Before and After a New Light Rail Stop

Resident Attitudes, Travel Behavior, and Obesity

Barbara B. Brown and Carol M. Werner

Problem: Transit-oriented development has been shown to be socially desirable for a variety of reasons, but little is known about the benefits it provides to individual residents.

Purpose: We used a natural experiment to better understand the value of convenient transit access to individuals.

Methods: We queried 51 residents of a revitalizing, mixed-use, Salt Lake City neighborhood near the TRAX light rail line about their behaviors and attitudes, classifying them into three groups: nonriders; new riders, who reported recent rail rides only after the stop opened; and continuing riders, who reported recent rail rides both before and after the new stop opened. Participants wore accelerometers and completed surveys during two different time periods, one before and one after a new light rail stop opened in their neighborhood.

Results and conclusions: Adjusted for income and employment, obesity was much higher among nonriders (65%) than new riders (26%) and continuing riders (15%). All other significant differences show the same pattern, with new riders' averages lying between the extremes of nonriders and continuing riders. Continuing riders had, on average, the largest number of moderate physical activity bouts, and reported the highest place attachment, the greatest neighborhood satisfaction, the most favorable attitudes toward transit-oriented development, took the fewest car rides, and had the least pro-suburban attitudes. New riders reported fewer car rides after the rail service started. The other group-by-time univariate interactions and the multivariate time main effect were insignificant.

Transit-oriented development represents a dramatic reversal of typical postwar community building practices, ideally combining varied housing and nonresidential destinations in walkable neighborhoods near rail stops. Its societal benefits include dense and affordable housing (Handy, 2005; Hess & Lombardi, 2004), and less pollution and automobile dependence and sprawl than more conventional suburban development (Dorn, 2004; Envision Utah, 2002; Shapiro, Hassett, & Arnold, 2002). However, individual residents typically choose housing for the personal, not the societal, benefits it provides (Rossi, 1980). Thus, this article focuses on the potential personal benefits of living in transit-oriented development. We take a transactional approach (Altman & Rogoff, 1987; Werner, Brown, & Altman, 2002), which assumes that people are embedded in a confluence of social, environmental,

Takeaway for practice: Development with convenient transit access may provide benefits to individuals as well as improving societal sustainability. Planners may want to promote the personal benefits associated with living in transit-oriented development and rail use, including high levels of neighborhood satisfaction and place attachment among riders. Walkable designs, density bonuses, and signage or other methods of orienting transit riders to destinations within walking distance of stops may enable obese residents or others who are especially sensitive to walking distances to use rail.

Keywords: transit-oriented development, obesity, physical activity, neighborhood satisfaction, place attachment

Research support: This work was supported by the University of Utah's Institute of Public and International Affairs, the University Research Committee, and the National Science Foundation grant ATM 0215768. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the view of the National Science Foundation.

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Journal of the American Planning Association,
Vol. 75, No. 1, Winter 2009
DOI 10.1080/01944360802458013

and policy factors that support individual behaviors and attitudes. We ask whether transit riders are significantly different from nonriders in what they report about their own health, car rides, leisure walks, residential attachments, and satisfactions before and after a new light rail stop is added to their neighborhood.

Whether transit-oriented development provides personal benefits to residents remains a matter of scholarly debate. For skeptics, the sustained popularity of suburbs demonstrates that transit-oriented development is less desirable. Many residents prefer suburban or small town locales (Fannie Mae, 1997), single-family detached home ownership (Gordon & Richardson, 1997), car ownership (Wachs & Crawford, 1992), and single-occupancy vehicles (Downs, 1994). For supporters of transit-oriented development, research shows that urbanites are sometimes as satisfied as suburbanites with their neighborhoods (Adams, 1992), and that some residents prefer denser more walkable neighborhoods (Levine & Frank, 2007) and transit (Bagley & Mokhtarian, 2002) even when they live in the suburbs. Transit-oriented housing areas are predicted to be preferred by aging and young adult populations (Myers & Gearin, 2002) and, by 2025, by 25% of all new households (Dorn, 2004). Although direct evidence is limited, new transit-oriented development in Portland, OR provides residents with community sociability at Orenco Station (Podobnik, 2002) and walkability at Fairview Village (Dill, 2004). However, few studies have examined resident experiences and behaviors as their urban neighborhoods transition to become more transit oriented (Hess & Lombardi, 2004).

