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The Impact of Individual Perception on the Utilization of a Recreational Urban Trail

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Abstract Recreational opportunities are associated with increased physical activity if they are conveniently located and feature adequate amenities. A pilot study on an urban trail in Austin, Texas revealed that 40% of the popular trail was underutilized despite adequate access and amenities over the entire length of the trail. The purpose of this study was to expand this research to identify the perceptions that are causing users to avoid the underutilized sections. An online survey measured user perception of 11 trail characteristics and a trail user count sought to replicate earlier findings and supplement the online survey data. Results showed that perception of safety, trail continuity, and route flexibility impacted trail utilization.

Keywords: *urban trail, recreation, physical activity, perception, built environment*

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1. Introduction

Physical activity (PA) is an important aspect of population health and has been shown to reduce mortality rates by improving cardiovascular health, reducing the risk of high blood pressure, improving mental health, and preventing weight gain [1]. However, according to the Behavioral Risk Factor Surveillance System (BRFSS), 50.6% of U.S. adults met the target of 150 minutes of aerobic physical activity per week in 2017. There is an abundance of research to explain why people adhere or not adhere to health guidelines. Some of the individual differences include socio-demographics, attitudes and beliefs, self-efficacy, and motivation [2,3,4]. For example, educational attainment is associated with meeting physical activity guidelines as adults with a college degree are more likely than those with less education to achieve 150 minutes of aerobic activity per week [1]. Income is also associated with physical activity levels. Adults who earn $75,000 per year are more likely to meet PA guidelines than those earning $50,000-$74,999, and those in this latter income bracket are more likely to meet the guidelines compared with those who earn less than $50,000 annually [1].

The Social Cognitive Theory (SCT), which addresses some of the individual differences stated above, also stresses the environment as a key player in predicting human behavior [2]. The fundamental concept of the Social Cognitive Theory (SCT) is *reciprocal determinism* which states that human behavior is the result of an interplay between the individual, the environment, and the behavior [2,5]. There is a growing body of evidence that suggests that features of the environment can discourage or promote physical activity [6,7,8,9]. This includes the design of cities, neighborhoods, recreational facilities, transportation systems, and the social interactions that take place therein [10]. Thus, the environmental factors that influence PA include both social and physical determinants.

Research on the social environment often focuses on the impact of social networks and social support on health behaviors [2,11,12] but also important is the concept of *social capital* and its impact on population health [13]. Social capital is defined as “information sharing that occurs between residents of a community, the mutual aid that they provide each other, and their ability to act collectively” [14]. One way to improve social capital is to provide opportunities for recreation in a community [15]. For example, urban trails offer spaces for people to meet and socialize with others and can build pride among communities [16]. Urban trails are described in the United States as the new “front porches of many communities” [17]. A possible explanation for how recreation can improve the social environment is the phenomenon that occurs when people vicariously experience the positive health behavior of others which increases the observer’s self-efficacy for initiating the desired behavior [2].

Urban trails also provide communities with walking, running, and biking opportunities and are associated with higher rates of individuals meeting recommended physical activity guidelines [18,19,20]. Recent studies of urban trails show that exercise, relaxation, and access to green space are some of the reasons people seek trails for recreation [21]. However, less is known about how perceptions of trail characteristics might impact trail utilization. While existing research addresses this question by comparing different trails [22], there also appears to be a high degree of variability in how different sections of a single trail are utilized which also warrants investigation.

The urban trail of interest in this study is a recreational resource for the community of Austin, Texas and is utilized by walkers, runners, and cyclists. Lady Bird Lake runs through the city center of Austin and is surrounded by a popular 10-mile trail. Previous research on this trail found that 88% of trail users stay on the western section of the trail [23] leaving 40% of the 10-mile trail under-utilized. This is surprising, as this under-utilized portion of the trail sits in the central section of the city, with high residential population density and easy access points across its length. Thus, the most common predictors of recreational use - proximity and access [24,25,26,27] - do not appear to predict usage.

