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Residents' expectations for new rail stops: optimistic neighborhood perceptions relate to subsequent transit ridership

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Abstract Although complete street policies are proliferating, little is known about how nearby residents perceive and act on their new active transportation opportunities. We survey the same neighborhood residents before and after they receive a new complete street renovation with five new light rail stops. We compare Time-1 expectations to use rail with Time-2 evidence of rail use, based on both self-reported and objective GPS/accelerometer measures of ridership. We examine neighborhood perceptions of four groups, created by combining Time-1 expectations to ride with Time-2 ridership: No expect/no ride, no expect/ride, expect/no ride, and expect/ride. The strongest differences were between the no expect/no ride and expect/ride groups. The riders had more positive expectations for light rail's impact on the neighborhood than non-riders; these broad expectations were more powerfully associated with rail ridership than individual barriers to use, such as time constraints or weather. More positive perceptions of the route to rail stops (pleasantness, traffic safety, and crime safety) were also held by riders. Some of the more positive perceptions helped distinguish between the expect/ride group and the expect/no ride group. These results underscore that increasing positive neighborhood perceptions might help convert expected riders into actual riders.

Keywords Light rail · Ridership · Expectations · Neighborhood perceptions · Perceived walkability · GPS

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Introduction

"Complete street" policies and designs give priority to active transportation and transit to allow residents and others to travel without requiring dependence on their cars. Over 900 states and localities in the U.S. have adopted complete street policies (Smart Growth America 2016), but most research to date focuses on the challenges of policy adoption (Moreland-Russell et al. 2013). We know less about how residents view complete street changes to their neighborhoods and how such perceptions might relate to anticipated and actual use of the new light rail service provided as part of complete street improvements. Given the expense of complete street and transit improvements, community transportation goals will be best served if nearby residents actively use the new infrastructure, although only a fraction of nearby residents use their neighborhood stops (Guerra et al. 2012). In one cohort of adults living near a new light rail extension we examine a variety of perceptions, including perceived barriers to neighborhood walking and expectations regarding light rail's neighborhood impacts, on the expected and actual use of the new light rail extension.

Background

Increasing active transportation choices through complete streets and transit-oriented developments can provide a number of possible societal benefits. Viable complete street and transit solutions, compared to auto-dependent development, can enhance air quality, make urban areas more convenient and livable, preserve greenfields and lower tax burdens, provide residences closer to desirable destinations or the means to get there, and enhance property values and spur economic development (Burden and Litman 2011; Zimmerman 2005; Litman 2013; Marshall 2013). Individuals benefit as well, through lowered costs of travel, less hassle in finding parking, multitasking possibilities en route (Mokhtarian et al. 2015; Frei et al. 2015; Brown et al. 2003), and lower weight and greater physical activity from walking to and from the stops (Brown et al. 2015).

However, a number of barriers exist that prevent residents from taking advantage of new transit options (Blainey et al. 2012). In car-oriented cultures, when new rail stops are added to the neighborhood, the habitual use of cars makes adopting a new behavior difficult (Thøgersen and Møller 2008). In addition, some individuals do not know enough about rail systems to assess whether they would provide good transportation options (Creemers et al. 2015). Residents may not ride transit due to "hard barriers," such as no stops at desired destinations or service that is too slow or unreliable. Transit deterrents also include "soft barriers," such as perceived crime, poor image of public transit, personal refusal to consider using rail, and inaccurate perceptions about riding transit (Blainey et al. 2012).

Limitations of past research

Few studies examine how residents view impending changes to their neighborhood or their likelihood of using new transit and other complete street improvements. Residents may hold inaccurate negative or positive perceptions of likely project impacts, which policymakers should address (Springer 2007; Lewis and Baldassare 2010). These expectations may relate to eventual ridership, although it may be difficult for policymakers to predict ridership, given gaps between stated intentions and behaviors (Hassan et al. 2016). Of the few studies focused on transit ridership, study designs are often cross-sectional, in which residents are asked about future ridership but without future validation of ridership (Kim and Ulfarsson 2012; Preston 1991). Some research does include verification of ridership with longitudinal measures. For example, college students' intentions to use new free university passes for pre-existing bus lines were related to reports of use, in both cross-sectional and change score analyses (Heath and Gifford 2002). Such findings may not generalize to new light rail ridership among individuals who may need to pay for riding and where rail stops are not so closely tailored to their needed destinations. Asking about intentions may be a useful way to identify individuals who are unlikely to use transit because it does not provide access to desired destinations or because of refusal to consider transit an acceptable travel mode (Blainey et al. 2012). However, the number of prospective users identified in this way is still typically overestimated, perhaps because the future service qualities are not accurately perceived (Preston 1991), or because complex internal or external barriers to behavior change exist for most environmentally friendly behavior choices (Kollmuss and Agyeman 2002).

Current study rationale

The current study examines Time-1 intentions to use the new light rail service in conjunction with measures of Time-2 rail use by the same individuals 1 year later. By examining both expectation and eventual use we can focus on the distinctive qualities of different rider groups. Those who expect to use and then use light rail are most likely to be different from those who do not expect to and do not use light rail; as discussed below, this study will address whether personal, environmental, or perceptual barriers distinguish these extreme groups. Perhaps of more importance to policy makers are residents who expect to but do not use light rail. By focusing on residents who expect to use rail more once the new neighborhood stops are provided, but who did not in fact use them, policy makers might use the resulting insights to convert willing non-riders into willing riders, while maximizing use of expensive transit infrastructure. Another group of interest would be the "surprise riders," who did not anticipate increasing their use of the service but did have subsequent use. Below we describe an array of internal barriers, external barriers, perceived poor or good conditions, and perceived walkability to anticipate how residents develop their rail ridership expectations and use patterns (Klöckner and Blöbaum 2010; Zainal and Mohamad 2013).

A number of personal walking barriers have been identified in the health literature that might distinguish between residents who have ridership expectations and subsequent ridership behaviors from residents who do not. For example, barriers like health problems or lack of desire to walk may prevent residents from taking advantage of new walking opportunities (Lee et al. 2013; Kesten et al. 2015; Brownson et al. 2001). Barriers can also be physical, such as poor traffic safety (Giles-Corti and Donovan 2003) or bad weather (Brownson et al. 2001). We will examine the specific personal and environmental barriers to walking in the neighborhood to understand whether common barriers exist and what residents believe would help overcome the barriers.

