good	1.8
I worry about my safety	1.0
My physical activity has remained the same	**25.2**
	N=107

Table 7.13 above shows a breakdown of individual perceptions and self reports regarding each individual‟s changes in physical activity over the past 12 months. Although the more detailed statistical analysis in Chapter 4 shows that there was a significant decrease in physical activity in the past 12 months (from AD1 to AD3), 46.7% of participants reported an increase in physical activity during that time period. Another 25.2% reported that their physical activity level had remained the same; and only 28% reported that their physical activity level decreased. Table 7.14 shows each individual‟s stated physical activity change compared to their actual physical activity change (change in the total minutes of physical activity acquired based on the diary). The shaded boxes delineate individuals whose stated behavioral change was consistent between the general statement and the diary.

TABLE 7.14 Stated Change versus Observed Change in Physical Activity

		Stated Change		
		Increase	**Decrease**	**Remained Same**
Observed Change	Increase	14.3%	4.1%	6.1%
	Decrease	14.3%	5.1%	12.2%
	Remained Same	17.3%	20.4%	7.1%

This reiterates that an individual‟s perceptions of their personal behavior (their intent) may not generally coincide with their observed/reported diary behavior. For example, 31.6% of respondents who reported increasing their physical activity level actually decreased their total physical activity level or it remained the same. Additionally, 24.5% of respondents who reported a decrease in their total amount of physical activity actually remained the same or even increased the total amount physical activity they acquired. This inconsistency between instruments may also be due to opposite signs of measurement errors induced by the survey. The stated change question may motivate individuals to please the surveyor and "exaggerate" the increase in desired physical activity, and the one day diary may miss some of the physical activity and therefore underestimate it. The net result is an exaggeration of inconsistent replies between stated and revealed activity.

7.2 Summary of Findings

Many of the attitudes, opinions, and lifestyle characteristics described above did have a significant impact on actual behavior, although not all did. These findings verify in an active travel behavior context prior research by Fishbein and Ajzen (1974), and Wicker (1969), which determined that stated preference and attitudes (which contribute to intent) do not always serve as predictors for actual behavior. It also confirms other findings in travel behavior that attitudes may be important but not the only determinants, and their role if heavily context dependent (Kuppam et al, 1999).

Transportation mode preference as identified by mode rankings that had a significant effect on actual travel behavior but contrary to the initial hypothesis. Individuals who viewed walking as a less favorable mode of transportation were significantly more likely to take walking trips than those who viewed walking favorably. This was a highly unusual finding and runs contradictory to logic which would state that a positive view would result in more trips and a negative view would result in fewer. Perhaps this is because individuals who take a significant amount of walking trips do so begrudgingly; and because they take so many walking trips they become antagonistic toward walking. Likewise, it is possible that individuals who do not participate in a great deal of walking view it rather quixotically, having a very positive outlook on walking for the very reason that they do not participate in these trips frequently.

The perception of danger or accident risk also had significant impact on walking trips, with the likelihood of walking decreasing as an individual‟s perception of risk increased. Individual‟s who perceived pedestrian risk as high and individual‟s whose perception of a safety level was contingent upon improved sidewalks, did not significantly differ from those who believed that the existing infrastructure was adequate. This implies once again that the presence or absence of infrastructure may not play a significant role in decision making.

Individuals which claimed that an increase in neighborhood paths/trails would make them walk more, showed no significant change in the total number of walking trips taken after a neighborhood trail was in fact installed. Ownership of transportation modes (both automobile and bicycle) were not significantly correlated to the number of walking trips, or the total amount of physical activity (time) acquired by members of the sample. This runs contrary to the cultural belief that individuals with greater access to automobile transportation would be less physically active than those without access, or that owners of bicycles would be more physically active.

When correlating stated preference for exercise type against total physical activity only one exercise type proved to be significant. Individuals with a stated preference for playing sports accumulated over one half an hour more (40 minutes) physical activity time per day than those who did not prefer playing sports. Individuals who preferred playing sports were more likely to be young males from larger households, owning fewer vehicles and more bicycles, as well as exhibiting a slightly higher likelihood of a household with an annual income over $80,000. An individual‟s exercise preference was not significantly correlated to the opinion that an increase in neighborhood trails/paths creates a personal walking stimulus. However, when controlling for exercise preference, income, auto ownership and employment status were significantly correlated to the above mentioned opinion. Individuals from higher income households were more likely to state that an increase in neighborhood trails/paths would make them walk more, while automobile owners, those who are currently employed, and individuals who completed their diary on Wednesday were less likely to have this opinion.

With regard to exercise equipment; ownership of elliptical machines, rowing machines, and “other” exercise equipment, proved to significantly impact walking behavior. Owners of elliptical and rowing machines were significantly less likely to take walking trips than the remainder of the sample. As mentioned above, this may be because these individuals feel that they are accumulating enough physical activity without adding neighborhood walking to their routine, or perhaps individuals who dislike walking are more likely to purchase elliptical or rowing machines. Additionally, owners of “other” exercise equipment (i.e. exercise videos, yoga paraphernalia, exercise ball, etc.) were significantly more likely to participate in walking trips than the rest of the sample.

Individuals were unlikely to accurately estimate their change in participation in physical activity over the previous 12 months prior. Only 26.5% of respondent‟s stated change in physical activity matched their observed change in physical activity. This could be due to the methodology of a single day activity diary which may miss some of the physical activity acquired by the sample (i.e. if a person only walks on Mondays and Wednesdays but they completed their diary on Tuesday). This may create some inconsistency in reporting versus observations.

8. New versus Historic Residents

As described in Chapter 3, new residents to the area were surveyed concurrent to Activity Diaries 2 and 3. They were asked questions identical to the historic residents in order to develop comparative data between the two samples. Sample characteristics for both historic and new residents are shown below in Table 8.1.

TABLE 8.1 Sample Characteristics of Historic versus New Residents

Sample Characteristics		Historic Residents	New Residents
Number of persons in the sample (age 5+)		181	117
Number of households in the sample		80	32
Number of persons per household		3.66	3.66
% of persons under age 5*		7.4	18.8
% of persons age 5-12*		13.0	15.4
% of persons age 13-15*		3.2	2.6
% of persons age 16-18*		2.3	4.3
% of persons age (18+)*		74.1	56.4
Number of cars per household		2.53	2.47
Number of bikes per household		2.01	1.65
Total Combined Household Income	<=$40,000	28.1%	13.7%
	$40,001 to $80,000	41.7%	81.2%
	=> $80,001	19.1%	5.1%
Mean length of tenure in current residence		12-15 years	6-9 months

*Percentages differ from table 5.1 due to inclusion of household members under age 5.

When comparing new residents (those who have moved to the areas since September 2007) to historic resident households, it is immediately evident that they differ greatly. From the breakdown within each sample we see that the new residents are younger, and in larger, and middle income families. Nearly one in five new residents (18.8%) is under the age of 5, and nearly 35% are under age 12. A very small percentage of the new residents are teenagers (less than 10%) and barely over half of new residents are adults. This is likely due to neighborhood turnover in which young families are moving into an area where a majority of historic residents have already raised their children to adulthood. This point is further proven by recognizing that the mean duration of tenure in current residence for historic residents is 12-15 years and only 6-9 months for new residents (by definition). Rates of ownership for vehicles per household were relatively comparable, while new resident households owned fewer bicycles.

After recognizing the demographic differences between historic and new residents, this analysis sought to identify the differences in motivation for choosing this residential location. Each responding household (historic and new) were asked which factors encouraged them to choose this particular location for their residence. Table 8.2 below shows that the major motivations for moving to the area were similar for the historic residents and new residents. Housing affordability, proximity to work, and proximity to friends and family were the top three contributors for both groups (in that order).

TABLE 8.2 Motivation for Choosing Residential Location

I Chose my Residence ….	Historic Residents	New Residents
Because it was affordable	82.7%	69.2%
To be close to work	34.6%	30.8%
To be close to friends or family	32.7%	28.2%
For the safe neighborhood	28.8%	13.7%
As a good environment for kids	25.0%	14.5%
Because I grew up in the area	21.2%	19.7%
To be close to shopping	17.3%	6.0%
For good access to transportation	5.8%	15.4%
To be closer to other amenities	5.8%	10.3%
For another reason	0.0%	1.7%

Some factors differ between historic and new residents. Perception of accessibility and amenities is more positive for the new residents than the historic. Perception of positive affordability is higher among the historic residents. For new residents noting access to transportation as more important than proximity to shopping, finding a good environment for children, or neighborhood safety. This is rather ironic considering that new residents have younger households and more children than historic residents. Other amenities (i.e. trails, parks, and open space) were more important to new residents than historic residents as well. It is of note that 83% of new resident households moved to this location from a prior residence located less than 5 miles away, and 30% relocated to the Academy Park Neighborhood from within West Valley City. This suggests that location familiarity may have been a big (although unrecognized) factor in choosing this new residential location.

Views of residential walking safety were another primary difference between historic and new residents. Although historic and new residents had similar opinions about the safety of their neighborhood (with new residents feeling slightly less confident about safety), new residents viewed safety as having a much higher impact on their behavior than historic residents (Table 8.3).

TABLE 8.3 Perceptions of Neighborhood Safety and Walking

	Historic Residents	New Residents
I feel very safe in my neighborhood	28.8%	17.9%
I feel somewhat safe in my neighborhood	55.8%	56.4%
My neighborhood"s safety impacts the amount of walking I do	25.0%	56.4%
I would walk more if I lived in a different neighborhood	15.4%	41.0%

Nearly 2/3 of new resident households stated that the safety of their neighborhood impacts the amount of walking they do (compared to ¼ of historic residents), and two in five new residents claimed that they would walk more if they lived in a different neighborhood. This suggests that they do not feel that their current neighborhood promotes walking and they did not choose this location based on walking environments. As a reminder of context, this survey (of both new and historic residents) was conducted after the trail"s construction was complete.

These differences were further evident after considering differences in the stated impact of different aspects of the built environment on neighborhood safety. Table 8.4 below shows the difference in responses to the hypothetical question "I would feel safer if…". Overall, new residents had more confidence in the impact of changes to the built environment on neighborhood safety than historic residents (with the exception of open space). A large percentage of new residents suggested that an increase in the number of street lights would make them feel safer (nearly double the response for more police officers). Only 4.3% of new residents reported that nothing would make them feel safer, further suggesting as above, that they do not currently feel as safe in their neighborhood as residents who have lived there longer.