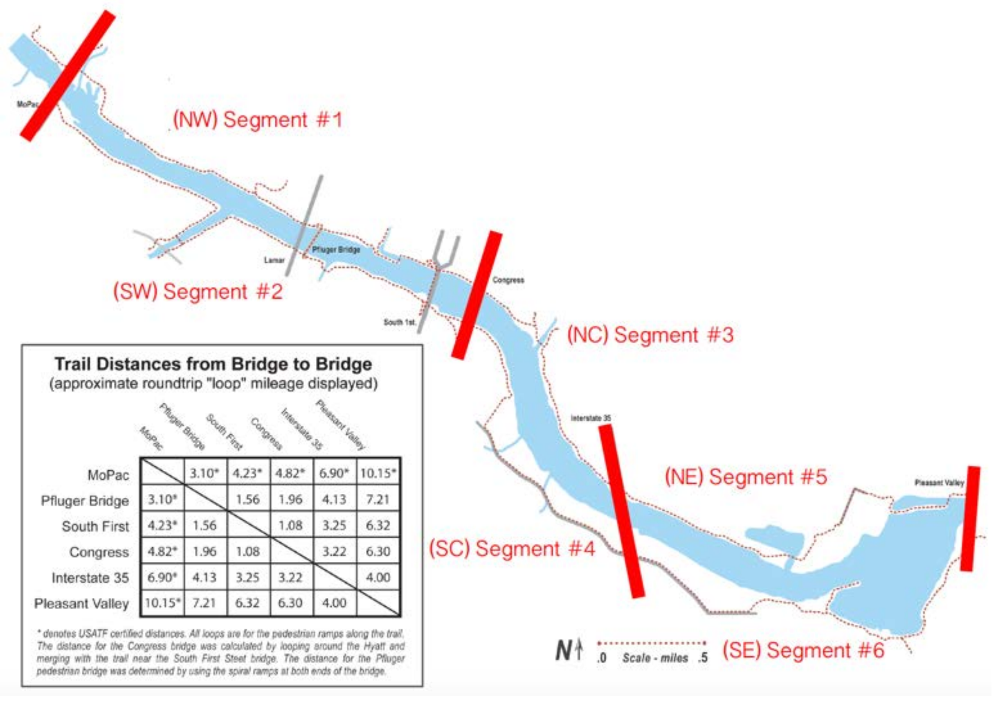
Interstate 35 in Austin has historically represented a cultural and socioeconomic divide with ethnic minorities and low-income families residing east of the highway [28]. Contrary to research that suggests lower income neighborhoods lack access to recreational resources [29] this trail offers ample access along the entire 10-mile loop regardless of the socio-economic status of neighborhoods adjacent to the trail. It is possible that the lower income neighborhoods adjacent to the eastern section of the trail may be affecting usage since those who earn less income tend to exercise less [1]. However, this doesn't explain why regular users are choosing to access the trail in other neighborhoods, particularly since prior research on this trail shows that 60% of trail users drive to the trail rather than walk or ride bicycles [23]. Thus, the majority of users are driving to the trail and choosing to access it west of the I35 highway. Despite 15 access points spread out across the entire 10-mile trail, over 75% of all users enter at one of four locations, all of which are west of Interstate 35. It was not the aim of the previous study to explain the differences in utilization. In response, this study was designed to replicate the trail count and supplement these data with user perceptions of trail characteristics. It is important to understand why trail users are avoiding certain sections of the trail in order to better understand trail use in general. In order for urban trails to positively impact the physical activity of all populations, all sections of the trail need to be perceived as traversable without barriers [30].

The purpose of this study is to examine utilization across different segments of an urban trail, and to identify perceptions of trail characteristics that contribute to utilization differences, including: safety, parking, trail continuity, clarity of trail direction, litter, bathroom & drinking water availability, shade, exposure to vehicular traffic, ability to make a loop of desired distance, and crowding. Identifying individual perceptions of these trail characteristics can guide local efforts to maximize use of existing trails and provide direction for future trail development.

2. Methods

2.1. Setting & Participants

The urban trail examined in this study is a recreational resource for the community of Austin, Texas and is utilized by walkers, runners, and cyclists. The *Ann & Roy Butler Trail* is a crushed granite path that travels a 10-mile loop around Lady Bird Lake, which is located in the city center. The trail is easily subdivided into routes of varying distances via bridges. Six segments were chosen for evaluation: northwest (NW), north central (NC), northeast (NE), southwest (SW), south central (SC), and southeast (SE). The dividing lines between the West, Central, and East zones were chosen based on a pilot study previously conducted to determine trail usage [23]. Figure 1 illustrates a map of study segments.



	MoPac	Pfluger Bridge	South First	Congress	Interstate 35	Pleasant Valley
MoPac		3.10*	4.23*	4.82*	6.90*	10.15*
Pfluger Bridge	3.10*		1.56	1.96	4.13	7.21
South First	4.23*	1.56		1.08	3.25	6.32
Congress	4.82*	1.96	1.08		3.22	6.30
Interstate 35	6.90*	4.13	3.25	3.22		4.00
Pleasant Valley	10.15*	7.21	6.32	6.30	4.00	

** denotes USATF certified distances. All loops are for the pedestrian ramps along the trail. The distance for the Congress bridge was calculated by looping around the Hyatt and merging with the trail near the South First Steet bridge. The distance for the Pfluger pedestrian bridge was determined by using the spiral ramps at both ends of the bridge.*

Figure 1. 10-mile trail divided into 6 segments

2.1.1. Trail User Count

Trained volunteers observed trail users on six segments of the trail on a Saturday morning in May from 9:00-11:00am.

2.1.2. Online Survey

Two different methods were used to recruit trail users to participate in an online survey. The first method briefly intercepted trail users to offer a small card that directed users to an online survey. A QR code was printed on the card to encourage timely response through use of a handheld device. Trail users were recruited while at rest on the trail, such as water stations or access points. The cards were distributed during the week and weekend during peak hours. The second recruitment method utilized an email newsletter produced by a local non-profit trail advocacy organization. A link to the survey was listed in the free monthly newsletter.

2.2. Measures

2.2.1. Trail Count

An observer trail count was conducted on all six segments of the trail to seek replication of earlier findings that revealed a disparity in usage across different segments of the trail [23]. Volunteer observers were trained on proper tally count procedures similar to the protocol established by the National Bicycle & Pedestrian Documentation Project [31]. Trail users were counted in 15-minute intervals for a 2-hr period.

