DTD Hero

Senior Design Capstone II Final Report

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BACKGROUND

Developmental Topographical Disorientation (DTD) is a recently discovered neurological condition that is characterized by the inability to orient oneself in any setting, even in very expectedly familiar surroundings, such as inside one's own home. It was discovered by Canadian neuroscientist, Dr. Giuseppe Iaria. Researchers estimate that 2% of the world population suffers from DTD. There is no cure at the moment, as this is a lifelong condition.

Recent studies using various imaging techniques suggest that certain regions of the brain are particularly less active than others in DTD patients when performing spatial duties.[1] DTD is best described as the lack of development of the ability to form cognitive maps, which let a "normal" person intuitively remember routes and identify and place themselves spatially. Their brains lack the ability to form the necessary connections between the several mechanisms required to create the neurological signal that lets a person understand routes and directions--it's not a matter of memory. It is important to note that DTD patients don't have any structural brain damage and that their struggles are solely developmental. They don't suffer from other intellectual or cognitive deficits. In fact, many patients go on to study and pursue complex topics and careers. It is also helpful to identify the difference between people who develop navigational confusion due to brain damage and people with DTD. For example, the region of the brain that affects navigation and spatial orientation is called the hippocampus[5]. The hippocampus also

controls emotions and memories[6]. If a person damages his/her hippocampus in an accident, their ability to form and remember long term memories and control their emotions may also be affected, along with their navigation abilities. However, DTD patients only lack in forming navigational and spatial relationships, and their memory and emotions are not affected at all.

There isn't any distinct demographic that is more susceptible to having DTD, as it originates from birth or early childhood. Moreover, there is a theory that DTD begins to form in children who have inadequate experience in training their navigational abilities. There have been case studies of people as young as 22 and as old as 68. In one case, a woman from Vancouver is described as having "topographical disorientation in absence of any structural lesions". She is unable to navigate through her environment despite having normal cognitive development. But she was able to follow a route traced on a map and get to her destination with the help of landmarks and verbal directions. This patient couldn't sketch a satisfactory diagram of her house, as the spatial scaling was warped.[3] In another case of a 68 year old woman, it was revealed that she has to re-learn her way to the kitchen every morning. She gets her friends to drive her to places when possible, as she feels uncomfortable to drive. There was an instance when she got lost merely two blocks away from her brother's apartment. She didn't have any history of brain damage either. She describes DTD as "embarrassing, humiliating, scary, and anxiety-provoking".

STATEMENT OF THE PROBLEM

Due to the fact that Developmental Topographical Disorientation is a recent discovery, there are little to no technologies present to help patients navigate inside buildings. Patients feel lost all the time. Simple activities such as walking to the bathroom after waking up or knowing which way to turn to get to the office meeting room are not easy to accomplish without some sort

of assistance. While conducting our own research through surveys and interviews with DTD patients, we have developed a cross-platform application, DTD Hero, to help individuals with DTD work around their challenges with indoor navigation by helping them make visually descriptive maps of frequently visited routes. It is accessible to any smartphone user and assists them in getting comfortable inside their homes as well as other, more complex indoor spaces like offices, airports, and hospitals.
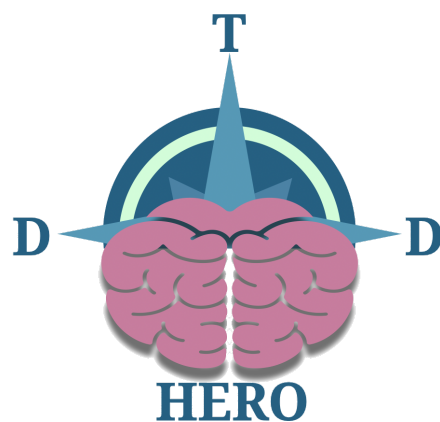