TABLE 8.4 The Built Environment and Safety

I would feel safer if…	Historic Residents	New Residents
There were more street lights	32.7%	41.9%
There were more police officers	44.2%	37.6%
Speed limits were slower	21.2%	22.2%
There were better sidewalks	17.3%	20.5%
There was more open space	15.4%	8.5%
There were more bike lanes	15.4%	18.8%
Nothing would make me feel safer	13.5%	4.3%

It is highly unlikely considering the above analysis, that new residents were drawn to this specific neighborhood by the new walking/biking trail. The new residents are large, young, middle income families, who moved to this location for much the same reasons as their historic counterparts (primarily housing affordability, and proximity to employment or friends/family). They do report the importance of access to transportation and other amenities (i.e. trails, parks, and open space) at a higher rate than historic residents, but also view their neighborhood as less safe than historic residents and report being less likely to walk due to safety concerns. When asked what would make them feel safer in their new neighborhood, new residents identify changes to the built environment (with the exception of open space) with higher response than historic residents, but only 4.3% report that "nothing would make them feel safer" indicating a lack of confidence in existing neighborhood safety.

9. Trail Intercept Survey Analysis

The lack of positive significance in the change of physical activity and trip making, in addition to the lack of evidence that new residents were drawn to the neighborhood because of the trail raises additional questions that were not originally expected at the design stage of this research. This lack of significance makes it highly important to identify any other exogenous factors that may inhibit local residents from utilizing the new trail.

As explained in Chapter 3, Academy Park Trail users were convenience sampled after the conclusion of Activity Diary 3 in February 2008 on two separate days of the week (Wednesday and Saturday). A demographic analysis of trail users (Table 3.6) revealed that trail users are either very young (55% age 5-17), or over the age of 65 (16.1%). That leaves slightly under 1/3 of trail users in the middle age category (18-64). Because of this overrepresentation of young and old individuals, we see that only 32% of trail users were employed, and only 51.6% possessed a driver"s license. The majority of trail users are female (61.3%), and the mean number of automobiles per household ($\overline{X} = 2.23$) is fewer for trail users than for residents of the study area as a whole ($\overline{X} = 2.66$). These demographics are almost perfectly representative of the individuals discussed in the Chapter 6, who were the most likely to participate in physical activity. This demonstrates that the analyses of demographics conducted above with regard to physical activity and active trip making holds up through observation.

In addition to identifying the demographic breakdown of trail users, the key reason for this follow-up to the Academy Park Activity Diary Survey was to identify the trail users‟ motivations for using this particular trail. This intercept survey also sought to identify key characteristics about their trail use and experience (i.e. what activity are they participating in, how did they travel to the trail, how frequently do they use they trail, etc).

An analysis of trail users‟ responses shows that the mean residential distance from the trail for all trail users is 1.75 miles (shown below in Table 9.1). Although this is within walking/biking distance for many, it may not be considered as such for a large percentage of individuals. Also shown in Table 9.1, is the mean residential distance for participants of each activity type.

TABLE 9.1 Trail Use by Activity Type

Activity Participation	% of Sample	Mean Residential Proximity (SD)
Walking	71.0	1.22 (1.92)
Bicycling	16.1	1.75 (1.37)
Jogging/Running	12.9	4.62 (2.17)
Total	100.0	1.75 (2.15)

*Residential proximity is given in miles.

With this larger distance in mind, it was important to determine how these users are accessing the trail. In other words, what mode are they using to get from their home to the trail? Table 9.2 shows a breakdown of the trail users" mode choice for traveling to the trail. Trail users who participate in walking, live closer to the trail than those who bike or jog/run. Runners live the furthest from the trail which suggests that they use the trail as just one portion of a much longer running route.

Recognizing that these trail users are drawn to this particular trail for a specific reason, we can analyze their responses based on several key factors. First, what type of activity were they participating in on the trail? Table 9.2 below also shows that the majority of trail users were walkers (71%), followed by a minority of bicyclers (16.1%) and jogger/runners (12.9%). It makes sense that many of these individuals would use the same active mode to access the trail as the activity in which they are participating (i.e. walkers would walk to the trail, and bicyclers would bike to the trail). This information creates a clearer picture by showing that different activities attract users from different distances.

TABLE 9.2 Trail and Access Mode Choice

Trail Access Mode Choice	Trail Users
Walk-Jog	80.6%
Bicycle	12.9%
Automobile	6.5%
Transit	0.00%

Trail users are overwhelmingly accessing the trail using an active mode of transportation (93.5% walking/jogging or bicycling). Only a small percentage of users accessed the trail by automobile (6.5%), and no users reported accessing the trail by transit. This information implies that the trail users are a highly motivated group who are attracted to this trail for a particular reason other than simply proximity to their home, as most residents living over 1 mile from a trail may find its location to be too far from home to utilize active access modes (as outlined in Burbidge, Goulias, and Kim, 2006).

The second key factor used to analyze trail users‟ responses, was whether or not they were actively engaged in their chosen activity prior to the construction of this trail. If indeed they did historically participate in this activity, where did they participate in the past? According to intercept survey responses, approximately 87% of trail users reported participating in the same type of activity prior to this trail‟s construction. The most frequent location for participation prior to the trail‟s construction was on local sidewalks (62.9%), followed by local streets (18.5%), or on another trail (18.5%). This confirms research by Brownson et al (2001), which found that people are most likely to participate in physical activity on neighborhood streets, sidewalks, or trails. It also shows that the trail is merely a convenience for the majority of users, as only 13% of users reported not participating in this type of physical activity prior to the trail‟s construction.

This follow-up with trail users suggests that the trail did not cause an increase in physical activity participation for the majority of them; it simply changed the location where they were participating in physical activity. This also confirms the data analysis set forth in the prior section of this document which found that the trail"s construction did not produce a significant increase in active travel behavior or physical activity and in fact the contrary was established.

The third key factor used to analyze trail users" responses, was how frequently they use this specific trail. Table 9.3 below shows that usage rates of the trail are spread across the sample, with a mean usage rate of 2.74 times per week. This suggests a nearly bimodal distribution of usage rates within the sample.

TABLE 9.3 Frequency of Trail Use

How often do you use this trail?	% of Sample
1 time per week	22.6
2 times per week	16.1
3 times per week	35.5
4 times per week	16.1
5 or more times per week	9.7
Mean	2.74 times per week

Lastly, by asking trail users about their likes and dislikes regarding this specific trail, this research attempts to create a clearer picture regarding potential benefits or problems associated with the newly constructed trail, which may also shed some light on why additional residents have not chosen to utilize the trail for physical activity. A qualitative analysis of the pros and cons offered by trail users reveals that the most positive aspects of the trail include its newness or "novelty factor" (32.3%), cleanliness (26%), width (19.4%), proximity to residence (9.7%) and lack of crowds

(9.7%). According to users, the most negative aspects of the trail included lack of amenities such as benches, lighting, and signage (32.2%), lack of distance or length ("too short"- 22.6%), and lack of connectivity to other destinations (9.7%). These issues were alluded to in Chapter 4, and are confirmed by this qualitative analysis. If this small sample of trail users reported lack of connectivity and lack of length as weaknesses of the trail, it is highly likely that a larger number of local residents feel the same way. However, for the other non trail-using residents, these issues may be critical enough to discourage their use of the trail completely.

By gaining a better understanding of individuals who have chosen to use the trail, we likewise gain a better understanding the Academy Park Survey participants. The demographic make-up of trail users was nearly identical to the demographic profile of those found most likely to participate in physical activity; these characteristics were revealed in the demographic analysis included in Chapter 5. The intercept survey also revealed that over the course of two four hour observation blocks, only 43 individuals were viewed using the trail (Wednesday = 26, Saturday = 17). This amounts to just over 5 persons per hour, or one every 12 minutes on average. This usage rate is remarkably low. Had this observational survey revealed high usage rates, it would make the sampling suspect and potentially threaten the internal validity of this data collection; however, the low trail usage rates confirm the statistical analysis shown above which revealed that physical activity and active trip making are not particularly prominent in this area, and that the installation of a new trail did not create an induced demand for this type of activity.

10. Analysis of Pilot Study Methods

The final goal of this research seeks to evaluate if the methods employed in the pilot study are sufficient for determining behavioral causality. This chapter provides a critical analysis of the methods employed as well as supplying a list of future do"s and don"ts for this type of research, with the ultimate goal of providing a framework for future researchers wishing to conduct evaluations of interventions to the built environment.

10.1 Limitations of Pilot Study

Although this study is the first research of its kind using a longitudinal data collection and analysis design to study changes in active travel behavior over time, there are five major methodological limitations.

First, although this study was pseudo-experimental, a truly experimental design would have required a control group (as discussed previously in Section 3.6). A control would provide comparison data from an area where no trail construction took place (a location without access to trails). By surveying the control group concurrent to the experimental group over time, the research could have more accurately identified the impact that the trail itself had on active travel behavior and physical activity. Having a control group, would allow for the identification of additional external factors which may impact active travel behavior or physical activity (i.e. the economy, weather, etc.).

Second, this study"s sample suffers from a high degree of panel attrition. Due to the restricted budget for the research the original sampling, as well as follow-up attempts with sampled households were not extensive. The initial sampling of 2,211 households resulted in a response rate of only 13.1% for the preliminary questionnaire, and only 9% (199 households) agreed to participate in the activity diary portion. After that initial sampling and household questionnaire, non-response households were not re-contacted due to the large cost of such an endeavor. As a result, the less than ideal initial response rate combined with panel attrition over the three activity diary waves resulted in a relatively small sample (32 of the original 2,211 households- 1.5%). This was a major drawback for the pilot study and inevitably impacted multiple components of the subsequent analysis. For example, a larger sample may have captured a higher representation of bicycle trips which were nearly nonexistent in the smaller sample. Also, a larger sample would have allowed for increased statistical significance through an increase in the allowable degrees of freedom for advanced statistical analysis. This potentially could have provided added strength to the zero-inflated Poisson analyses. An increased sample size would also have allowed the use of additional sophisticated methods such as structural/simultaneous equation models (SEM), which require thousands of observations to run successfully. Also, the sample that participated in all four waves of data collection was not entirely representative of the population as a whole (as shown in Table 3.8), with a high percentage of unemployed (retired) individuals and individuals over age 65. This limits the ability to make broad based generalizations based on the findings of this work.

Third, there are inherent limitations created by the data collection instruments themselves (surveys and activity diaries). The survey instruments used for this data collection were relatively brief, as it was determined that fewer questions would reduce panel fatigue and encourage completion. The limited length of the surveys accompanying the three activity diaries (5 questions each) did not provide enough information to identify additional exogenous factors which inevitably may have contributed to the observed negative changes in active travel behavior and physical activity. Likewise, more open ended questions could have allowed respondents to provide their own undefined responses to a variety of stimulus questions, allowing a more thorough qualitative analysis of responses. This additional data could undoubtedly have provided a clearer picture of active travel behavior and the acquisition of physical activity.

