Title

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Results from a Roadway Design Survey of Pedestrians, Drivers, Bicyclists, and Transit Users in the Bay Area

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ABSTRACT
This paper presents findings from a recent study on roadway design preferences among pedestrians, drivers, bicyclists, and public transit users along a major urban corridor in the East San Francisco Bay Area. Sponsored by the California DOT, the research focused on exploring design preferences that could increase perceived traffic safety, walkability, bikability, and economic vitality along urban arterials.

Results from an intercept survey showed that all user groups desire similar roadway design features along the test corridor, which carries 25,000-30,000 motorists bi-directionally and has comprehensive sidewalk coverage, but no bicycle facilities. In an open-ended question about street improvements to enhance perceived traffic safety, all respondent groups requested the same top five improvements. Bicycle lanes were ranked first by pedestrians, drivers, and bicyclists (fifth by public transit respondents), and improved pedestrian crossings were ranked second by pedestrians, drivers, and public transit users (third by bicyclists). The other top five suggestions were the same for all groups, though ordered slightly differently: slowing traffic/improving driver behavior, increasing street lighting, and increasing traffic signals/stop signs. Similar preference alignment was found regarding street improvements to encourage more visits to the corridor.

These findings suggest that design features generally thought to benefit one road user group, such as bicycle lanes for bicyclists, may also benefit other users. Moreover, these results provide evidence that roadway planning can take advantage of synergistic opportunities to benefit multiple user groups by implementing a few key design interventions. Overall, the findings support the continued implementation of complete streets principles and policies.

INTRODUCTION

Despite state and national goals of increasing walking and bicycling, rates have remained fairly stagnant over the last ten years *(1)*. A greater understanding of how roadside design features affect walkability and bikability could benefit local, state, and national complete streets efforts that seek to improve health through increased physical activity associated with non-motorized travel, enhance mobility for those who cannot or do not drive, and decrease greenhouse gas emissions from the transport sector. This paper presents results from a recent pedestrian and bicyclist intercept survey conducted to understand how landscaping and street design features currently or could potentially affect perceived traffic safety, economic vitality, and general satisfaction along a major urban arterial in the San Francisco Bay Area.

While little research exists on the subject, popular news stories indicate that people tend to assume that certain roadway design features are intended to benefit only a subset of road users. For instance, sidewalks are seen to benefit pedestrians, while bike lanes benefit bicyclists. This assumption has been writ large in cities like San Francisco, CA, and New York City, NY, whose efforts to install bicycle lanes have been met with a lawsuit (the former) and protests (the latter) related to arguments that bicycle lanes benefit a small minority and negatively impact the majority of road users. This paper reports findings suggesting that roadway design features typically considered user-specific may have much broader, synergistic benefits for all road users.

This survey was conducted along San Pablo Avenue, a State route acting as an arterial in six Bay Area cities, as part of a larger project to develop performance measures for pedestrian and bicyclist safety and mobility for the California Department of Transportation (Caltrans). The findings may be applicable to urban arterials in general.

Literature Review
This study began with a comprehensive literature review of research examining various design interventions and their effects on pedestrian, bicyclist, and driver safety and mobility *(2)*. The review found that several studies have examined the factors affecting whether a person walks or bikes, including perceived and objective measures of safety from traffic in various street environments and the role of street design features in enabling or thwarting non-motorized transportation. For pedestrian design, much research has analyzed the relationship between neighborhood and street characteristics and reported mobility and safety trends, rather than stated preferences. In contrast, several studies on bicycling patterns have focused on stated preferences in an attempt to understand how to encourage more bicycling. This discrepancy seems to be due in part to the lack of revealed preference data for bicyclists, who traditionally make many fewer trips than other roadway users. While studies have investigated driver preferences for roadway design elements such as pavement and landscaping treatments, little research has examined preferences for features traditionally viewed as specific to pedestrians and bicyclists *(3)*. The research highlighted here is excerpted from the broader literature review, and focuses on revealed and stated preferences for roadway design features along arterial roadways.

Numerous studies suggest that urban form and traffic patterns influence whether or not a community is considered walkable. In their review of the literature, Saelens and Handy found that sidewalks and network connectivity were positively associated with walking, as were mixed land uses and higher density. However, findings linking aesthetics and walking were less clear *(4)*. Lee and Moudon found that approximately 40% of pedestrians and bicyclists viewed "too much traffic" as the top barrier to more walking and bicycling near Seattle, Washington. Dangerous street-crossing conditions were also a top barrier for pedestrians, while a lack of bike lanes, trails, and nearby safe places to cycle were top barriers for bicyclists. Respondents suggested that good street lighting and more street trees would encourage more walking and bicycling, as would more benches (for pedestrians) and more bike lanes/trails and bike parking (for cyclists) *(5)*.

Schlossberg, Agrawal, et al. surveyed people walking to transit stops in the Bay Area of California and Portland, Oregon. They found that perceived safety (from both crime and traffic) and route directness were key factors in route choice to the stop. Nearly half of respondents prioritized sidewalks in route choice, while over one-third prioritized aesthetic factors such as landscaping. Objectively, the street sections considered least walkable by respondents tended to occur along arterials and collectors *(6)*. Research by Petritsch et al. on pedestrian level of service (LOS) at signalized intersections and along arterials in Florida indicates that conflicts with turning vehicles, the volume and speed of perpendicular traffic, and width of driveway and intersections crossings have the most negative effect on pedestrians' perceptions of comfort *(7)*. In their study of the areas surrounding transit stops in Portland, Oregon, Schlossberg and Brown found that streets with high volumes of traffic and multiple lanes may act as barriers to pedestrians attempting to cross the street *(8)*.