Residents of transit-oriented development could experience health benefits, such as opportunities for physical activity and obesity prevention associated with walking when using transit. Interest is growing in community designs that support health, given that 32.2% of U.S. adults are obese (Ogden et al., 2006). Taking a moderately active 15- to 20-minute walk to offset 100 calories each day would prevent the average adult gain of 1 to 2 pounds per year (Hill, Wyatt, Reed, & Peters, 2003). Adults should accrue 30 minutes of moderate activity in healthy bouts of at least 8 minutes most days of the week (U.S. Department of Health and Human Services, 1996); walks in and around transit-oriented development may contribute to this goal.

Rail riders are more physically active than nonriders according to self reports (Besser & Dannenberg, 2005; Moudon et al., 2007) and pedometer-measured steps (Wener & Evans, 2007). Residents of neighborhoods that are densely developed, with mixed land uses, and pedestrian-friendly features report more walking (Coogan, Karash, Adler, & Sallis, 2007; Handy & Clifton, 2001) and lower body weights (Ewing, Schmid, Killingsworth, Zlot, & Raudenbush, 2003; Frank, Andresen, & Schmid, 2004). However, obese women reported that walking was too effortful (Mattsson, Larsson, & Rössner, 1997), suggesting that pedestrian-friendly neighborhoods might not support activity for all residents.

Underlying attitudes about suburban versus urban neighborhoods may also be important. Individuals who walk more are more positive about urban neighborhoods (Coogan et al., 2007). Those who take more transit trips are more pro-transit (Kitamura, Mokhtarian, & Laidet, 1997), more open to living near rail stops (Brown, Werner, & Kim, 2003), more positive about urban neighborhoods (Schwanen & Mokhtarian, 2005), and less positive about suburbs (Kitamura et al., 1997). Such attitudes might underlie their choices regarding neighborhoods, rail ridership, and walking. In contrast, other research demonstrates that housing considerations (Schachter, 2001), not transportation preferences (Hunt, 2001), drive housing choices.

No studies have related residence in transit-oriented development or rail ridership to healthy weight, activity intensity, or neighborhood attitudes over time. We draw on new data from our prior study (Brown & Werner, 2007) to examine new questions. We examine three ridership groups (nonriders, new riders, and continuing riders) before and after rail stop construction for healthy activity bouts, obesity, car rides, leisure walks, residential satisfaction, place attachment, and attitudes toward suburban and transit-oriented development.

Methods

Neighborhood Site, Sampling, and Procedures

City redevelopment funds financed construction of the newest stop on Salt Lake City's TRAX light rail line at 900 South, just south of the central business district. We focused on the neighborhood within a walkable distance (one half mile) of the new rail stop. Within this circle, zoning supports transit-oriented development (42% of the area is downtown-support zoning, which allows a variety of uses including warehouse, commercial, multifamily, and mixed uses; 31% is general commercial zoning; and 8% is multi-family or mixed-use housing). Recent and planned development demonstrates the area is transitioning to become more transit oriented, with no parking at the new rail stop, reduced parking requirements at new multistory apartments, and many walking-distance single- and multi-family dwellings, including new subsidized apartments. Since the study, a new market-rate, live-work condominium has been completed and an entire block has been slated for mixed-use redevelopment.

We mailed study notifications to all residential addresses within one half mile of the new stop, then phoned or visited door-to-door to recruit individual participants and obtain signed consents, as many residents did not own phones. Someone answered the door at 215 of the 496 potentially eligible addresses. From these, we recruited 102 participants, of whom 100 provided accelerometer data[1] for our first measurement period (Time 1), during the summer of 2005. During our second measurement period (Time 2), during the summer of 2006, we were able to recruit 51 of the 100 residents who had completed data at Time 1 to complete the survey; 47 of these wore the accelerometer again. The remaining did not participate for a variety of reasons: 38 had moved, 1 was too ill, and 10 refused to participate again. (See Brown & Werner, 2007, for additional recruitment details.) Eligible participants included adult Spanish- or English-speakers in the study area who could walk a few blocks. Participants wore accelerometers for one week, except when they slept or were in water.