The activity diary was specifically designed to provide all the necessary information for analysis. However, even after providing detailed directions and examples for how to complete the diary with each packet, individuals continued to provide vague or incomplete entries which resulted in the need for researchers to make judgments regarding the intent of certain responses. Also, although the use of a single-day activity dairy was used to reduce response burden, it did not allow this analysis to account for day-to-day variation which may prove to be a significant factor in measuring active travel behavior and physical activity. For example, there may be individuals in the sample who are highly active and participate in physical activity every day except, for example, on Wednesdays. Now consider the implications to validity if these individuals were assigned to complete their activity diary on Wednesday in all waves. These individuals would be classified as "inactive" in the analysis, as there was no way to identify their behavior during the remainder of the week. This research attempted to control for such an example by asking respondents if the assigned day represented a "typical day" for them, but did not acquire additional information for individuals who said "no". Also, even by asking if it represented a typical day, this research ran the risk of the above respondents stating "yes" due to the fact that it does indeed represent a typical Wednesday.

The fourth drawback of this methodology was expressed in the data analysis rather than in the data collection portion of the study. Although this research acquired detailed activity information which allowed for delineation between active transportation trips and active recreation trips, they were not coded or analyzed independently. All walking trips were treated equally and all biking trips were treated equally regardless of trip utility (recreation or transportation). This was done based on the logic that regardless of trip utility the trips utilize the same infrastructure. However, recent research has begun to focus on variation in motivation for active trips depending on trip utility. As Handy, Cao, and Mokhtarian assert, "factors [contributing to walking behavior] almost certainly vary depending on whether the walk or the destination is the motivation for the trip (2006)". Similarly, this study may not have identified an adequate geographic catchment area for the trail itself. The trail intercept data revealed that individuals were traveling as far as 6 miles to reach the trail. The methodology of this intervention only included residents living within approximately 1 mile (walking distance) of the Academy Park Trail.

The last major drawback of this methodology was a lack of information dissemination regarding the trail. No concentrated effort was made to announce the construction of the trail or to alert neighborhood residents that it was complete. The only public involvement effort was conducted one year prior to the trail‟s construction and consisted of an open public meeting to hear arguments from residents against the trail‟s construction. Only 14 individuals were in attendance and the majority of attendees were property owners who lived adjacent to and were opposed to the proposed right-of-way for the trail. As shown in Figure 2.2 "information" has been shown to play a critical role in informing the behavioral decision making process and the lack of information availability regarding the new trail in the pilot study may very well be partially responsible for its lack of significant impact on active travel behavior and overall physical activity. If neighborhood residents did not know that a trail had been constructed, it is unlikely that the trail would impact their behavior?

10.2 Methodological Lessons for Future Research

There have been many lessons learned throughout the process of completing this research. As shown above, this pilot study"s methodology was not completely adequate to establish behavioral causality, but it did move several steps in the right direction by improving upon prior research methods. However, based on the five methodological and analytical drawbacks discussed above, this section seeks to provide a comprehensive discussion of needs for future research.

Two types of recommendations are presented in this section. The preferred methods are presented without regard for time or funding. These are perfect world methodologies which may or may not be feasible within the constraints of future research agendas. Therefore, the second recommendations are alternatives to the preferred methods defined. These methodologies do have some drawbacks but are in most cases easier and less expensive to implement that the preferred methods. These acceptable methods may provide necessary information for evaluation studies regarding the impact that built environment interventions have on active travel behavior and overall physical activity.

When conducting intervention analyses, it is imperative that evaluation methods be both longitudinal and experimental by design. This means that the study must measure the intervention"s impact over time while providing a control group that mirrors not just the demographics of the experimental sample, but also the other characteristics of the intervention study area. Longitudinal analyses allow for researchers to measure behavior both before and after a given intervention providing the opportunity for direct measurement of change. Therefore longitudinal methods are preferred for any evaluation of interventions regarding the built environment. Quasi-longitudinal methods (i.e. asking individuals what their behavior was like in the past without directly measuring it) however, could be used in cases where the intervention being evaluated has already taken place. Results from quasi-longitudinal methods can however exhibit threats to validity, as they rely on individuals accurately recalling what their behavior was like in the past which can be highly inaccurate as shown in Table 7.14.

Additionally, a control group is preferred for intervention analyses as it provides a direct comparison of behavioral changes over time. The control group should be located geographically close enough to the intervention site to control for weather/climate variation as well as any economic effects which may impact the study area. A preferred control group would also experience land-use and development changes that are identical to those experiences within the study area over the measured time period, as well as an identical (or highly similar) change or turnover in residents over time. This would require not only a control for existing demographics but also a control on residential self-selection both in the control group as well as the intervention group. Only by applying these types of constraints could the actual change in behavior be completely attributed to the intervention while controlling for confounding covariates. However, in cases when a control group cannot be included, it is acceptable to include appropriate control covariates in the analysis of behavioral change. Variables that have been shown to impact behavior, which should therefore be included in such analyses, include: age, sex, number of children in the household, household income, drivers license possession, number of household cars, employment status, and measurement day.

Future evaluation research should begin with a very large sample. The initial population should be over sampled to ensure a large end sample size (accounting for panel attrition). Extensive efforts should be made to reduce panel fatigue and attrition. For each wave of data collection a reminder card should be sent prior to the wave, and at least one follow-up should be made including additional materials if necessary. Participation should be encouraged through incentives or other motivational strategies to ensure that after panel attrition and drop-outs, there are approximately 1,500 complete observations. A sample that size would provide ample opportunities for using sophisticated statistical techniques, and would be more likely to consist of a representative sample that would allow for broader generalizations regarding findings. If utilizing complex methodologies limits the ability to provide an adequate sample size, it is acceptable to reduce the response burden (through reduced complexity of the methodologies) in order to ensure a larger complete sample. However, great care should be taken to maintain as much methodological integrity as possible. Care should be taken not to significantly reduce methodological complexity for only a marginal increase in sample size. For example, if a 60 question survey will yield response from 1,000 individuals but a 30 question survey will yield responses from 1,300 individuals, it would be more valuable to have the additional 30 responses from the 1,000 respondents than to have half as much information from the slightly larger sample.

With regard to data collection instruments, regardless of survey size or available resources, it is recommended that future researchers utilize existing survey questions (from prior research) which have already been validity and reliability tested. This will both reduce the amount of effort required in testing a new instrument, and prevent future researchers from attempting to reinvent the wheel so to speak when adequate measurements are already available. This research highly recommends conducting a preliminary survey to collect a comprehensive profile of demographic and personal characteristics for each respondent. It is preferred that this survey be as exhaustive as possible to provide controls in all subsequent analyses. Survey questions regarding attitudes or personal opinions should also provide open ended opportunities for respondents to express their thoughts without simply selecting from a predefined set of variables. If limited resources require a smaller survey instrument, it is acceptable to acquire information on demographic characteristics (and the control covariates mentioned above) and specific information which is deemed necessary for the proposed analysis. It is also suggested that researchers utilize predetermined response questions (multiple choice) rather than open ended questions. When crafting survey questions for this type of behavioral research it is imperative to decide first what information is necessary for the analysis and then devise specific questions which will provide that information.

In addition to the recommendations given above for the survey instrument, this research also recommends the use of contingent valuation/stated preference methodologies in future survey data collection. Contingent valuation has long been used by economists measuring differences between stated preferences and revealed behavior. When using this methodology, the respondent is presented with a number of hypothetical choice sets for a given circumstance. The respondent then chooses the response that best represents their preference (Vandresse, 2003). When developing these choice sets it may be useful to first conduct smaller focus groups to get general ideas, and then strategically select questions that are strictly related to the research hypotheses (Clifton and Handy, 2001). As this research has raised additional doubt about the connection between intent and revealed behavior (discussed in Chapter 11) it is imperative that future intervention evaluations employ this methodology. Additionally, acquiring stated preference information in surveys allows for the application of multinomial logit (discrete choice) models in the analysis, which are more robust than the traditionally employed methods described in Section 2.9 (Hensher and Bradley, 2005, Train and Wilson, 2007, and Vandresse, 2003).

For collection of behavioral data, this research recommends the use of a multi-day activity dairy (a full week would be ideal) which not only provides a complete picture of activity scheduling and behavior within a single day, but also allows for analysis of day-to-day variation in behavior. This provides a complete behavioral picture by showing individual time use over the course of several days. This type of data collection would also allow for more robust analysis regarding the amount of time individuals spent participating in physical activity or active travel over the course of a week, provide a picture of interaction between and physical activity, active travel, and other activities, and provide information on which days individuals are the most physically active. It is, however, recognized that activity diary data collection is both tedious and expensive and requires a great deal of time and effort on the part of the research staff. In many cases it may not be possible to conduct a multi-day activity diary measurement for a given intervention. In that case, there are a variety of acceptable options. First, researchers could use a single day activity diary. A single-day activity diary similar to the one employed in this research provides information regarding individual time-use and scheduling, trip/activity purpose, other individuals involved in the activity, distance, duration, etc. A single-day activity diary however, cannot measure variation between days and only provides a snapshot of a single day. This would inherently not record any active travel or physical activity which was acquired during the remaining unmeasured 6 days of the week. Additionally, if the day measured was not typical or representative for that individual, it would threaten the validity of the data collected.

Another option for collecting behavioral data for measurement in an intervention evaluation is the use of a behavioral survey. This type of survey could collect data from an entire week (like the recommended multi-day activity diary) but with less response burden. This type of survey could also be administered through the mail or via telephone. For this type of survey researchers would ask respondents to report how many times they walked, biked, participated in physical activity, etc. throughout that day. Respondents could also be asked to estimate how many minutes they spent participating in physical activity. Although these questions could provide the basic data necessary for conducting an analysis of behavioral change over time, they do have some drawbacks. First, the questions rely on a respondent remembering their behavior throughout the course of the day. If an individual forgets to include linked trips as separate events (i.e. walking from home to the bus stop and from the bus stop to work), these trips will not be included in the analysis. Also these surveys do not measure time-use throughout the entire day, so there is no way for the researcher to evaluate how the respondent"s active behavior fits into their overall pattern of behavior. These questions do not directly provide information regarding trip purpose, distance, duration, or if anyone else participated in the trip, which limits the ability to provide a complete picture of active travel behavior, but additional questions could be included to examine those variables as well.