Specific perceived physical conditions for the route to and along the complete street are also examined with respect to what might deter or attract use. We measure both perceived incivilities, residents' reports of physical signs that the area might not be under the control of residents or local officials and thus vulnerable to crime, such as litter or graffiti (Skogan 1990), and "civilities," or positive signs that the community is attractive to residents, such as new landscaping or home construction. Although it might be sensible to expect crime-related perceptions to discourage walking, evidence is surprisingly mixed. A systematic review uncovered 17 studies where perceived crime problems related to physical activity and 16 that did not (Foster and Giles-Corti 2008). Other studies suggest that incivilities may be more visible to those who walk their neighborhoods more (Duncan and Mummery 2005), or that incivilities may be more common in places where many people walk (Suminski et al. 2008), or that fewer incivilities are perceived by residents who have stronger urban identities and attachments than others (Félonneau 2004). However, past research with this sample demonstrated that fear of crime was more likely among those who get less objectively measured physical activity and have higher body mass indices (Brown et al. 2014). Therefore, we examine whether perceived incivilities or their opposite—evidence of improving physical conditions—relate to ridership expectations and increases.

The physical improvements to the neighborhood targeted a specific street running east and west in the middle of the neighborhood. Most residents do not live on this specific street and would need to access the complete street from residential areas to the north or south. To determine whether the improvements to the street are perceived to enhance walkability and to assess the role of the side streets connected to the complete street in association with use, we explore global perceptions of both of these routes in terms of pleasantness, safety from crime, and safety from traffic.

We focus on rarely studied correlates of transit use involving the broader economic, social, and physical changes perceived to be associated with the new transportation infrastructure, assessed as both Time-1 pre-construction expectations and then Time-2 perceived post-construction conditions for the same sample. Prior research on a different light rail stop in the same city as the current study has shown that residents of a neighborhood receiving a new light rail stop anticipated the light rail would bring mostly economic changes to the neighborhood (Brown and Werner 2011), which may be especially valued by residents (de Graaff et al. 2007). Other research suggests that new rail stops can also communicate hopeful messages about a community and its trajectory, which may predispose residents toward trying the new service (Alexander and Hamilton 2015), but this suggestion has not been tested systematically on a large sample. Despite the small sample size in the Brown and Werner 2011 study ($n = 51$), residents who were more likely to expect the rail project to bring improvements to neighborhood reputation at Time-1 were more likely to ride the light rail at Time-2. This type of analysis can be useful to policy makers by clarifying how local residents expect rail to affect their neighborhood, following through post-construction to see if their expectations have been met, and associating expectations with ridership.

A novel feature of our analysis is that we examine rail ridership two ways: self-reported and objectively measured from GPS and accelerometer units. Few transportation studies have the capability of providing both the typical self-reports of ridership along with a more objective assessment. Therefore, both types of measures are analyzed. The objective measures are based upon a 1-week time when participants wore GPS and accelerometer devices. Self-reports, which inquired about the same week, are known to have memory distortions, which might lead participants to refer to a longer or shorter time span in their "past week" report of riding transit. Therefore, a comparison of results can be useful for future researchers to determine whether the extra time and expense of objective measures is worthwhile.

The following specific research questions are addressed.

1. What are residents' reported walking barriers and desired improvements, perceived problems and improvements en route, route-specific global perceptions, and the expected neighborhood changes associated with rail and the complete street improvements?
2. Do perceptions outlined above relate to residents' expectations to use the new rail line and subsequent reports and objective measures of ridership?
3. Do perceptions outlined above change over time, once the light rail service starts?

Methods

Sample and procedures

The area for sampling encompassed residential units within 2 km of a planned 3.5 km complete street improvement in Salt Lake City, UT that included five new light rail stops, the completion and improvement of bike lanes, and the widening of sidewalks installed with pedestrian-friendly features, such as new landscaping and lighting. The 2 km buffer was chosen for another aim of the project, which was to demonstrate greater use of the complete street by residents living nearby (<1 km) compared to farther from (1–2 km) the street (Brown et al. 2016a). The distance of approximately one half mile (about 0.8 km) is considered the "acceptable distance" for estimating a light rail station catchment area (Guerra et al. 2012). The neighborhood includes many businesses and services along the complete street and a mix of low to high income residential units. Residences include manufactured housing parks, apartments, condominiums, duplexes, and single family detached homes.

In 2012, 910 residents participated but by 2013 the sample was reduced to 536 due to 34 refusals and the rest lost to relocation or becoming ineligible by Time-2. Those who dropped out of the sample were more likely to be renters (76%) than those who stayed [49%, $F(1, 535) = 58.23$, $p = 0.001$]. Those who dropped were not different from those who remained on most self-reports of transportation behavior over the past week. Specifically, they did not differ in number of walks ≥8 min to get someplace (sample m = 3.94, SD = 6.67), walks ≥8 min for fun (m = 3.45, SD = 6.32), bus rides (m = 1.20, SD = 3.86), car rides (m = 11.02, SD = 9.46), or uses of complete street businesses (m = 2.18, SD = 3.20). To be eligible for the study residents needed to be adults, not pregnant, able to speak English or Spanish, intend to live in the area for at least 1 year, able to give informed consent on a form approved by the first author's institution, able to fill out the surveys, and willing to wear accelerometers and global positioning system (GPS) units for about a week each time (a minimum 3 days, with 10 h/day of wear at Time-1). Research assistants met residents in their homes to administer surveys and fit and retrieve the equipment used for measuring physical activity and locations of travel.

Four ridership groups: self-reported and objectively measured

The group measure in this study is based on whether residents thought, at Time-1, they would ride the rail more once the new rail service started in combination with their ridership at Time-2. Expectations of ridership were gathered at Time-1, prior to the completion of the rail line. Participants indicated whether they would ride the rail more post-construction (expect = expect their ridership to increase "a little" or "a lot"; no expect = "stay the same" to "decrease a lot" from a 5-point scale). The Time-2 ridership variable is defined by both self-reports, the measures that are typically available in transportation studies, and by accelerometer and GPS measures, a fairly novel and more conservative assessment. Self-reported ridership increase was constructed from a question administered in Time-2 about whether the new rail stops increased their frequency of riding light rail (increased ride = increased "a little" or "a lot"; no increased ride = "stayed the same" to "decreased a lot" from a 5-point scale). Specifically, these four expectation/ridership groups are named:

1. "no expect/no ride": residents who did not expect to ride more and did not;
2. "no expect/ride": residents who did not expect to ride more but did;
3. "expect/no ride": residents who did expect to ride more, but did not;
4. and "expect/ride": residents who did expect to ride more and did increase their rides.