Construction on the new light rail stop in the neighborhood began in spring of 2005 and was not yet complete when participants responded to surveys at Time 1. The new stop opened in September 2005, and participants responded to surveys again at Time 2 the following summer. In both waves, researchers visited each resident at the end of his or her participation to download accelerometers, obtain surveys, and pay $20.00 for participation.

Participants who stayed in the sample were similar to those who dropped out, except that they included marginally more employed residents (68% vs. 51%, $F[1, 97] = 2.99$, $p = 0.087$). All remaining analyses in this article focus on the longitudinal sample. Gender, ethnicity, and home ownership in the sample (shown in Table 1) were comparable to neighborhood statistics from the 2000 census. Participants' mean household incomes were low ($24,000) compared to the city's 2000 mean household income adjusted for inflation ($43,367). Among those who started using rail, bus ridership was low (less than one ride a week) at both Time 1 and Time 2, so new riders are not simply those who switched from bus to rail ridership (Brown & Werner, 2007).

Measures

Transportation. Respondents reported how often they rode TRAX light rail, walked for leisure, and rode in cars in the last two weeks in 12 response categories ranging from "never" to "5 or more times per day." We recoded these to category midpoints (e.g., "11–13 times in 2 weeks" was coded as "12").

Ridership groups. Given that the average distance from TRAX to respondents' residences was 743 meters at Time 1, we were surprised to find that almost half the

Table 1. Characteristics of participants by their use of light rail.

	Nonriders (n = 15)		New riders (n =11)		Continuing riders (n = 22)			
	Mean	SD	Mean	SD	Mean	SD	F	p
Female[a]	0.53	0.52	0.55	0.52	0.36	0.49	0.71	0.50
Homeowner[a]	0.47	0.52	0.55	0.52	0.24	0.44	1.79	0.18
Household size	2.53	1.19	2.18	0.75	2.09	1.31	0.67	0.52
Income ($1,000)	35.00	22.68	21.36	9.24	18.30	14.07	4.80	0.01
Student[a]	0.33	0.49	0.30	0.48	0.30	0.47	0.02	0.98
Employed[a]	0.73	0.46	0.73	0.47	0.59	0.50	0.50	0.61
White[a]	0.87	0.35	0.90	0.32	0.70	0.47	1.13	0.33
Hispanic[a]	0.07	0.26	0.27	0.47	0.14	0.35	1.08	0.35
Age	36.80	11.38	46.36	18.66	40.55	11.81	1.59	0.21
Meters to closest light rail stop at Time 1	873.65	475.29	763.66	336.20	677.54	271.29	1.32	0.28
Meters to closest light rail stop stop at Time 2	410.79	252.86	293.55	151.24	302.27	198.79	1.48	0.24

Note:
a. This is a dummy variable. Individuals identifying themselves as having this attribute were coded as 1 and all others as 0.

respondents were continuing riders (45.8%, n = 22; six had no car access) who reported riding TRAX in the previous two weeks at both Time 1 and Time 2. New riders were the 22.9% (n = 11; two had no car access) who reported riding TRAX only at Time 2, when the new, closer stop opened. A final 31.3% (n = 15; one had no car access) were classified as nonriders. In this last group, we included two respondents who had ridden TRAX at Time 1 but not at Time 2. We did this in part because their responses were similar to those of nonriders. Three respondents did not answer the TRAX ridership question.

Obesity. We used portable stadiometers to measure height and scales to measure weight, and calculated body mass index (weight in kilograms divided by height in meters squared). The standard definition of adult obesity is a body mass index over 30 (see Ogden et al., 2006).