The last acceptable tool for measuring behavioral change over time is the use of either pedometers or accelerometers. A pedometer measures the number of steps a person takes over a specified period of time, and an accelerometer measures the amount of physical exertion a person exhibits over a specified period of time. Although each of these methods could provide a measurement of physical activity over a given time period, they have some serious drawbacks which may limit their usefulness in an intervention evaluation. For example a pedometer only measures walking but not other forms of physical activity and it cannot tell you whether the walk was for recreation or transportation purposes. It also cannot tell you how long it took to walk a specific distance or how many separate walks that individual took over the course of the day as it measures single steps comprehensively. Likewise, accelerometers do not provide any information about what type of physical activity was acquired or how many episodes of physical activity an individual participated in. Depending on the individual‟s baseline fitness, an accelerometer may report different amounts of physical for different individuals even though their actual activity was similar. Neither accelerometers nor pedometers allow for the identification of potential confounding factors which may have impacted any measured change in active trip making or physical activity. Therefore these methods would most effective if used in conjunction with one of the other methods described above.

Additionally, some techniques from qualitative research such as focus groups (discussed in detail below) could be utilized concurrent to the data collection methods described above to "test the conclusions of the survey methods and to explore in more depth the factors which influence decision making (Handy, Clifton, and Fisher, 1998)".

Future research should delineate between walking/biking for recreation versus walking/biking for transportation. Recent research has determined that motivations and intent vary depending on trip utility, therefore it is highly important to treat them independently in the analysis. This pilot analysis did not take that difference into account. Had it been accounted for the analysis may have resulted in additional significance (i.e. perhaps the construction of a trail produced an increase in recreation trips but not transportation trips). Likewise, a more accurate geographic catchment area should be established for the infrastructure prior to the evaluation measurement. This study"s evaluation methods only included households located within 1 mile of the canal trail, but the subsequent intercept survey revealed that individuals were traveling as far as 6 miles to access the trail. It is recommended that an intercept survey be conducted on a trail/path similar to the one in which the intervention will be measured prior to the evaluation to identify a potential catchment area for the new infrastructure. This would ensure that a large enough study area is included in the intervention evaluation to measure real behavioral thresholds. For example if a trail similar to the one being evaluated shows a catchment area or draw of ten miles, that information tells researchers that it would behoove them to include households up to ten miles from the intervention site. If it is not possible to conduct an intercept survey of a characteristically similar site then it is acceptable for future work to utilize previous analyses identifying thresholds for active modes (i.e. Burbidge, Goulias, and Kim, 2006). Please note however that using these thresholds may limit catchment area identification, as threshold data only provide information regarding how far people generally travel using the active mode. This would inherently leave out individuals who drive to access a trail/path and then participate in active behaviors once there.

Intervention evaluations can also include some type of information component. The pilot study had no information component and it is highly likely that only a small percentage of neighborhood residents even knew about the new trail. As information is a key component of the active travel behavior choice process, it may be important to include it in any evaluation of a built environment intervention. An information program could consist of a "travel feedback" program; which is "an educational program or travel campaign focused on behavioral modification of the participants (Taniguchi and Fujii, 2007)". Although Taniguchi and Fujii (2007) and Karash, Coogan, and Adler (2007) both address information/educational interventions, both note that it is not well understood how travel feedback programs such as educational interventions, actually modify travel behavior. Future research evaluating interventions could also incorporate some type of information/educational program intervention concurrent to the built environment intervention. Integrating an educational program would also provide an opportunity to evaluate, in a true experiment, any behavioral differences between individuals who received the educational intervention and those who did not.

Table 10.1 shows the key methodological components proposed above for future evaluations of built environment interventions.

TABLE 10.1 Methodological Components of Future Work

Component	Preferred Methods	Acceptable Methods
Intervention Measurement	-Longitudinal methodologies which directly measure behavior at various time points	-Quasi-longitudinal methodologies which ask respondents to report their behavior from past and present time points
Experimental Design	-Include a true control group consisting of individuals similar in demographics as well as an area with similar built environment characteristics	-Include control covariates in the analysis including: age, sex, # children in HH, HH income, drivers license possession, # HH cars, employment, and measurement day
Sampling	-Ensure the sample is large enough to provide at least 1,500 observations after accounting for panel attrition	-Increase sample size by reducing response burden and methodological complexity
Survey Instruments	-Utilize existing survey questions which have already been validity and reliability tested -Exhaustive preliminary questionnaire including demographics variables, and attitudinal questions with open ended response -Use of contingent valuation methods for stated preference questions	-Utilize existing survey questions which have already been validity and reliability tested -Survey which acquires data on necessary controls (as defined above) through predetermined reponses (multiple choice) -Use of contingent valuation methods for stated preference questions
Behavioral Data Collection Instruments	-Multi-day activity diary data collection	-Single-day activity diary, surveys of stated behavior, and pedometers or accelerometers used concurrently with other measurement tools

Trip Utility	-In data coding and analysis treat active trips for recreation or transportation independently based on trip utility	
Geographic Catchment	-Conduct an intercept survey of a similar infrastructure site prior to the intervention to identify an appropriate study area size for the evaluation	-Utilize data on active mode choice thresholds to identify a catchment area for infrastructure users
Information	-Perform an information/travel feedback intervention concurrent to the built environment intervention to evaluate the impact of knowledge on behavior	

Lastly, there are some benefits to utilizing qualitative methods in future intervention evaluations. Qualitative methods are non-positivist in the sense that they do not assume an objective reality that can be understood through experimental methods and quantitative analysis alone. There are five recognized strategies within qualitative methods: 1-Biography, which involves the building of a chronology of an individual over time, including information such as life stages, turning points, interactions, and context; 2-Phenomenalogical studies, which attempt to evaluate life in terms of perception, beliefs, attitudes, and individual decisions; 3-Grounded theory, which seeks to build a theory (rather than test a theory), provide tools for analysis, explore alternative meanings, and combine creative and systematic approaches; 4-Ethnography, the description and interpretation of a cultural system which seeks to work with unstructured data and investigate small samples through participation and immersion by the researcher in the everyday lives of the individuals being studied; and 5- Case studies, in which data collection includes “mixed methods” and multiple sources of information where researchers seek to identify commonality within the specified cases (Goulias, 1995). Although these types of methods are outside the positivist approach used in this pilot study and are based on a philosophically different position, qualitative tools do have a place in future evaluation research. For example, the qualitative approach seeks to provide insight into behavior through activities such as individual and group interviews, direct observation, visualization, and personal experience. These tools can be used in cooperation with existing quantitative methods to enrich the understanding of behavior and provide additional insight into human decision making.

10.3 Necessary Components of Intervention Evaluations

based on the drawback and suggestions presented in Sections 10.1 and 10,2, this research lastly seeks to identify, at minimum, what information is absolutely necessary in order to evaluate the impact of an intervention of the built environment on active travel behavior and physical activity. Table 10.2 below identifies necessary information for each component of the evaluation.

TABLE 10.2 Necessary Components of Intervention Evaluations

Evaluation Component	Necessary Information
Demographics	Age Sex Household income Number of children per household Education Race/Ethnicity
Personal Characteristics	Number of automobiles (per household) Possession of driver"s license Possession of other amenities
Behavioral Data	Total walking trips per day Total biking trips per day Total physical activity episodes Total time spent being physically active
*Attitudinal Covariates	Preference for walking/biking/physical activity Identification of barriers to physical activity Attitudes regarding the new infrastructure both before and after the intervention
*Information Component	Test if respondents are aware that the intervention has occurred and measure the impact of information

*Suggested but not mandatory

Demographics should be acquired for all participants including age, sex, household income, number of persons per household, and education level. Race and ethnicity can also be acquired to identify and control for differences between ethnic groups. Personal characteristics such as automobile ownership per household, possession of driver"s license and possession of other amenities such as in home exercise equipment (which may impact their use of any new active infrastructure). Regardless of what data collection methodology is employed, researchers should gather data on total walking and biking trips per day (delineating between recreation and transportation trips), total physical activity episodes, and total time spent being physically active. This will allow for an analysis of change in both active travel behavior as well as physical activity accumulation over time. Although attitudinal data is not absolutely necessary in an evaluation of an intervention to the built environment it is highly recommended as it provides additional insight into the change, or lack of change, revealed by the evaluation analysis. Attitudinal questions could include a measurement of preference for walking and bicycling as well as physical activity in general. These measurements could also include an identification of any perceived barriers to physical activity (perceived behavioral controls). Also, the respondents should be asked about their attitudes regarding the new infrastructure both before and after the intervention. Finally, the intervention evaluation may also include an informational component. This will ensure that the respondents being measured are in fact aware that the intervention has occurred.

11. Conclusions

This study fills a research gap by providing the first truly longitudinal data collection and analysis evaluating the impact of trail development on the active travel behavior and total physical activity of neighborhood residents. This pilot study used a pseudo-experimental setting to measure changes in travel behavior and physical activity of neighborhood residents from before a trail was constructed to two time points following construction. In addition to measuring the behavior of historic residents, this study also analyzed households who moved into the neighborhood after the trail‟s construction allowing for the control of potential residential self-selection. The longitudinal design is the natural approach for this type of experiment as it allows for the construction of conclusions based on individual variation over time rather than a comparison between independent samples. The trail intercept survey also provided an opportunity to identify a demographic profile for actual trail users independent of the demographic analysis of the neighborhood sample.

In Figure 2.2 a conceptual model for active travel behavior was proposed based on components of the Theory of Planned Behavior, Decision Field Theory, and additional mechanisms suggested by prior active living research. As described in Section 2.5 this research examined several of the relationships presented in the conceptual model including infrastructure and environment, time-allocation, demographics, personal characteristics, attitudes, perceived behavioral control, intent, residential location selection, and revealed behavior and physical activity.

Although results from the pilot study cannot conclusively prove or disprove the validity of any of the components within the model, the analysis can provide valuable insight to the relationships between components and potentially raise doubts about those relationships. Figure 11.1 shows the conceptual model originally presented in Figure 2.2 for reference.