Research on bicycling tends to find strong stated preferences for on-road bicycle facilities. Vernez-Moudon, Lee, et al. surveyed residents in King County, Washington, about their bicycling habits and the built environment. When asked about changes that would encourage them to bicycle more, nearly 50% of respondents (cyclists and non-cyclists) said more bike lanes and trails *(9)*. Wardman et al. examined revealed and stated preferences of cyclists in the United Kingdom and found that their participants currently used few bicycle lanes to bicycle to work, but that this was generally because the lanes were not available for use. Respondents indicated that more on-road bicycling facilities would encourage them to bicycle more *(10)*. In their random-sample survey of Portland, Oregon, residents, Dill and Voros found that nearly 40% of people who wanted to bicycle more cited a lack of bike lanes or trails as a barrier to doing so *(11)*. Research by Petritsch and Landis on bicycle LOS in Florida found that the presence or absence of a bicycle lane was the most commonly cited reason for giving a roadway a high or low score, respectively *(12)*. In their analysis of perceived cycling risk and route acceptability, Parkin et al. found that bicycle lanes could mitigate the perceived risk of bicycling near high amounts of auto traffic *(13)*.

The biggest limitation of stated preference research is that the preferences are generally not verified through longitudinal analysis to see if and how survey respondents' behavior changed when their preferred facilities were built. However, ecological trends within revealed preference research, which may be detected by reviewing the results from multiple studies conducted across neighborhoods or communities, seem to corroborate findings from stated preference studies. For example, using GPS data from 166 cyclists in Portland, Oregon, Dill and Gliebe found that cyclists riding for utilitarian purposes rode mainly on streets with bicycle infrastructure. Nearly 30% of the travel occurred on streets with bicycle lanes and bicycle boulevards—even though only 24% of shortest-path trips would have occurred on those streets *(14)*. Correspondingly, Winters, Teschke, et al. found that frequent and infrequent cyclists in Vancouver, British Columbia, go out of their way to use routes with bicycle facilities. An analysis of recorded bike trips for 74 cyclists indicated that 49% of the total trip distance took place on designated bike routes, as compared to 21% in a shortest-path scenario *(15).*

Research examining how various roadside design features affect driver safety and behavior is fairly robust, although recent research has challenged accepted design strategies for urban roadways (particularly arterials), arguing that recommendations about sight lines for street trees and parking, speed limits, lane widths, and configurations may increase crash risk for drivers and other roadway users. For example, Fitzpatrick et al. found that higher posted speed limits and increased lane widths were associated with significantly increased driver speed on multi-lane arterial roadway sections in Texas *(16)*. Dumbaugh compared sections of roadway in Florida with and without "livability" treatments such as on-street parking, trees, sidewalks, and buildings close to the right-of-way. After controlling for ADT, posted speed, lane and median widths, and related factors, he found that the livable street segments had fewer roadside and mid-block crashes, and that drivers drove more slowly through the area *(17)*. Naderi found that landscaping improvements along arterials in Toronto, Canada, were positively associated with reduced mid-block crash rates *(18)*. Macdonald used computer modeling to evaluate sightlines for drivers in various scenarios. She found that on-street parking was much more likely to block drivers' views of oncoming traffic than were street trees, which are more strictly regulated *(19).* Despite these and related studies, relatively little research has investigated driver preferences for roadway design in urban areas. The few studies that exist have been small and qualitative in nature, precluding general conclusions about driver preferences for roadway design in various contexts.

Economic vitality also has an important impact on local quality of life. Although little research has investigated the relationship between economic vitality and street design elements in urban areas, general findings suggest that, as prime commercial areas, urban arterials should provide access opportunities for all modes, as well as amenities such as street trees that enhance comfort and therefore may encourage foot traffic. In particular, Wolf found a clear preference for areas with landscaping and trees when she surveyed 365 shoppers in downtown Athens, Georgia, about their preferences in shopping districts *(20)*. Researchers from Schaller Consulting surveyed 507 roadway users in a commercial district in New York City, and found that pedestrians and transit users visit the area most often. When asked how various roadway design changes would change their visit frequency, the overwhelming majority of respondents answered that they would visit more often if more sidewalk space were created—even at the expense of on-street parking *(21)*. Sztabinski examined the potential effects of roadway design changes on businesses in a commercial district in Toronto, Canada. He found that pedestrians and bicyclists tend to spend more money than drivers, suggesting that catering to them could increase business. In addition, 62% of the 536 respondents (including 46% of drivers and 63% of pedestrians) preferred replacing on-street parking with a bicycle lane versus a widened sidewalk or do-nothing scenario *(22)*. In his evaluation of pedestrian improvements to a downtown business area, Whitehead, Simmonds, et al. found them to be associated with both increased pedestrian traffic and increased property values *(23)*.

SURVEY METHODOLOGY

The survey included questions about trip purpose, frequency of visits to the area, perceptions of traffic safety under various conditions, and preferences for various design amenities. After obtaining a human subjects exemption from the UC Berkeley Office of Human Subjects Protection, the researchers worked with a survey firm to randomly intercept participants on foot or bicycle at eight sites along the study corridor. The survey was conducted in English only. The surveyors included men and women, working alone, divided between the different sites. They intercepted participants in a variety of locations along the street, including at intersections and bus stops, while entering or leaving local businesses, and mid-block. Approximately 25% of people refused to participate, for a total of 537 respondents.