Physical Activity. Participants wore Actigraph GT1M belt-mounted accelerometers, shown by Welk, Schaben, and Morrow (2004) to be reliable, during waking hours to measure moderate-intensity activity bouts lasting at least 8 minutes[2] (Freedson, Melanson, & Sirard, 1998). We used all days of data (ranging from 5 to 12 days to accommodate participants' schedules, and averaging 7.2 days for Time 1 and 8.2 days for Time 2). We did not use hours with zero activity for 30 or more minutes (useable hours averaged 75.5 for Time 1 and 85.9 for Time 2). We calculated the number of moderate-intensity activity bouts per valid hour, log-transformed and multiplied by 100.

Attitudes. Table 2 contains the items and Cronbach's alpha reliability scores for four attitudinal composites: place attachment (Brown, Perkins, & Brown, 2003), neighborhood satisfaction (Brown & Perkins, 2001), pro-suburb

Table 2. Attitudinal variables, response options, and internal consistency of responses within categories.

Attitudinal variables by category	Response options
Place attachment	
Cronbach alpha[a] for Time 1 = .85, Time 2 = .85	
How proud are you of	
your neighborhood?	Not at all (0) to extremely (10)
your block?	Not at all (0) to extremely (10)
your house or apartment?	Not at all (0) to extremely (10)
the way your front yard looks?	Not at all (0) to extremely (10)
the way the outside of your house or apartment looks?	Not at all (0) to extremely (10)
If for any reason, you had to move to another neighborhood would you be . . . ?	Very unhappy (5) to very happy (0)
Neighborhood satisfaction	
Cronbach alpha[a] for Time 1 = .92, Time 2 = .88	
How satisfied are you with	
your neighborhood as a place to live?	Not at all (0) to very (10)
your block as a place to live?	Not at all (0) to very (10)
your home as a place to live?	Not at all (0) to very (10)
Pro-suburb attitudes	
Cronbach alpha[a] for Time 1 = .66, Time 2 =.42	
I need to have space between me and my neighbors.	Strongly agree (4) to strongly disagree (1)
I would only live in an apartment or multi-family housing as a last resort.	Strongly agree (4) to strongly disagree (1)
It is important for children to have a large backyard for playing.	Strongly agree (4) to strongly disagree (1)
Favorable attitudes toward transit-oriented development	
Cronbach alpha[a] for Time 1 = .78, Time 2 =.79	
TRAX makes Salt Lake City a . . .	Less livable place (1) to more livable place (7)
Because of TRAX, I like Salt Lake City . . .	Less (1) to more (7)
Because of TRAX, I am . . .	Less (1) to more (7) interested in going downtown
Because of TRAX, I am . . .	Less (1) to more (7) interested in living near TRAX
Because of TRAX, I . . .	Don't (1) to do (7) want to know what is near TRAX stops

Note:
a. The Cronbach alpha statistic measures the internal consistency of individuals' responses within these four categories of variables.

attitudes (Kitamura et al., 1997), and favorable attitudes toward transit-oriented development (adapted from Brown, Werner, & Kim, 2003).

Sociodemographics. Potential control variables included gender, age, household income, race, ethnicity, marital status, number of children living in the household, employment status, and student status.

Results

Ridership Group

Ridership groups have comparable sociodemographic attributes (see Table 1), except that higher income residents are less likely to ride light rail ($p = .01$). Therefore, we controlled for income and, following Dill (2006), employment status in subsequent analyses.

Ridership Group, Health, Travel, and Attitudes

We treated the construction of the new light rail stop as an intervention, and tested for differences between the three ridership groups (nonriders, new riders, and continuing riders), for differences over time (before and after the rail stop existed), and for a group-by-time interaction effect using a three (ridership group) by two (time) General Linear Model using SPSS 15 GLM procedure and MVA missing data imputation. We tested separate Time 1 and Time 2 measures of obesity and physical activity, neighborhood satisfaction and place attachment, car rides and leisure walks, and favorable attitudes toward suburbs and transit-oriented development. In the multivariate tests, ridership group is significant (F[16, 72] = 2.45, $p = .01$) and time is only marginally significant (F[8, 36] = 2.05, $p = .07$);[3] the multivariate interaction is nonsignificant ($p = .38$). One significant univariate interaction shows that new riders reduce their car rides when they start using TRAX (Figure 1). Remaining analyses focus on the significant ridership group *main effects* (which combine Times 1 and 2), again adjusting for income and employment.