For objectively defined ridership, the firm GeoStats (now Westat) assigned trip modes after merging accelerometer and GPS data into 10-s epochs. As further described in Miller et al., the accelerometer and GPS measures yielded information on speed, acceleration, and location, which were used to categorize trips by mode, including taking light rail or bus (Miller et al. 2015). For example, motorized travel was defined as travel averaging over 16 m/s, and GeoStats had the transit system GIS layers to confirm stop/start patterns typical of transit, which allowed distinguishing between transit and automotive trips. For objective measures, Time-2 ridership was designated as either riding rail or not, based on GPS and location data. The same four ridership groups were developed from the Time-1 expectations and objective Time-2 ridership variables.

Survey measures

Residents' reports of barriers to and use of light rail transit and their expectations and experiences with the new infrastructure improvements in their neighborhood are described below.

Walking barriers and desired improvements

Nine items measured typical barriers to walking more in the neighborhood, such as lack of time and interest, a scale used in past research (Brown and Werner 2011), derived from earlier studies of barriers (Brownson et al. 2001). Ten items assessed resident perceptions of physical or social changes that would encourage more walking, such as more stores or crosswalks. This scale was also used in past research (Brown and Werner 2011), and derived from earlier studies of walking encouragement (Addy et al. 2004; Owen et al. 2004) Both sets were rated 0 for no and 1 for yes and all items were included in the same analysis.

Perceived problems and improvements en route

Residents were provided maps to help them answer questions about the route from their home to the nearest of the new light rail stops. The problems included five incivilities, such as graffiti and vacant homes, which have been associated with crime and fear in past research (LaGrange et al. 1992), rated on a 1–10 scale, from "no problem" to "big problem." There were three "civilities" or signs of neighborhood attractiveness, such as new homes and landscaping, again rated on a 1–10 scale from "no, none" to "many."

Route-specific global perceptions

We asked about the perceived safety from crime, traffic, and pleasantness for the walk to the complete street. We then repeated these three questions to assess perceptions along the complete street route itself. These three questions regarding safety from crime, safety from traffic, and pleasantness, while not comprehensive, reflected general categories of walkability found in many walkability studies (Day et al. 2006); residents rated each quality on a 1–5 scale from "not at all" to "very."

Expected neighborhood changes associated with rail

We asked about a range of neighborhood economic changes (n = 4; e.g., economic opportunities and housing costs), anticipated hassles or problems (n = 5; e.g., noise and parking difficulties), and community benefits (n = 4; e.g., neighborhood reputation and sense of community) believed to be associated with light rail. Adapted from past research (Brown and Werner 2011), these items asked whether the new rail line will change (Time-1) or has changed (Time-2) conditions such as economic opportunities, noise, and sense of community. Responses were on a 5-point scale from −2 "decreased a lot" to + 2 "increased a lot."

Control variables

All the multivariate analyses control for gender (proportion female = 0.51, SD = 0.54), age in years (m = 41.72, SD = 14.77), college education (proportion graduated from college = 0.37, SD = 0.48), car access (m = 0.87, SD = 0.33) and household income (m = $41,560, SD = 31,818). Due to 75 of 536 cases missing data on the household income variable, the missing cases were imputed by regression analyses, with random residuals chosen from complete cases. The addition of random residuals allows the imputed data to avoid problems of overidentification and excess precision. (Graham 2009). The imputation allows a more complete data set to be examined and the inclusion of the education variable also provides a broader socioeconomic control than use of income alone. In addition, data were reanalyzed using time 2 income, which had less missing data, using time 1 data to impute 14 missing cases at time 2; results were similar, so we retained the time 1 imputed variable for income. The only control variable that differed significantly across groups was the car access variable, at 92% for the two groups that did not ride transit and 78% no-expect/ride group and 79% for the expect/ride group [$F(3, 532) = 6.52$, $p < 0.001$].

Data analyses

General linear models (procedure GLM, SPSS, Armonk NY) tested the four expectation/ridership groups and the two-level time main effects as well as group by time interactions. Separate analyses are conducted for each of the four groups of survey dependent variables from the surveys: walking barriers/desired improvements, perceived problems and improvements en route, route-specific global perceptions, and expected neighborhood changes. These analyses are conducted first on the four expectation/ridership groups defined using Time-2 self-reported ridership, then repeated for the four expectation/ridership groups defined by objectively measured Time-2 ridership.

The GLM analyses are similar to a repeated measures multivariate analysis of covariance, with one between group factor (ridership group), one within participant factor (Time 1 vs. 2), an interaction between group and time, and five control variables. Group and time effect tests are commonly tested when there is an intervention, such as a new light rail, that happens over time to different groups (Fitzmaurice et al. 2013; UCLA: Statistical Consulting Group 2017). In this case, recall that our groups (the between subjects factor) are the four expectation/ridership groups: no expect/no ride; no expect/ride; expect/no ride; and expect/ride. The group main effect refers to whether the four expectation/ridership groups differ significantly on the survey measures (collapsing across the time factor). The time main effect refers to whether the within-participant repeated measure changes significantly from Time-1 to Time-2 (collapsing across the group measure). For example, if participants expected rail to increase economic opportunities at Time-1 but then said that rail decreased economic opportunities at Time-2, a significant time main effect would show that the participants changed over time to more negative perceptions of economic opportunities. The group by time interaction tests whether any changes over time are different across the four expectation/ridership groups; it also tests whether group differences change depending upon which time is examined. Multivariate effects are tested with Pillai trace (Olson 1976; Pillai 1967), the most robust of four common multivariate tests of significance across individual items (IBM Corporation 2013; Olson 1974). All the multivariate analyses control for gender, age, education, car access and household income; for brevity, these coefficients are not listed in the tables. Significant multivariate effects in the SPSS General Linear Model procedure are followed up with univariate tests, which explain which of the individual survey items contribute to significant differences. Pairwise follow-up tests are available to describe which cells are different from others when significant effects are found. These pairwise tests are Sidak-adjusted for multiple comparisons (Field 2009). The effect size is the partial eta squared statistic (η^2) (Levine and Hullett 2002; Cohen 1988), which ranges from 0 to 1. Cohen suggested effect size benchmarks of small = 0.0099, medium = 0.0588, and large = 0.1379 for partial η^2 (Richardson 2011).