2.2.2. Online Survey

A 44-item online survey was developed from an extensive literature review and served four purposes: (1) to collect general preferences for trail characteristics, (2) to collect subjective ratings of trail characteristics on six different segments of the trail, (3) to collect individual patterns of trail use, and (4) to obtain demographic information. General preferences for trail characteristics were collected through the survey question: *"How much do the following characteristics influence your choice of route?"* A 6-point Likert-scale (1- "strongly disagree, 2- "moderately disagree", 3- "mildly disagree", 4- "mildly agree", 5- "moderately agree", 6- "strongly agree") was used to measure perceived importance of safety, ability to make a loop, preference to be around people, access to parking, trail direction clearly marked, limited exposure to traffic, continuous path (unbroken route - no need to use urban streets or sidewalks), and access to amenities such as drinking water and bathrooms.

Individual ratings of characteristics on the Ann & Roy Butler trail were collected by having participants examine and rate six segments on a map, each representing a different section of the 10-mile trail. A 6-point Likert-scale (1- "strongly disagree, 2- "moderately disagree", 3- "mildly disagree", 4- "mildly agree", 5- "moderately agree", 6- "strongly agree") was used to measure subjective ratings of 11 characteristics: (1) safety, (2) ease of parking, (3) crowding, (4) ability to complete a loop, (5) trail continuity, (6) trail direction clarity, (7) adequate drinking water, (8) shade, (9) bathroom availability, (10) litter, and (11) exposure to cars and noise. This was repeated for each of the six segments. Patterns of trail utilization were obtained through survey questions that focused on mode of travel to trail, distance traveled to access trail, most common access point, mode of recreational activity on trail, most common route on trail, and route type (loop, out & back, one-way & exit).

2.3. Analysis

2.3.1. Trail Count

Results from the trail count were compared to self-reported data collected in the online survey to verify similar patterns of usage.

2.3.2. Online Survey

Descriptive statistics were used to analyze patterns of use and demographics. Survey responses suggested that participants should be divided into two groups of users for comparison (high-traffic west users, low-traffic east users) based on the trail route they reported as traveling most often. An ANOVA was conducted to determine if there were differences in trail characteristic preferences between high-traffic west users and low-traffic east users. A multivariate analysis of variance was performed to determine the effect of group (High usage, Low usage) on all ratings of the two segments chosen for comparison (NW, NE). This was followed by a 2x2 mixed design ANOVA with one between- subjects factor and one within-subjects factor. A simple effects analysis was conducted for each of the significant interaction effects to identify where the differences occurred. Greenhouse-Geisser correction was used for violations of sphericity.

3. Results

Table 1 shows the demographic differences between high-traffic west users and low-traffic east users that were self-reported on the online survey.

3.1. Trail Count

Table 2 shows the results of the trail count. Weather conditions during the count varied from mostly cloudy and 73 degrees to mostly sunny and 84 degrees. Five thousand eight hundred and twenty-one (n=5,821) adults (44% male) were counted between 9:00-11:00am. The busiest 15-minute block was 10:00-10:15am with 786 people observed on the trail across all segments. The NW and SW segments had the highest number of people between 10:00-10:15am with 665 users combined. The highest number of people (n=5,493) were observed on the Western sections of trail which represents 95% of users during the 2-hour trail count. The lowest number of people (n=327) were observed on the Eastern sections of trail which represents 5% of users during the 2-hour trail count. Mode of activity was 94% walking or running and 6% cycling. Forty-eight percent (48%) of trail users were traveling alone.

Table 1. Demographic Characteristics for West Users (high-traffic) and East Users (low-traffic)

Characteristic	West Users	East Users	All Users
Sex			
Male	42%	57%	46%
Female	58%	43%	54%
Race			
White	95%	97%	95%
Black/African American	0%	0%	.05%
Asian	4%	0%	3%
Native Hawaiian	0%	0%	1%
American Indian	1%	3%	.05%
Hispanic			
Hispanic	8%	17%	10%
Non-Hispanic	92%	83%	90%
Age			
Mean	44	43	44
Median	44	40	44
Mode	42	35	39
Annual household income			
< $30,000	3%	22%	7%
$31,000 - $70,000	26%	19%	25%
$71,000 - $100,000	13%	15%	14%
> $100,000	57%	44%	54%
Education			
Some high school	0%	0%	0%
Completed high school	1%	0%	.05%
Some college/vocational	4%	10%	5%
Completed college degree	46%	38%	43%
Some graduate school	10%	17%	10%
Completed graduate degree	39%	35%	41%
Resident			
< 2 years	4%	13%	5%
2-4 years	9%	17%	10%
5-9 years	14%	17%	15%
> 10 years	73%	53%	70%

Table 2. Saturday Trail Count Results

	NW	SW	NC	SC	NE	SE	Total
9:00am	262	288	87	39	23	23	722
9:15am	278	292	64	38	20	15	707
9:30am	275	274	52	45	29	17	692
9:45am	310	299	50	54	26	29	768
10:00am	328	337	63	34	14	10	786
10:15am	313	317	54	23	22	26	755
10:30am	265	300	87	44	24	19	739
10:45am	241	302	40	39	13	17	652
Total	2,272	2,408	497	316	171	156	5,821