To capture a wide variety of participants, the survey team visited the sites from 9 am – 6 pm over a two-week period (including five weekdays and three weekend days) in September, 2010. There was no rain during the survey period, and the temperature averaged approximately 75 degrees Fahrenheit (24 degrees Celsius). The data was entered into Microsoft Excel, and then analyzed using the statistical software package STATA 12 (StataCorp, College Station, TX). Findings presented in this paper are statistically significant through Chi Square and Kruskal-Wallis tests at the level of $p \leq 0.10$.

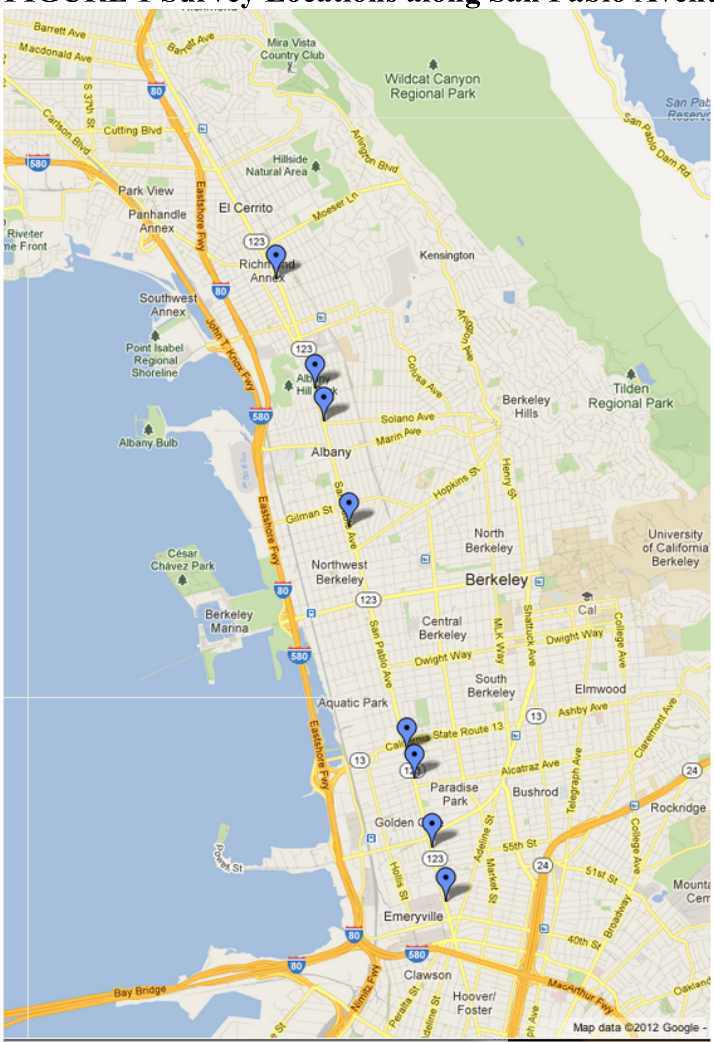
Area Information & Survey Sites

San Pablo Avenue is officially under Caltrans' jurisdiction as State Route 123, but the roadside design features found in various sections are influenced by the six cities (Richmond, El Cerrito, Albany, Berkeley, Emeryville, and Oakland) and two counties (Alameda and Contra Costa) through which the urban arterial passes in the East Bay of the San Francisco Bay Area. State Route 123 has 181 intersections along its 9.5-mile (15.3 km) length, and the character of the street ranges from traditional "main street" with small buildings built to the lot line, to big box superstores with large building footprints separated from the roadway by parking lots. The entirety of the street carries bidirectional traffic with at least two lanes in each direction. It also has nearly 100% bidirectional sidewalk coverage, but no on-street bicycle facilities.

The eight survey locations represented a variety of street design amenities and land uses, and were chosen after each intersection was graded on its pedestrian crash rate and the amount and presence of a variety of pedestrian-friendly design elements. Pedestrian-friendly design elements included the presence or absence of pedestrian-friendly features such as street trees, median trees, a raised median island, landscaping, public seating, and trash cans. The pedestrian crash rates and context sensitivity ratings were then divided into thirds, representing low, medium, and high values. Intersections were chosen from the low and high areas in order to provide maximum possible differentiation between the locations.

Figure 1 shows the eight locations where surveys were conducted along the corridor. In one case, the survey team experienced harassment at the site and therefore moved to another site similar in design and crash rate. Data from the two sites were combined and analyzed as one.

FIGURE 1 Survey Locations along San Pablo Avenue.



Map credit: Google© Maps

Table 1 presents data for the various survey sites. In order to obtain enough responses to facilitate analysis, the survey sites encompassed two blocks on either side of the selected intersection. Asking respondents about survey areas, rather than just single intersections, was also thought to better reflect how contiguous intersections and segments interact to influence people traveling along the corridor. In one case (54^{th}-59^{th}), a mostly residential area where the average block size was short and several intersections were offset, the survey area was extended two more blocks on each side to increase the number of respondents. Table 1 presents the average and standard deviation of data from the individual intersections in each survey area.