Given that missing data was typically less than 5%, a level at which power losses and biases are considered inconsequential (Graham 2009), analyses were conducted with cases dropped for missing data; for most analyses, this resulted in a sample size between 520 and 533 from a total of 536 cases; it resulted in a somewhat lower sample size (n = 503) for the analysis of perceived problems, due to lower response rates for perceived problems items of drug dealing (n = 529) and perceived poor lawn conditions (n = 530). In order to enhance policy relevance and comparability across studies, an important consideration when studying rare community interventions such as new light rail systems, individual items are retained in analyses instead of reducing them to factors or composites (Foster and Giles-Corti 2008).

Results

Time main effects and group by time interaction effects were seldom significant so that results can be organized in terms of the main effects for group. Although control variable effects are not shown, their effects are consistent with past research. For example, women are more likely to report perceived traffic and crime danger, poor health, and weather as impediments to walking (Brownson et al. 2001). Older residents are more likely than younger residents to say that neighborhood improvements, like parks, stores, trees, and sidewalks would not encourage more walking and they reported health barriers, some of which have been found in past research (Lee et al. 2013). As shown below, specific barriers and problems that prevent walking did not differ substantially across ridership groups, but broader expectations for neighborhood change and global perceptions of the route to and along the complete street did differ across groups.

Walking barriers and desired improvements

Walking barriers and desired improvements for walking did not differ across group or by time or show a significant group by time interaction (all $p > 0.30$). To summarize the estimated marginal means in Table 1, about half or more of residents cited two common barriers to walking: no time and extreme weather. The third most common barrier was that there were not enough neighborhood walking destinations. Fewer residents cited health barriers (although recall that the sample was screened to ensure that health conditions did not preclude walking a few blocks), traffic barriers, or crime barriers. When asked what changes to the neighborhood might encourage more walking, over half the participants cited more stores, better night lighting, more parks and trails, and more trees. Thus, both practical and recreational destinations were important to residents.

Perceived problems and improvements en route

The perceived problems or physical incivilities and the perceived improvements along the route to and along the complete street did not differ by self-reported ridership group, time, nor the group by time interaction (all $p > 0.20$). To simplify presentation, a table is not provided for the insignificant group and time factors, given that the following average values can summarize how the sample responded. On the 1–10 scale representing whether each item constituted “no problem” to a “big problem,” no estimated means were higher than 5. From most to least frequently noted improvements and problems residents cited: graffiti (overall M = 4.90, SE = 0.14), poor lawn conditions (M = 4.88, SE = 0.13), noise (M = 4.51, SE = 0.13), people moving into the neighborhood (M = 4.38, SE = 0.11), house or place of suspected drug dealing (M = 4.35, SE = 0.14), newly landscaped properties (M = 3.90, SE = 0.11), vacant homes or buildings (M = 3.91, SE = 0.12), and new construction of homes (M = 3.22, SE = 0.11).

Route-specific global perceptions

Route-specific global perceptions assessed perceived crime, traffic, and pleasantness for two distinct parts of the route: from home to the complete street and along the complete street. The four expectation/ridership groups showed a marginally significant between group effect [$F(18, 1524) = 1.55, p = 0.07, \eta^2 = 0.018$], in conjunction with a significant time by group interaction [$F(18, 1524) = 1.72, p = 0.03, \eta^2 = 0.020$], and an insignificant time effect [$F(6, 506) < 1$, n.s.]. The univariate follow-up tests show that groups differed in perceived safety from crime [$F(3, 511) = 3.15, p = 0.03, \eta^2 = 0.018$] and traffic along the route to the complete street [$F(3, 511) = 2.62, p = 0.05, \eta^2 = 0.015$]. Pairwise tests, noted in Table 2, show significant changes over time, within each group, as well as differences between groups, within each time.

Pairwise tests revealed several instances in which groups differed over time. The expect/ride group reported increases in perceived safety from traffic, rising from 3.51 to

Table 1 Walking barriers and desired walking improvements across ridership groups: Estimated marginal means (above) and standard errors (below)

What keeps you from walking more in your neighborhood? (0, 1)	Four expectation/ridership groups			
	No expect		Expect	
	No ride	Ride	No ride	Ride
No time/too busy	0.57	0.55	0.59	0.60
	0.03	0.07	0.03	0.03
Extreme weather	0.50	0.48	0.55	0.54
	0.03	0.07	0.03	0.03
Not enough destinations	0.39	0.37	0.41	0.46
	0.03	0.07	0.03	0.03
Feel unsafe due to crime	0.26	0.27	0.32	0.29
	0.03	0.07	0.03	0.03
Get enough exercise elsewhere	0.35	0.42	0.31	0.28
	0.03	0.07	0.03	0.03
Health reasons	0.17	0.25	0.18	0.21
	0.02	0.06	0.03	0.03
No interest	0.31	0.22	0.25	0.23
	0.03	0.06	0.03	0.03
Other barriers	0.15	0.11	0.18	0.16
	0.02	0.05	0.02	0.03
Feel unsafe due to traffic	0.20	0.17	0.22	0.15
	0.02	0.06	0.03	0.03
What would allow you to walk more?				
More stores	0.57	0.51	0.67	0.69
	0.03	0.07	0.03	0.03
More parks and trails	0.64	0.64	0.71	0.64
	0.03	0.07	0.03	0.03
Better lighting at night	0.58	0.69	0.65	0.61
	0.03	0.07	0.03	0.03
More trees	0.54	0.53	0.61	0.59
	0.03	0.07	0.03	0.03
Better or more sidewalks	0.47	0.47	0.46	0.51
	0.03	0.07	0.03	0.03
Better police enforcement	0.52	0.49	0.53	0.50
	0.03	0.08	0.03	0.04
Cleaner streets	0.47	0.39	0.49	0.49
	0.03	0.07	0.03	0.03
Better or more crosswalks	0.48	0.52	0.50	0.47
	0.03	0.07	0.03	0.03
Improved traffic signals	0.40	0.42	0.43	0.38
	0.03	0.07	0.03	0.03
More bus stops	0.18	0.20	0.19	0.25
	0.03	0.06	0.03	0.03