3.3. Online Survey

Two hundred and fifty-eight (n=258) adults (aged 20-73, 46% male) participated in the online survey. Response rate was 16% for participants who were recruited on the trail. Response rate for the online survey via *The Trail Foundation* newsletter is approximate. Each month the newsletter is sent to approximately 7,000 subscribers and roughly 2,000 people open the newsletter. Of these, 204 participants completed the on-line survey, which is approximately 10% of the people contacted. The trail count and survey results show similar patterns of usage. Seventy-four percent (74%) of trail users reported their primary route as being in western sections, with 11% using the central sections and 15% using the eastern sections. Based on these responses, and given the interest in examining strong differences in utilization, participants were divided into those who primarily used the western (n=163) sections and those who primarily used the eastern (n=33) sections of the trail. Participants who reported the central sections as their most common route (n=25) were removed from the segment rating analysis in order to focus on users who mainly use the high-traffic (NW) and low-traffic (NE) sections. Because the usage drops from 80% to 14% at the west/central boundary, removing these "in-between" users helped separate west and east users more distinctly.

Survey respondents reported their primary mode of recreation on the trail as running (68%), walking (27%), and cycling (5%). These results mirror the trail count results, suggesting that this online sample was representative of typical users on the trail. The survey provided a wider array of information than was observable during the pedestrian trail count. Specifically, 95% of participants reported using the trail for recreational purposes while 5% reported utilitarian /commuting purposes. The types of routes users chose included loops (85%) and out-and-back (15%). Users reported mode of transportation to the trail to include automobiles (66%), walking or running (28%), and bicycling (6%). Trail users originated their trip to the trail from home (80%) and work (20%). Distance traveled to access trail from home showed some traveling more than 5 miles (32%), others 2-5 miles (36%), or less than two miles (32%). Only 9% of trail users travel less than .25 miles from home to access the trail. Distance traveled to access the trail from work showed that most (55%) traveled less than two miles. Of these, 24% travel less than .25 miles to access the trail from work. The other most common patterns were those traveling more than 5 miles (24%) and those traveling 2-5 miles (21%). A descriptive comparison of the trail count and online survey results are presented in Table 3.

Table 3. Comparison of Trail Count and Online Survey Results

Sex	Trail Count	Online Survey
Male	44%	46%
Female	56%	54%
Activity		
Walkers/Runners	94%	95%
Bicyclists	6%	5%
Segment usage		
West	95%	85%
East	5%	15%

3.4. General Preferences for Trail Characteristics

General trail preference ratings were attained through the survey question *"How much do the following characteristics influence your choice of route?"* A 6-point Likert-scale (1- "strongly disagree, 2- "moderately disagree", 3- "mildly disagree", 4- "mildly agree", 5- "moderately agree", 6- "strongly agree") was used to rate preferences for personal safety, ability to make a loop, preference to be around people, access to parking, trail direction clearly marked, limited exposure to traffic, continuous path (unbroken route - no need to use urban streets or sidewalks), and access to amenities such as drinking water and bathrooms. Figure 2 and Figure 3 show the preference ratings of high-traffic west and low-traffic east users, respectively.

A one-way ANOVA determined if there were differences in preference ratings between high-traffic west users and low-traffic east users. Significant differences were found for the preference *to be around less people*, $F(1,183) = 12.93$, $p < .05$, the preference for *trail direction to be clearly marked* $F(1,180) = 12.96$ $p < .05$, the preference *to be around people*, $F(1,184) = 14.14$, $p < .05$, and the preference for *a continuous path* $F(1,185) = 4.57$, $p < .05$. There were no significant differences between groups for preferences on safety, ability to make a loop, parking access, exposure to traffic, and access to amenities ($p > .05$). Figure 4 illustrates the significant differences in mean trail preferences between high-traffic and low-traffic users.