Figure 1: DTD Hero Logo

RATIONALE OF SOLUTIONS

DTD Hero was developed based on thorough research on DTD and interviews with patients through an online forum called "Getting Lost" and a Facebook Group called "Directional Disorientation" dedicated to discussing how it feels to live with DTD. These forums are made up of members who have this condition. The goal of the surveys and interviews was to learn how DTD affects the quality of life directly from the people who suffer from it. Some of the information these interviews and surveys requested were demographics, what current technologies and techniques are used to bypass challenges with DTD, what is needed to ease

concerns of living with DTD, and what current technologies are not addressing. The responses helped us find the common issues that DTD patients suffer from and what kind of help they need most. One 59 year old woman's symptoms show the commonalities throughout the body of responses we got, "I have no sense of orientation. If I leave a room, even in a familiar place, I have to stop and think which direction to turn. In an unfamiliar place I'm completely lost. I rely on visual cues and memory to find my way around. I know my right hand from my left but if someone tells me to turn left, I'm not sure which way that is. If I have to take a detour or my visual cues are missing, I can't find my way around."

When asked how they deal with DTD given current technologies, it was apparent that many interview and survey participants try to improve their quality of life by using GPS tools and apps like Waze and Google Maps. However, they also expressed how these apps aren't enough. These apps only help with outdoor navigation, doing almost nothing to help with indoor navigation. For example, Google Maps does not provide them a route from their bedroom to the kitchen inside their homes or a route from the hospital bed to the bathroom inside a hospital.
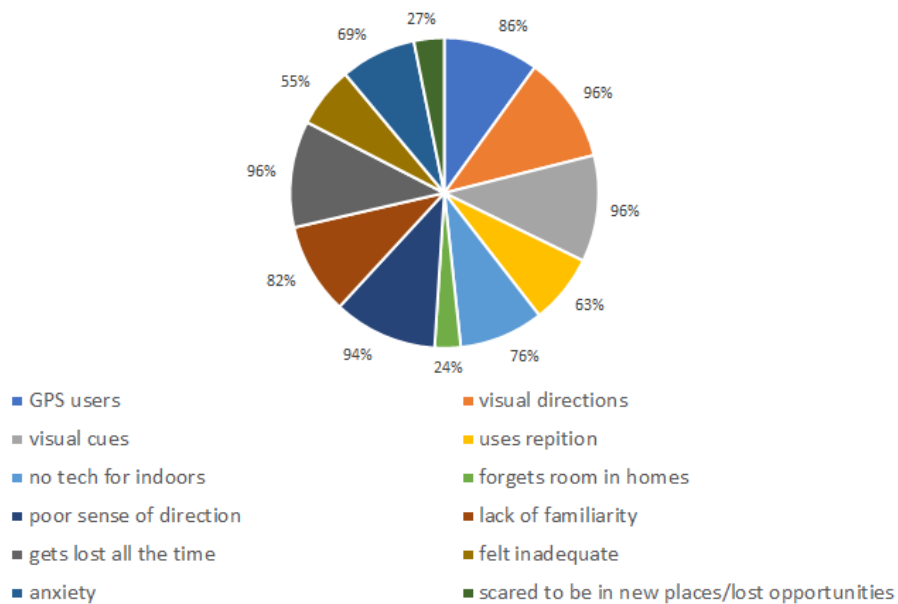

Figure 2: Survey and Interview Highlights (Pie Chart)

Seeing these common trends of preferring visual cues, experiencing a lack of resources for indoor spaces, and struggling to find their way around in the most intimate and familiar of places, we adjusted DTD Hero so it addressed these themes. DTD Hero is a navigational app intended strictly for indoor spaces, helping individuals get around the obstacles that they face. It is essentially a map journal, where users can create maps of specific, personal, frequently used routes. These maps are made very descriptive using the camera feature, which lets the user take a picture of their surroundings at any point during the map making process. These pictures can then be annotated, and are saved on the corresponding location on the map, serving as visual cues. Our app will provide a straightforward navigation system designed specifically for individuals with spatial disorientation, fit for indoor navigation needs.

