# Walking Dissonance in Delhi: Intersections among Daily Mobility, Environmental Exposures, and Wellbeing

February 26, 2020

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#### Abstract

Despite the rapid pace of change and investment, most Delhi residents continue to struggle to get where they need to go, often depending on simply walking to get where they need to go. During travel, residents are directly exposed to the urban environment, with its air pollution, noise, and natural and built features that vary significantly in their quality and maintenance. How these exposures affect residents, both in how its shapes their travel and its impact on personal wellbeing, remain little investigated or understood. In order to address that gap in both scholarship and local knowledge, in 2019 we conducted a survey in two Delhi neighborhoods to better understand intersections among how people travel, perceptions of the urban environment, and effects on personal wellbeing. This survey of one thousand adults focuses on peripheral neighborhoods – Bhalswa Dairy and Batla House – with primarily low-income populations that have traditionally received little attention or investment from authorities. The survey results show that for residents of these neighborhoods, perceptions of low environmental quality are wrapped up with a perception of poor walking conditions that are nevertheless is an unavoidable facet of daily life for most residents. I introduce the concept of "walking dissonance," which occurs when individuals must walk frequently despite negative perceptions of walkability. The findings underscore that the development of a just, equitable transportation system in Delhi cannot just focus on investments in large-scale, regional networks, but need to address the effects of the environment on the fine-scaled, (in)human spaces of local mobility.

#### Introduction

As with all cities, Delhi's economy and social fabric depend on a vast, complex, multimodal transportation system. In Delhi, that system is comprised of rails and roads loaded with commuter trains, Metro, buses, roads, private autos, taxis and rideshares, autorickshaws, bicycles, and many, many people walking. Delhi's media, as well as scholars of the city, regularly observe significant dysfunction in Delhi's transportation system (Cox, 2010; Dasgupta, 2015). Despite its challenges, the national, regional, and local government continue to invest in mobility for the megacity, with rapid expansions of Delhi's Metro and its road network ongoing. These investments, and how they are integrated with Delhi's development, will have significant implications for the region's long-term viability and sustainability. In addition, these systems have direct effects on the ease of access to jobs, goods, services, and other essential destinations for Delhi's socially and economically diverse population. Despite the rapid pace of change and investment, most Delhi residents continue to struggle to get where they need to go, often depending on simply walking to get where they need to go. During these walks, or bike rides, autorickshaw trips, or travel by any other mode, residents are directly exposed to the urban environment, with its air pollution, noise, and natural and built features that vary significantly in their quality and maintenance. How these exposures affect residents, both in how its shapes their travel and its impact on personal wellbeing, remain little investigated or understood. In order to address that gap in both scholarship and local knowledge, in 2019 we conducted a survey in two Delhi neighborhoods near the Yamuna River to better understand intersections among how people travel, perceptions of the urban environment, and effects on personal wellbeing.

This survey of one thousand adults focuses on peripheral neighborhoods – Bhalswa Dairy and Batla House – with primarily low-income populations that have traditionally received little attention or investment from authorities. Bhalswa Dairy is in the north central National Capital Region (NCR), lying along the polluted Najafgarh Drain. Batla House is located in the southwestern NCR, along the Yamuna River.

The survey results show that for residents of these neighborhoods, perceptions of low environmental quality are wrapped up with a perception of poor walking conditions that are nevertheless is an unavoidable facet of daily life for most residents. I introduce the concept of "walking dissonance," which occurs when individuals must walk frequently despite negative perceptions of walkability. The findings underscore that the development of a just, equitable transportation system in Delhi cannot just focus on investments in large-scale, regional networks, but need to address the effects of the environment on the fine-scaled, (in)human spaces of local mobility.

#### **Conceptual Background**

In Delhi, the same path or neighborhood may represent walkable access to opportunities, a forced march through toxic air, or both, depending on individual and community context. Thus, while transportation researchers attribute significant benefits to walking, the same facets of cities that increase walking rates, such as high densities and convenient access to destinations, have also been found to exact a toll in terms of safety, exposure to emissions and noise, and mental well-being. In Delhi specifically, researchers have observed how pedestrians are exposed to significant traffic safety hazards (Rankavat & Tiwari, 2016), air pollution (Mishra et al., 2016; Sahu et al., 2011), and noise (Patsarika et al., 2018).

Less well studied, however, are how environmental exposures and hazards directly affect travel behavior and personal wellbeing. Does environment have a significant effect on the way we travel, or are travel choices primarily determined by personal exigencies, such as household budgets, daily routines, and a simple lack of alternatives to being exposed (Mondschein, 2018b)? If urban residents are forced to walk, not only may we observe impacts on physical health but also mental wellbeing, as exposures and their inescapability increase stress and reduce sense of control (Mondschein, 2018a). In this research, I ask whether walking in "unwalkable" conditions has an impact on mental wellbeing.