Table 1 also shows traffic injury data from 2003-2007, the most recent years for which data was available when this survey was conducted. This data is from the California Statewide Integrated Traffic Records System (SWITRS). No pedestrian or bicyclist fatalities—and only three motor vehicle fatalities—were reported in the project's eight survey areas during this time period. Injuries for motor vehicle occupants were closely correlated with volume; this was less clear for pedestrians and bicyclists due to a lack of verifiable volume data for those two modes.

Weekly pedestrian crossings for these locations were estimated using a model by Schneider et al., developed for the East San Francisco Bay Area *(24)*. Average annual daily traffic was obtained through the Caltrans Traffic Accident Surveillance and Analysis (TASAS) system. Speed data was gathered through the researchers' observations of at least 100 vehicles in free-flow traffic at an intersection in the middle of each survey area.

It should be noted that all survey areas had 100% bi-directional sidewalk coverage that was at least five feet in width. The roadway carried motorized traffic in two lanes in both directions, and all survey areas but Castro-Kains and Solano-Castro had raised, landscaped medians measuring approximately 10 feet. There was also parallel, on-street parking the length of each survey area, but there were no on-road bicycle facilities.

TABLE 1 Pedestrian, Driver, and Bicyclist Injury, Volume, and Speed Information for San Pablo Avenue Survey Areas

	Stockton-Fresno	Castro -Kains	Solano-Castro	Gilman-Cedar	Ashby-Haskell	54th-59th	40th-45th	65th-Alcatraz
Segment length in miles (km)	0.1 (0.16)	0.3 (0.48)	0.3 (0.48)	0.4 (0.64)	0.1 (0.16)	0.4 (0.64)	0.3 (0.48)	0.1 (0.16)
# intersections on west side of street	2	2	5	5	3	4	3	3
% of signalized intersections in area	33%	40%	40%	40%	20%	11%	40%	50%
Average ped injuries[1] (std dev)	0 (1)	1 (2)	1 (3)	1 (1)	1 (1)	0 (0)	1 (1)	1 (1)
Average bike injuries[1] (std dev)	0 (0)	0 (0)	1 (1)	2 (2)	1 (1)	0 (0)	1 (1)	0 (1)
Average motor vehicle injuries[1] (std dev)	1 (2)	6 (7)	5[f] (6)	10 (7)	9[f] (14)	0[f] (0)	5 (4)	3 (3)
Average weekly ped crossings[2] (std dev)	7,590 (146)	9,354 (841)	10,533 (820)	6,189 (185)	5,875 (294)	8,466 (119)	10,322 (217)	7,576 (230)
Average AADT[3] (std dev)	28,765 (31)	28,583 (932)	28,850 (335)	27,990 (422)	26,685 (391)	26,518 (3,720)	30,397 (425)	24,407 (277)
*Average speed (std dev) in mph [kph]	29 (4) [47 (6)]	26 (4) [42 (6)]	27 (4) [43 (6)]	29 (4) [47 (6)]	29 (4) [47 (6)]	27 (5) [43 (8)]	27 (4) [43 (6)]	25 (4) [40 (6)]
85th % speed in mph [kph]	33 [53]	32 [52]	31 [50]	33 [53]	32 [52]	32 [52]	31 [50]	28 [45]

*The posted speed limit is 25 mph along the corridor
[1]California Statewide Integrated Traffic Records System (SWITRS), 2003-2007
[f] Indicates one fatality in the survey area during the time period 2003-2007.
[2] Estimated using Schneider, et al., (2009) pedestrian volume model
[3]Caltrans Traffic Accident Surveillance and Analysis (TASAS) data

FINDINGS AND DISCUSSION

Survey Population

This section describes the basic data from the survey, including socio-demographic data, overall trip purpose, travel mode, and visit frequency.

Sociodemographic Characteristics

Table 2 shows how the demographic data for the respondent population compare to the data for the surrounding Census tracts and counties. The data show that the survey population is slightly younger, more male, more educated, and less racially and ethnically diverse than would be expected given the data of the surrounding Census tracts and larger region. This may bias the survey findings, although more research would be necessary to understand the extent of the bias.

Note that the transportation data from the Census likely underrepresents the percentage of people who walk or bicycle for trips other than the commute. In addition, this information is not comparable to the arrival mode of the survey respondents, as a large portion of the respondents were not commuting while intercepted. This data is included to give more information about the survey areas in the absence of more detailed travel information.

