Learning the Language: The Importance of Studying Written Directions in Designing Navigational Technologies for the Blind

Morgan Klaus Scheuerman
UMBC
Baltimore, MD 21250, USA
smorgan2@umbc.edu

Amy Hurst
UMBC
Baltimore, MD 21250, USA
amyhurst@umbc.edu

William Easley
UMBC
Baltimore, MD 21250, USA
easley1@umbc.edu

Stacy Branham
UMBC
Baltimore, MD 21250, USA
sbranham@umbc.edu

Ali Abdolrahmani
UMBC
Baltimore, MD 21250, USA
aliab1@umbc.edu

CHI'17 Extended Abstracts, May 06-11, 2017, Denver, CO, USA
ACM 978-1-4503-4656-6/17/05.
http://dx.doi.org/10.1145/3027063.3053260.

Abstract
Independent navigation is important to individuals who are blind and visually impaired (VI). Researchers have long explored how blind and VI people navigate to inform the design of more useful, accessible wayfinding devices. However, there has been little research on the role language plays in providing effective Text-to-Speech directions for this population. In this paper, we investigate the language and cues expressed in written navigational directions exchanged between blind and VI members of a Yahoo! Group mailing list. Through qualitative analysis, we unpack the types of and frequencies of information exchanged, including how distances are represented, how direction is indicated, and what landmarks are referenced. We notably found that written directions often included warnings about when a navigator may have gone too far, which alternate routes are easier to navigate, and how welcoming and accessible destinations might be for people with disabilities.

Author Keywords
Blind navigation; people with vision impairments; written navigational directions.

High-Level Category	Instances
Directional Cues	96
Relative Locations of Landmarks to Destinations	46
Methods of Travel	42
Expressing Distance	25
Describing and Navigating Using Physical Space	18
Cautionary Directions and Warnings	10
Interacting with Others	9
Destination's Accessibility for the Blind/VI	4

Table 1: Summary of instances in each of the high-level categories we identified.

ACM Classification Keywords
K.4.2. Social Issues: Assistive technologies for persons with disabilities.

Introduction
Much past research has studied and understood differences in how blind and sighted individuals navigate [1,3,6]. Specifically, Williams et al. [6] have focused on the cues that are important to blind individuals and how they can inform the creation of a navigation device. This work has helped identify the technical and social implications of navigational technology created for the blind but designed by the sighted. In this paper, we focus on the qualitative characteristics of the language blind/VI individuals use to communicate directions to *one another*. We conducted a study of emails exchanged over a three-year period between members of a Yahoo! mailing list that include written directions. We use our findings to illuminate the important role of written directions exchanged between blind/VI individuals in designing wayfinding devices.

Related Work
Past work has evaluated and produced diverse accessible tools to assist blind users with independent navigation. Much of this work focuses on creating accurate and useful navigational systems [2,3,5,6] and improving indoor navigation for blind individuals [4].

Beyond the technical, researchers are exploring the many ways social characteristics affect the adoption of technological navigational aids by the target user demographic. As studied by Williams et al. [6] and Bradley and Dunlop [1], sighted people often have misconceptions about the ways in which blind people navigate, the cues that are important to them, and how to convey those cues successfully. Bradley and Dunlop [1] have published significant contributions illuminating the different cues and verbiage used by sighted and blind individuals in an experimental setting to describe contextual route information when asked to navigate to pre-determined landmarks, as well as the ways these differences can cause cognitive load as each group tries to understand the way the other perceives directional language. The current study complements and extends their findings by investigating directions written "in the wild" by a larger participant pool.

Because many navigational aids communicate information through Text-to-Speech [7,8,9], the language used must be useful and relevant to the target user base for these technologies to be effective. We believe that researchers and designers can better understand the needs of blind users by studying naturalistic directions written and exchanged between blind/VI individuals without any preconceived prompts.

Methods
Mailing List Dataset
To investigate how individuals who are blind or visually impaired use language and cues in written navigational directions, we performed a qualitative analysis of emails exchanged between blind/VI individuals meeting up for social activities in the D.C. metro area. The group was created in 2009 and hosts 68 members as of the date of this publication. With permission of the group administrators, we collected all emails sent between September 2013 (when an author joined the group) and September 2016 (total of 347 emails). Of these, 30 contained navigational directions. Directions pertained to 17 different destinations (all restaurants or

Directional Cues

Quote from Sender B (Email 2) asking for clarification on navigational directions given by SA (Email 1):

"Can you give the directions in terms of left and right turns? ***I'm not sure what direction is north*** *over there."*

Quote from SD (Email 4) providing directional cues:

"It is basically a one to two block walk with no major street crossings and only ***one turn at the end****."*

Relative Locations of Landmarks to Destinations

Quote from SA (Email 1) using the library as a landmark:

*"You cross G and cross 9th****, as if you were going to the library****. But instead of turning on G as you would when going to the library, you keep walking north…"*

bars). Of these 30 emails, there were 11 unique senders. Nine of the emails analyzed were responses for clarification or to expand upon directions given in previous emails.