Obesity is much higher among nonriders (65%) than new riders (26%) and continuing riders (15%); see Table 3. This pattern of differences also holds for other measures. Activity bouts, place attachment, neighborhood satisfaction, and favorable attitudes toward transit-oriented development increase from nonriders to new riders to riders. The number of car rides decrease significantly and pro-suburb attitudes decrease marginally ($p = .10$) from nonriders to new riders to riders.

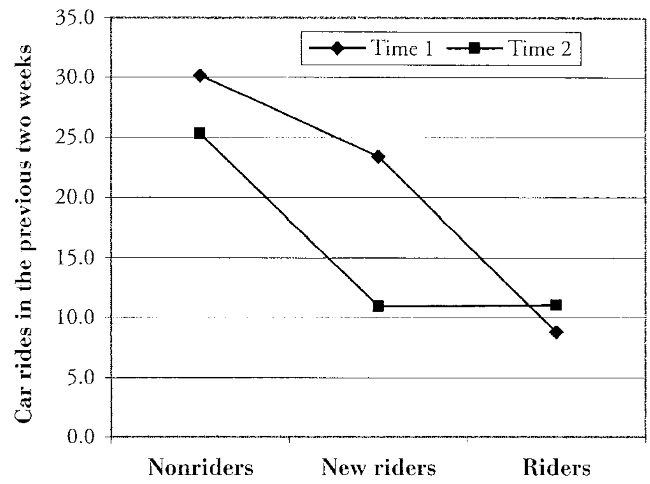

Figure 1. Number of car rides in the previous two weeks at Time 1 and Time 2, by ridership group.

Discussion

When comparing ridership groups, striking and fairly consistent differences emerge. Rail riders have more healthy walking bouts, fewer car rides, and a lower prevalence of obesity than nonriders. They have higher place attachment and neighborhood satisfaction, and are more positive about transit-oriented development, reporting that light rail enhances city livability. Riders also tend to be less pro-suburb ($p = .10$), saying that spacious lots and back yards are not essential. The main effect for time was not significant, demonstrating that the new rail service did not alter resident attitudes and transportation behaviors overall. However, 23% of the sample (11 out of 48) started using rail service, and a significant univariate interaction reveals that these new riders also decreased their reported numbers of car rides between Time 1 and Time 2.

Although the small sample size limits our ability to generalize, these findings are promising and strengthened by objective measures of obesity and physical activity. The small sample size limited power to detect effects, but results suggest these effects are worth testing with a larger sample. The fact that participants had access to more distant light rail stops at Time 1 may even have reduced the effect of the new stop on ridership. This study also relies on self-reports of transit use and attitudes, which may be inaccurate, although rail rides are likely easily recalled. Still, it provides a rare pre- and posttest of a transit stop "intervention" that, if replicated with larger samples, suggests new planning, research, and policy directions.

Table 3. Ridership group and time effects for resident attitude and behavior measures.

	Nonriders		New riders, Time 2		Continuing riders, Times 1 and 2		Ridership group effects		Time effects	
	Mean	SE	Mean	SE	Mean	SE	F (2, 43)	p	F (1, 43)	p
Obesity (1 = yes, 0 = no)	.65	.12	.26	.13	.15	.10	4.80	.01	.05	.82
Moderate activity bouts (log transformed/100 hours)	1.07	.76	1.77	.83	3.68	.60	3.89	.03	1.28	.26
Place attachment (z-scored)	−.31	.16	−.03	.18	.24	.13	3.24	.05	.59	.45
Neighborhood satisfaction (z-scored)	−.42	.20	−.12	.22	.29	.16	3.83	.03	.35	.56
Leisure walks (number in preceding 2 weeks)	7.29	2.13	9.63	2.35	8.90	1.70	.28	.76	12.68	.00
Car rides (number in preceding 2 weeks)	27.72	3.73	17.16	4.10	9.94	2.96	6.44	.00	1.54	.22
Pro-suburb attitudes (1 lowest, 4 highest)	3.43	.19	3.04	.20	2.89	.15	2.38	.10	.01	.90
Pro-transit-oriented development attitudes (1 lowest, 7 highest)	5.13	.24	6.23	.26	6.38	.19	8.35	.00	.00	.98

Note:
Means adjusted for income and employment.