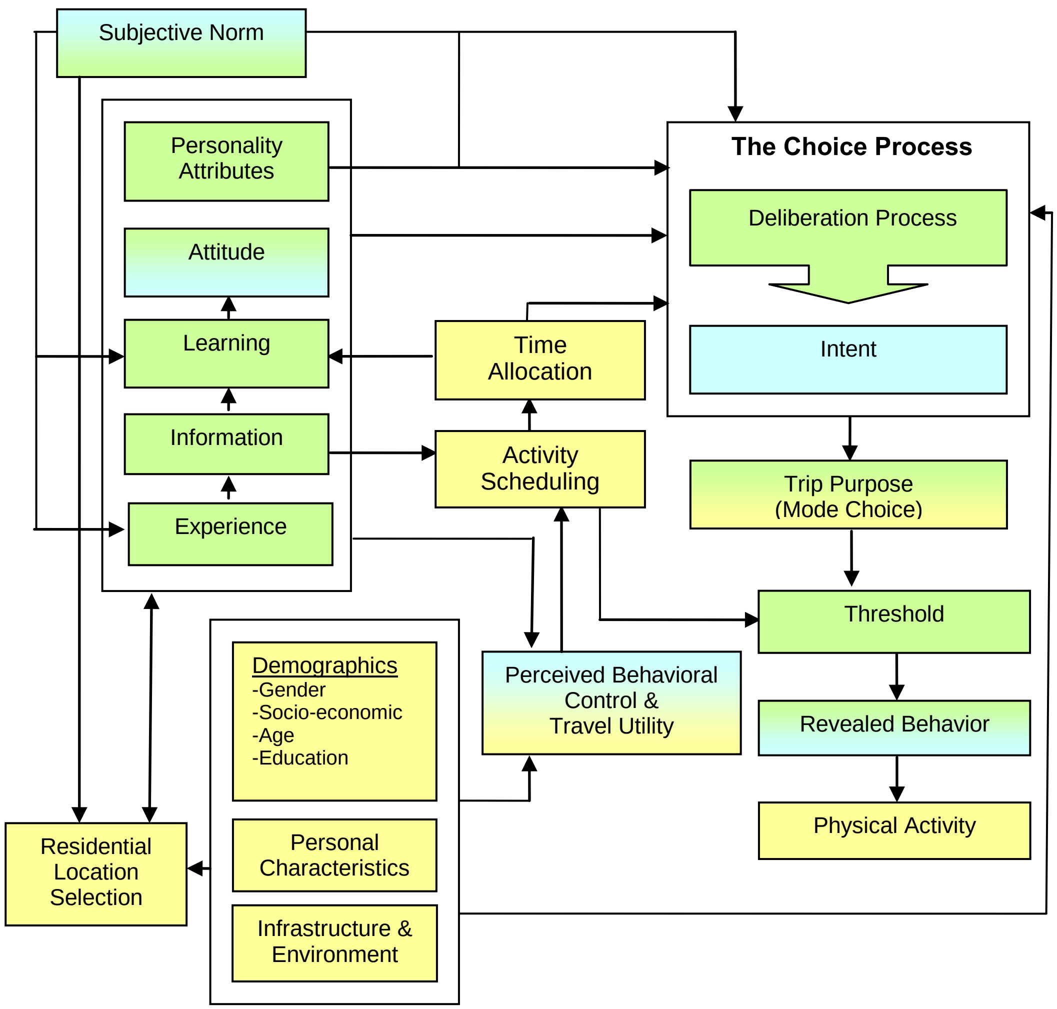

Figure 11.1 Conceptual Model of Active Travel Behavior-Revisited

1-Blue shaded boxes taken from Ajzen‟s Theory of Planned Behavior (1985)
2-Green shaded boxes taken from Busemeyer and Townsend‟s Decision Field Theory (1993)
3-Yellow shaded boxes proposed by this research

First analyzed, was the relationship between individual attitudes and active modes of transportation and physical activity. Attitudes were found to have a significant impact on actual behavior. However, contrary to the hypothesis, individuals who viewed walking as a less favorable mode of transportation were significantly more likely to take walking trips. The perception of danger or accident risk also had significant impact on walking trips with the likelihood of walking decreasing as an individual‟s perception of risk increased. Individuals whose perceptions of safety level were contingent upon improved sidewalks did not significantly differ from those who believed that the existing infrastructure was adequate. Preference for playing sports significantly impacted total physical activity, with those individuals acquiring nearly 40 minutes more physical activity per day than the remainder of the sample. These results confirm that attitude does in fact impact the choice process as outlined in the conceptual model.

Next, the study evaluated the impact of demographics, personal characteristics, and infrastructure and environment on active travel behavior and physical activity. Demographics and personal characteristics both had a significant impact on walking and physical activity participation, but the impact was not consistent across waves of data collection. Although there was some consistency in behavior, a large percentage of participants change their behavior over time, even when holding the completion day of the week as a constant. After further analyzing which demographics were most likely to determine a participant‟s physical activity level, traditional measures were significant at predicting activity level. Age was significant, but only for individuals ages 18-65. The pilot study found that individuals ages 18-65 significantly increased their total physical activity episodes from before the trail was constructed to after. In addition to age; sex, number of children in the household, and employment, were significant predictors of activity. Women and individuals from households with a large number of children were more likely to participate in walking trips and physical activity, while employed individuals were highly likely to participate in motorized travel but were unlikely to participate in physical activity or walking trips. Although these demographics were found to significantly impact active travel behavior and overall physical activity, there are still additional opportunities to examine these relationships in greater depth. Future research is needed to investigate the 18-64 age group, breaking it down into smaller life stage age groups for analysis. Additionally, there is a need to study active travel behavior in children and the elderly in more depth, as they did not show a significant change in active travel behavior or physical activity.

Various personal characteristics significantly impacted behavior as well. Households owning at least one automobile were likely to change their physical activity over time and were unlikely to remain consistently inactive. Also, ownership of home exercise equipment proved to be a deterrent to physical activity. Owners of elliptical or rowing machines were significantly less likely to take walking trips than the rest of the sample, while owners of “other” equipment were more likely to walk.

An analysis of means as well as the fixed effects panel analysis, found that the installation of the trail did not significantly impact the active travel behavior of participants or the total amount of physical activity neighborhood residents were acquiring over time. Although this does not discredit other potential impacts that the built environment may have on behavior, it does raise doubts about the potential impact that the presence or absence of infrastructure has on active travel behavior and physical activity. As described in Chapter 10, additional research involving evaluations of interventions is necessary to fully identify the relationship between changes to the built environment and changes in active travel behavior and overall physical activity.

The pilot study examined the impact of residential location selection on the choice process by identifying if new residents choose to move to the area due to the presence of the neighborhood trail. The analysis reveals a degree of uncertainty regarding the connection between infrastructure and environment and residential location selection. A complete qualitative analysis of new resident households revealed that it is highly unlikely that new resident households were drawn to the area due to the presence of the Academy Park Trail. New resident households were large, young, middle-income families, who chose this neighborhood for similar reasons to the historic residents including: housing affordability, proximity to employment, and proximity to family and friends. This suggests some degree of demographic and personal characteristic similarity among residents as shown in the model. New residents were likely to have different attitudes than historic residents about the same area, which calls into question the connection between residential location selection and individual attitudes.

A preliminary measurement of perceived behavioral control, and concomitantly intent, was conducted analyzing correlations between promised behavioral change and observed behavior. Individuals who stated an increase in trails would make them walk more, did not participate in significantly more walking trips following the construction of the local trail. These results suggest that perceived behavioral controls may not inform revealed behavior as asserted in the both the Theory of Planned Behavior and this conceptual model. Additionally, these results paired with prior research on stated versus observed behavior assert that intent does not necessarily equate to revealed behavior (Fishbein and Ajzen, 1974 and Wicker, 1969). Because the pilot study did not analyze perceived behavioral control or intent in depth, the relationship between these components and active travel behavior remains unclear and should be examined in more completely in future research. This future research should utilize the methodologies of contingent valuation and stated preference research described in Section 10.2. Additionally, future work provides the opportunity to utilize a longitudinal methodology to first ask about preferences and intentions, then collect data on revealed behavior, and subsequently follow-up with participants asking why they did not follow through with their original intentions; in other words, why did they not end up doing something they claimed they would. This can provide additional insight into the correlations between intentions and revealed behavior as they occur over time.

The activity diary allowed this research to examine an individual‟s activity scheduling and time allocation throughout the entire course of the day by putting active travel behavior and physical activity choices in context with other activities. For example, this research identified that time spent participating in any physical activity as a percentage of total time use, decreased in each wave of measurement. Also, the number of trip chains per person (linking two or more trips together) substantially increased over time. Activity diary completion day was significantly correlated to behavior, and completion on different days of the week yielded different behavioral characteristics. The pilot study also examined time allocation using residential proximity as a construct. Residential proximity displayed some significant correlation to total physical activity and active travel behavior, although continuous distance regressions were not significantly correlated to total physical activity or active trip making. A categorical distance construct analysis revealed that households living one-half to three-quarters of a mile from the new trail participated in significantly fewer minutes of physical activity (nearly 45 per day) than the remainder of the sample. Additionally, a fixed effects panel regression uncovered that the change in residential proximity to the nearest local trail, brought about by the new trail‟s construction, was significantly correlated to total physical activity episodes and total walking trips. Once again, however, these results ran contrary to the expected outcome. As the residential distance from a local trail decreased (or nearness increased), individual physical activity episodes and walking trips significantly decreased. These analyses confirm that activity scheduling and individual/household time allocation are both significant predictors of revealed behavior.

Lastly, although outside the scope of this particular research and therefore not included herein, it is important to note that human interactions inevitably impact human behavior. There is potential for future research which includes an analysis of the interactions experienced both between individuals as well as within households. These interactions and relationships could prove to significantly impact the way that individuals make decisions regarding active transportation and physical activity.

The conceptual model provided by this research positions active travel behavior research within the broader framework of behavioral theory by providing a context in which these types of decisions are made and identifying appropriate contributing factors. However, an analysis of the conceptual model using the pilot study did raise some doubts about several of the components of existing behavioral theories (i.e. the impact of infrastructure and environment and the relationship between intent and revealed behavior). This suggests a need for additional research to fully test the components of the model in the real world. Additionally, the methodologies employed in this intervention evaluation pilot study (described in Chapter 10) were evaluated, and several recommendations were made for improvement, thus providing a general framework for future studies to continue to test and refine this new conceptual model of active travel behavior.

Future intervention evaluations should pay special attention to their methodological design. Although a control group is highly recommended to ensure that significance can be confirmed without the possibility of confounding covariates. However, when it is not possible to utilize a control group, proven control covariates should be included in all analyses. Additionally, every effort should be made to maximize sample size, as a large sample provides the opportunity for greater statistical power and increased generalizability. Care should be taken however not to balance any reduction of methodological complexity with the benefit of an increased response. Measurement instruments should be carefully created to be exhaustively inclusive of potential controls while limiting response burden. Existing survey questions, which have already been reliability and validity tested, should be utilized whenever possible in order to avoid any unnecessary burden on the research staff and potentially recreating existing instruments. Additionally, for attitudinal questions and those measuring intent (i.e. stated preference) contingent valuation measurement and analysis methods should be employed to provide maximum analytical strength.

