Empathy Through Data

Loneliness through the lens of data visualization

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ABSTRACT

This research examines strategies aimed at fostering empathy through data visualizations. Loneliness experienced during the COVID-19 pandemic (during May, July and September 2020) is used as a case study to explore alternate ways of representing data. Along with ways to humanize data representation and curb Statistical numbing, this research uses metaphors to encode sensitive data to help visually represent people suffering loneliness in Ontario during the first wave of the COVID-19 pandemic. The research amalgamates 'affect theory' with concepts of 'arithmetic of emotions' and 'compassion fade' to try and create a solution for issues related to the ways in which we respond to sensitive issues. By employing the mixed methods of research for creation and iterative design development, this thesis comprises 1) a written document stating the research process; 2) a series of iterations leading to a data visualization for the first wave of the COVID-19 pandemic and 3) an interactive web-based data story.

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INTRODUCTION

The motivation for my research topic came from my interest in statistics, information visualization and human psychology. I had been looking at sensitive[1] issues that became prominent during the COVID-19 pandemic. A couple of them being racism, loneliness, COVID-19 deaths, lockdown, etc. One of these topics particularly sparked my interest because of my personal experience, and this was loneliness. I came across lots of articles stressing the fact that loneliness had increased during the COVID-19 pandemic, and it was affecting a lot more people given the restrictions on mobility. In order to see this for me, I went to the CAMH[2] website. I saw a set of line graphs that showed viewers the rising angle of loneliness. The graphics also included details about financial conditions, substance and alcohol consumption around the same time. What I realized as a viewer was the fact that around a thousand people were made into a simple line graph. Somehow, I didn't find myself connecting to their suffering. And that's when I realized that something this important needed to stand out to create awareness and be less mechanical for people to understand it. It should be more personalized and relatable. That is how I chose my subject, loneliness, especially with a focus on the province of Ontario and its people.

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[1] By using the term 'sensitive' along with data I am referring to a sensitive subject, situation, etc. which needs to be dealt carefully in order to avoid upsetting people. (As per Cambridge dictionary) dictionary.cambridge.org/dictionary/English/sensitive.
Here sensitive data would point to the topic of people's mental health during isolation. In this research we are excluding topics that involve sensitive information like personal and private details that have legal implications, critical business information and trade secrets. For more details Refer to Chapter II, Section: Sensitive data.

[2] CAMH or The Centre for Addiction and Mental health is Canada's largest mental health teaching hospital and one of the world's leading research centers in its field. CAMH is fully affiliated with the University of Toronto and is a Pan American Health Organization/World Health Organization Collaborating Centre. More details for reference - https://www.CAMH.ca/en/driving-change/about-CAMH.

I have been fascinated by the different ways in which data is represented across various mediums and how some of them are more helpful in connecting with people at an emotional level. This is one of the principles of 'humanized data' theory that ignited my interests. By studying related visualizations, especially in the context of sensitive issues during the time of the COVID-19 pandemic, I realized the importance of building a personal relationship between the data being represented and the viewer. The act of humanizing data was popularized by Giorgi Lupi and Stefanie Posavec in their book 'Dear Data.' This book focuses on the importance of the ubiquitous nature of data, compelling us to make it more unique, contextual and intimate. As Giorgia puts it, 'The way we visualize data is crucial as it is the key to translating numbers into concepts we can relate to'(PrintMag).

During my continued research, I came across the Data Stories podcast[3] hosted by Enrico Bertini and Moritz Stefaner. The episode featuring Paul Slovic and his work in the field of statistics and psychology grabbed my attention. His research shows us how the concept of 'Statistical Numbing[4]' in data representation is one of the possibilities to explain why the viewers show a decline in compassion for sensitive issues. 'Arithmetic of emotions'[5] and 'compassion fade'[6] further explain the way humans respond to these issues. With the

[3] A podcast for data visualization experts, enthusiasts and beginners. For more details: https://datastori.es/

[4] Refer to Chapter II: Literature Review, Section: 'The concept of Statistical Numbing'.

[5] In the article 'The Arithmetic of Emotion: Integration of Incidental and Integral Affect in Judgements and Decisions', Arithmetic of compassion is a phenomenon that unlike basic integration arithmetic laws, doesn't follow the laws of arithmetic when different sources of affect are averaged or summed. Polish poet Herbert gave the peculiar form of integration of affective calculus the name of 'the arithmetic of compassion'. (Västfjäll et al.)

[6] A function of cognitive processing in which affect, and sympathy decreases as the number of people suffering increases. This term is used to denote decreases in behaviour and affect when the number of needy individuals

understanding of these concepts, I started looking into the representation of loneliness and the way that viewers perceived it in terms of the information being conveyed. Being someone who has experienced the same by being away from friends and family, I always felt that to understand loneliness one needs to feel empathic towards those suffering. This led me to question ‘how can data visualizations elicit empathy by overcoming statistical numbing?’. I began by learning more about the way visuals and number representation can help to tackle this issue. Drawing from my experiences and learnings, I investigated and scanned the industry to study the ways in which similar issues are conceptually represented across different mediums. For this purpose, I streamlined into the way statistical numbing in the representation of data, pre-COVID-19 and during the COVID-19 pandemic, gave rise to a lack of emotions necessary for the delicate issues. Employing mixed methods of research for creation and iterative design development, I created data visualization prototypes that address the issue of loneliness. I conducted user testing sessions using the visualizations to gain insight into the design choices in terms of representation and metaphorical choices, preferences, and criticisms with approval from the Research Ethics Board at OCAD University. My prototype is one of the many possible alternative ways to approach visualizing data in a more humanized way with the use of visuals and voice and by no means the only way to do so. I used these approaches as a reference, by learning and then implementing them to prototype a design system of empathic, aesthetic and hand-drawn visualizations.

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increase. “Compassion” is thus used to both capture the subjective and behavioural components of this phenomena. Refer to articles – “Statistics Don't Bleed": Rhetorical Psychology, Presence, and Psychic Numbing in Genocide Pedagogy” and “Compassion Fade: Affect and Charity Are Greatest for a Single Child in Need” for more details. (Frank et al.)

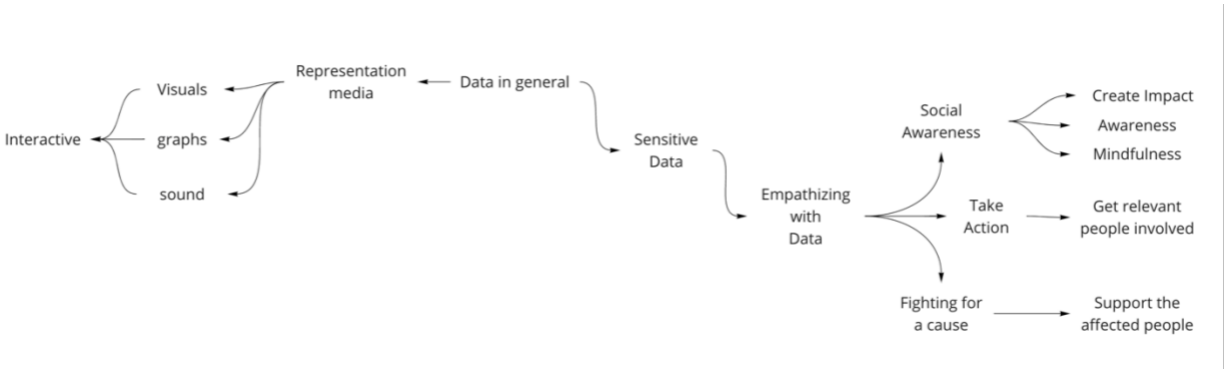


Figure 1: Mind map that streamlines through the process that leads to the focus subject of empathizing with data. (Created by the author)

The broader purpose of my project was to help other designers understand how to humanize the data representation and make it more helpful in terms of the affect that is being conveyed. The project helps them understand the approach that is needed to cater to similar sensitive issues. This understanding is vital as a designer, not only to create the data visualization but also to form a connection with the people being represented through the data.