Table 1 continued

What keeps you from walking more in your neighborhood? (0, 1)	Four expectation/ridership groups			
	No expect		Expect	
	No ride	Ride	No ride	Ride
n	194	32	159	148

Covariates appearing in the model are evaluated at sample averages (female proportion = 0.51, college graduates = 0.37, age = 41.76, car access = 0.87, household income = $41.710)

Table 2 Route-specific global perceptions to and along the complete street: By expectation/ridership group and time

	Four expectation/ridership groups				Four expectation/ridership groups			
	No expect		Expect		No expect		Expect	
	No ride Time 1	Ride	No ride	Ride	No ride Time 2	Ride	No ride	Ride
The route from home to complete street is								
Safe from crime	3.23	3.73	3.30	3.46	3.30	3.81	3.36	3.54
	0.09	0.21	0.09	0.10	0.08	0.20	0.09	0.10
Safe from traffic	3.35	3.53	3.27	3.51[a]	3.44	3.78	3.42	3.71[a]
	0.08	0.20	0.09	0.10	0.08	0.19	0.09	0.09
Pleasant	3.39	3.87[a]	3.29[a,b]	3.44	3.46	3.77	3.45[b]	3.47
	0.08	0.20	0.09	0.09	0.08	0.20	0.09	0.10
The route along the complete street is								
Safe from crime	2.73	2.68	2.66	2.81	2.81	3.04	2.58	2.90
	0.08	0.20	0.09	0.09	0.08	0.19	0.09	0.09
Safe from traffic	2.94	2.84	2.66	2.85[a]	2.94	3.27	2.81	3.11[a]
	0.08	0.20	0.09	0.10	0.08	0.21	0.09	0.10
Pleasant	2.76	2.93	2.50[a]	2.63[b]	2.89	3.05	2.83[a]	3.17[b]
	0.08	0.20	0.09	0.09	0.08	0.20	0.09	0.10
n	190	32	156	142	190	32	156	142

Control variables (not shown) are evaluated at sample averages (female = 0.51, college graduate status = 0.37, age = 41.84 years; car access = 0.88; household income = $41,620.). Within a row, cells sharing a superscript are significantly different, based on pairwise comparisons

3.71 over time for safety along the route to the complete street and from 2.85 to 3.11 for traffic safety along the complete street (both $p < 0.05$). They also reported increased perceptions of pleasantness of the path to the complete street, from 2.64 to 3.17 ($p < 0.001$).

The expect/no ride group reported increased perceived pleasantness of both routes: the route to the complete street rose from 3.29 to 3.45 ($p < 0.05$) and the complete street route rose from 2.50 to 2.83 over time ($p < 0.001$).

As for differences across groups, within each time, only one effect was significant. Within Time-1, the no expect/ride group perceived greater pleasantness of the route to the complete street (m = 3.87) than for the expect/no ride group (m = 3.29, $p < 0.05$). The marginally significant group effect reported above ($p = 0.07$) reflected one significant pairwise difference across groups (collapsed across time). The no expect/ride group perceived higher crime safety than the no expect/no ride group (3.77 vs. 3.27, $p = 0.05$). Thus, there were some more positive perceptions over time for several of the groups, but most consistently for the expect/ride group.

Expected neighborhood changes associated with rail

The expectation/ridership groups differed significantly on the changes they associated with light rail [$F(39, 1542) = 3.16$, $p < 0.001$, partial $\eta^2 = 0.074$]. However, the time main effect [$F(13, 512) = 0.73$, $p = 0.73$] and interaction [$F(39, 1542) = 1.07$, $p = 0.36$] were insignificant. Univariate tests of the between group significance are listed in Table 3, which also denotes cells that differed on follow-up pairwise tests.

As shown in Table 3, the largest expected changes involved economic changes, with the expect/ride group generally endorsing the strongest expected increases for economic changes. Specifically, the expect/ride group anticipated greater increases in economic opportunities, housing costs, and housing improvements, compared to the no expect/no ride group. For housing improvements and costs, the expect/ride group anticipated more housing improvements than the expect/no ride group. In addition, the expect/no ride group anticipated more economic opportunities from rail development than the no expect/no ride group.

The groups did not disagree about hassles or problems associated with rail that involved parking difficulties, crime, or child and pedestrian safety. Compared to no expect/no ride group, residents in the expect/ride group perceived that noise would increase and traffic would decrease as problems.

The groups consistently differed on the anticipated community benefits associated with light rail development. Again, the expect/ride group expressed the most positive expectations regarding community. Anticipated rail benefits to neighborhood reputation, sense of community, number of neighbors seen, and access to healthy food were significantly more positive for the expect/ride group than the no expect/no ride group. In all cases, except for healthy food access, the expect/ride group was also more positive than the expect/no ride group. Thus, in Table 3, expecting to ride is often not sufficient to translate into Time-2 reported ridership; instead, only when expectations for community benefits and housing improvements are also high do those individuals translate their expectations of greater ridership into ridership increases reported a year later.

Figure 1 shows how residents who reported increases in their rail ridership at Time-2 had anticipated, at Time-1, greater community benefits from the new rail line. Whether residents expected to ride the new rail at Time-2 or not, those who end up riding it had stronger expectations of community benefits at Time-1.

Generality tests

Analyses were recomputed using objective measures of light rail ridership at Time-2 instead of self-reported increases. There were fewer cases of objectively defined rail ridership at Time 2 (n = 88) than self-reported (n = 182), given that participants would need to have worn the GPS logger and to have ridden within the 1-week window to be detected as riding light rail. Nonetheless, results are quite similar to those reported above. For

Table 3 Time-1 expectations for expected neighborhood changes associated with rail by Time-2 self-reported rail ridership: Between group effects