Although a multi-day (preferably week long) activity diary is recommended to account for day-to-day variation in behavior. However, if resources are limited it is acceptable to utilize a single day activity diary (with typicality controls), behavioral surveys, or pedometers and accelerometers used in conjunction with other methods All data coding and analysis should differentiate between active trips for recreation and active trips for transportation. Each trip utility should be treated independently to establish a clearer picture of causality.

Regardless of available resources, it is imperative that all intervention evaluations include data on several specific characteristics including demographic controls, personal characteristics, and behavioral data (identified in Table 10.2). Additionally, attitudinal covariates should be included to provide additional insight into revealed behavior. Finally, an information/education intervention can be conducted concurrent to any built environment intervention to identify potential impacts that knowledge of the infrastructure may have, as it is highly unlikely that an individual"s behavior will be impacted by infrastructure if they are unaware of its presence.

As shown herein, a before-after study can be methodologically designed in many ways, and future research will have to determine the optimal way. Some options have been presented above including repeating the pilot study"s methodology with some adjustments (described in Chapter 10), repeating the pilot study methodology with an additional 2-3 waves that offer general or tailored information on what happens next, and combining building trails with an informational provision. These methods can be blended with a variety of stated preference and choice experiments to provide additional insight into active travel/physical activity behavior. Additional details regarding how to go about this type of research are not part of this dissertation and are left as a future task.

In conclusion, although some of the findings of this research run counter to the original hypotheses, this research does not seek to discredit any of the alternative benefits that a neighborhood trail creates (i.e. crime reduction, increase in property values, etc.). A trail does indeed have a place as a part of the overall urban structure. Trails should not be constructed merely to provide induced demand for physical activity, but rather should be incorporated into the overall design of a community as one component of a multi-modal transportation and recreation system. Trails can be a strong asset to a community but care should be taken to design the trail including appropriate characteristics (as discussed in Chapter 2) and according to current urban design best practices. The trail evaluated in this pilot study suffered from several flaws including: lack of amenities, lack of length, and lack of connectivity to destinations. Perhaps one of the biggest lessons learned from this research is that simply installing a paved path (such as this trail) where there was not one before is not enough to create an induced demand for physical activity. To encourage a change in behavior the trail may have to exhibit a number of positive characteristics. Additional work is needed to identify exactly how trail components, such as length and connectivity to destinations, impact potential change in active behavior that accompanies trail construction. Although in this particular case there was no way for the researcher to influence the design of the trail, it would be encouraged for future work. Perhaps by participating in the planning and design process future studies can avoid potential negative impacts that the design of the trail may have on promoting physical activity and active travel behavior.

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Appendix A

Household Questionnaire
November 2006

November 15, 2006

Dear Resident:

As you may have heard, a research team from the Department of Geography at the University of California Santa Barbara is surveying residents of West Valley City to learn what activities they participate in every day and how they travel to and from these activities. We are also asking their opinions on some key transportation issues facing West Valley City.

You household was randomly selected to participate in this survey from a list of West Valley City residents. **Please have one person complete the enclosed questionnaire on behalf of the entire household.** The questionnaire will take about 10 minutes to complete. Don"t forget to complete both sides of each page.

Please be assured that your answers will be kept completely confidential. We plan to produce summaries of the information provided and will not identify any information coming from a specific household or person. Please try to answer all of the questions, but if you do not feel comfortable answering specific questions you may skip them.

When you are finished, please place the questionnaire in the enclosed stamped addressed envelope and return it as soon as possible.

If you would like to receive a summary of the survey results, please check the box at the end of the survey indicating that you would like a summary.

If you have any questions or require additional information about this study, please feel free to contact the project staff at (801) 963-3527, or email at westvalleyresearch@hotmail.com.

If you would like to participate in future project activities, make sure to fill out the last page of this packet. Households participating in all project activities will be entered into a drawing for a grand prize at the conclusion of the project.

Thank you very much for your assistance with this project.

Project Staff

University of California, Santa Barbara-
Department of Geography Research Unit
3600 Constitution Blvd., Rm 210
West Valley City, UT 84119-3720

Note: This project is conducted in association with Salt Lake County and the West Valley City Planning Department

Please Start Here *(Don't forget to complete both sides of each page)*

To help us better understand your responses, please mark your answers like the example on the right:

For "Check Boxes" X
For Numbers 1 2 3 4 5 6 7 8 9 0
For Words Please Print

1. In the next 10 years, how much do you think the use of the following transportation types will change in West Valley City? *Please check the appropriate box below and rate the change as good or bad.*

Type of Transportation	Decrease a Lot	Decrease Some	No Change	Increase Some	Increase a Lot	The Change will be Good	Bad
Walking							
Bicycling							
Automobiles							
Public Transportation (Buses)							

2. In your opinion how likely is it that the following types of travelers will be involved in a traffic accident in West Valley City? *Please check the appropriate box below.*

Type of Transportation	Risk of being involved in a Traffic Accident: Very Low	Low	Moderate	High	Very High
Pedestrians					
Bicyclists					
Motorcycles					
Automobile Drivers					
Commercial Truck Drivers					
Bus Riders					

3. Rank the following transportation modes in order of your preference for using them. *Please rank each mode based on the following scale (1-most likely to use, 5-least likely to use).*

Mode	**Rank**
Automobile	
Walking	
Public Transportation	
Bicycling	
Motorcycle	

4. I would walk more if: *(please check all that apply)*

☐ There were better destinations to walk to
☐ My neighborhood had more paths/trails
☐ The weather were better outside
☐ Nothing would make me walk more
☐ Sidewalks were improved
☐ I felt safer
☐ I had more time
☐ Other *(please specify)*___________

5. How frequently do you use public transportation?

☐ I never use it
☐ 5 or fewer times per year
☐ About once a month
☐ 2-5 times per month
☐ 5-10 times per month
☐ 11+ times per month
☐ Other *(please specify)*____

> *For the following questions, please note that a household is a group of people living together. They DO NOT have to be related to each other.*

6. How many people live permanently in this household, including yourself?

7. How many people in your household are:

Younger than five years old		
5 to12 years old		
13 to 15 years old		
16 to 18 years old		
18 years of age or older		

8. Which of the following best describes the building you live in?

☐ Mobile Home
☐ A Duplex Home
☐ Apartment Building
☐ Single Family House (detached)
☐ Townhouse or Condo
☐ Other *(Please describe)*_________________________

9. Does anyone in your household work from home?

☐ Yes ☐ No

10. Which of the following do you or anyone else in your household have in your home? *(Check all that apply)*

- ☐ Cellular Telephone
- ☐ Computer *(desktop or Laptop)*
- ☐ Satellite Television
- ☐ Cable Television
- ☐ Internet
- ☐ MP3 Player

11. What is your <u>TOTAL</u> combined household income received from jobs, businesses, and all other sources? *(Please include the income of everyone in the household)*

- ☐ $10,000 or less
- ☐ $40,001-$50,000
- ☐ $80,001-$90,000
- ☐ $10,001-$20,000
- ☐ $50,001-$60,000
- ☐ $90,001-$100,000
- ☐ $20,001-$30,000
- ☐ $60,001-$70,000
- ☐ $100,000 or more
- ☐ $30,001-$40,000
- ☐ $70,001-$80,000

12. How many vehicles are owned or leased by members of your household?

- ☐ No Vehicles
- ☐ 2 Vehicle
- ☐ 4 Vehicles
- ☐ 1 Vehicles
- ☐ 3 Vehicles
- ☐ 5 or More Vehicles

13. How many bicycles are owned by members of your household?

- ☐ No Bicycles
- ☐ 2 Bicycles
- ☐ 4 Bicycles
- ☐ 1 Bicycle
- ☐ 3 Bicycles
- ☐ 5 or More Bicycles

14. Which of the following exercise amenities does your household have?

- ☐ Treadmill
- ☐ Elliptical Machine
- ☐ Stair Climber
- ☐ Exercise Bike
- ☐ Rowing Machine
- ☐ Free Weights (i.e. dumbbells)
- ☐ Weight Machine
- ☐ Other *(Please specify)*____________________________

☐ If you would like a summary of the results, please check this box, and supply your name and mailing address in the space provided.

Thank you for taking the time to assist us in our research by filling out this questionnaire. The next portion of this research project will consist of a short activity diary to monitor the travel behavior of your household. In order to prepare your materials please complete the following information.

Please fill in the following table for each member of your household. A last name is required only for the head of the household, for all other household members you may list their first name only.

Name	***Age***	***Gender (M or F)***

Full Street Address:

Preferred Mailing Address *(if different than street address)*:

By completing the upcoming activity diaries, your household will be entered in a drawing for a variety of prizes (gift certificates, etc). At the conclusion of the project households that have participated in all project activities will be entered in a drawing for a grand prize.

We would once again like to assure you that all household and person specific information provided through this process will be kept completely confidential.

Appendix B

Activity Diary 1
February 2007

February 5, 2007

Dear Johnson Household:

We would like to begin by thanking you for your participation in the West Valley City Travel Behavior Research Project, and commend you for being one of nearly 300 households that returned a completed questionnaire. We would also like to thank you for your willingness to support your city through continued participation in this valuable research study. As mentioned in the preliminary questionnaire, the following portions of this study will consist of individual activity diaries tracking your household"s time use throughout the day. Enclosed you will find a one day activity diary for each member of the household over age five (as specified by your introductory questionnaire). The format of the activity diary is similar to a page of a day planner or organizer. Each individual will specify: which activities they participated in, who participated with you, the activity"s beginning and end times, and where the activity took place. In addition, for each activity you will specify if travel was required, what travel mode was used, and how far you had to travel. Exact instructions and an example are provided with each activity diary form.

The activity diary should be completed on Monday, February 12th. If you are unable to complete the diary on this day, please contact the research staff and we will be happy to assign you a different day.

Once again, please be assured that your information will be kept completely confidential. We plan to produce only aggregate summaries of all information provided and will not identify any information coming from a specific household or person. To ensure this confidentiality, please make sure that all individuals over age 18 sign the enclosed confidentiality agreement. A parent or legal guardian should sign for any individuals under age 18. **Without this signed agreement, we will not be able to analyze any of the information you provide.** Please note that the ID numbers shown on the activity diaries (above your name) simply allow us to track when the diary was initially mailed, and when it is returned.

When your household has completed its activity diaries, please place the diaries in the provided stamped addressed envelope and return them as soon as possible. If your activity diaries are returned before March 30th, 2007, your household will be placed in a drawing for one of four (4) $25 gift cards to Walmart. As an additional reminder, at the conclusion of the project, households that have participated in all project activities (2 more after this) will be entered in a drawing for a grand prize.