My Research Question

The main research question of my thesis is – 'How can visualizations foster empathy and help people relate to those suffering from loneliness during the COVID-19 pandemic?'

Significance of the project

The significance of the research lies in its ability to explore abstract elements, the things that cannot be seen, i.e., the feelings and emotions of humans with the care and integrity that is required by humanizing the data. The research project contributes to the field of data visualization by using affect theory along with the concepts of 'arithmetic of emotions' and 'compassion fade' to help curb statistical numbing in data representation. It focuses on sensitive data in order to inculcate a feeling of empathy in the people engaging with it. The data visualization uses metaphors to encode data in the form of the visuals used. The goal of the research is to try and show the suffering of people by making the viewers aware of it and help them emotionally connect to these people. As the research starts forming context, I realized that the COVID-19 pandemic lockdown had brought some sensitive issues into the limelight. With curiosity in knowing more about them, I decided to focus on the overall well-being of people at this time. The research lets us look at sensitive data and treat it with much-needed care in terms of how it is represented. It is through this data visualization experience that I hope the viewer can find peace by cognizance, appreciation, dealing with and knowing that this COVID-19 pandemic too shall pass.

One of the motivations for this research is that more and more people were getting affected by the extended isolation, the loss of mobility and socializing and remote functioning, which was indirectly affecting the mental balance necessary in human life (Sohn). We were experiencing an overload of daily updates about the COVID-19 pandemic that were data-driven, depicting the rising numbers of infections, deaths and its social impacts. This research tries to find the balance between the way data is represented, makes it more humanized and brings in affective visual elements that assist the viewers in understanding the suffering shown through the medium of data visualizations.

CHAPTER I

DOMAINS OF RESEARCH

Sensitive data

Sensitive data, when put in simple words, is data that is sensitive in nature. This does not include concern privacy-related data, as that is counted under private data. But instead, sensitive data deals with sensitive personal[7] issues or delicate topics. Some topics that can be considered sensitive include - religious or philosophical issues, political issues, racial or ethnic origin related, etc. (Irwin). Some broad categories are pointed out below (Figure 2).

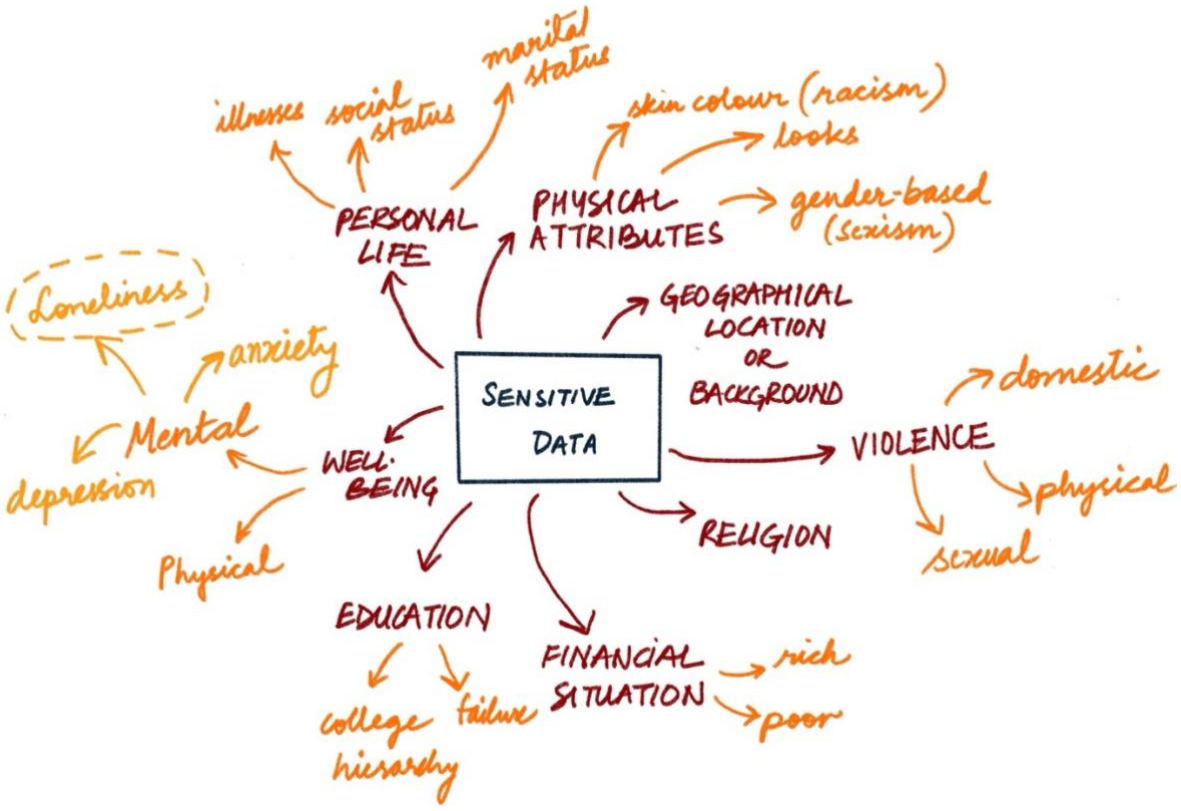


Figure 2: The various types of sensitive issues that comprise the domain of sensitive data (non-exhaustive list). (Created by author)

[7] Sensitive data is a broader umbrella that includes sensitive personal data. GDPR has defined sensitive personal data here: https://www.itgovernance.co.uk/blog/the-gdpr-do-you-know-the-difference-between-personal-data-and-sensitive-data#what-is-sensitive-personal-data.

Sensitive data refers to any data which is of a 'sensitive' or fragile nature. This means that such types of data may hurt sentiments, generate problematic or awkward situations or may even be of volatile nature. These types of data should be handled with care and should not be misused when being shared with others.

Data visualization

Data visualization, as a practice, combines the disciplines of statistical analysis and design. It enhances our abilities to both better understand and summarize a particular data set, as well as communicate the same to an audience. Without statistical analysis, data visualization is ‘an exercise only in illustration and aesthetics,’ while without good design, it fails to inspire (Yau). Sometimes, given the volume of data that one has to analyze, it may get overwhelming and time-consuming. For this purpose, software plays a handy role in aiding this process. Data visualization hence can be digitally created as well. They hold the ability to represent numbers and data in a manner that is easier to understand and draw conclusions from. Data analysis plays a vital role in creating these visualizations. Understanding the data, the context, the audience and the goal of its representation is important for a successful data analysis. In ‘An Introduction to Information Design,’ Aaron Koblin, the Creative Director of the Data Arts Team at Google Creative Lab, describes Digital data visualization as a medium that “allows the designer to present information in real-time and to interpret a database that can constantly be updated” (Coates and Ellison 181).