Sender	A	B	C	D	E	F	G	H	J	K	L
Emails Sent	1	4	1	1	8	4	7	1	1	1	1

Table 2: Sender IDs (omitting the letter I) and how many emails each sender wrote—for a total number of 30 emails analyzed.

We thematically coded all 30 emails, developing a total of 35 codes and 8 high-level categories (Table 1). Codes are presented in descending order by the number of instances (Tables 3-10). Because written responses provide rich details, we encountered several statements which were illustrative of multiple codes. Quotes taken from the emails include bolded text that highlights the motivation for coding.

Categories of Written Language Instructions

Below we present findings from our qualitative analysis, organized by high-level categories.

Category 1: Directional Cues

Instances in this category describe navigational signals written in the emails. Relative Physical Directions was applied when navigational routes were described in terms of the current position of the potential navigator (e.g., "left"), and was the largest occurring code. Cardinal Directions (e.g., "north") were used in varying contexts across 6 instances, but Cardinal Directions also attributed to instances of Directional Confusion, where group members expressed not knowing which direction the cardinal direction actually was. In one instance of Directional Confusion, a member asked others to describe which way to turn from the metro exit in terms of left and right.

Directional Cues	**Instances** (96 Total)
Relative Physical Directions	53
Street Crossing	21
Detailed Orientation	13
Cardinal Directions	6
Directional Confusion	3

Table 3: Summary of Directional Cues codes and instances

Category 2: Relative Locations of Landmarks to Destinations

This category is composed primarily of descriptions of landmarks for navigators to use as navigation cues. Streets and street corners are included as well, as they act as point-by-point markers. This also includes the code Location of Entryway, which is often described as relative to the street the route describes (e.g. *"its entrance is actually on L St" [SF, Email 16]*). Other examples of landmarks referenced include a library, Warner Theater, the Mayflower Hotel, and specific metro stations.

Relative Locations of Landmarks to Destinations	**Instances** (46 Total)
Location of Entryway	11
Orientation Relative to Streets and Street Corners	16
Relative Directions from Landmark	10
Landmarks	9

Methods of Travel

Quote from SG (Email 20) explaining directions if using the metro:

"***By metro**, take the Green or Yellow metro line to U street."*

Expressing Distance

Quote from SF (Email 16) using blocks and buildings as a form of measuring distance:

"***After a block**, cross 17th St. Continue[sic] **a few** [sic]**buildings down, less than half a block**…"*

Describing and Navigating Using Physical Space

Quote from SL (Email 28) detailing structural cues:

"*…and **the enclosed patio juts out close to the curb** … the entrance is to your right, **set back from the curb** on the side of the building **(follow the carpet strip)."***

Table 4: Summary of Relative Locations of Landmarks to Destinations codes and instances.

Category 3: Methods of Travel
Methods of Travel described the different ways writers informed readers to navigate to the described destination. While simply walking was implied in many of the directions, these are instances that highlighted specific cues (such as metro exits to take) or specific options for navigation (such as using an escalator). In a couple of cases, another possible route was mentioned but not given in full detail. One instance suggested another mode of transportation (e.g. "*Regular taxicabs service 17th Street regularly as well*").

Methods of Travel	**Instances** (42 Total)
Metro Exit	21
Metro Route	13
Indicates Using Escalator	3
Multiple Routes	2
Bus Route	1
Other Mode of Transport	1
Indicates Using Stairs	1

Table 5: Summary of Methods of Travel codes and instances.

Category 4: Expressing Distance
This category represents ways of expressing distance to readers. The code Relative Distances is dedicated to estimating approximate distance in directions using measurements like city blocks. Instances ranging from "halfway down the length of the room" to "less than half a block" inform navigators of relative distances before turning, reaching their destination, or reaching a landmark. None of the emails use measurements of inches, feet, meters, or miles.