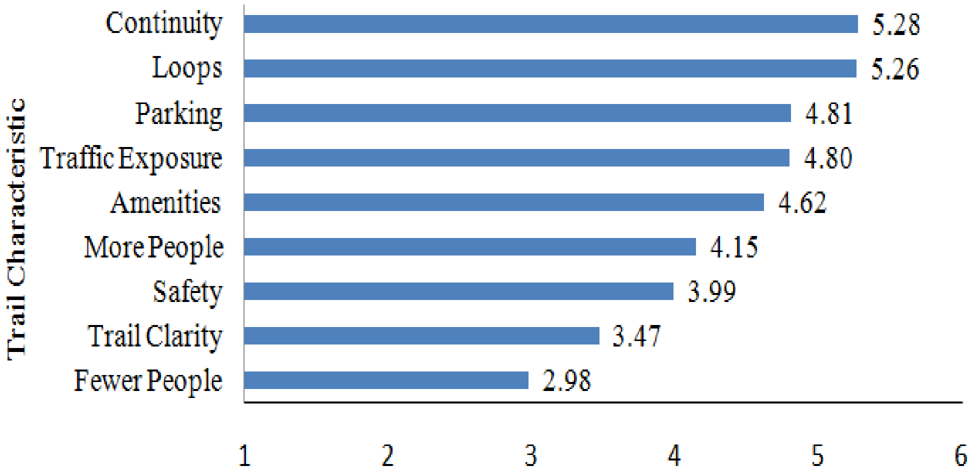


Figure 2. High-traffic West Users Mean Preference Ratings

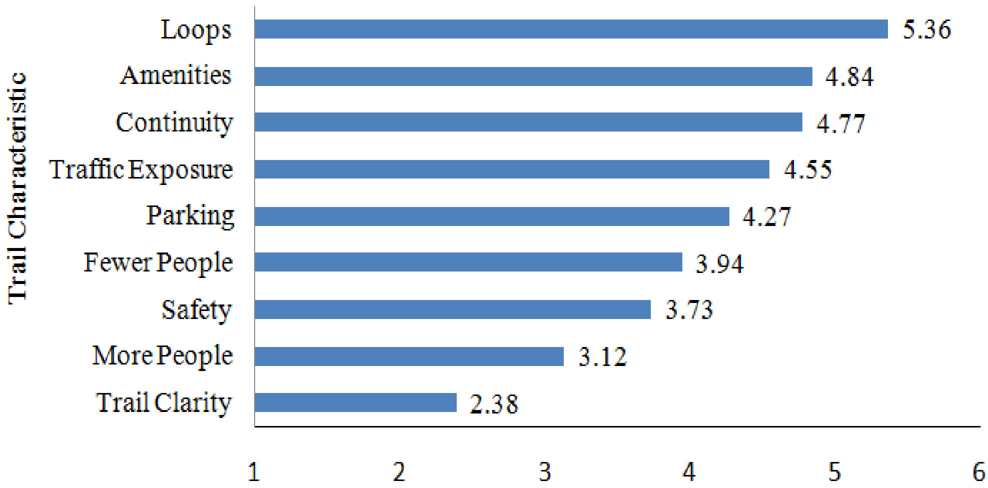


Figure 3. Low-traffic East Users Mean Preference Ratings

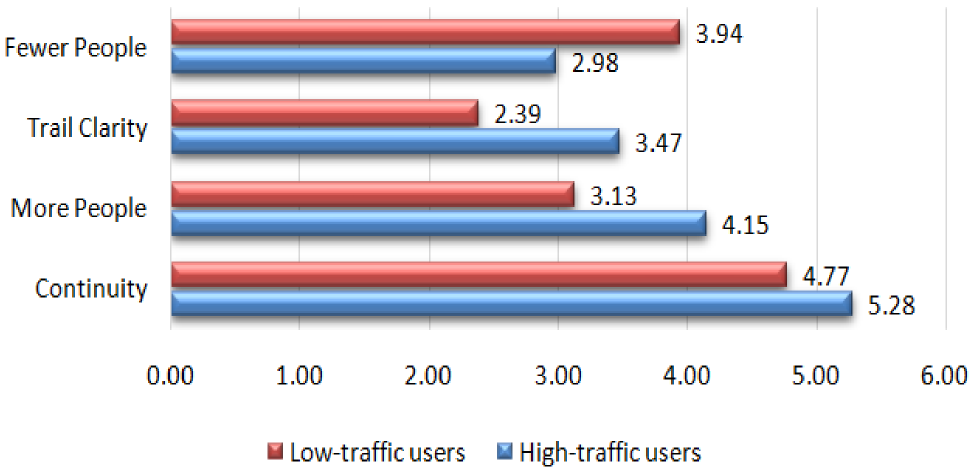


Figure 4. Significant differences in mean trail preferences between high-traffic and low-traffic users

3.5. Ratings of Trail Segments

High-traffic west and low-traffic east users rated trail characteristics for all six segments of the trail. To simplify the analysis, two segments were selected for further comparisons determined by the segment with the highest traffic (NW) and the segment with the lowest traffic (NE). Ratings of NW and NE segments were compared between high-traffic west and low-traffic east users on all trail characteristics: safety, parking, continuity, clarity of trail direction, bathrooms, drinking water, shade, litter, exposure to traffic, loop options, and crowding. A multivariate analysis of variance was performed to determine how the high-traffic and low-traffic users differed in their ratings of the NW (high-traffic) and NE (low-traffic) segments. There was a significant effect of user group on the combined dependent variables, $F(20, 74) = 2.890$, $p < .000$; Pillai's Trace = .439; partial η2 = .439. Table 4 shows the results of the simple effect analysis.

A series of 2 group (high-traffic west users, low-traffic east users) x 2 segment (NW and NE) ANOVAs were performed on the segment ratings. There was no significant group x segment interaction for bathroom availability, drinking water availability, or shade. There were main effect differences between group for bathroom availability, $F(1,112) = 5.35$, $p<.05$, partial η2 = .04, and drinking water, $F(1,113) = 6.22$, $p<.05$, partial η2 = .05. The main effect of group did not show a significant difference in shade ratings between east and west users, $F(1,110) = .15$, $p<.05$, partial η2 = .001. Pairwise comparisons showed that the low-traffic east users rated bathroom availability (+0.783) and drinking water (+0.629) higher than high-traffic west users. There were also main effects of segment for bathroom availability, $F(1,112) = 44.10$, $p<.05$, partial η2 = .28, drinking water availability, $F(1,113) = 77.05$, $p<.05$, partial η2 = .40, and shade, $F(1,110) = 41.81$, $p<.05$, partial η2 = .27. Pairwise comparisons showed all three variables received higher ratings in the NW segment: bathroom availability (+1.06), drinking water (+1.53), and shade (+0.90).