With data visualization being an important part of information design, this realization leads to the importance of the medium chosen for the representation of data. The choice of medium depends on the task at hand and the audience. It helps in representing the depth of the topic at

hand through its communication abilities. For the data visualization that I created, choosing the appropriate medium helped in elevating the affective experience and focussing on people above eighteen years of age was primary. With the subject of loneliness, hand-drawn visuals with appropriate metaphorical representation on a platform accessible to everyone added to the creation of a shareable platform to spread awareness about the subject.

Aesthetic choices play a major role along with the communication of the data. Elements like colours, communication principles used, composition, metaphorical appropriateness, etc. help direct the essence of the data visualizations (Ware 6). For this project, I worked on both the visual and the sound as a medium in helping the user understand the data visualization created, as the 'propositions given with a combination of imagery and speech were recalled better than propositions given only through images' (Ware 332). I made use of voice as a medium to shed light on the importance of the presence of a known voice or person for those feeling loneliness. The voice also acts as a soothing enforcer for the viewers to understand the importance of proper dialogue and communication.

To design a compelling data visualization and understanding of the following components is important– the data and what it means, what needs to happen with the data in terms of the goals, knowing and defining your audience or stakeholders and choosing the representation of the data that will fulfill the task for the users. Knowing these four components is ideal for gaining insights and making new discoveries with the data (Fisher and Meyer 12).

Data visualization of sensitive issues requires looking into the emotions associated with them (As shown in Figure 3). With an insight into the nuances of the delicate topic, the designer

needs to strike a balance between the simplicity and the complexity of the subject while it conveys the information along with the needed emotional qualities associated with it.

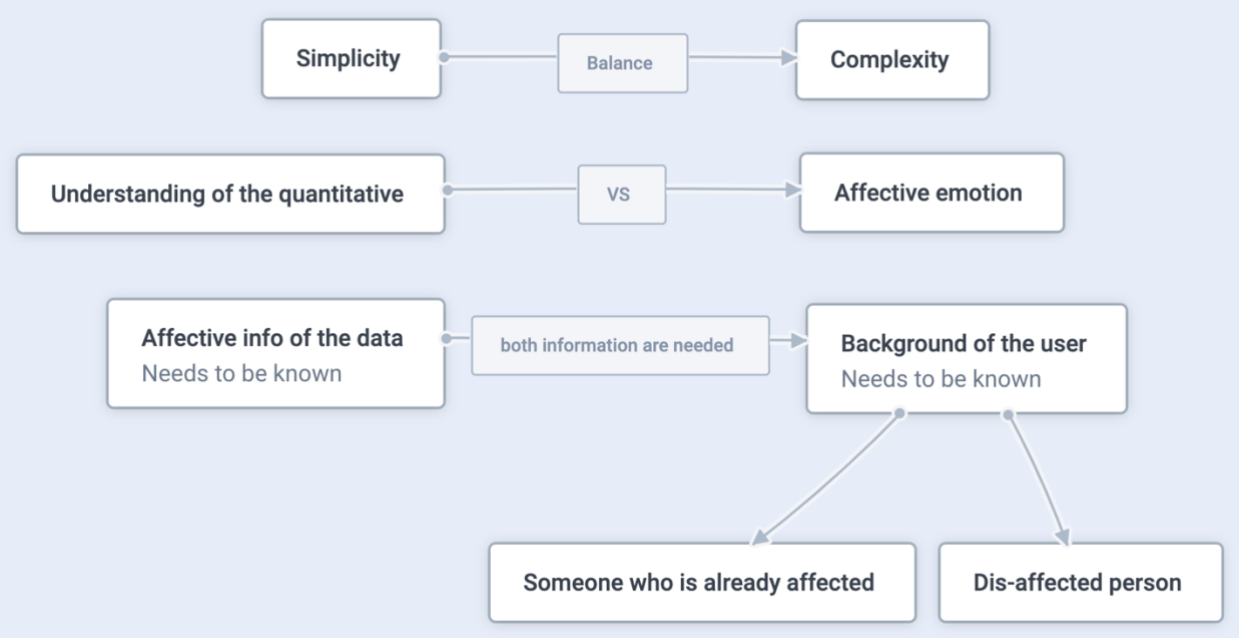


Figure 3: Comparing the affective element of the data and how to approach it with respect to the people forming the audience. (Created by author)

Well-Being

Well-being, which is synonymous with good health, refers to an individual's sound mind and body. It encompasses the physical, social, emotional, societal and workplace well-being of an individual (Davis).

A lot of times, well-being comes to be considered upon hedonistic theories. These theories state that well-being is subjective in nature. For example, human minds have this adaptive capability based on the overall situation, and it tries to adjust and reach a new level of adjusted happiness. This concept is derived from the 'hedonic treadmill.' Psychology Today defines the hedonic treadmill as an idea that an individual's level of happiness, after rising or falling in response to positive or negative life events, ultimately tends to move back toward where it was prior to these experiences (*Hedonic Treadmill*). A hedonic treadmill is a process

by which an individual reaches a balanced point between the emotionally positive and the negative. Below (Figure 4) is the mind-map of the hedonic treadmill in relation to the way it is defined by the context of this project, specific to sensitive issues.