DESIGN AND DEVELOPMENT OF SYSTEMS

We used Flutter and Firebase to develop our application. The key feature in our app is a route generating control pad used to guide the user to any indoor location. The route is generated using Flutter Grid. To form the initial map, the user is expected to get someone who will help them walk to their destination and create the map (once a map is saved, though, the user can use it on their own). Once the user is ready to trace their path, a control pad will be displayed at the top of the screen, which will generate the drawing of the route in a window at the bottom as the user walks. The control pad consists of 5 buttons: an up button, a left button, a right button, an undo button, and a camera button. The user presses and holds the up arrow key as they are walking, to indicate they are walking straight, until they have to stop. The amount of time the button is held will determine the length of the line segment of the drawing. When the user has to

make a turn, they press either the left or right arrow key to change the direction of the route that will be drawn next. After turning, the user uses the up arrow again to continue walking in this new direction. This is meant to ensure that the user always feels like they are walking straight-- from our surveys, we learned that following a straight path causes less navigational confusion in DTD patients.

Throughout this trip, the user can stop to take photos and label them with descriptions. Once the photo is taken, that photo will serve as a landmark/visual cue, plotted onto the route in the appropriate spot. These pictures are recommended to be taken at the very least each time the user makes a turn. If the user encounters a floor change, they can also click a '+' icon to begin the map for the new floor. After the destination is reached, the user can indicate that the drawing of the route is complete, which will then show the simple drawing of the route that was just generated. The visual cues will show on the map, as well as a staircase icon if there was a floor change, which will allow the user to toggle between those floors.

The next time the user has to travel to and from the same places, he/she must start at the starting point and then indicate on the app that the trip has begun. As the user walks and follows the route, the user will be expected to compare the picture taken of the nearest landmark with their surroundings to help them recognize where they currently are. In our research we found that while some DTD patients praise and rely on the reorientation feature of Google Maps, some also strongly dislike it. Hence, we decided to let the user decide if they would like to reorient the map or not. As the user makes a turn, they can rotate the map and zoom in or out according to their own preferences.

Our application will be free for users to use and download from the App Store or Play Store. The app is intended to follow a B2C freemium model, in which the free version of the app

allows users to save a limited amount of maps, whereas a premium version allows users to save as many maps as they need. This paid version would cost a one-time charge of $1.99.

We also wish to place ads that are specific to the problems of DTD patients. For example, we will promote Dr. Giuseppe Iaria's training program that intends to help improve the cognitive map-making skills of people with directional difficulties. We can similarly promote research programs as well as new developments in DTD research. These ads would not interfere with the users' navigation--they would only be displayed when the app is opened or at the end of a map-making or map-using session.

Another stream of revenue will come from sponsored research, where Dr. Iaria and/or his sponsors will help fund our app in exchange of user data for research. The users will be given the option to complete surveys and questionnaires about the improvement of their condition, or anything else that the researchers we partner with like. Our app users may also serve as study participants. This way we have a mutually beneficial relationship with researchers, where we contribute to bettering the knowledge and academia surrounding DTD, and in turn have the necessary information about DTD and funding to continuously improve our app.

EVALUATION WITH USERS AND PARTNERS

We received a total of 77 interview and survey responses. At the end of some interviews with DTD sufferers, we showed them our prototype. Many of them liked the idea and think it can be even more useful if the map-making functionality is automated rather than triggered by constant button pressing.

We also met with the renowned neuroscience researcher who discovered DTD, Dr. Giuseppe Iaria. We had a lengthy and productive conversation with him about our goals and

what we know about DTD. He believes our idea of developing an app that lets users trace their path so they can get back to where they started is very useful. He offered to pay for some app developing expenses and connected us with influential members of his lab.