TABLE 2 Survey Area Characteristics at the Census-Tract Level

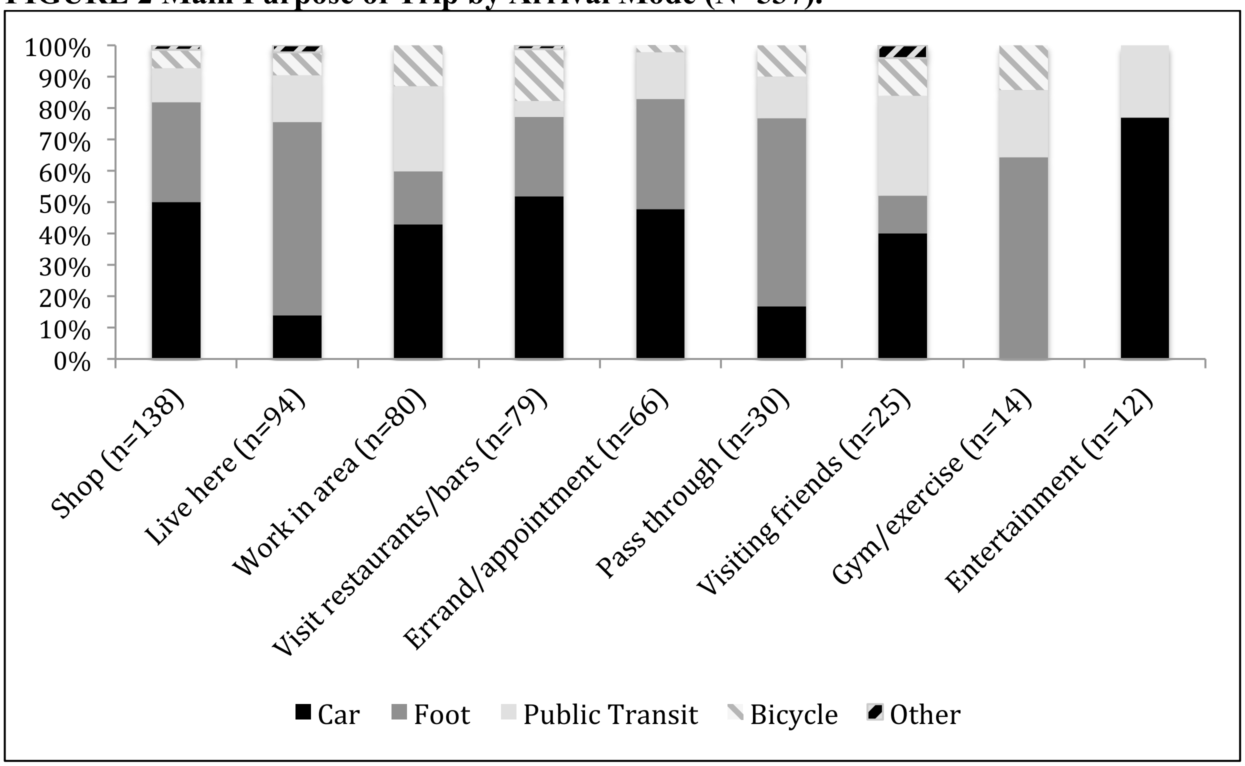
	Survey Sample Population (N=537)	**Survey Area Population** (N=21,074)	**Survey Region Population** (N=2,502,789)
Age[1]	**%**	**%**	**%**
18-24	14	10	12
25-34	23	24	18
35-44	17	18	20
45-54	17	18	20
55-70	22	19	19
70+	5	10	11
Sex[2]			
Male	57	49	49
Female	43	51	51
Race/Ethnicity[2]			
Caucasian or White	51	49	53
*Hispanic	6	13	23
African American or Black	29	21	11
Asian	9	22	21
Native American or Alaska Native	0	0	0
Other	5	3	10
Education[3]			
Less than high school	3	10	13
High school graduate	16	17	21
Some college	24	25	30
College degree or higher	55	49	36
Commute Mode[4]			
Car, truck, or van	-	63	79
Public transportation	-	20	10
Bicycle	-	4	1
Walked	-	6	3
Motorcycle, taxi, other	-	1	1
Arrival Mode to Survey Area			
Car, truck, or van	39	-	-
Public transportation	16	-	-
Bicycle	9	-	-
Walked	35	-	-
Motorcycle, taxi, other	0	-	-

1 American Community Survey 2006-2010 5-year Estimates, S0101 Age and Sex
2 ACS 2006-2010 5-year Estimates, DP05 ACS Demographic and Housing
3 ACS 2006-2010 5-year Estimates, S1501 Educational Attainment
4 ACS 2006-2010 5-year Estimates, B08006 Sex of Workers by Means of Transportation to Work
*Hispanic counted separately from other races in Census, so totals add up to more than 100%.

Trip Characteristics
The survey asked several questions to learn about respondents' trip characteristics, including their mode of arrival, trip purpose, and how often they visit the corridor.

Arrival Mode
The majority of respondents arrived at the survey areas by car (39% of respondents) or by foot (35%). Public transit users comprised another 16% of the survey sample, while 9% of respondents were bicyclists. The mode of arrival was significantly related ($p \leq 0.001$) to the main purpose of one's visit and the respondents' age, as might be expected given the trip purposes shown in Figure 2.

FIGURE 2 Main Purpose of Trip by Arrival Mode (N=537).



Typical Trip Purpose
Respondents were then asked about their typical activities when visiting San Pablo Avenue. Shopping and eating were the clear dominant activities, with 61% of respondents citing them as typical. Excluding respondents who live in the area and cited that as their primary trip purpose, nearly 50% of respondents intended to shop and/or eat on the survey days.

Frequency of Visits
When asked how often they visit the survey area, 56% of respondents stated that they visit "all the time", while another 18% visit "fairly often." This suggests that the respondents have experience and familiarity with the area. When frequency of visit is examined within each mode, the data show that pedestrians visit most often, with 72% reporting that they visit "all the time," compared to 42% for drivers, 49% for bicyclists, and 57% for transit users.