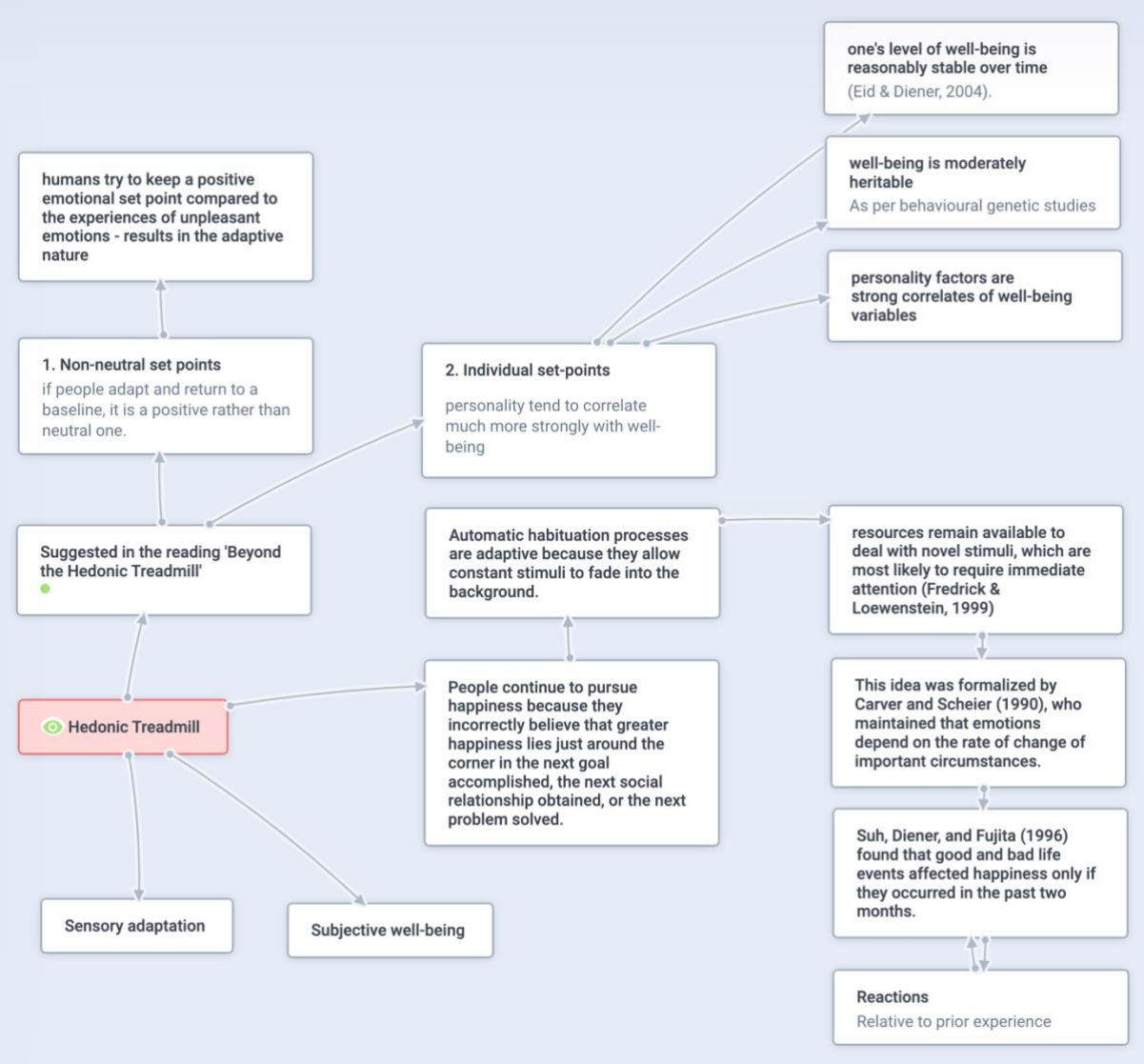


Figure 4:The mind-mapping for the concept of a hedonic treadmill in the context of the project (Created by Author).

We see that the human tendency to adjust and come to a common ground in terms of feelings is usual. This is evident in the COVID-19 pandemic situation - our reaction and attention to the time when it had just begun, which was one of the extreme situations we faced versus how we behaved after the first wave, is a series of adjustments through various stages of the extremities of it. And if we compare these two time periods, we can see the differences in the

way we adhered to the guidelines, how seriously we took the issue and what we did to prevent it.

My thesis works on one of the strings that indirectly affects mental well-being – which is loneliness. Findings support the view that loneliness poses a significant health problem for a sizeable part of the population with increased risks in terms of distress (depression, anxiety), suicidal ideation, health behaviour and health care utilization (Beutel). Although I lack the expertise in medically providing assistance in this area, my idea is for people to be aware of this suffering that impacts the mind. A sound mind is one of the few necessities to overall well-being. And in the case of loneliness, it means more than just being around people. With the hope that loneliness can be prevented, or its effect can be reduced, and the people around can be helpful to those in need, I continue my research in this domain.

CHAPTER II

LITERATURE REVIEW

Sensitive data

Sensitive data in the context of the proposed research

In the context of my research, the focus of sensitive data lies in the emotional well-being of an individual – specifically those who suffered loneliness. I am representing those who felt lonely during the COVID-19 pandemic lockdown, with the broader picture enlightening the viewers about the way it affects those who are suffering.

The majority of us have been in dire situations during this lockdown and for some of us, being away from family and friends felt agonizing. Being locked away in our present locations, with no physical communication with others in itself, has caused some damage as anticipated. As Aristotle proposed that man is by nature a social and political animal (qtd. in Carter 66), devoid of social interactions have given rise to the feelings of loneliness. With what we have been through, the idea is to focus on something a lot of us felt, and that too for a period of almost a year – loneliness. This data visualization addresses the silent illness that has affected people across age-groups and gender groups and continued doing so even before the COVID-19 pandemic struck.

An overview of data visualization

Using visuals – The visual landscape & visual context

In this research, I came across a lot of examples of data visualization that either worked on digital platforms or as installation in an interactive way. With the intention of creating something similar, a digital output for the purpose of ease of sharing seemed to be apt. I came across a project by Sonja Kuijpers, a renowned Information designer based in the Netherlands. Her data visualization 'A view on despair' drew from her personal struggle wherein she was depressed, in pain and felt low for a long period of time (Kuijpers). Her depression and pain pushed her to try to commit suicide. Her struggle through depression and also seeing other known people in her circle commit suicide by drowning themselves or jumping off a building is what motivated her to create this beautiful data visualization. A delicate subject of suicide deaths in the Netherlands was tackled by Sonja in the form of a beautiful and thoughtful data visualization to pay tribute to those who died by it either by hanging, overdoses, drowning, jumping in front of trains or from a height or in other ways by showing them as trees, waves, stars, buildings, fireflies, etc. Being a highly sensitive issue, she has respectfully showcased the reality of the situation that leaves the audience thinking. She creates this detailed visualization that looks beautiful and serene yet shows the extent of devastation at the same time. She created what she calls ‘data art’ as a method that experiments with form and style (See Figure 5).

Figure 5: The data visualization by Sonja to show the suicide in the Netherlands in 2017. Link - http://www.studioterp.nl/a-view-on-despair-a-datavisualization-project-by-studio-terp/ (Accessed 4 June 2020).

Sonja got her data from the Dutch Statistical Bureau website for the year 2017 and also the Dutch suicide prevention service for the purpose of creating this visualization (Kuijpers). She began by sketching how various ways of suicide would convert to visuals without being brutal. These sketches were then incorporated into a landscape using the application of Adobe illustrator. She also created charts using the application of Microsoft Excel that helped her examine the data. What made her visualization interesting is the two-dimensional landscape with a three-dimensional depth to it letting the viewer compare the men and the women who committed suicide and form startling observations. Her storytelling, along with the visualizations, is what adds a touch of personalization to the entire experience. She decided to create a website for the same while providing detailed information about her motivation to create this along with other resources that would help the needy seek professional help if needed.

Another project dealing with the sensitive issue of 'loneliness' was by Marissa Korda and developed by Leslie Ink – 'An Imperfect archive of us: The loneliness project.' It's built in the form of a scrollable website that shows a night scene with a building in focus. This building has windows that light up on hovering, making the audience interact with the elements on the screen (Figure 6). The website has a background street noise that plays to give the feeling of a building standing on an actual street with cars moving through, etc. On clicking on one of these windows, we get to read about the story of an individual with their age, when was the last time they felt lonely, what loneliness means to them, the first they realized they felt lonely and a story about when they felt most lonely in their life. These anonymous personal stories from the lives of real people make the truth more hard-hitting. When reading these stories, you feel the suffering that the person was feeling at that time. It creates a more personal connection, despite the viewer not knowing the name or not having seen the person

about whom the story is. The website uses a ‘share your story’ approach where anyone can anonymously share when they felt lonely. This approach helps make loneliness more human, and the stories shared have the power to heal both the listener and the teller. The digital space helps Marissa share stories to the world to help build empathy and grow kindness amongst the people towards this universal problem of loneliness (*An Imperfect Archive of Us: The Loneliness Project*). The beauty of this project lies in the simplicity of the narrative of storytelling. The stories are real, come straight from the heart and are all contributed by the viewers themselves.

Figure 6: A visual representing one of the windows in the building also shows a glimpse of one of the stories that get revealed upon clicking. Link - http://thelonelinessproject.org/ (Accessed 4 August 2020).

Marissa and Leslie's work deeply inspired me to look at loneliness as my subject of focus. Their work and after reading some of the stories made me realize how common loneliness is.