There were significant interaction effects for trail user group on *safety* $F(1,120) = 16.32$, $p=.00$, partial η2 = .12, *parking* $F(1 ,120) = 4.86$, $p=.03$, partial η2 = .04, *continuity* $F(1 ,120) = 6.24$, $p=.01$, partial η2 = .05, *clarity of trail direction* $F(1 ,120) = 7.17$, $p=.0$, partial η2 = .06, *litter* $F(1 ,120) =4.54$, $p=.03$, partial η2 = .04, *exposure to traffic* $F(1 ,120) =10.03$, $p=.00$, partial η2 = .08, *ability to make a loop of desired distance* $F(1 ,120) = 18.86$, $p=.00$, partial η2 = .14, and *crowding* $F(1 ,120) = 6.30$, $p=.01$, partial η2 = .05. These results show that west and east users rated segments differently on 8 out of 11 trail characteristics. A simple effects analysis was conducted for each of the significant interaction effects to identify where the differences occurred. Greenhouse-Geisser correction was used for violations of sphericity. Most of the significant effects pertained to the NE segment where the mean ratings on trail characteristics were higher among low-traffic east users than high-traffic west users. These included: *safety* $F(1, 120) = 14.71$, $p<.05$, partial η2 = .10, *trail continuity* $F(1 ,113) = 9.06$, $p<.05$, partial η2 = .07, *trail direction clarity* $F(1 ,107) = 5.64$, $p<.05$, partial η2 = .05, and *loops* $F(1, 109) = 20.00$, $p<.05$, partial η2 = .15. Significant simple effects pertaining to the NW segment showed that mean ratings were higher among high-traffic west users than low-traffic east users. These included: *crowding* $F(1,116) = 8.72$, $p<.05$, partial η2 = .07 and *exposure to traffic* $F(1 ,111) = 5.91$, $p<.05$, partial η2 = .05.

Table 4. Means, Standard Deviations, and Analysis of Variance of Segment Ratings by Group. NW segment = high traffic, NE segment = low traffic

	High-traffic Users		Low-traffic Users					
Segment Rating	M	SD	M	SD	n	F	p	η2
NW safety	5.15	0.72	5.36	0.89	76	0.55	.458	.006
NE safety	2.96	1.42	4.00	1.29	19	8.35	.005	.082
NW parking	4.76	1.01	4.73	1.14	76	0.10	.922	.000
NE parking	3.89	1.51	4.10	1.44	19	0.30	.585	.003
NW continuity	5.26	1.19	5.36	0.95	76	0.12	.722	.001
NE continuity	3.45	1.44	4.10	1.76	19	5.98	.016	.060
NW direction	5.35	0.93	5.15	1.01	76	0.65	.420	.007
NE direction	3.05	1.47	3.94	1.84	19	5.03	.027	.051
NW bathrooms	4.18	1.17	4.57	1.34	76	1.61	.206	.017
NE bathrooms	2.88	1.17	3.52	1.50	19	4.06	.047	.042
NW water	4.38	1.33	4.94	1.12	76	2.88	.093	.030
NE water	2.80	1.16	3.36	1.77	19	2.85	.094	.030
NW shade	4.67	1.03	4.74	1.30	76	0.49	.484	.005
NE shade	3.65	1.13	3.57	1.64	19	0.06	.806	.001
NW litter	5.13	0.92	5.00	0.88	76	0.31	.578	.003
NE litter	3.82	1.26	4.10	1.37	19	0.69	.406	.007
NW traffic	4.34	1.09	3.89	1.10	76	2.55	.114	.027
NE traffic	3.51	1.40	3.89	1.28	19	1.15	.286	.012
NW crowding	2.89	0.90	2.42	0.80	76	0.66	.418	.007
NE crowding	4.90	1.45	5.00	0.76	19	20.52	.000	.181
NW loop	5.44	1.07	5.26	1.01	76	2.99	.087	.031
NE loop	3.59	1.28	5.15	1.20	19	0.77	.778	.001

Although there were significant interactions between user group and trail segment ratings for parking (p=.03) and litter (p=.03), none of the high-traffic west user vs. low-traffic east user simple effects for either trail segment was significant. In this case, simple effects analysis tests whether west - east = 0 for the NW segment and/or west - east = 0 for the NE segment. However, with a significant interaction, although neither of these differences is significantly different from 0, it is possible that these differences are significantly different from each other [32].