	Four expectation/ridership groups				F	p	η^2
	No expect		Expect				
	No ride	Ride	No ride	Ride			
Cell name and sample size	a = 194	b = 32	c = 159	d = 148			
Economic effects							
Economic opportunities	0.36	0.78^{a}	0.69^{a}	0.77^{a}	12.83	0.000	0.068
	0.05	0.12	0.05	0.06			
Housing costs	0.44	0.54	0.50	0.68^{ac}	4.92	0.002	0.027
	0.04	0.10	0.04	0.05			
Housing improvements	0.22	0.49	0.40^{a}	0.59^{ac}	11.99	0.000	0.064
	0.04	0.10	0.04	0.05			
Property taxes	0.51	0.61	0.51	0.58	0.73	0.534	0.004
	0.04	0.10	0.05	0.05			
Hassles or problems							
Noise	0.16	0.17	0.29	0.33^{a}	3.13	0.025	0.018
	0.04	0.10	0.04	0.05			
Parking difficulties	0.14	−0.05	0.17	0.17	1.56	0.199	0.009
	0.04	0.10	0.04	0.05			
Car traffic	0.09	−0.10	−0.07	-0.16^{a}	3.87	0.009	0.022
	0.05	0.12	0.05	0.06			
Crime rates	0.07	−0.01	0.07	−0.04	1.15	0.330	0.007
	0.04	0.10	0.05	0.05			
Child or pedestrian safety	−0.06	0.17	0.04	0.14	2.38	0.068	0.013
	0.05	0.12	0.06	0.06			
Community benefits							
Neighborhood reputation	0.21	0.42	0.40^{a}	0.62^{ac}	12.78	0.000	0.068
	0.04	0.11	0.05	0.05			
Sense of community	0.17	0.30	0.25	0.46^{ac}	7.30	0.000	0.040
	0.04	0.10	0.04	0.05			
Number of neighbors seen	0.09	0.16	0.16	0.39^{ac}	11.09	0.000	0.060
	0.04	0.09	0.04	0.04			
Access to healthy food	0.08	0.35^{a}	0.32^{a}	0.47^{a}	15.42	0.000	0.081
	0.04	0.09	0.04	0.04			

Control variables (not shown) are evaluated at their averages: female = 0.51, college educated = 0.37, age = 41.8 years, car acces = 87%, household income = \$41,710. Cells that differ on pairwise tests are identified by superscripts, $p < 0.05$

example, personal barriers remained non-significant and expectations regarding community changes detailed in Table 3 showed the same significant changes.

However, with respect to specific route problems and improvements, the greater specificity of the objectively-verified light rail ridership analysis, compared with the self-reported ridership, yielded significant univariate group differences, as shown in Table 4.

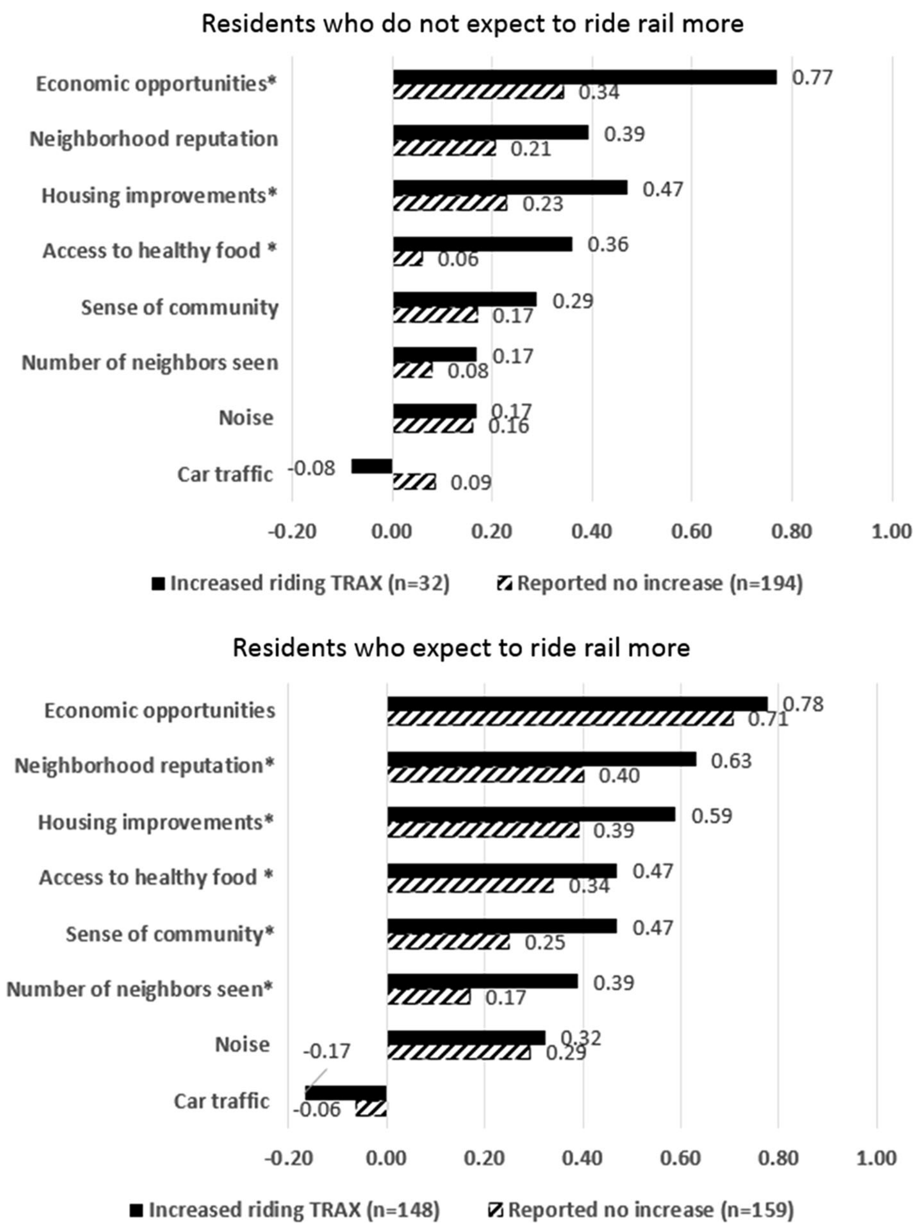

Fig. 1 Expected consequences of rail: differences across ridership groups (expect to ride X ride). * Indicates a variable with a significant pairwise difference, Sidak-adjusted

These differences also attest to the more positive ratings by the expect/ride group. Although the group multivariate differences are only marginally significant [$F(24, 1467) = 1.44$, $p = 0.08$, partial $\eta^2 = 0.023$], the univariate tests are consistent with the theme of relatively positive ratings by the expect/ride group (both time and group by time multivariate effects are nonsignificant, $p > 0.17$). These significant between group

Table 4 Time-1 perceived problems and improvements en route expectations by Time-2 objectively measured rail ridership: Between group effects