Using sound – The sound landscape & sound context

'Sound' – the input that gives us the sense of hearing is a very strong element. Sound and its affective qualities have moved people during performances, songs, noise – be it through voices, shrieking, pleasant tones or even utter noise. By using the brief videos that users upload on Snapchat, Christian Marclay, a visual artist and composer, along with Snapchat, created a sonic art piece that represents 'Sound stories' as the name suggests. Sopan Deb, a writer at The New York Times, described their work in his article (Deb). He shares how the pictures and videos used in this piece are public stories of people that have been uploaded on Snapchat and are available for people to see. The 'Sound stories' project makes use of Snapchat videos as raw material to fuel the idea of combining sound and technology and create five immersive audio-visual installations, two of which are interactive ("Christian Marclay"). The idea was to see how Snapchat sounds like instead of how we see Snapchat as it is. Christian Marclay's musical composition was used as a reference, and musical noted were picked from the Snap stories (10-second snaps or gifs) to recreate the same composition. Using algorithms that picked the notes from these Snapchat stories, they were linked to the musical instrument keys. And once the instrument was played, the stories would show up along with the sounds associated with their stories (Figure 7). This is a unique and interesting take on visualizing sound from videos in the form of an interactive exhibition, by making use of something that is publicly available. The uniqueness in terms of playing with sounds produced by videos is what made me look into the way forms of sound can help improve the visual experience of the audience.

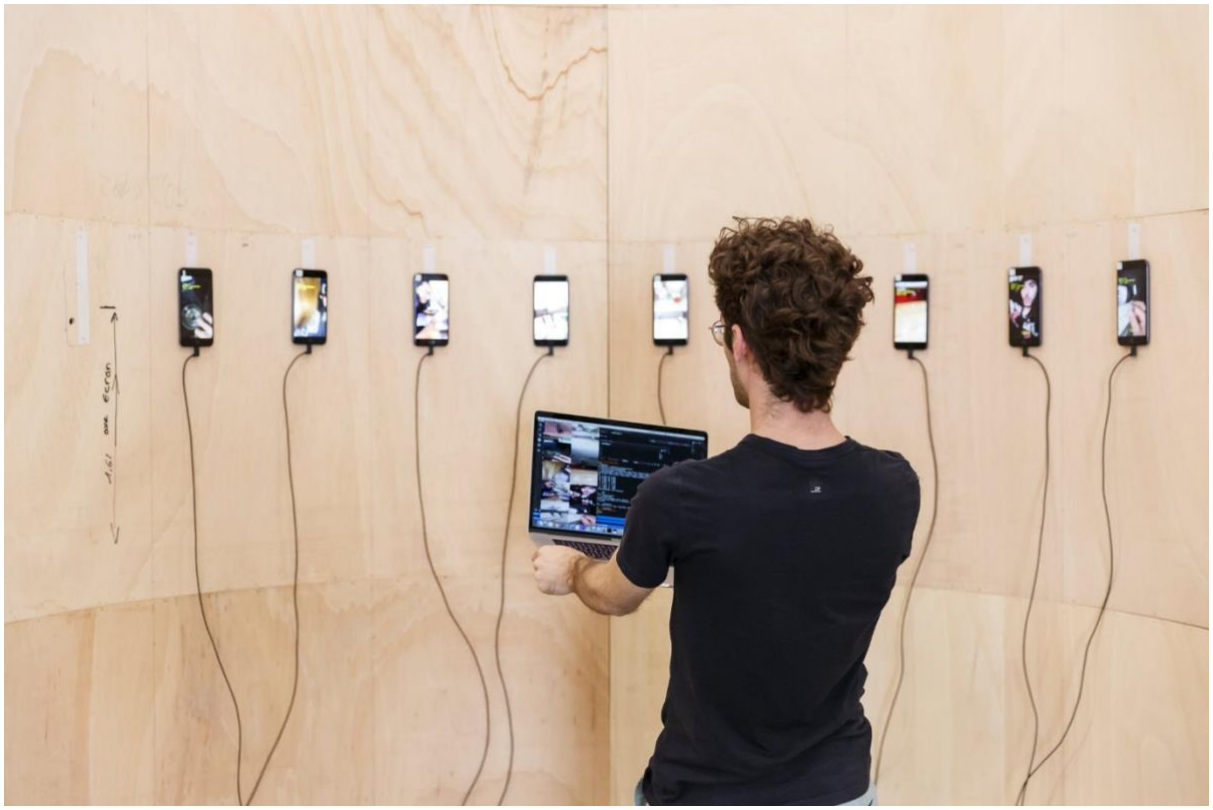


Figure 7: The installation of the piece, with the videos being set to the compositions by Christian Marclay. Link - https://www.nytimes.com/2018/06/08/arts/design/snapchat-christian-marclay.html (Accessed 4 August 2020).

Another project in terms of sound was the project called 'Sonic cities.' Created by the MIT Senseable city lab ("Sonic Cities"), this recent project showed us the change in the background noise pre-COVID-19 and during COVID-19. The sound recorded has been shown in the form of an interactive graph. The data visualization shows five different park locations - Central park in New York City, Hyde Park in London, Public gardens in Milan, Marina bay in Singapore and Golden gate park in San Francisco. The map shows a pre and during COVID-19 comparative soundscape of how the lesser the people are on the streets and public spaces, the lesser environmental sounds. The comparison shows how sounds of birds and winds can be heard clearly during the COVID-19 phase. This project reminds us about the beauty that lies in nature and how we are undermining it. This project shows the value of the sounds from nature. For my project, I wanted to bring in this quality that could help in improving the balance between what we see and what we feel from it.

Using sound & visuals – The combined landscape

Visuals, along with sound, create a perfect combination that appeals to multiple senses of the human body. They elevate the overall affective qualities associated with them. Due to this primary reason, we see extensive use of both these mediums in performances and installations to create a more profound effect on the audience.

Some other projects worth mentioning were 'Moody quarantine music,' 'Listen to Wikipedia, and 'Messa di Voce' make use of both visuals and sound. 'Messa di Voce (2003)' by Golan Levin and Zachary Lieberman is a real-time visualization that interacts with the audience by taking their speech as input (*Messa Di Voce (Installation) - Interactive Art by Golan Levin and Collaborators*). The installation works with customized software that makes use of computer vision and speech analysis technologies. It's a playful and creative way to showcase the effects of sounds, music and speech in the form of abstract audio-visual narratives. The concept behind this installation is to make human voices visible. The real-time abstract visualizations created are unpredictable as well as spontaneous, having a synesthetic effect where sound can be visualized. This installation is a good way to engage people and see the way sound and visuals go hand-in-hand to create an experience that is unpredictable yet fun in nature. This project was essential in terms of deciding how human voices are crucial or can lead to a crucial change in a visual in a powerful manner.

'Listen to Wikipedia,' a project by Stephen LaPorte and Mahmoud Hashemi (Hashemi and Laporte), is a real-time data visualization that combines a big platform like Wikipedia and represents the changes made on its platform in a very creative way. As the title suggests, 'Listen to Wikipedia,' it works on the principles of real-time changes made by the users and

admins on any page of the Wikipedia platform, and this, in turn, is associated with a particular sound note. These sound notes when heard together, create a beautiful symphony. Every change be it, addition or subtraction of details, anonymous edits, new user or registered users, will make a new symphony every time. The visuals associated are very pleasant to look at while we hear the sound notes. This digital data visualization, and its element of surprise in the music created is what keeps the users engaged along with its soothing concentric circles that form visualizations.