Perceived Traffic Safety on San Pablo Avenue
The survey participants were then questioned about their perceptions of traffic safety along the corridor. In particular, participants were asked a series of questions about how safe they feel while walking and bicycling on and across San Pablo Avenue. Table 3 shows that respondents generally feel much safer walking than bicycling along San Pablo Avenue. Only 6% of respondents reported feeling unsafe while walking along the street, while about 25% reported feeling unsafe while crossing the street. In contrast, over 50% of respondents answered "not applicable" to the question about bicycling. While this half likely includes many respondents with no desire to ride a bicycle, it may also include people who would like to bicycle but do not consider it because of perceived danger on San Pablo Avenue. Of those who did answer the questions about bicycling, 40% felt unsafe biking across the street, and nearly 60% felt unsafe bicycling along San Pablo Avenue.

TABLE 3 Perceptions of Traffic Safety while Walking and Bicycling on San Pablo Avenue (N=537)

How safe do you feel from traffic…[1]	Very safe	Somewhat safe	Neutral	Somewhat unsafe	Very unsafe	N/A[2] or Don't know
Walking across the street	28%	20%	25%	15%	10%	2%
Walking on the sidewalk	57%	25%	10%	4%	2%	2%
Bicycling across the street	7%	8%	12%	10%	8%	**52%**
Bicycling on the roadway	4%	5%	9%	12%	15%	**53%**

[1]The entire question was worded, "When you're walking or riding your bike along this section of San Pablo Avenue, how safe do you feel from traffic…"
[2]Some respondents answered "not applicable" when asked this question, suggesting that they do not walk (a handful of respondents) or bicycle (over half of the sample) along or across San Pablo Avenue.

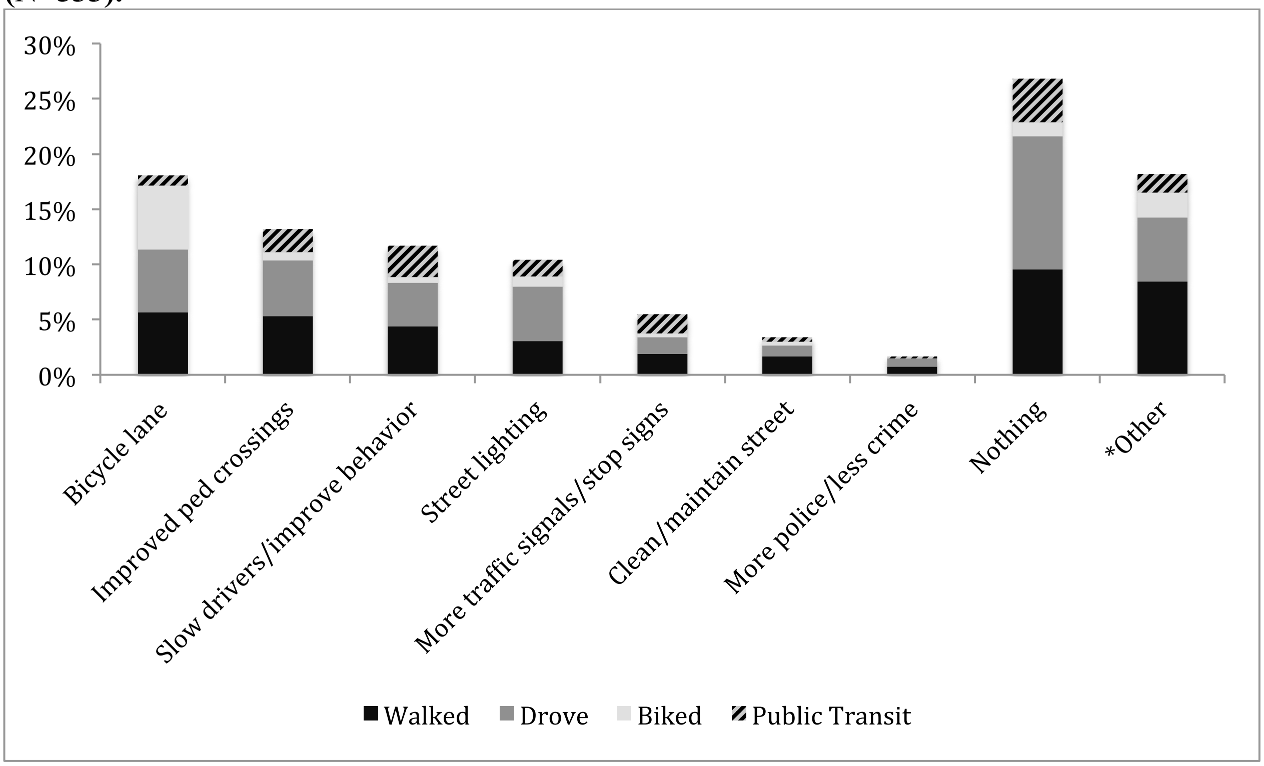
Perceived safety while walking or bicycling was not significantly related to survey area, although there were clearly some areas where respondents felt safer than others. which was not particularly surprising given the near uniformity of the roadway design between areas. Perceived safety was also not significantly related to arrival mode.

Street Improvements that Would Increase Perceived Traffic Safety
Respondents were then asked to name the various types of street improvements they thought would improve traffic safety. The question was open-response, so respondents could name as many things as they wanted, and many respondents named more than one street improvement.

As Figure 3 shows, there was clear alignment between user groups in terms of the most requested street improvements, and the alignment persisted between survey areas. Among those who suggested improvements, a bicycle lane was the most requested improvement, followed by elements that could improve pedestrian crossings, such as lighted crosswalks and longer crossing times.