### **Survey Development and Deployment**

The survey collects information on three aspects of daily life in the Bhalswa Dairy and Batla House neighborhoods:

- 1. Everyday travel behavior
- 2. Perceived environmental exposures
- 3. Subjective, personal wellbeing

These measures can address how perceptions of environment shape everyday travel, particularly walking and its impact on mental wellbeing. We also asked a set of demographic control questions, including age, gender, and household income of survey respondents.

Travel behavior data was collected across a range of questions designed to capture the modes most often used by residents for everyday travel, as well as car ownership, rates of recreational walking, and perceived neighborhood walkability. Perceived environmental exposures were measured through a set of environmental rating questions, focused on air quality, the quality of local natural features, and the condition of the Yamuna River. Because both neighborhoods are located along the Yamuna or its tributary, the Najafgarh Drain, we sought to determine whether perceptions of the river have a relationship with either mobility or wellbeing.

We measured subjective wellbeing with two composite measures. The first, the Short Warwick-Edinburgh Mental Well-Being Score (SWEMWBS), is a set of fourteen questions that measure mental wellbeing, which has been validated to appropriately measure mental wellbeing across a range of populations (Ng Fat et al., 2017). We also included the Curiosity and Exploration Inventory (CEI-II) developed to understand individuals' motivation to seek new experiences and willingness to embrace unpredictability in everyday life (Kashdan et al., 2009). Finally, we included the Connectedness to Nature Scale (CNS), which measures the closeness that individuals feel to nature (Mayer & Frantz, 2004). Collectively, these measures of psychological wellbeing and attitudes may be associated both with travel and perceived environmental quality. Importantly, these measures have generally been validated in European and North American contexts. Their use in India remains infrequent and not well-covered in the literature. Therefore, we interpret the results of these measures with caution.

The survey was distributed in May and June 2019, working with Outline, an Indian NGO focusing on the collection of reliable survey results in communities across India. Outline captured a representative sample of the Bhalswa Dairy and Batla House neighborhoods, with approximately 500 participants in each neighborhood, stratified to be representative of gender and income in the neighborhoods.

### Analysis

## Neighborhood Demographics and Travel

Table 1 describes the basic demographics of the two surveyed neighborhoods, Bhalswa Dairy and Batla House. The Batla House respondents we more skewed to male respondents, while the Bhalswa Dairy respondents were more balanced between male and female. Average ages are similar in both neighborhoods. Both neighborhoods also have average annual household incomes far lower than the Delhi NCR average. Batla House respondents report going to work or school on average more hours than Bhalswa Dairy residents.

Table 1: Neighborhood Demographics				
	Bhalswa Dairy	Batla House	Overall	
% Female	49.4%	39.9%	44.4%	
Mean Age	35.3	34.7	35.0	
Mean Annual Household Income	₹ 99 <i>,</i> 565	₹ 1,02,827	₹1,01,275	
Mean Weekly Hours Work/School	31.7	35.8	33.9	

Figure 1 illustrates typical travel modes used by residents of Bhalswa Dairy and Batla House. Note that survey respondents could report using more than one mode on a typical day (so percentages do not add up to 100%). Walking is by far the dominant mode in both neighborhoods, with over 50% of residents in Bhalswa Diary and 60% of residents in Batla House reporting daily walking. The most notable differences between the two neighborhoods are in the relative rates of bicycle usage, including motorized bikes, versus transit use, whether bus or Metro. Bhalswa Dairy, which is not located on the Metro network and also has limited bus service is far more reliant on two-wheel travel, while Batla House residents are able to take advantage of bus and Metro. Vehicle usage, whether autorickshaw, ridehail, or private vehicle use, is similar and quite limited in both neighborhoods.



Table 2 shows that both neighborhoods are quite similar in terms of car ownership rates, with about 14% of respondents owning cars in both neighborhoods. Bhalswa Dairy respondents report walking for exercise or recreating at nearly double the rate (3.0 vs. 1.6 trips per week) of Batla House residents. The presence of Bhalswa Lake and its park may encourage additional leisure walking. Intriguingly, residents of Bhalswa Dairy only consider the neighborhood marginally more walkable than do residents of Batla House, indicating a disconnect between reported walking behavior and perceived neighborhood walkability.