Another creative output was using Google's AI to create a lo-fi player. A project by Vibert Thio, gives the user an opportunity to create quarantine tunes to vibe with. Karen Hao, a writer of MIT Technology Review explains how this project out of Google Magenta helps the users create melodies and sceneries on their own. The idea of this project was to try and make music-mixing a simple and friendly experience. The music made corresponds to a pixelated illustration that is interactive and can be altered based on the various elements in the illustrated scene (Figure 8). The virtual room uses machine learning to help mix the tunes and create their own lo-fi hip-hop soundtracks (*Create Your Own Moody Quarantine Music with Google's AI | MIT Technology Review*). These machine learning models that work in the background curate the various aspects of sound such as bass lines, drum lines and background ambience. This lo-fi player launches into an interactive YouTube livestream where users can type the commands (e.g., 'turn off the lights', 'click the cat', etc.) to change the music. This platform was made with the idea of bringing together people during COVID-19 to help create music together. The concept of working together with others to create a musical composition was an inspiring input. I wanted to use the 'bringing people together' through sound into my project as well.

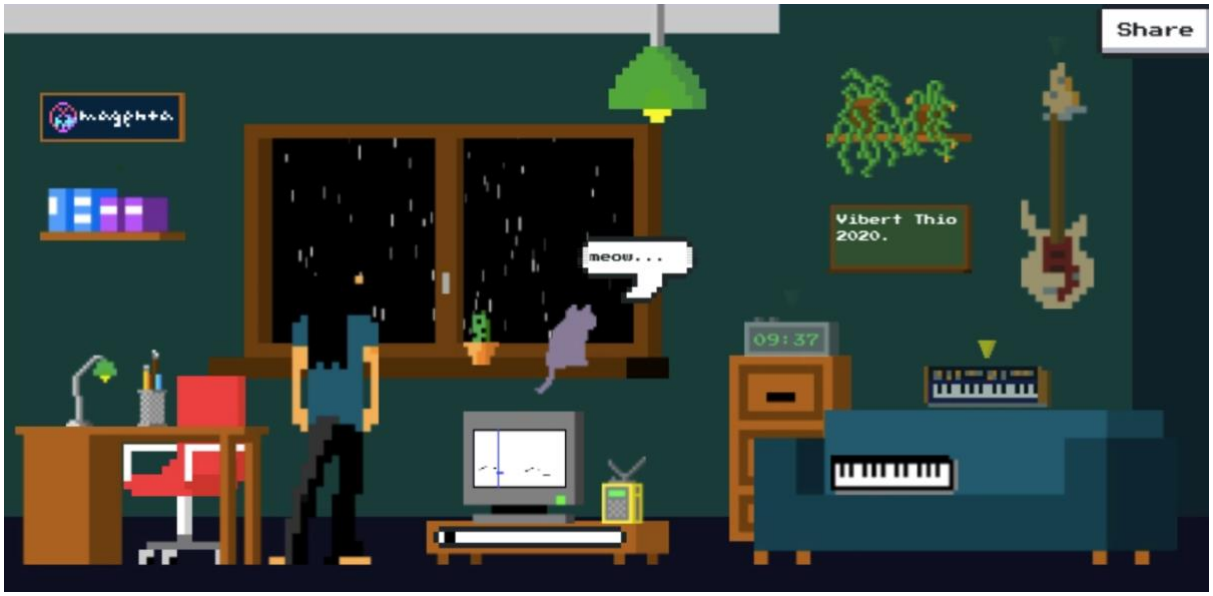


Figure 8: A visual piece created by the elements chosen in the scene. Example: the night sky instead of daylight by turning off the lights, created and played a certain piece of music in this case. Link - https://www.technologyreview.com/2020/09/04/1008151/goo (Accessed 7 September 2020)

A heart touching data visualization by Giorgi Lupi, called 'Bruises – The Data we don't see' was created in collaboration with Kaki King, a musician, composer and Lupi's friend. This data visualization has a serene quality to it. The representation was that of Kaki's three-year-old daughter who suffers from Idiopathic Thrombocytopenic Purpura, an auto-immune disease. In this disease the blood vessels burst and leave bruises all over the body (lupi). Lupi created this data visualization piece showing her support for the family and the emotional turmoil that they were in. The visualization is created with the daily observations that were made from Kaki's daughter's symptoms, such as the platelet counts, the bruises on the skins, the intensity of the bruises, etc. These details were made into the floral petals with red spots, to show a visual metaphor of being beautiful yet fragile (Figure 9). As Lupi puts in her own words – 'These unique four months of their lives, ultimately became a musical score and a data visualization, but probably not exactly the type of representation someone would normally expect from clinical data' (lupi). This data visualization went along with a song that Kaki composed for the data collection. This combination of visual and sound, that represent

the 120 days of data collected, paint a sensorial picture of this personal journey. And as Lupi rightfully shares with us – 'Data are never only what we see at a first glance, they are never only the hardcore numbers. They always come with an often-overlooked set of more fluid and nuanced information that therefore requires new forms of representations in order to be captured fully' (lupi). This project was one the major steppingstones in my research that guided me in the direction of looking at data in more ways than one. This project taught me about data humanism, and how delicate story representations can capture the emotions along with it to play a vital role in the healing journey of those involved.

Figure 9: The data visualization created by Giorgi Lupi to evoke empathy for Kaki's daughter's illness. Link - http://giorgialupi.com/bruises-the-data-we-dont-see (Accessed 19 October 2020).

The concept of Statistical Numbing

What is Psychic Numbing?

Psychic Numbing was a term coined by Robert J. Lifton, a renowned American Psychiatrist and author. As per Lifton, psychic numbing was used to describe how victims of great trauma block out certain painful experiences in order to survive. It's a psychological phenomenon that came into the limelight during mass atrocities and genocides, that showed us how people did not comprehend the pain, felt indifferent and somehow completely felt numb towards any form of suffering and pain to a large number of people by a 'compassion fatigue'[8]. This decline in feelings begins when the number of affected people go over one, because the mind cannot connect to two people simultaneously (Frank et al. 10).

"One death is a tragedy; a million deaths is a statistic" – Joseph Stalin

(qtd. in "Psychic Numbing")

In 'Statistics Don't Bleed: Rhetorical Psychology, Presence, and Psychic Numbing in Genocide Pedagogy' researchers and statisticians Paul Slovic, David Frank and Daniel Vastfjall show us how "*psychic numbing* disables moral intuition"(Frank et al. 3). The term itself has been seen widely used in the cases of PTSD or Post Traumatic Stress Disorder. Researchers, behavioural scientists and psychologists have observed and developed theories that explain the way in which humans behave during extreme situations. In the same journal article, we see that as per human psychology, affect play a vital role in this ignorance to mass

[8] Prolonged exposure to other people's trauma can be vulnerable to compassion fatigue, also known as secondary or vicarious trauma; they can experience acute symptoms that put their physical and mental health at risk, making them wary of giving and caring. Refer to these links for more details - https://www.psychologytoday.com/us/basics/compassion-fatigue and https://www.psychologytoday.com/us/blog/high-octane-women/201407/are-you-suffering-compassion-fatigue.

murders and genocide. Without this, the information lacks meaning (Slovic 4) and this is crucial to motivate positive behaviour and make decisions.

What is Statistical Numbing?