Within-group and simple effects analysis showed that both west and east users rated the NW segment higher for safety, continuity, bathroom availability, water, clarity of trail direction, and shade. West users: *safety* $F(1,93) = 267.03$, $p < .05$, partial $\eta 2 = 0.742$, *continuity* $F(1,88) = 149.19$, $p < .05$, partial $\eta 2 = 0.629$, *bathroom availability* $F(1,87) = 76.09$, $p < .05$, partial $\eta 2 = 0.467$, *water* $F(1,87) = 94.39$, $p < .05$, partial $\eta 2 = 0.520$, *clarity of direction* $F(1,85) = 152.41$, $p < .05$, partial $\eta 2 = 0.642$, *shade* $F(1,85) = 61.92$, $p < .05$, partial $\eta 2 = 0.421$. East users: *safety* $F(1,25) = 14.42$, $p < .05$, partial $\eta 2 = 0.417$, *continuity* $F(1,25) = 14.42$, $p < .05$, partial $\eta 2 = 0.366$, *bathroom availability* $F(1,25) = 7.11$, $p < .05$, partial $\eta 2 = 0.222$, *water* $F(1,26) = 19.08$, $p < .05$, partial $\eta 2 = 0.423$, *clarity of direction* $F(1,22) = 8.44$, $p < .05$, partial $\eta 2 = 0.277$, and *shade* $F(1,25) = 12.19$, $p < .05$, partial $\eta 2 = 0.328$. The only NE trail characteristic that both east and west users rated more favorably than the NW is *crowding*. West users, $F(1,86) = 31.95$, $p < .05$, partial $\eta 2 = 0.271$. East users, $F(1,24) = 4.92$, $p < .05$, partial $\eta 2 = 0.170$.

West users also rated the NW segment higher for *parking* $F(1,85) = 27$, $p < .05$, partial $\eta 2 = 0.241$, *loops* $F(1,83) = 93.83$, $p < .05$, partial $\eta 2 = 0.531$, *litter* $F(1,85) = 75.29$, $p < .05$, partial $\eta 2 = 0.470$, and *exposure to traffic* $F(1,85) = 75.29$, $p < .05$, partial $\eta 2 = 0.470$. East users showed no difference between NW and NE ratings for parking, loops, litter, and exposure to traffic ($p = >.05$).

4. Discussion

The purpose of this study was to examine trail utilization across different sections of an urban trail and identify perceptions of trail characteristics that might contribute to utilization differences. In general, high-traffic west user ratings showed larger differences in favor of their own areas of use, as they rated the NW segment very high and the NE segment very low. Although low-traffic east users typically followed the trend of rating the NW segment higher than the NE segment, the mean differences were considerably less than that of west users. This suggests that east users do not view the two segments to be as extreme in their differences as do the high-traffic west users. Objective measurement of these characteristics would help identify which ratings are in agreement with actual physical condition.

In general, a comparison of both user groups indicates that high-traffic west users perceive the eastern sections of the trail as less safe, difficult to navigate, and lacking route options. Low traffic east users see the western sections of trail as more crowded and exposed to vehicular traffic and noise. However, the results of the within- group differences show that although low-traffic east user ratings of NW *exposure to vehicular traffic* was statistically different from west users, within-group differences were not. This suggests that exposure to traffic is probably not a perceived barrier to east users traveling on the west side. This is supported by the *general trail preference* ratings, not to be confused with the *trail segment ratings*, which showed no significant differences between groups on their general trail preferences for safety, ability to make a loop, parking access, exposure to traffic, and access to amenities.

The difference in perception between groups was analyzed to uncover why high-traffic west users do not use the east side. Regarding *safety*, low-traffic east users "moderately agreed" that the NE segment was safe to travel alone while west users "mildly disagreed". Prior research suggests that several trail characteristics can influence an individual's perception of safety. For example, areas with low population density, extensive tree canopy, or the presence of litter may be associated with a perceived risk of personal safety [21]. Incivilities such as graffiti and garbage impact aesthetics and thereby influence perceived safety [25]. There was a moderate positive correlation between the high-traffic west users' rating of *safety* and their rating of *litter* on the NE segment, r = .36. In addition to the need to compare these subjective ratings to objective measures in order to distinguish perception from actual physical conditions, future research should expand on these findings to illuminate possible moderating variables on perception of safety for recreational activity on urban trails.

Research studies in the field of transportation and urban design show that improving connectivity can increase physical activity [33] but most of this research is focused on utilitarian activity in urban environments rather than recreational physical activity on trails. This study defined *continuity* as a trail segment with no deviations from the primary path that would expose users to sidewalks, street crossings, or vehicular traffic. High-traffic west users "mildly disagreed" that the NE trail is continuous with no need to use streets or sidewalks. This significantly differed from the low-traffic east users' rating of "mildly agree". It is plausible that there is an association between *continuity* ratings and *directional clarity* ratings and that lack of experience on the eastern section contributes to an association between trail direction clarity and continuity among west users. Lack of trail direction clarity may be related to poor signage at points on the trail that appear to lack continuity, which leaves unfamiliar users uncertain about direction of travel. Experienced users on the eastern section who have greater familiarity with direction may not notice lack of signage, and thereby rate it leniently, but are able to visualize points on a trail that lack continuity more easily. Thus, low-traffic east users might show a weaker association between continuity and trail direction clarity than west users. Signage should be explored as a possible moderator for perceptions of continuity as adequate signage might alleviate the impact of poor continuity.

The results of this study also revealed that a variety of route options and loops are important to trail users. The loop rating was based on "can do a loop of desired distance" which showed less than satisfactory results on the NE segment among high-traffic west users. The NE segment, when combined with the SE segment, offers only one loop option with a distance of four miles. The NW segment offers a variety of loop options from 1.5 to 4.8 miles. On average, low-traffic east users rated the NW segment only slightly higher on loop options than the NE segment (5.185 vs. 4.963), which was not statistically significant and suggests that loops in the four-mile range are generally acceptable to low-traffic user group. It is unknown whether the availability of shorter loops in the NW segment is what yields more favorable ratings among high-traffic west users. However, descriptive analysis shows that 32% of high-traffic west users are walkers compared to 17% of low-traffic east users. Loops shorter than 4 miles might be preferable to some walkers on the west side.