Table 2: Car Ownership and Local Walkability				
	Bhalswa Dairy	Batla House		
Car Ownership (% of respondents)	13.9%	14.1%		
Average Weekly Walk Trips for Recreation/Exercise	3.0	1.6		
Mean Neighborhood Walkability Rating (1 to 5 scale)	3.2	3.0		

Perceptions of Environmental Quality

As shown in Table 3, overall perceptions of environmental quality in the two neighborhoods are, on average, quite neutral. Notably, however, perceptions of the quality of the Yamuna are worse among those living in Batla House (2.30 vs. 2.78 in Bhalswa Dairy). This may be because Batla House is sited directly on the river, whereas Bhalswa Dairy is more distant, though along the Najafgarh Drain. If the question has directly asked about the Najafgarh Drain, Bhalswa Dairy residents may have answered differently.

Table 3: Perceptions of Environmental Quality by Neighborhood					
	Bhalswa Dairy	Batla House			
Air Quality (1 - Very Bad / 5 - Very Good)	3.02	2.99			
Natural Features (1 - Very Bad / 5 - Very Good)	2.72	2.65			
Yamuna River Quality (1 - Very Bad / 5 - Very Good)	2.78	2.30			
Cleaner or Dirtier over Last 5 Years (1 - Dirtier / 5 - Cleaner)	3.28	3.22			

The relationship between perceived environmental quality and perceived neighborhood walkability is illustrated in Figure 2. In the figure, a series of bar charts show how walkability, on a scale of 1 to 5, covaries with the four measures of environmental quality: air quality, natural features, Yamuna quality, and whether a neighborhood has become dirtier or cleaner over time. All four environmental quality measures have a strong, positive relationship with walkability. As perceptions of environmental quality go up, so do perceptions of walkability in the neighborhood. Note that this relationship is equally strong for both Bhalswa Dairy and Batla House.

Table 4 examines perceived environmental quality relative to actual reported walking behavior. The same four environmental quality measures – air quality, natural features, Yamuna quality, and change in neighborhood quality – are assessed relative to being a regular walker (No/Yes) and across the number of weekly leisure walks reported. The results show that perceived environmental quality across categories barely varies at all with reported walking. This is a stark difference with the powerful relationship between *perceived* walkability and environmental quality shown in Figure 2. Taken together, the analysis shows that despite residents clearly perceiving that poor environmental quality reduces walkability, when it comes to actual walking behavior, environment appears to have little effect on whether residents walk regularly or for leisure purposes.



Table 4: Perceived Environmental Quality vs. Reported Walking Behavior							
		Air	Natural		Yamuna	Dirtier vs.	
Walking Behavi	or by Category	Quality	Features		Quality	Cleaner	
Regular	No	3.1		2.7	2.5		3.2
Walker	Yes	3.0		2.7	2.5		3.3
Leisure Walks per Week	0 walks	3.0		2.7	2.5		3.3
	1-4 walks	2.9		2.5	2.3		3.2
	5 or more walks	3.1		2.8	2.8		3.3

### Walking Dissonance: Differences between Walking Behavior and Perceived Walkability

The analyses above show that the environment has a strong relationship with perceived walkability but little apparent relationship with actual walking behavior. Is this deviation between walking behavior and perceived walkability evenly distributed among neighborhood residents, or do some people experience a greater deviation between their level of walking behavior and their perceptions of walkability? In order to assess this, I construct a measure of "walking dissonance," which quantifies the degree to which a person walks in environments that they perceive as unwalkable. I calculate walking dissonance as the difference between a person's walking frequency and perceived walkability, where both measures are standardized so they are scaled equivalently. The interpretation of walking dissonance is:

- High values indicate that the individual walks frequently but perceives local walkability as poor.
- Low values indicate that the individual does not walk much but perceives local walkability as high.
- Middle values suggest that the individual walks at a rate roughly equivalent to their perception of local walkability.

For the purposes of this analysis, I am most interested in individuals with high levels of walking dissonance. Again, these are individuals who walk frequently in their neighborhood but do not perceive that neighborhood as walkable. Who are individuals with high levels of walking dissonance, and does this dissonance have any relationship to demographic characteristics, other perceptions, or wellbeing?

Table 5 compares survey participants at the highest quartile (N=250) of walking dissonance to the remaining survey participants (N=750). Individuals with high levels of walking dissonance tend to be more likely to reside in Bhalswa Dairy, slightly more female, younger, and own a car. Average time spent working or in school is significantly lower for those with high walking dissonance. One explanation may be that those with more free-time available tend to walk more, despite the quality of the environment. All of the perceived environmental measures vary significantly between high dissonance individuals and others, with high dissonance individuals having much poorer perceptions of air quality, local natural features, and the Yamuna specifically. Finally, and critically, the mental wellbeing score of high walking dissonance individuals is significantly lower on the Short Warwick-Edinburgh Mental Wellbeing Scale. This suggests that walking despite having a negative perception of walkability can detrimentally impact wellbeing.