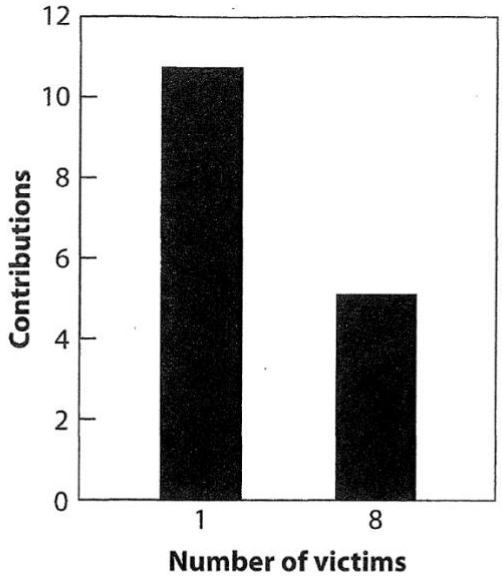
Paul Slovic introduced statistical numbing, which is a derived version of the term ‘psychic numbing' (“84 | Statistical Numbing with Paul Slovic”). It is the phenomenon of being indifferent towards statistics and numbers about sensitive issues, tragedies and stories. The human brain is designed in a way that it can understand stories better than numbers (Frank et al.11). And when as an audience, one is shown statistics, numbers and numerical representation, we often fail to associate the emotional baggage that it requires.

“If I look at the mass I will never act. If I look at the one, I will."

– Mother Teresa. (Slovic 2)

Mother Teresa, the symbol of compassion and charity said so. This shows us the baffling realities of how humans behave when they see others plight. But this inability to comprehend others pain of the large numbers has other reasons associated with it. A single impacted person has the ability to make us feel empathy for them. This is because our mind can comprehend the empathy needed for a single person. But the moment the number of impacted people increases, we fail to show the same level of empathy for the situation. The abstract nature of emotions and our inability to understand the ‘faceless nameless lifeless abstraction of number’ (Ropeik) leads to statistical numbing. Humans can relate more to the reality of one individual, and because of this as the number of deaths increase, our compassion and emotional association goes down. As Paul Slovic puts it, “We not only become numb to the significance of increasing numbers, but our compassion can actually fade or collapse overall

as numbers increase" (Ropeik). Slovic through his research introduces the unquantifiable nature of emotions and empathy that leads to this.



7.7. Mean contributions to individuals and their group.
(Data from Kogut and Ritov, 2005b)

Figure 10: To show statistical numbing leading to compassion fade. The results of a research by Kogut and Ritov. This was used by Paul Slovic in his research study. (Slovic et al. ch. 7, p. 132) (Accessed 11 February 2021).

We as humans, do not know the amount of empathy that needs to be associated with the death of 100 people, because we only know these 100 people as numbers and not as individual people. In simpler words, the human brain is equipped to understand what Koestler mentioned as 'small lumps' of reality (Frank et al.10). Using Weber's Law (Weber-Fechner Law) 'the more the affected people, the lesser empathy it provokes' (Slovic 6). The research further suggests that humans face a loss of compassion the moment the number of affected people increases from one. This is due to the inability of our minds to connect two or more people simultaneously (Slovic 7).

Table 2. Two modes of thinking: Comparison of experiential and analytic systems (adapted from Epstein, 1994, Copyright 1991, with permission from Guilford).

System 1: Experiential System	System 2: Analytic System
Affective: pleasure-pain oriented	Logical: reason oriented (what is sensible)
Connections by association	Connections by logical assessment
Behavior mediated by feelings from past experiences	Behavior mediated by conscious appraisal of events
Encodes reality in images, metaphors, and narratives	Encodes reality in abstract symbols, words, and numbers
More rapid processing: oriented toward immediate action	Slower processing: oriented toward delayed action
Self-evidently valid: "experiencing is believing"	Requires justification via logic and evidence

Figure 11: The two systems of the human mind and a comparison of what aspects they focus on. Taken from "Psychic numbing and genocide" ch. Judgment and Decision Making, Vol. 2, No. 2, April 2007 (Slovic 6) (Accessed 19 October 2020).

Statistical numbing in the context of proposed research

For my thesis research, I am closely looking at the way statistics and numbers have similar repercussions on the people in term of sensitive issues like loneliness during the COVID-19 pandemic. I understand the feeling of loneliness, because I have been one of those people who has seen this illness take shape. Especially being away from family and friends, loneliness has had a stronger grip over me. This led me look at how others were feeling in Canada. I was wondering whether I was the only one who felt this way.

The Centre for Addiction and Mental Health or CAMH ("COVID-19 National Survey Dashboard") showed 'What Canadians are reporting about their mental health and substance use during the COVID-19 pandemic'(link-https://www.CAMH.ca/en/health-info/mental-health-and-COVID-19/COVID-19-national-survey). I knew what level of care and compassion is needed for those who were suffering. This made me realize that creating a more human relatable data visualization, with proper attention to the individuals who suffered will be a starting point to garnering the compassion when the viewers see this data. The statistical numbing that played its effect into the CAMH charts needed to be tackled. With the

context of creating data visualizations that elicit empathy, my goal was to try and curb the effects of statistical numbing.

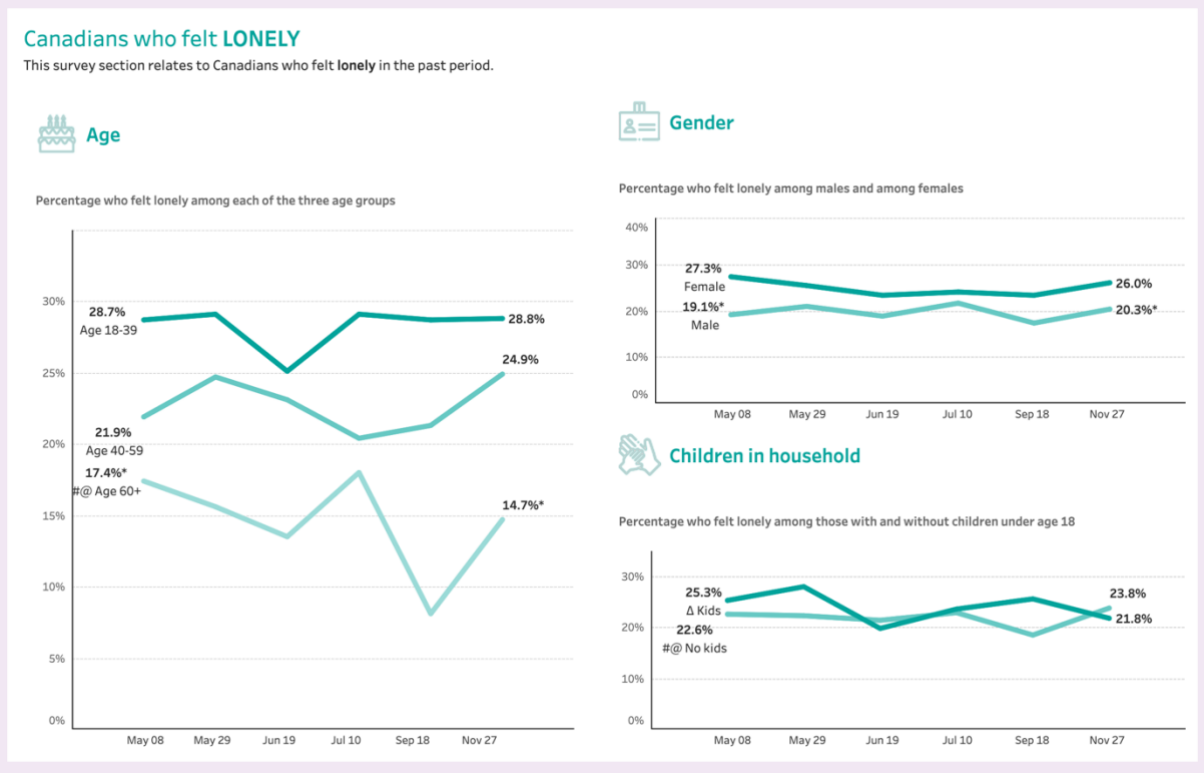


Figure 12: Charts that show loneliness felt by Canadians from May 2020 to Nov 2020 ("COVID-19 National Survey Dashboard") (Accessed 11 February 2021).