Crowding ratings on the NW segment were significant for both between-group and within-group comparisons among low-traffic east users. This may reveal a perceived barrier for these users. This finding aligns with the low-traffic east users' preference to "be around less people on the trail" which was significantly lower than high-traffic west users. West users rated the NW segment more favorably than the NE segment on all variables except crowding, thereby acknowledging the significant difference in population density between the east and west sides. Given their group preference to "be around people on the trail", and prior research that shows higher usage on trails in areas of higher population density [34], the lack of trail users on the east side may play a role in their route choice. In addition to examining the relationship between population density and perceived safety, future research should also investigate individual or demographic correlates that are associated with a desire to be around more or less people while controlling for personality differences.

4.1. Group Membership

The trail count reported the number of users per segment while the survey reported the user route traveled most often. Thus, a true comparison was not possible. For the survey, user group was determined by route traveled most often and was based on the furthest east one traveled. As described in the methodology, trail users that *only traveled west of I35* were identified as high-traffic west users and those who traveled *east of I35 at any time in their route* were identified as low-traffic east users. Therefore, some low-traffic east users reported traveling a route that included both east and west segments. This categorization creates the possibility that east users may be familiar with more parts of the trail than west users. However, this was not viewed as a limitation because the purpose of the study was to identify barriers to traveling on the eastern sections of trail, and while west users may hold misperceptions due to lack of familiarity, they are likely acting on these misperceptions.

Sixty-eight percent of the low-traffic east users travel loops that extend west of I35 and 50% of all east users travel the entire 10-mile loop as their most common route. A closer look at the survey participants who were recruited on the trail vs. via the trail organization newsletter reveals that only 33% east users recruited on the trail travel west of I35 compared to 84% of newsletter subscribers. Furthermore, 63% of newsletter respondents reported that their most common route was the entire 10-mile loop. Thus, there appears to be relationship between newsletter participants and traveling the entire 10-mile trail. This pattern of utilization among low-traffic east users also means that they travel loops of longer distances since the loop contained within the NE/SE segment is 4 miles and the next shortest loop option is 6.3 miles. Because bicycling on the trail only accounts for 4-6% of travel on the trail, this pattern suggests that low-traffic east users may be running longer distances. Future research should examine whether or not different levels of intensity and/or distance traveled predicts choice of route on an urban trail. Route choice for more serious exercisers might also be associated with population density and a preference to be on less crowded sections of the trail.

If regular users increase usage on trail segments adjacent to lower SES neighborhoods, the trickle-down phenomenon that can occur when people vicariously experience the positive health behavior of others, thereby increasing the observer's self-efficacy for initiating the desired behavior [2], may take effect. This role modeling makes a favorable imprint on the inactive observer which collectively builds social capital over time [35].

4.2. Limitations

There are several limitations to this study. Participants were required to rely on recall when evaluating trail segments. Even though a map of each segment with landmarks was provided to orient participants to the segment they were rating, this required them to visualize each segment in the context of the trail characteristic, which opens the possibility of errors in memory. There is also a risk that they rated the segments based on reputation rather than experience. However, knowledge through the opinions of others is not uncommon and this perception of the environment may be just as powerful a predictor of physical activity as the actual environment [36,37]. A recent review of the literature on physical activity and the environment [38] illuminates the complex interplay of physical characteristics in the environment and the social and cultural interpretations that give those attributes meaning. Such socially constructed beliefs might regard a low socio-economic neighborhood adjacent to a trail as unsafe even in the absence of evidence to support those beliefs. The lack of objective measurement of these variables makes it difficult to distinguish perceptions that match reality from those that don't. Thus, errors in perception are less of a limitation than a basis for behavior that may need to be addressed through an information or social marketing intervention.

A major limitation of this study is unequal sample sizes between high-traffic west users (n = 163) and low-traffic east users (n = 33). Inherent to the phenomenon under study, it was expected that the low-traffic east group would be much smaller than the high-traffic west group as 85% of trail users reported that their activity occurs on the western section of trail. The concern with unequal sample sizes is that it can affect the homogeneity of variance assumption. Levene's test was significant for NE segment ratings on "can make a loop of a desired distance". Although this weakens the ability to confidently interpret the significant interaction effects, this is lessened through the use of simple effects of differences between trail segments within each group.

This study focused on existing trail users in an effort to understand why certain sections of the trail are avoided. Consequently, it may be logical to assume that non-users of the trail hold similar perceptions. However, the barriers for non-users may be different as indicated in a study that showed perceived safety of trail use was more troubling for new users than regular users [39]. As such, the generalizability of this study extends to urban trails that are primarily used for recreational purposes by regular users. The ability to generalize to other trail settings might also require trails that are comprised of loops, such as in the present study, rather than linear out-and-back trails.

4.3. Future Directions

Objective measurement of variables on which perception is being measured would provide the data necessary to examine whether or not objective ratings are in agreement with subjective ratings. If agreement occurs, then trail improvements may be necessary. If objective and subjective ratings are not in agreement then education about the actual trail environment may be necessary in order to increase usage on under-utilized segments.

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