The responses to this question were not significantly related to the survey area, except in the case of bicycle lanes ($p \leq 0.05$). Whether someone requested a bicycle lane or improved pedestrian crossings was also significantly related to arrival mode ($p \leq 0.000$ and $p \leq 0.05$, respectively). Whether someone requested increased traffic signals or stop signs was significantly related to visit frequency ($p \leq 0.01$), with those visiting the most often requesting this improvement.

FIGURE 3 Street Improvements Requested to Increase Perceived Traffic Safety, by Mode (N=533).



* "Other" includes 14 requested improvements, such as traffic signal timing, landscaping, larger parking spaces, and dedicated turn signals. Each suggestion in the "other" category was requested by less than 2% of the sample.

Table 4 shows how each user group ranked the five most-requested improvements, as well as the percentage of the group requesting "nothing."

TABLE 4 Respondents' Top Five Street Improvements to Increase Perceived Traffic Safety, by Mode

	All Users (N=531)	Pedestrian (n=190)	Driver (n=208)	Bicyclist (n=49)	Transit User (n=84)
Improvement	% of responses	%	%	%	%
1. Bike Lane	18	16	14	63	6
2. Improve Pedestrian Crossings	14	15	13	8	13
3. Slow traffic/ Improve Driver Behavior	11	12	10	6	18
4. Street lighting	9	5	13	10	10
5. More traffic signals and stop signs*	5	8	4	4	11
- Nothing	28	27	31	14	25

* Note that the survey respondents themselves combined traffic signals and stop signs and/or indicated a desire for more stops along the corridor. When users wanted other features typically associated with traffic signals, such as turn arrows or timed signals, these were classified differently.

The overall preference order was the same when weighted by individual response and mode. It is impossible to precisely interpret these results without further research. However, findings from other studies may give some clues as to the reasons some users requested street improvements not typically deemed as benefiting them (such as drivers requesting bicycle lanes and improved pedestrian crossings). First, these complementary preferences may reflect the benefits of various roadway design features to users other than the primary group for whom they are intended. For example, that pedestrians, drivers, and bicyclists all requested a bicycle lane in high numbers to improve traffic safety may reflect the fact that some pedestrians and drivers bicycle at other times and would therefore appreciate a bicycle lane. However, it may also reflect benefits to the pedestrians and drivers from having a bicycle lane for bicycle traffic. Evidence of this is found in a recent survey of Bay Area drivers, who overwhelmingly agreed that bicycle lanes "make bicyclists more predictable" and "give bicyclists their own space"*(25)*. Bicycle lanes may also encourage more bicyclists to ride on the roadway instead of the sidewalk, thus improving pedestrian comfort and safety on the sidewalk.

Improved pedestrian crossings may also benefit multiple user groups—not just by increasing the predictability and visibility of people when they cross as pedestrians, but also by providing more awareness to the drivers and bicyclists who may conflict with crossing pedestrians. Street lighting may similarly benefit all user groups by increasing visibility. Slowing traffic/improving driver behavior and adding traffic signals/stop signs may also reflect synergistic benefits from increased predictability through mandated stops and better behavior from roadway users. Additional research into this topic could help clarify these findings.

Limitations

These findings are subject to a few limitations, which also apply to the other findings described in this article. First, 27% of respondents said that "nothing" could improve perceived traffic safety. This can be partially explained by the fact that 60% of those who answered "nothing" already feel "very safe" walking along and across San Pablo Avenue, while no respondent who felt "very unsafe" walking answered "nothing." However, this logic applies less clearly to bicycling safety: 12% of those who felt "very safe" bicycling answered "nothing"—but so did 35% of those who felt "very unsafe" bicycling. In the latter case, it may be that those respondents perceive the situation to be so bad that "nothing" could help it, but this cannot be assumed. What is clear is that nearly three-fourths of these street users think traffic safety could be improved. In the case of bicyclists, 86% requested traffic safety improvements. This strongly suggests that perceived traffic safety is an important subject area to be addressed in the future.

The second limitation is that all survey respondents were intercepted on foot or bicycle, regardless of their mode of arrival to the corridor. Their answers may therefore have reflected their preferences as a pedestrian more than their preferences as a driver or transit user. Likewise, pedestrians may have different preferences for street design when traveling via other modes. There is no way to measure those possible differences from this data, although it is worth noting that the answers of the other roadway user groups do not exactly mirror (and in some cases diverge from) those of the pedestrian group, suggesting that they did not think solely as a pedestrian when answering the questions. Third, while intercept surveys tend to have a high response rate, they are also by nature short in order to improve the odds that the respondent completes the survey. This necessarily limits the terms of the number of questions it can ask.

A fourth, but related, limitation is that this survey explores roadway design preferences of traffic that has stopped at some point along this corridor. While traffic safety design preferences are not generally significantly related to visit frequency, it cannot be said that this data represents the preferences of people who use this corridor solely for traveling through these locations. Future research should investigate the preferences of this user group, such as through a survey mailed to local households. While an important limitation, the magnitude of this concern is mitigated by this study's focus on improving pedestrian and bicyclist safety and mobility. Data about walking and bicycling trip characteristics indicate that it is highly unlikely that very many, if any, pedestrians and bicyclists would traverse the 9.5 miles (15.3 km) without stopping.