Table 5: Differences Between High Walking Dissonance Residents and Others				
	Walking Dissonance		Statistical	
	High	All Others	Significance	
% Bhalswa Dairy Resident	54.1%	47.2%	*	
% Female	45.2%	44.1%		
Age	33.68	35.42	*	
% Auto Owners	15.6%	13.5%		
Weekly Hours Work/School	30.32	35.07	**	
Air Quality Scale (1 to 5)	2.09	3.33	***	
Natural Features Quality (1 to 5)	1.84	2.97	***	
Yamuna Quality (1 to 5)	2.02	2.69	***	
Wellbeing (SWEMWBS)	12.67	13.75	**	
Statistical Significance: T-Tests of Means, *=p<0.10, **=p<0.05, ***=p<0.001				

## Effects of Walking Dissonance on Wellbeing

While the means comparisons in Table 5 showed a significant difference in wellbeing between those with high levels of walking dissonance and other neighborhood residents, this approach does not control for the influence of other factors on wellbeing. Does walking dissonance still have a significant relationship with wellbeing when other critical factors are included in the model? Table 6 presents the results of a multivariate linear regression predicting mental wellbeing (SWEMWBS), controlling for a range of factors including walking dissonance, resident demographics, and perceptions of environmental quality. The regression demonstrates that walking dissonance remains significantly, negatively associated with mental wellbeing, even when controlling for a wide range of factors. The neighborhood a resident lives in is not a significant explanatory factor, nor is gender. However, older residents show significantly higher levels of wellbeing, as do those who work or are in school more hours.

The effects of the environmental variables on wellbeing are mixed. As expected, those who report their neighborhood becoming cleaner over the past five years (rather than dirtier) have significantly higher wellbeing. However, the relationship between residents' perceptions of natural features generally or the

Yamuna specifically are significantly negative. Put another way, a positive perception of the local natural environment is associated with worse wellbeing. While this effect is perplexing, these variables may be proxies for other psychological phenomena not directly measured in the survey. Finally, the coefficient of the Connectedness to Nature scale is significantly positive, indicating that those feeling closer to nature also feel increased wellbeing.

Table 6: Predicting Wellbeing			
Outcome Variable			
Wellbeing (Short Warwick-Edinburgh Mental Well-Being Scale)			
Predictor Variables	Coefficients		
Walking Dissonance	-0.472**		
Neighborhood: Batla House v. Bhalswa Dairy	-0.422		
Gender: Female v. Male	0.720		
Age (Years)	0.0323**		
Weekly Hours in Work or School	0.0146*		
Perceived Air Quality (1 to 5 scale)	0.196		
Natural Features Quality (1 to 5 scale)	-0.776***		
Yamuna River Quality (1 to 5 scale)	-0.463**		
Neighborhood Change: Dirtier or Cleaner Last 5 Years (1 to 5 scale)	0.409**		
Connectedness to Nature Scale	4.668***		
Constant	4.864***		
Observations	615		
R-squared	0.168		
*** p<0.01, ** p<0.05, * p<0.1			

### Discussion

The analysis shows that for residents of neighborhoods like Bhalswa Dairy and Batla house, mobility is not just a matter of easy access to destinations. Substantial amounts of travel occur on foot, as well as by other modes that expose individuals directly to the environment. Many respondents, however, do not perceive their neighborhoods as walkable, a perception that is highly correlated with negative perceptions of the environmental features of their neighborhoods, including the Yamuna River. The result is a phenomenon that I term "walking dissonance," where individuals walk frequently but perceive their neighborhood as unwalkable. Increased walking dissonance is significantly associated with decreased mental wellbeing.

The psychological impacts resulting from the disconnect between the necessity of walking in many Delhi residents' daily lives, and the poor quality of its infrastructure and environment compound with other impacts. We already know that Delhi's traffic and environmental degradation have significant physical health and safety consequences for its residents. The lack of high-quality mobility choices available residents of Bhalswa Dairy, Batla House, and similar neighborhoods are also a matter of social and political concern.

As a society, there are two clear ways to solve issues walking dissonance: decrease walking or improve walkability. Individuals have, or feel they have, little control over the urban environment, so the easiest

way to avoid this dissonance is to walk less and reduce negative environmental exposures. Unfortunately, for many this may mean the purchase or use of a car that only adds to the existing environmental burden. Only governmental and collective action address the other side of the equation, increasing walkability through investment in regional infrastructure, neighborhood design, and proenvironmental policies. The benefits to wellbeing are significant and will likely manifest not just in people's physical health but – as this study demonstrates – their mental wellbeing as well.

## Funding

This study was funded by the Yamuna River Project and the UVA Center for Global Innovation and Inquiry.

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