If you have any questions or require additional information about this portion of the study, please feel free to contact the project staff at (801) 963-3527, or email at westvalleyresearch@hotmail.com.

Again, thank you so much for your valuable assistance with this project.

Project Staff

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West Valley City Travel Behavior Research Project- Questionnaire 2

Please answer each of the following questions and return this sheet with your activity diary.

1. On average, how many minutes per day are you physically active (exercise, manual labor, etc.)?

- ☐ I do not get any physical activity each day
- ☐ 1-15 minutes per day
- ☐ 16-30 minutes per day
- ☐ 31-45 minutes per day
- ☐ 45-60 minutes per day
- ☐ More than 60 minutes per day

2. Which of the following types of exercise do you regularly participate in? *(please check all that apply)*

- ☐ Running or Jogging
- ☐ Walking
- ☐ Bicycling (stationary, road or mountain)
- ☐ Weight Lifting
- ☐ Aerobics classes or videos
- ☐ Sports or Games (basketball, soccer, football, tag, etc.)
- ☐ Other Aerobic Machine (elliptical, stairmaster, etc.)
- ☐ I do not exercise regularly
- ☐ Other *(please specify)*__________________________________

3. How many walking/biking trails are currently located within walking distance of your home?

- ☐ 0
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

4. Would an increase walking/biking path be beneficial to your area? ☐**Yes** ☐**No**

Why?____

5. For which of the following trips would you be most likely to walk or bicycle for transportation? *(please check all that apply)*

- ☐ Work
- ☐ School
- ☐ Recreation
- ☐ Shopping
- ☐ Errands
- ☐ Dining
- ☐ Visiting
- ☐ Appointments (i.e. medical)
- ☐ Escorting someone
- ☐ Traveling to another mode (i.e. bus, train)
- ☐ I never walk or bike for transportation
- ☐ Other *(please specify)*____________

*The actual survey used for the study took up the entire page.

West Valley City
Travel Behavior Research Project

Activity Diary 1

To be completed by: **John** 196-1

Consent Agreement:
I understand that by participating in this research project I consent to have my information used only for specific research regarding travel behavior and time use. I understand that my personal information will be kept completely confidential and information gained from my participation in this project will only be disseminated in aggregate, and will never identify information coming from my specific household or person. Furthermore, I understand that the neither the project staff from the University of California, West Valley City, or Salt Lake County will ever disseminate or supply my personal information to any outside source, either complimentarily or for financial gain. I also understand that I may withdraw myself from the study at any time without incident or reprisal by the project staff.

____
Full Name of Participant (shown above)

____
Signature (parent or legal guardian if under age 18)

Instructions:
The following activity diary should be completed by the person shown above on **Monday, February 12th**. If it is impossible for you to complete the diary on this day, please contact the research staff and we will assign you a different day. The diary should be completed as follows: For "Begin and End Times" please specify the chronological time the given activity began, and likewise the time the activity ended. For "What Activity did you do?" please specify in general terms the type of activity (i.e shopping, work, cleaning, exercise, etc.). Under "Did you do the activity with anyone" please specify how many individuals you participated with and your relationship to them (shown in the example). For "Where did you do the activity" you can either provide a street address, or the name of the location (i.e. work, school, home, etc.). "Did you travel" can be answered by simply circling yes or no. If you did travel please fill in which mode you used (car, bus, walk, bike, motorcycle, etc.), and please estimate the distance you traveled. Examples are provided on the activity diary below. **Please try to include all activities and travel experiences throughout the day, no matter how small they seem**. Please begin by answering the questions as the beginning of the diary. If you have any questions or comments, or if it is impossible for you to complete the diary on this assigned day, please contact the research staff please contact the research staff at (801) 963-3527 or email us at westvalleyresearch@hotmail.com.

*The actual Activity Diary Form used for the study took up the entire page.

West Valley City Travel Behavior Research Project- Activity Diary 1

Please Complete Diary On: February 12, 2007 **Does this day represent a typical day for you?** Yes No

EXAMPLE

Begin and End Times		What Activity did you do?	Did you do the activity with anyone?	Where did you do the activity?	Did you Travel?	How did you travel? (Car, bus, walk, bike, etc.)	Approximate travel distance?
Begin Time:	7:00 AM	Exercise	No	Home	Yes No		
End Time:	7:30 AM						
Begin Time:	8:00 AM	Went to Work	2 Friends	123 S. Main St.	Yes No	Car	10 miles
End Time:	8:30 AM						
Begin Time:					Yes No		
End Time:							
Begin Time:					Yes No		
End Time:							
Begin Time:					Yes No		
End Time:							
Begin Time:					Yes No		
End Time:							
Begin Time:					Yes No		
End Time:							
Begin Time:					Yes No		
End Time:							
Begin Time:					Yes No		
End Time:							
Begin Time:					Yes No		
End Time:							
Begin Time:					Yes No		
End Time:							
Begin Time:					Yes No		
End Time:							

**Diary continued on other side

*The actual Activity Diary Form used for the study took up the entire page.

Begin and End Times	What Activity did you do?	Did you do the activity with anyone?	Where did you do the activity?	Did you Travel?	How did you travel? (Car Bus, walk, bike, etc.)	Approximate travel distance?
Begin Time: End Time:				Yes No		
Begin Time: End Time:				Yes No		
Begin Time: End Time:				Yes No		
Begin Time: End Time:				Yes No		
Begin Time: End Time:				Yes No		
Begin Time: End Time:				Yes No		
Begin Time: End Time:				Yes No		
Begin Time: End Time:				Yes No		
Begin Time: End Time:				Yes No		
Begin Time: End Time:				Yes No		
Begin Time: End Time:				Yes No		
Begin Time: End Time:				Yes No		
Begin Time: End Time:				Yes No		
Begin Time: End Time:				Yes No		
Begin Time: End Time:				Yes No		
Begin Time: End Time:				Yes No		

*The actual Activity Diary Form used for the study took up the entire page.

April 1, 2007

Dear Johnson Household:

We would like to once again thank you for your participation in the West Valley City Travel Behavior Research Project, and commend you for being one of nearly 300 households that returned a completed questionnaire. We would also like to thank you for your willingness to support your city through continued participation in this valuable research study. As mentioned in the preliminary questionnaire, this portion of the study will consist of individual activity diaries tracking your household‟s time use throughout the day.

Materials for the activity diary portion of the study were mailed to your household in February and March of 2007, and we have not yet heard back from you. It is not too late to participate, and your involvement is very important to us.

Enclosed you will find a one day activity diary for each member of the household over age five. The format of the activity diary is similar to a page of a day planner or organizer. Each individual will specify: which activities they participated in, who participated with you, the activity‟s beginning and end times, and where the activity took place. In addition, for each activity you will specify if travel was required, what travel mode was used, and how far you had to travel. Exact instructions and an example are provided with each activity diary form.

The activity diary should be completed on the day designated in the top left hand corner. If you are unable to complete the diary on this day, please contact the research staff and we will be happy to assign you a different day.

Once again, please be assured that your information will be kept completely confidential. We plan to produce only aggregate summaries of all information provided and will not identify any information coming from a specific household or person. To ensure this confidentiality, please make sure that all individuals over age 18 sign the enclosed confidentiality agreement. A parent or legal guardian should sign for any individuals under age 18.

When your household has completed its activity diaries, please place the diaries in the provided postage paid envelope and **return them as soon as possible**. As an additional incentive, at the conclusion of the project, households that have participated in all project activities (2 more after this) will be entered in a drawing for a grand prize (valued at nearly $1,000).

If you have any questions or require additional information about this portion of the study, please feel free to leave a message for the project staff at (801) 963-3527, or email us at westvalleyresearch@hotmail.com.

Again, thank you so much for your valuable assistance with this project.

Project Staff

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Appendix C

Activity Diary 2
November 2007

September 24, 2007

Dear Johnson Household:

We would like to let you know that is time once again for your household to participate in the West Valley City Travel Behavior Research Project, and would like to thank you for your willingness to support your city through continued participation in this valuable research study. A record number of participating citizens like you are making this project highly successful, and information acquired from this research is contributing to improvements in short and long term planning for West Valley City. We would like to congratulate the Nelson, Burnham, Downing, and Aoyama households who were each randomly selected to receive a $25 gift card to Walmart for their participation in the previous research activity.

This portion of this study once again consists of individual activity diaries tracking your household‟s time use throughout a given day (similar to those completed in February 2007). Enclosed you will find a single day activity diary for each member of the household over age five, with exact instructions and examples being provided on the activity diary form. If your household completed the activity diaries in February of this year we thank you and look forward to your continued participation; if your household was unable to participate in February we ask that you please make every effort to participate in this exercise, as the information you provide will be very valuable for future planning in West Valley City.

The enclosed activity diaries should be completed on Monday, October 1st. If you are unable to complete the diary on this day, please contact the research staff and we will be happy to assign you a different day.

When your household has completed the activity diaries, please place them in the provided envelope and return them as soon as possible. If your activity diaries are returned before October 31st, 2007, your household will be placed in a drawing for various prizes including a variety of gift certificates to local West Valley City businesses.

Don‟t forget that at the conclusion of the project, households that have participated in all project activities (only 1 more after this) will be entered in a drawing for a grand prize valued at nearly $500.00. Households who have participated in two or three project activities will be entered into a separate drawing for a large variety of prizes as well.

If you have any questions, require additional information about this portion of the study, or if you would like to be removed from the study please feel free to contact Shaunna Burbidge, the Project Manager at (801) 963-3527, or by email at burbidge@umail.ucsb.edu.

Again, thank you so much for your valuable assistance with this project.

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West Valley City Travel Behavior Research Project- Questionnaire 3

Please answer each of the following questions and return this sheet with your activity diary.

1. Which of the following best describes your reason for choosing your current residence? *(please check all that apply)*

- ☐ Close to work
- ☐ Price was affordable
- ☐ Close to good shopping
- ☐ Good access to transportation
- ☐ Close to friends or family
- ☐ Grew up in the area
- ☐ Good environment for kids
- ☐ Safe neighborhood
- ☐ Close to other amenities *(please specify)*____________________

2. How long have you lived in your current residence?

- ☐ Less than 3 years
- ☐ 3-5 years
- ☐ 5-10 years
- ☐ 10-15 years
- ☐ 15-20 years
- ☐ Over 20 years

3. Which of the following best describes your opinion of the safety of your neighborhood?

- ☐ I feel very safe in my neighborhood
- ☐ I feel somewhat safe in my neighborhood
- ☐ I feel somewhat unsafe in my neighborhood
- ☐ I feel very unsafe in my neighborhood

4.A Does the safety of your neighborhood affect the amount of walking you do? ☐**Yes** ☐**No**

4.B Do you think you would walk more if you lived in a different neighborhood? ☐**Yes** ☐**No**

5. Which of the following would make you feel safer in your neighborhood? *(please check all that apply)*

- ☐ More street lights
- ☐ More public open space (i.e. parks)
- ☐ Slower speed limits
- ☐ Nothing would make my neighborhood safer
- ☐ More police officers
- ☐ Better sidewalks
- ☐ More bike lanes
- ☐ Other *(please specify)*: ____________________

*The actual survey used for the study took up the entire page.