Planners and developers may want to encourage residents toward transit-oriented development and transit use by highlighting the positive qualities that were salient for rail riders in addition to transit service. For example, the riders in this study also reported high levels of place attachment and neighborhood satisfaction. Similarly, Lund (2006), reported that housing quality (60%) and cost (54%) were more frequently cited reasons for moving to transit-oriented development than transit access (33%). When ridership is viewed as one of many benefits of a neighborhood, both ridership and neighborhood attractiveness and stability may be enhanced.

Both attitudes and environmental supports were important for ridership. New riders seemed prepared to ride by virtue of their positive attitudes toward the neighborhood and transit-oriented development before the new stop opened. However, pre-existing favorable attitudes toward rail were insufficient to motivate new riders to walk long distances to stops at Time 1. Thus, we conclude that supportive attitudes have limited power in the face of an unsupportive environment. By combining positive attitudes with the opening of the new, more convenient stop, residents could more easily act on their pre-existing attitudes by becoming transit riders.

Attitudes favorable to transit-oriented development predicted ridership, which may reflect several psychological processes. We cannot rule out the possibility of a selection effect, meaning pro-transit individuals moved to the neighborhood because they anticipated new transit service. However, this is unlikely because the new stop was not advertised extensively in advance. We can rule out a dissonance reduction effect, meaning TRAX riders began to ride and then later adopted attitudes favorable to transit-oriented development to maintain psychological consistency. This does not fit the evidence because new riders (those who would begin riding at Time 2) were already pro-TRAX at Time 1. Thus, using a preintervention/postintervention research design and measuring neighborhood preferences together do reduce the threat self-selection poses to validity in most studies of neighborhood effects, but they do not eliminate it.

Planners may want to combine two facets of these results: the health benefits of walking and the eagerness of those who favor transit-oriented development to learn about walkable destinations near rail stops. An advertising program could emphasize both. In Australia, a program that encourages residents to walk 10,000 steps per day reinforces walking by providing signs that indicate the distance in steps to local destinations (Central Queensland University, 2008). Currently, TRAX riders have to find walking destinations near stops on their own. Both the proprietors of local destinations and rail riders might benefit from publicizing walking distances and destinations as well as health benefits of walking around TRAX stops.

However, obese residents, who most need physical activity, were least likely to ride transit, a heretofore unrecognized burden of obesity. Recently, participants in a health study who agreed to gain weight were also found to reduce their walking (Levine et al., 2008). Walking is also perceived to be especially effortful by obese participants (Mattsson et al., 1997). Obesity-related barriers to physical activity, as well as social barriers such as feared stigmatization by other riders, merit investigation in future studies.

If findings from this small study replicate, traditional planning tools such as density bonuses may need to be adapted for transit-oriented development. For example, California allows a density bonus for senior housing (California Housing Law Project, 2001). But seniors, people with disabilities, or obese individuals may be very sensitive to distance, and need enhanced density bonus requirements, such as especially close proximity and a well-constructed route from the housing to the rail stop. Given baby boomer aging and projections that about half the homes and businesses needed by 2030 have not yet been built (Nelson, 2004), good planning of the next generation of rail stops may enhance both livability for individuals and societal sustainability.

Acknowledgments

We thank research assistants Stephanie Nalbone, Jonathan Gallimore, Melissa Napier, Elisa Hamblin, Chad Killpack, Bekah Larson, and Edward Cusack; programmers Jared Campbell and William Hanewinkel; and Salt Lake City planner Matthew Dahl.

Notes

1. One unit was lost; one participant withdrew for health reasons.
2. We allowed two-minute interruptions for street crossings or similar pauses.
3. The univariate follow-up tests revealed that only leisure walking showed a significant change over time, ($F[1, 43] = 12.68$, $p = .001$). The number of walks declined across time for all groups, suggesting that new riders were not substituting walks to TRAX for leisure walks. Further exploratory analyses revealed that less walking at Time 2 was not related to temperatures during the week of data collection.

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