Ratings 1–10: no to big problem or none to many	Not expecting more rides		Expecting more rides	
	No > rides	Rides	No > rides	Rides
Column name and sample size	a = 189	b = 20	c = 233	d = 61
Graffiti**	4.80	3.62	5.37[b]	4.39[c]
	0.18	0.57	0.17	0.33
Poor lawn conditions*	4.78	4.34	5.22	4.24[c]
	0.17	0.53	0.15	0.31
Noise	4.36	4.13	4.75	4.14
	0.17	0.52	0.15	0.30
People moving into the neighborhood*	4.20	3.76	4.42	5.04[a]
	0.15	0.46	0.13	0.27
Suspected drug dealing home/place	4.13	3.56	4.55	3.87
	0.18	0.57	0.17	0.33
Newly landscaped properties**	3.80	3.23	3.88	4.68[a,b,c]
	0.15	0.45	0.13	0.26
Vacant home or buildings	3.79	3.51	4.24	3.79
	0.15	0.46	0.13	0.27
New construction of homes*	3.03	2.70	3.26	3.92[a]
	0.15	0.45	0.13	0.26

Control variables (not shown) are evaluated at sample averages (female = 0.50, college graduate status = 0.37, age = 41.61 years; car access = 0.87; household income = $42,020). When a cell differs from another cell in the row, the superscript identifies the significant difference

* $p < 0.05$, ** $p < 0.01$ for expectation/ridership group univariate tests ($p < 0.05$)

univariate effects had been insignificant when self-reported ridership was tested, suggesting that objectively measured ridership provides a precise measure that can enhance the strength of the relationships between the psychological variables and ridership. In most cases, the residents who expected/rode perceived more positive features and fewer negative features along the route to and along the complete street. The expect/ride group, compared to the no expect/no ride group perceived more people moving into the neighborhood, more newly landscaped properties, and more new home construction. The expect/ride group, compared to the expect/no ride group, perceived less graffiti, fewer lawns in poor condition, and more newly landscaped properties. The expect/ride group also perceived more newly landscaped properties than the no expect/ride group. The expect/no ride group perceived more graffiti than the no expect/ride group (all $p < 0.05$).

Discussion

The current research shows that psychological associations with light rail ridership are complex, even among residents who initially stated that they expected to ride more once the new neighborhood rail stops were completed. However, gathering data on expected ridership, experienced barriers and facilitators of ridership, as well as general neighborhood expectations helps to clarify how ridership groups differ. As anticipated, the no expect/no ride group was most consistently different from the expect/ride group. These groups did not differ much in terms of more individualistic barriers to walking to the new stops, such as extreme weather or health problems. Instead, both specific neighborhood conditions en route to the complete street and the broader connotations of the complete street improvements as perceived by residents significantly differentiated the groups. At the risk of simplification, we see the no expect/no ride group as light rail pessimists and the expect/ride group as light rail optimists. When objective ridership data were used, the expect/ride group reported more positive changes of new landscaping, new homes, and people moving into the neighborhood. Although these differences might reflect differences in actual conditions of the routes surrounding the homes in the sample, the questions regarding broader expectations for the entire light rail extension asked residents about the exact same physical locale, thus controlling for actual conditions.

However, it is the broader neighborhood changes residents believe come with the complete street improvements that provided the most consistent differences between the two groups with consonant expectations and rider behavior. The expect/ride group, compared to the no expect/no ride group, associated the light rail construction with greater economic opportunities, housing improvements, improved neighborhood reputation, sense of community, number of neighbors seen, and better access to healthy food. The only counter to this theme was that the expect/ride group did expect more noise associated with the rail line. In all of these cases there was no significant time effect or time by group interaction. That makes it clear that the perceived and expected neighborhood qualities that associated with ridership predated the residents' ability to test out the new stops. The residents who expected to ride and later rode the rail more brought their positive expectations with them before the new stops opened. Policy makers have not considered the community attitudes of residents around future stops to be a resource to cultivate to enhance ridership, but they might want to consider involving targeted neighborhoods in ways that might help residents develop optimism and convert it into reality and subsequent ridership.

In contrast to those who had congruent expectations and subsequent ridership, about 36% of the sample did not fulfill their own expectations for ridership once the new service was available. Most of these (n = 159) were residents who expected to ride more but who did not, although a few were residents who did not expect to ride but did ride more post-construction (n = 32). The expect/no ride group should be of special interest to policy makers, given that their initial favorable attitudes did not translate into ridership behavior. Psychological research shows that habits, such as car use, are difficult to break in part because they are so mindlessly guided (Bamberg and Schmidt 2003). The expect/no ride group also had distinct perceptions of the neighborhood even before the new rail opportunity became available. In keeping with the differences outlined above, the expectation data suggested a bit more optimistic perceptions in the expect/ride group and a bit more pessimistic perceptions in the expect/no ride group. The expect/ride group perceived less graffiti, fewer poor lawn conditions, and more newly landscaped properties en route to and along the complete street. They also associated the rail extension with more housing improvements, improved neighborhood reputation, greater sense of community, and more neighbors seen. These results suggest that coordination with police and community development agencies and citizen groups might provide more resources to assure timely graffiti removal, greater programming of neighborhood events to enhance neighborhood contacts, and assistance with housing and property upkeep, which may in turn enhance ridership.

Although there were few "surprise riders" (the no expect/ride residents), which made it difficult to achieve statistical significance in tests against other groups, they too seemed to perceive more positive associations with light rail than did their neighbors who also did not expect to ride and did not ride. These differences were significant in terms of the surprise riders seeing more economic opportunities and access to healthy food associated with light rail. It should be noted that one of the new rail stops is adjacent to a full service grocery store in the neighborhood, so that rail riders do have a convenient food shopping outlet.

The relative absence of changes over time suggest again that residents of the neighborhood hold fairly consistent ideas about what the new rail extension to their neighborhood will bring. The one group by time significant interaction was reassuring in that it showed greater pleasantness ratings for the complete street post-construction, when the design elements such as landscaping, specially colored paving surfaces, and pedestrian-oriented lighting were in place. Although it is reassuring that these changes were visible soon after light rail service started, other changes associated with rail development may take more time. For example, residents noted that more stores would give them a reason to walk in their neighborhood (Table 1) but transit-oriented developments, with their supporting stores, housing, and services, take time to develop. It would be interesting to know whether the optimism of those who anticipated good things from the light rail extension can be maintained across the years it can take for transit oriented developments to mature.