November 6, 2007

Dear Johnson Household:

We would like to thank you for your willingness to support your city through your participation in the West Valley City Travel Behavior Research Project. We are very appreciative of the efforts your household made in returning the first round of activity diaries, and ask that you please continue to assist in this project. As you can see below, you have already completed the first two out of four total project activities, and the third is included in this packet.

West Valley City Travel Behavior Project Activities:

- ☑ 1- Household Questionnaire (November 2006)
- ☑ 2- Activity Diary #1 (March 2007)
- ☑ 3- Activity Diary #2 (November 2007) ** *Materials included in this packet*
- ☐ 4- Activity Diary #3 (February 2008)

It is imperative that you continue your participation throughout all project activities in order for the data analysis to be successful and meaningful for the city. Information acquired from this research is contributing to improvements in short and long term planning for West Valley City, and incomplete data could prevent the city from implementing many neighborhood specific improvements.

Materials for the second activity diary portion of the study were mailed to your household in early October, and we have not yet heard back from you. It is not too

Enclosed you will find a single day activity diary for each member of the household over age five, with exact instructions and examples provided on the activity diary form. This activity diary is identical to those your household completed in February or March of this year. **The enclosed activity diaries should be completed on . If you are unable to complete the diaries on this day, please contact the research staff and we will be happy to assign you a different day.** When your household has completed the activity diaries, please place them in the provided envelope and return them as soon as possible.

Also, don‟t forget that at the conclusion of the project, households that have participated in all project activities (only 1 more after this) will be awarded a variety of prizes and will be entered into a drawing for a grand prize valued at nearly $500.00.

If you have any questions, require additional information about this portion of the study, or if you would like to be removed completely from the study, please feel free to contact Shaunna Burbidge, the Project Manager at (801) 963-3527, or by email at burbidge@umail.ucsb.edu. Again, thank you so much for your valuable assistance with this project.

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September 24, 2007

Dear Resident:

We were recently informed that you are new to the area and would like to officially welcome you to the neighborhood. As a new resident we would like to ask you a few questions about the decisions you made prior to moving to your new home. This activity is part of a larger research project and the information you provide will help create improvements in short and long term planning within West Valley City.

Please have one person complete the enclosed questionnaire on behalf of the entire household. The questionnaire will take about 10 minutes to complete. Don't forget to complete both sides of each page. Please feel free to share any additional comments you may have in the space provided at the bottom.

When you are finished please place the questionnaire in the enclosed envelope, and return it as soon as possible. All households returning this survey will be entered into a drawing for a variety of prizes (gift certificates, etc) provided by local West Valley City businesses.

Please be assured that your information will be kept completely confidential and will only be used for aggregate analysis purposes. No personal information will be released, and you will not be contacted by any third parties as a result of your participation. Please try to answer all of the questions, but if you do not feel comfortable answering specific questions you may skip them.

If you have any questions regarding the survey itself or the West Valley Travel Behavior Research Study, please feel free to contact Shaunna Burbidge, Project Manager, at (801) 963-3527, or by email at burbidge@umail.ucsb.edu.

Thank you so much for your valuable assistance with this project, and welcome to the neighborhood.

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West Valley City -New Resident Survey

(Don't forget to complete both sides of each page)

To help us better understand your responses, please mark your answers like the example on the right:

For "Check Boxes X
For Numbers 1 2 3 4 5 6 7 8 9 0
For Words Please Print

1. Which of the following best describe your reasons for choosing your current residence? *(please check all that apply)*

☐ Close to work
☐ Price was affordable
☐ Close to good shopping
☐ Good access to transportation
☐ Close to other amenities
☐ Close to friends or family
☐ Grew up in the area
☐ Good environment for kids
☐ Safe neighborhood
☐ Other *(please specify)*___________

2. How long have you lived in your current residence?

☐ Less than 1 month
☐ 1-3 Months
☐ 3-6 Months
☐ 6-9 Months
☐ 9-12 Months
☐ Over 1 year

3. Where did you live prior to your current residence?

City:_______________________________

State:______________________________

4. Did you look for housing in other areas prior to deciding on this area?

☐ No, I only looked in this area
☐ I only looked in West Valley City
☐ I looked at locations in Salt Lake County
☐ I looked all along the Wasatch Front
☐ I looked at locations throughout Utah
☐ I looked for housing nationwide

5. Which of the following best describes your opinion of the safety of your neighborhood?

☐ I feel very safe in my neighborhood
☐ I feel somewhat safe in my neighborhood
☐ I feel somewhat unsafe in my neighborhood
☐ I feel very unsafe in my neighborhood

6. Does the safety of this neighborhood affect the amount of walking you do?

☐**Yes** ☐**No**

7. Do you think you would walk more if you lived in a different neighborhood?

☐**Yes** ☐**No**

8. On average, how many minutes per day are you physically active (exercise, manual labor, etc.)?

☐ I do not get any physical activity each day
☐ 1-15 minutes per day
☐ 16-30 minutes per day
☐ 31-45 minutes per day
☐ 45-60 minutes per day
☐ More than 60 minutes per day

9. Which of the following types of exercise do you regularly participate in? *(please check all that apply)*

☐ Bicycling (stationary, road or mountain)
☐ Weight Lifting
☐ Aerobics classes or videos
☐ Running or Jogging
☐ Sports or Games (soccer, football, tag, etc.)
☐ Walking
☐ Other Aerobic Machine (stairmaster, etc.)
☐ I do not exercise regularly
☐ Other *(please specify)*____

10. Which of the following would make you feel safer in your neighborhood? *(please check all that apply)*

☐ More street lights
☐ More police officers
☐ More public open space (i.e. parks)
☐ Better sidewalks
☐ Slower speed limits
☐ More bike lanes
☐ Nothing would make my neighborhood safer
☐ Other *(please specify):* ___________________________________

For the following questions, please note that a household is a group of people living together. They DO NOT have to be related to each other.

11. How many people live permanently in this household, including yourself?

12. How many people in your household are:

Younger than five years old		
5 to12 years old		
13 to 15 years old		
16 to 18 years old		
18 years of age or older		

13. Which of the following best describes the building you live in?

□ Mobile Home □ Single Family House (detached)
□ A Duplex Home □ Townhouse or Condo
□ Apartment Building □ Other *(Please describe)*___________________________

14. Does anyone in your household work from home?

□ Yes □ No

15. Which of the following do you or anyone else in your household have in your home? *(Check all that apply)*

□ Cellular Telephone □ Computer *(desktop or Laptop)* □ Satellite Television
□ Cable Television □ Internet □ MP3 Player

16. What is your <u>TOTAL</u> combined household income received from jobs, businesses, and all other sources? *(Please include the income of everyone in the household)*

□ $10,000 or less □ $40,001-$50,000 □ $80,001-$90,000
□ $10,001-$20,000 □ $50,001-$60,000 □ $90,001-$100,000
□ $20,001-$30,000 □ $60,001-$70,000 □ $100,000 or more
□ $30,001-$40,000 □ $70,001-$80,000

17. How many vehicles are owned or leased by members of your household?

□ No Vehicles □ 2 Vehicle □ 4 Vehicles
□ 1 Vehicles □ 3 Vehicles □ 5 or More Vehicles

18. How many bicycles are owned by members of your household?

□ No Bicycles □ 2 Bicycles □ 4 Bicycles
□ 1 Bicycle □ 3 Bicycles □ 5 or More Bicycles

19. Which of the following exercise amenities does your household have?

□ Treadmill	□ Elliptical Machine	□ Stair Climber
□ Exercise Bike	□ Rowing Machine	□ Free Weights (i.e. dumbbells)
□ Weight Machine	□ Other *(Please specify)*___________________________	

Is there any other information you would like to share with us about your decision to move to West Valley City?

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Thank you for taking the time to assist us in our research by filling out this questionnaire. If you have any questions please do not hesitate to contact the project manager at (801) 963-3527.

Appendix D

Activity Diary 3
February 2008

January 7, 2008

Dear Johnson Household:

We would like to let you know that is time for your household to participate in the final activity for the West Valley City Travel Behavior Research Project. We would like to thank you for your willingness to support your city through continued participation in this valuable research study, and commend you for your diligence. We would also like to congratulate the Reeve, Cordova, Bassett, Lindsey, Brewer, and Downing households who were each randomly selected to receive gift certificates to local area businesses for their participation in the previous research activity.

West Valley City Travel Behavior Project Activities:

- ☑ 1- Household Questionnaire (November 2006)
- ☑ 2- Activity Diary #1 (February 2007)
- ☑ 3- Activity Diary #2 (November 2007)
- ☑ 4- Activity Diary #3 (January/February 2008) ** *Materials included in this packet*

This final portion of this study once again consists of individual activity diaries tracking your household"s time use throughout a given day (similar to those completed in February and October of last year). Enclosed you will find a single day activity diary for each member of the household over age five, with exact instructions and examples being provided on the activity diary form.

The enclosed activity diaries should be completed on <u>Friday, January 18th</u>. If you are unable to complete the diary on this specific day, please notify the research staff and we will be happy to reassign you to a different day.

When your household has completed the activity diaries, please place them in the provided envelope and return them as soon as possible. For participating in all household activities, your household will be placed in the grand prize drawing, to take place on February 15th, 2008**.** That means that we must have your activity diaries back before that date. Some of the grand prizes include: a flat screen plasma television, a 1 year family pass to the West Valley City Fitness Center, a home stereo system, MP3 players, and a variety of gift baskets and gift certificates from local area businesses.

If you have any questions, or require additional information about this portion of the study, please feel free to contact Shaunna Burbidge-Project Manager at (801) 963-3527, or by email at <u>burbidge@umail.ucsb.edu</u>.

Again, thank you so much for your valuable assistance with this project.

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West Valley City Travel Behavior Research Project- Questionnaire 4

Please answer each of the following questions and return this sheet with your activity diary.

1. In the last 12 months (since February 2007) have you become more physically active? ☐Yes ☐No

2. If you answered yes to question #1, please explain why you have become more physically active. (If no, skip to #3)

3. If you answered no to question #1, please explain what has kept you from becoming more physically active.

*The actual survey used for the study took up the entire page.