Expressing Distance	**Instances** (25 Total)
Relative Distances	18
Counting Steps	3
Counting Buildings	3

Table 6: Summary of Expressing Distance codes and instances.

Category 5: Describing and Navigating Using Physical Space
This category encompasses descriptive characteristics of a pathway, space, or objects that can be used to guide a route. For example, L writes in email 28, "*You enter the space at the end of a long rectangle*," which acts as a detailed description of the geometric space. Describing physical space can help orient blind navigators trying to get from point A to point B quickly, offering tactile spatial cues to inform their orientation.

Describing and Navigating Using Physical Space	**Instances** (18 Total)
Geometric Spatial Description	11
Using Physical Objects to Guide Path	3
Description of Entryway	2
Fork in Route	2

Table 7: Summary of Describing and Navigating Using Physical Space codes and instances.

Category 6: Cautionary Directions and Warnings
This category provides readers with alerts about potential hazards or difficulties they might meet along a route. Some sets of directions given provided cues to

Cautionary Directions and Warnings

Quote from SG (Email 22) providing step-by-step directions to the restaurant:

*"You'll head into the street once again but **do not be alarmed** - the sidewalk opens up on your left about halfway to 14th street … Entry can also be gained via revolving door, **which spins quite fast**."*

Quote from SG (Email 20) describing directions to the restaurant:

*"… if you find a low wall on your right **you've gonetoo**[sic] **far**."*

Interacting with Others

Quote from SE (Email 14) suggesting to ask for help if navigators cannot find the door:

*"Matchbox is somewhere on your left, I don't remember which door. **Just ask someone.**"*

navigators that they had gone too far and to backtrack, both using street location to inform navigators they would miss their destination.

Cautionary Directions and Warnings	**Instances** (10 Total)
Warning Not to Follow Path	3
Indicates to Backtrack	2
Warning for Interacting with Entryway	1
Warning of Easy to Miss Entryway	1
Warning of More Challenging Route	1
Do Not Be Alarmed	1
Wrong Side of Street	1

Table 8: Summary of Cautionary Directions and Warnings codes and instances.

Category 7: Interacting with Others
These instances include occurrences where members offer assistance or inform others to ask for directions. The small size of this category, and no responses to inform reader comfort level, it is hard to infer if asking for directions is something navigators would want do.

Interacting with Others	**Instances** (9 Total)
Ask for Directions	5
Outside Navigators	3
Offer of Assistance	1

Table 9: Summary of Interacting with Others codes and instances.

Category 8: Destination's Accessibility (for the Blind/VI)
Some writers informed readers of the destination's known familiarity with and accessibility levels with blind/VI patrons. Comments include identifying whether a destination is familiar with blind/VI individuals and whether guide dogs are welcome.

Destination's Accessibility (for the Blind/VI)	**Instances** (4 Total)
Guide Dog Allowance	2
Blind Accommodation	2

Table 10: Summary of Destination's Accessibility (for the Blind/VI) codes and instances.

Discussion

The language and cues used in these emails suggest potentially valuable insights into how navigation aid designers can better serve blind/VI (and possibly even sighted) individuals in navigation tasks. While researchers have focused their work on the types of real-time directional cues the blind use in situ while navigating [1,2,3,6], with one notable exception [1], they have largely done so without consideration for how blind individuals communicate directions amongst each other. Our observation of direction sharing between blind/VI users has surfaced previously undocumented cues that may be useful for navigation aid designers.

We found that participants used indoor landmarks such as entryways and escalators in route descriptions. However, the Trekker Breeze navigation aid only offers turn-by-turn navigation, without any detailed feature identification to help users orient themselves indoors or outdoors. Street names were often included in written directions despite previous findings that street signs are often are often inaccessible [2]. This suggests that users may have to rely on other O&M training or outside help to locate destinations if their device is not

Destination's Accessibility for the Visually Impaired

Quote from SL (Email 28) describing a restaurant's familiarity with blind patrons:

"*Annie's* ***is use****[sic]* ***to a blind invasion occasionally,*** *and* ***they are dog Friendly****[sic]."*

Quote from SF (Email 27) calling ahead to reserve a table and ensure accessible accommodations:

"*I'll call Ted's at 5 to have them get the table ready and tell them: 1) To get a table for 10 ready and 2) That* ***people with white canes and/or dogs will arrive****…"*

reliable. Many individuals may be hesitant to ask others for help for fear of further perpetuating stereotypes about disability or being perceived as a burden.