Results of the current study are consistent with those of the few comparable studies. Like other studies of barriers, many residents cited general busyness and poor weather as barriers to walking more in their neighborhoods (Lee et al. 2013; Brownson et al. 2001). Time barriers may be addressed as transit service improves and provides more frequent service to needed destinations. Alternatively, transit providers can focus on the benefits of the ways in which transit trips allow for activities that are not possible during driving trips. For example, using smart phones, catching up on email, reading, chatting with others, enjoying scenery and other activities are more possible when riding a train than when driving (Gamberini et al. 2013). Innovative policies, such as having "work on the train" time counted as work time (Gripsrud and Hjorthol 2012) might reduce the perception that walking to transit takes too long, if the ride itself counts as work time. In addition, weather barriers to transit use might be partially mitigated through providing more transit stop shelters and sheltering trees along routes, both of which riders and prospective riders desire (Ewing 2001).

Few studies exist that have focused on residents' broad expectations for rail changing the economic and community aspects of their neighborhood. However, most residents expected the greatest impact on economic conditions, then improvements to reputation and community, and lastly hassles about noise or crime, a rank ordering similar to that found in a small study conducted elsewhere on the same rail system (Brown and Werner 2011). Other research has shown that residents with liberal attitudes have preferences for the type of housing associated with transit-oriented development (Handy et al. 2008; Lewis and Baldassare 2010), so it may be that we are just beginning to appreciate how orientations to the larger society and the neighborhood may be connected to travel mode choices. Furthermore, this research did not focus on traditional attitudes toward transit use or environmental behaviors, which have been found to predict ridership Given that broad neighborhood expectations were most consistently related to ridership in the current study, we encourage adding these expectations to more traditional models that include psychological variables such as attitudes towards transit, environmental values, and subjective norms (Heath and Gifford 2002).

We acknowledge that there are limitations to this study. We focused the study on one neighborhood surrounding five new rail stops. Although we were able to provide pre- and post-construction information, the 1 year between data collection intervals covers a limited span of time. We had to select residents who might be especially likely to ride, due to lack of health problems that would prevent them from walking a few blocks and because we only recruited residents who believed they would stay in the neighborhood for at least a year. Given that the perceptions of residents that were most strongly associated with ridership were present prior to the construction of the rail line, we cannot document how those perceptions originated or how policy makers might cultivate them to enhance rail ridership.

In the current efforts to create more walkable communities, even substantial complete streets investments, such as adding light rail corridors, providing bike lanes, and improving sidewalks, only focus on one corridor. Transportation officials have dubbed “First Last Mile” strategies those that prioritize safe, convenient, multimodal access pathways around transit stops, extending out to a pedestrian or bike-shed area up to one mile beyond the transit corridor itself (Los Angeles County Metropolitan Transportation Authority 2014). Transportation agencies have limited power to improve conditions a mile around each light rail stop. Quite sensibly, their improvement strategies often focus on transportation elements, such as crosswalks, new access paths, bus-rail connections, signage, or bike storage (Los Angeles County Metropolitan Transportation Authority 2014). Other experiments in providing easier access to transit stops focus on a variety of solutions, such as Segway vehicles, electric bikes, and bicycles (Shaheen and Rodier 2008; Rose 2012) or autonomous personal vehicles (Chong et al. 2011). These solutions vary in how much they encourage healthy physical activity and how much investment and storage space they require. Current policy supports for last mile access often do not consider the aesthetic amenities along the route to the rail stations. In the future, it may be useful to consider public health benefits of active travel to stations and how design elements beyond sidewalks or bike paths might facilitate safe, low-carbon, physical-activity inducing travel, given the low levels of physical activity within the adult U.S. population (Troiano et al. 2008). Developing surrounding neighborhood conditions that encourage active travel to stations will require coordination with other agencies that deal with the broader neighborhood landscape.

Indeed, our results suggest that it is important to re-conceptualize rail travel decisions as embedded within the entire neighborhood in order to maximize the attractiveness of rail to residents. This study showed that different groups of riders found the route linking them to the complete street more pleasant and safer from traffic and crime. Thus municipalities that want to encourage transit use should work in conjunction with others to improve walking conditions throughout the walkshed to each stop. That is, communities may want to adopt land use, health, employment, and policing policies that attract residents to live in such communities and to take advantage of opportunities to access a transportation network in more active ways than always relying on their cars. Residents’ positive orientations toward their local transit stops can be part of connecting within communities (Alexander and Hamilton 2015) and perceptions of bustling street life around transit stops have been described as part of a broader transit mobility culture (Klinger and Lanzendorf 2016). By coordinating with other agencies it might be possible to broaden the appeal of the entire neighborhood to encourage greater walking, bicycling, or transit use among existing residents and to attract new residents who appreciate such opportunities. A more immediate possible policy improvement would be to provide more information about how transit improves access to desired destinations. Residents often reported that a lack of destinations was a barrier to neighborhood walking, but many could walk to the new stops that provide access to hundreds of destinations across the transit network. As the city evolves from car-dominant access, public information campaigns may be needed to remind residents near transit stops that they can walk to many destinations via transit.

Studies of transit ridership, when they include psychological perceptions, often focus on the quality of the transit service. For example, riders who are happy with waiting times, travel times, and on-board experiences are more likely to recommend transit to others (Diab and El-Geneidy 2014). Other studies have shown that transit access is related to higher life satisfaction (Cao 2013). However, the current study suggests that residents' perceptions of broader consequences to the neighborhood might serve as a strong but relatively neglected spur to use as well. Similarly, in the same data set we also found that residents who held stronger place attachments to their neighborhoods were more likely to become riders (Brown et al. 2016b). As suggested in that study, it might be worthwhile considering a transit ambassador program, in which neighborhood optimists, such as those identified in the current study, make connections with their neighbors in ways that spread the optimism and the ridership. At the outset of new service, the early optimistic users might be able to distribute free passes (Abou-Zeid and Fujii 2016), an intervention shown to be associated with satisfactory use of transit. This might also provide an engaging way to keep early users committed to ridership until it becomes habitual, a need cited in past research (Ahmad Termida et al. 2016). To maximize their use, good complete streets need good complete communities as well as enthusiastic neighborhood light rail proponents.

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Compliance with ethical standards

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

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