DISCUSSION OF POTENTIAL MARKETS AND FUTURE WORK

2 percent of the world population has DTD, according to Dr. Iaria himself. That's up to 160 million people worldwide. There are many more people in the world who suffer from DTD but don't know that that's the condition they have, so this number is potentially much larger. Furthermore, people who have other general navigational problems other than DTD also fall under DTD Hero's market. There's even more people who can benefit from our app, such as the elderly, those with early dementia or Alzheimer's, etc.

We have ambitious goals for this project and have already spoken to Dr. Iaria. He has also given us some ideas. We can include a diagnostic tool in our app that detects whether the user possibly may have DTD. We agreed to have more meetings with him and others from his lab in the future.

We plan to seek an AR professional so that our app could evolve into one that lets the user use their phone camera to view their surroundings and have real-time visual directions viewable on the screen. Before then, we plan to add voice commands so directions can be heard by those with visual impairments. We also plan to automate the turning of the map when the user makes a turn in real life, implement automatic and passive creation of maps, and integrate a crowdsourcing feature. This crowdsourcing feature will allow users to share maps that they have created with others who use the app. This will be especially helpful for navigating public indoor spaces, and help us form a central database of these places as well.
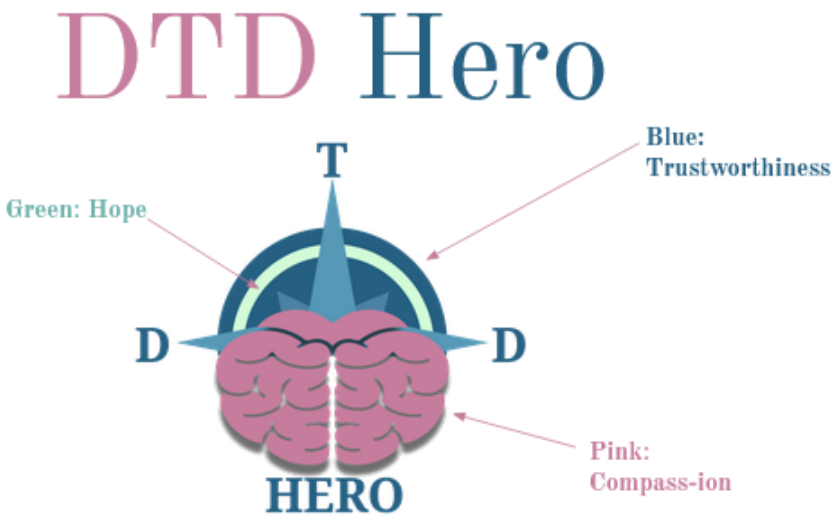
BRANDING

While brainstorming several ideas for this project--from resources for the homeless, the undocumented, and other marginalized groups--we came across DTD, something that none of us had ever heard of before. This piqued our interests and curiosities right away, and when we saw how new it was, how much awareness it lacked, how little information and research about this was out there, and how much the people with DTD suffered because of lack of resources, we decided to focus on DTD. We thought that working with DTD would help us make the most difference and it would be a better way to spend the resources we get from this class.

After struggling to find names for our project, and at that time just having been introduced to DTD, we thought that the name "DTD Hero" would best describe our intentions. Hence, we went with "DTD Hero" for the time being. However, as we spent more time researching and learning about DTD, and found that our app could also help a much wider range of people, we understood that "DTD Hero" as a name is restrictive and somewhat misleading, so we decided to come up with a new name. The people we interviewed also agreed that we need a name change. We are still in the process of picking a name that adequately represents our team and app values.

To reiterate, DTD is a neurological condition that deals with the lack of sufficient navigational abilities. For this reason, we thought it would be fitting to include a brain in our logo to represent the neurological aspect as well as a compass to represent the navigational and orientation aspect of DTD, into our logo. The logo is composed of three colors: blue, green, and pink. The blue represents trustworthiness and heroism, which are qualities that our users look for in a tool that's supposed to help lead them to where they want to go. The green symbolizes hope and encourages our users that they will get the help they need to manage their symptoms. Lastly,

pink symbolizes compassion and expresses the app's solidarity with and understanding of the DTD community. DTD sufferers have felt alone and embarrassed for much of their life and have doubted themselves for a long time, but can rest assured that DTD Hero was designed specifically for them in mind. It's the Hero they've always wanted--and just found.