Our findings indicated that users navigated primarily based on landmarks or physical environmental cues and measured their distances in city blocks. However, BlindSquare, Guide Dots, and Ariadne GPS—existing off-the-shelf navigation aids for people who are blind—only offer estimated distance to destination in miles, feet, meters, or estimated time to arrival [7,8,9]. While this could be contextual to writing directions, it has been found that blind individuals use their environment heavily to navigate and it may be less abstract to mentally map blocks, rather than meters or miles. Designers should consider the way blind navigators measure distances when implementing distance measurement features. We found that the overwhelming majority of directions used relative distances instead of step counts or full street blocks to describe how far to go.

Analyzing emails exchanged in this group provides perspective on how exchanging navigational information could impact a technological device. Certain cues might be difficult to accurately deliver to users in real time with an app or device, but could be improved upon through crowdsourcing or participatory design functions. This would empower the blind community to make meaningful contributions to aspects of directions they find critical and provide researchers with a continued means of gathering this data.

Crowdsourcing would more easily allow users to receive cautions and warnings like those we found in our study. Some writers informed navigators not to follow a certain path (or else they would have to backtrack) and one suggested an alternative route was more challenging to navigate. Most navigational technology algorithmically determines the fastest or shortest route based on distance. It may be necessary acknowledge that certain routes are more challenging (e.g., having large intersections or densely crowded areas [6]). Crowdsourcing can improve the route selection processes by allowing users to comment-on or rate their experiences with routes. Currently, Guide Dots was the only technology (of the 4 referenced) which offers crowdsourcing functions [9].

Conclusion and Future Work

Examining written navigational directions has given us insight into the language the blind community uses to communicate directions, as well as important aspects of directions to use in navigational aids and devices. Our work offers guidance to designers of navigational technologies in their deliberation over what navigational language and cues may be helpful to blind and visually impaired users. We believe that our findings may also extend to the design of more usable navigation technologies that are accessible to users with a wide range of abilities outside our target population. In the future, we plan to conduct follow-up interviews with the individuals who crafted these emails in order to further our understanding of navigational cues and route decision making. We believe these findings give insight into the language the blind community uses to communicate directions, as well as important aspects of directions to use in navigational aids and devices.

Acknowledgements

This work was supported by Toyota Motor Engineering & Manufacturing North America.

References

1. Nicholas A. Bradley and Mark D. Dunlop. 2005. An Experimental Investigation into Wayfinding Directions for Visually Impaired People. *Personal Ubiquitous Computing.* 9, 6 (November 2005), 395-403. http://dx.doi.org/10.1007/s00779-005-0350-y
2. Richard Guy and Khai Truong. 2012. CrossingGuard: exploring information content in navigation aids for visually impaired pedestrians. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (CHI '12). ACM, New York, NY, USA, 405-414. DOI: http://dx.doi.org/10.1145/2207676.2207733
3. Kotaro Hara, Christine Chan, and Jon E. Froehlich. 2016. The Design of Assistive Location-based Technologies for People with Ambulatory Disabilities: A Formative Study. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems* (CHI '16). ACM, New York, NY, USA, 1757-1768. https://doi.org/10.1145/2858036.2858315
4. Dhruv Jain. 2014. Path-guided indoor navigation for the visually impaired using minimal building retrofitting. In *Proceedings of the 16th international ACM SIGACCESS conference on Computers & accessibility* (ASSETS '14). ACM, New York, NY, USA, 225-232. http://dx.doi.org/10.1145/2661334.2661359
5. Gary Look, Buddhika Kottahachchi, Robert Laddaga, and Howard Shrobe. 2005. A location representation for generating descriptive walking directions. In *Proceedings of the 10th international conference on Intelligent user interfaces* (IUI '05). ACM, New York, NY, USA, 122-129. http://dx.doi.org/10.1145/1040830.1040862
6. Michele A. Williams, Caroline Galbraith, Shaun K. Kane, and Amy Hurst. 2014. "just let the cane hit it": how the blind and sighted see navigation differently. In *Proceedings of the 16th international ACM SIGACCESS conference on Computers & accessibility* (ASSETS '14). ACM, New York, NY, USA, 217-224. http://dx.doi.org/10.1145/2661334.2661380ACM
7. Ariadne GPS | Mobility and map exploration for all. Retrieved January 11, 2017 from http://www.ariadnegps.eu/
8. BlindSquare. Retrieved January 11, 2017 from http://blindsquare.com/
9. Guide Dots. Retrieved January 11, 2017 from http://www.guidedots.org/