Finally, the open-response questions such as the one about traffic safety improvements did not give users a choice set from which to select responses. While this has the benefit of not leading the respondent to a certain answer, it has two main disadvantages. First, all users may not have the same knowledge or ideas about what street improvements are possible. Second, and relatedly, without a choice set, respondents may not know what is possible beyond their general familiarity. For example, roadways with high amounts of fast-moving traffic like San Pablo Avenue would be designed with physically-separated bicycle lanes (i.e., cycle-tracks) in cities like Copenhagen or Paris. However, these treatments are rarely used in the United States and therefore likely unfamiliar to most of the respondents to this survey. Future research should examine the difference in responses along a corridor with a variety of bicycle treatments.

Street Improvements that Would Encourage More Visits

Respondents were also asked to name the various street improvements that could encourage them to visit the area more frequently. Table 5 demonstrates that, similar to preferences for traffic safety, there was alignment between the modal groups for the most requested street improvements to encourage more visits. In this case, however, there is more differentiation between user group preference, as well as a greater variety of suggested improvements overall. The "other" category for this question included 20 suggestions, such as reducing crime, slowing traffic, and increasing seating—all of which were requested by less than 3% of the sample.

Responses to this question were significantly correlated with arrival mode in the case of trees/landscaping and art/beautification ($p \leq 0.10$), and bicycle lanes ($p \leq 0.001$). Responses of bike lanes and art/beautification were significantly related to survey area ($p \leq 0.01$ and $p \leq 0.10$, respectively). Visit frequency was significantly related to requesting more retail/food/ entertainment options ($p \leq 0.001$) and bike lanes ($p \leq 0.05$). Improvements not under a department of transportation's purview, such as increasing shops and restaurants, were left in to allow comparability between users' overall priorities, and to show the complexity of creating attractive environments.

Note that nearly 3 times as many people requested bicycle lanes to improve traffic safety as to encourage more visits (96 respondents versus 35, respectively). This further supports a hypothesis that bicycle lanes may have previously unrecognized traffic safety benefits for users other than bicyclists.

TABLE 5 Respondents' Top Five Street Improvements to Encourage More Frequent Visits, by Arrival Mode

	All Users (N=531)	**Pedestrian (n=190)**	**Driver (n=208)**	**Bicyclist (n=49)**	**Transit User (n=84)**
Improvement	% of Responses	%	%	%	%
1. Trees & landscaping	15	22	11	12	11
2. Retail, food, entertainment	13	15	11	20	8
3. Clean area/more trash cans	8	8	6	8	14
4. Street lighting	8	11	6	4	8
5. Bike lane*	7	4	8	20	2
5. Art/beautification*	7	8	6	10	4
- Nothing	43	61	37	24	27

*Tied for fifth most-requested improvement.

Limitations

These findings are subject to the same limitations described above. In this case, the "nothing" answers may be partially explained by the fact that 34% of those who answered "nothing" already visit the area "fairly often" or "all the time", and could therefore not visit more. Another 29% "rarely" visit the area and may have no plans to visit more. The difference between mode groups is again notable: a majority of pedestrians say that "nothing" will make them visit more, but still less than 25% of bicyclists and only 27% of public transit users answered that "nothing" could be done.

CONCLUSIONS

This research provides evidence that road users who stop at some point along a multi-use corridor—including pedestrians, bicyclists, transit riders, and drivers—want similar things to improve traffic safety and encourage visits. In terms of traffic safety, all modes of San Pablo Avenue roadway users generally agreed about the desirability of bicycle lanes and improved pedestrian crossings, while landscaping and street trees, street lighting, and area cleanliness were preferred by all user groups to encourage more visits to the area. These findings strongly suggest that a “complete streets” approach—in contrast to more traditional, siloed planning—may provide opportunities to create an urban street environment that is pleasing to all users. Additionally, priorities for throughput, walkability, bikability, economic activity, etc. may be more compatible than traditionally thought.

These findings are based on a survey of one corridor, and more research needs to be done to further explore preferences for roadway design and how they may change depending on one’s mode or trip purpose. Future research should also involve different geographies, particularly those with harsh summer or winter weather, to mitigate the potential influence of the study region on the findings. However, the findings presented in this paper are potentially applicable to any place with multi-modal traffic, particularly where issues of sharing right-of-way exist in a similar manner to San Pablo Avenue. Based on these findings, transportation officials may have opportunities to broadly benefit users and communities while focusing limited resources on a few select design elements. Because of the potential synergistic benefits of certain roadway features, roadway design does not have to be a zero-sum game.

One purpose of this survey was to understand how to contribute to greater economic vitality of Caltrans’ partner communities. It is clear from these survey results that the factors that ultimately encourage economic vitality are many and complex. The survey respondents indicated that, although the destinations (i.e., opportunities to shop, dine, and run errands) are crucial to encouraging visits, design elements such as landscaping do have a role to play in further encouraging visits to an area.

Transportation agencies throughout the U.S. face the complicated tasks of decreasing congestion and greenhouse gas emissions, increasing road user safety and active transportation, and staying within budget. In addition, they are often expected to partner with communities to bring economic vitality through transportation improvements. Traditionally, these goals have been prioritized and addressed through distinct design elements. However, the findings from this survey suggest that there are roadway elements that have the potential to meet multiple goals for multiple user groups. This research suggests that more synergistic roadway design considerations—particularly designs fitting with complete streets principles—will offer transportation agencies an opportunity to simultaneously work toward multiple goals at lower costs to become better partners to the communities they serve.

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