Figure 3: DTD Hero Logo Branding Diagram

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Ahmed Benmasour	-	Industry Mentor	-	Founder, Ouvous, Zahn Center Alum
Zahn Center	-	Finance, Branding, and Market Mentors	-	Katherine Olives, Kesia Hudson, Steven Monzon, Anna Hutchinson

DTD Patients

City College of New York

CCNY Campus Engagement Network

Moxie Foundation

Goodwill New York New Jersey

Rutgers University

New York State Industries for the Disabled

Lighthouse Guild

INDIVIDUAL CONTRIBUTIONS

Mahin Khan:

- It was my idea to make an app that helps people with DTD navigate their surroundings more easily via maps

- It was my idea to plot pictures onto the map to serve as visual cues and checkpoints, which is what we used for our MVP

- Set up team meetings

- App pricing and freemium model of app was my idea

- My idea to promote Dr. Iaria's training program via ads

- Brainstormed techniques to change orientation of route after making a turn

- Researched and formed ideas for map-making algorithm

- Found and researched potential competitors

- Suggested using step tracker and compass as alternative for automatic map creation

- Created documents organizing things like research, ideas, findings, questions

  - Compiled insights and common themes from survey responses

  - Wrote and compiled questions and answers to prepare for questions from pitch judges and improve our ideas

- Found research foundations for possible funding

- Initialized Github repository with Flutter project

- DTD research

  - Read publications such as articles and research papers

- Technologies research

  - My idea to use Flutter as the software development kit

- ○ Found a Flutter course for everyone to train from

- ○ My idea to use Firebase for database

- Market research

  - ○ Found publications specifying amount of people with DTD

  - ○ Created market sizing diagram

- Brainstormed marketing ideas

- Initial/current logo brainstorming

  - ○ Color scheme of logo was my idea

- Financial Forecasting research and calculations

- Costs and revenue stream research

- Income statement calculations

- Wrote and edited reports

- Wrote and edited scripts

- Wrote and edited pre-read/agendas for Zahn check-in meetings

- Emailed and scheduled meeting with Zahn mentor

- Made wireframe designs on Figma

- Made March Round Robin Pitch Deck for Zahn

- Created several potential logos

- Brainstormed several app names

- Found DTD online forum and DTD Facebook group

  - ○ Introduced team and made posts on the forum and Facebook group

  - ○ Emailed many DTD patient interviewees to schedule interviews and follow-up

  - ○ Conducted many DTD patient interviews

- - - Logged interview insights in rainbow spreadsheet

    - Created slides to present to interviewees for app feedback

- Emailed Dr. Iaria for interview and scheduled the meeting

    - Emailed his lab partner as well

    - Researched Dr. Iaria

    - Spoke with Dr. Iaria and asked him some questions

- Spoke and answered questions in Capstone and Zahn presentations

- Weekly Wiki Log Updates

- Presentation editing (Zahn and Capstone)

- Video editing (Zahn and Capstone)

- Made survey questions and deployed surveys by posting on forum and DTD Facebook Group

- Made interview questions to ask DTD patients and Dr. Iaria

- Rigorously tested app to identify bugs

- Contributed to helping team win the Zahn Bux Prize by earning a significant amount of the Zahn Bux throughout the competition

- User authentication and creation via Firebase

- Camera function

- Log-in screen

- Control pad screen

Wei-Cheng Lin:

- UI

- Control pad screen

- Register screen

- Adjusted the function of the undo button

- Fixed and modified the code

- Integrated the code

- Built up iOS version of the app

- Presentations (both zahn and capstone)

- Video editing (both zahn and capstone)

- Wiki log updates

- Ideas for names and logos

- DTD Hero name was my idea

- I suggested using AR as a future implementation

- Brainstormed map-making refinements

- Took notes during interviews and populated rainbow spreadsheet

- Uploaded slides to wiki

- Spoke at all presentations (both zahn and capstone)

- Posted on DTD Facebook Group

- Researched ideas for map-making algorithm

- Ideas for live location and direction tracking

    - Using step tracker and timer to show current location on map

    - Using orientation triangle to update orientation

- Contributed to helping team win Zahn Bux Prize by earning many Zahn Bux throughout the competition

Sumaiya Mahin:

- Contacting DTD patients for interviews

    - Making posts on DTD forum and Facebook page

    - Sharing our surveys

    - Emailing and communicating with DTD patients about interview scheduling and follow ups

- Set up team meetings

- Forming survey questions

- Forming interview questions

- Conducted many DTD patient interviews

- Emailing Dr. Iaria

- Forming questions for Dr. Iaria

- Answering and asking Dr. Iaria during the meeting

- Spoke at all presentations (both zahn and capstone)

- Answered a lot of questions at all presentations and pitches

- Wrote and edited pre-read/agendas for Zahn check-in meetings

- Emailed and scheduled meeting with Zahn mentor

- Map selection

- Financial forecast calculation

- Income statement calculation

- Cost revenue analysis

- Wrote and edited scripts for videos

- Wrote and edited scripts for presentations

- Created and edited videos

- We won the Zahn Bux Award in the Zahn Incubator Competition, and the majority of the Zahn bux were from my contributions.

- Make visualizations for collected data and information from surveys and interviews

    - Rainbow spreadsheet

    - Pie chart

- Focusing on indoor navigation was my suggestion

- Came up with sponsored research idea

- Research about sponsored research possible funders

- Research for revenue streams

- Marketing ideas

- Made social media pages for DTD Hero

- Using cost per click and Google ad mob for ad revenue

- Came up with initial DTD Hero catchphrase

- Research for DTD

    - Read papers and articles

- Research for Dr. Iaria

    - What institutes he is affiliated with

    - His partner and his affiliated organizations

    - Getting an idea of possible funders or organizations we could reach out to for help

- Brainstormed many ideas for map making mechanism/algorithm

    - Suggested using a series of steps rather than continuous drawing for the technical map making procedure, which is what we did

- My idea to use the flutter grid for map making, which is what we used for the mvp

- App and UI Design: Majority of the figma wireframe

- Initial logo design brainstorm

- Name ideas brainstorm

- Designed several potential new logos

- Wrote and compiled questions and answers to prepare for questions from pitch judges and improve our ideas

- Made and edited presentations and pitch decks (Zahn and Capstone)

- Wrote and edited reports

- Created future growth and milestone timeline

- Crowdsourcing as a future element

Risa Morishima:

- Coded the function of control buttons

- Coded the map making creation

- Coded the categorization of maps

- Coded the rotating/zooming of maps

- Coded the database storage of maps and images via Firebase

- Coded the adding and updating visual cues(images) and descriptions

- Coded the multiple floor creation

- Presentation creation and editing (both Zahn and Capstone)

- Video creation and editing (both Zahn and Capstone)

- Wiki Log Updates

- Initial logo design brainstorm

- Designed several potential new logos

- I designed DTD Hero logo

- Took notes during interviews and populated rainbow spreadsheet

- Updated visualizations for collected data and information from surveys and interviews

  - Rainbow spreadsheet

  - Pie chart

- Wrote a work schedule

- Spoke at all presentations (both zahn and capstone)

- Posted on DTD Facebook Group

- Researched possible ideas/algorithms to integrate AR and automated map making

- Tested and debugged the app at multiple versions

- Made demo gifs of the app

- Contributed to helping team win Zahn Bux Prize by earning critical Zahn Bux towards the end of the competition