Given the things we see and hear every day, on the news or social media, statistical numbing unknowingly plays a vital role in these too. Drawing more information about Statistical Numbing, through researcher and Statistician Paul Slovic, we get to know that the human mind is slow and more careful when it comes to analytical aspects of information ("84 | Statistical Numbing with Paul Slovic"). We tend to use reasoning in these cases. But for the intuitive ones, we rely on affect and feelings generated. Trying to tackle this similar situation of loneliness in this COVID-19 pandemic has been my focal point.

Dealing with Statistical Numbing

When COVID-19 pandemic had begun, it did come as a surprise to all of us. With none of us having experienced it before, everyone was glued to the social media and the news to know more about daily second-by second update of what's going on around them. It was new, no one knew what had fallen upon us and people were scared. We all tried to keep up with the daily dose of information, but overtime, we didn't. Some people started avoiding news altogether to keep themselves sane, others began to resort to alternative news platforms and channels. With so much at stake, not being aware was not an option. But everyone was tired. People were tired of trying to comprehend the data, with so many staggering numbers on the screen, we lost track of how to feel. We became numb to the news (Illing). That gives us an example of what Statistical numbing is.

In a series of research studies in 2014 in Sweden, Paul Slovic and other researchers demonstrated how statistical numbing leads to compassion fade as the numbers increase (Wen). The results of the experiment went on to prove that easier calculations, smaller numbers and relatable events are more likely to draw compassion compared to others. The participants in the study were more inclined to donate money to a single starving child than a number of people starving in the same region from where the child was from. As Paul Slovic puts it, "You feel bad that you cannot help everyone and those bad feelings come in, mix with the good feelings and devalue the good feeling" (Wen). In these sorts of situations, empathy and compassion are key. And this is exactly what we are facing even today. But what can we do to avoid these traps? How can data visualizations help to eliminate or reduce the effects of statistical numbing, especially when it comes to sensitive data? How do we tackle these issues? From the same research, Paul Slovic suggests how we can improve the situation. In order to avoid the problems of Statistical numbing we need to focus on a couple of specific

things. Enrico Bertini in his research paper along with his colleagues deep-dives into how visualizations elicit empathy (Bertini et al. 5). The summary of the results is shown below.

1. By introducing Anthropographics: Anthropographics are the "visual strategies to make the connection between data and the humans behind them more direct and, hopefully, more empathic." This concept is strengthened by introducing the use granularity, realism and expressiveness, labelling and unit grouping.

- Much similar to the design principles that are used in communication, Anthropographic's works well when data is visualized in the form of separate units rather than in an aggregated format. Especially with the sensitive issues involving people, one unit is representative of one person, which is more relatable.
- When using this unit form, the icon that is used should be close to realism. It should be able to express the emotional quality of the issue in hand.
- Proper labelling of the different icons used has an evocative effect on the people while perceiving them.
- Individual units that represent people, can be grouped in more organic ways. Rather than using a grid or structured way of grouping, the organic-ness seems to give a more realistic outlook to the data visualization.

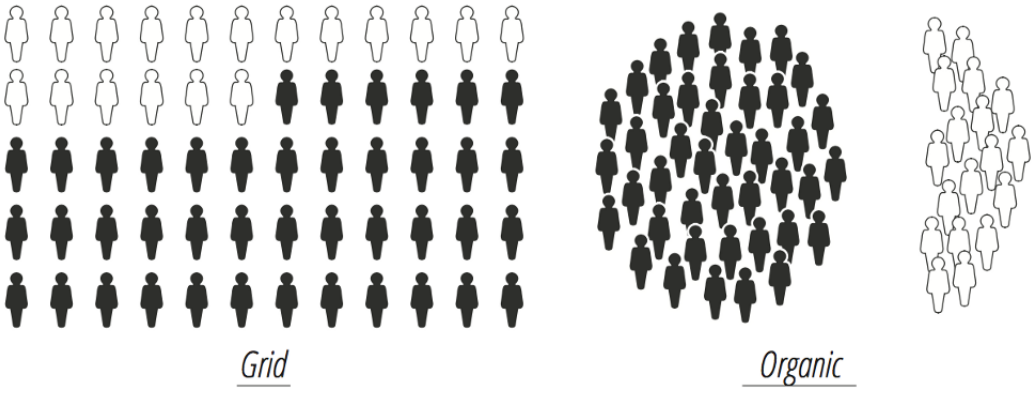


Figure 13: This is how grouping works in a grid and organically. The type of grouping helps in adding onto the way we perceive it (Bertini et al. 5) (Accessed 4 August 2020).

2. Excessive usage of text in the data visualizations also leads to decrease in overall empathy levels. Graphics play a vital role, especially given the way the human Brain functions. Our minds are more adapted to the visual side than to the textual side.
3. For the audience to understand the 'amount of empathy' that is necessary for a sensitive issue, they need to be able to relate to the issue when it affects one person. Human brains can fathom the compassion and empathy needed for a single person. So, if we maintain the 'relatable' factor in the data visualizations, people understand the evocative value of it more. Evocative add-ons could be use of more imagery, photographs or cinematic effects such as animations, transitions or sound.

From the above results, we can clearly see that Statistical numbing cannot be eliminated, but its effects can be reduced by making changes in the graphical representation of the data to generate empathy. "Empathy is often considered a precursor and motivator for prosocial behaviour" (Bertini et al. 2). Keeping this in mind, I have incorporated these features to the maximum extent in my prototypes.

In my research I've used metaphorical elements by following the above requirements that help in avoiding statistical numbing. I used the scientific findings described in this section to inform my research project, including the use of visual metaphors that helped me in creating relevant graphical elements. More details about the structure and elements considered in the research can be found under the visualization methods in the next chapter.

Loneliness

Loneliness is a phenomenon where most of us feel alone when the innate need to connect isn't met. Often, people who feel lonely are not alone. The lack of social connections is one of the major reasons for this. Individuals undergo ‘a range of feelings or deficits of connections, including how often they feel the lack of companionship, left out, 'in tune' with people around them, outgoing and friendly and feel there are people they can turn to’ (*Loneliness | Psychology Today*).

How is loneliness affecting people during the COVID-19 pandemic lockdown?

‘Loneliness is a complicated emotion’ (Sohn). We have realized the need for human connection, despite the daily amount of solace and solitude that we need. Research studies have shown that ten hours of isolation from people, social media and any sort of technology leads to more social craving and loneliness in the end. It even has a similar effect as ten hours of fasting (Tomova et al. 7). This goes on to prove to us the importance of social interactions, people and staying in touch with them in the lives of humans.

Globally, almost everyone has felt lonely at some point of time in their lives. Kay Tye, a renowned American Neuroscientist shares with us that ‘humans between the age of 16 and 24 are the most likely to report feeling lonely and this is also the age when many mental-health disorders first begin to manifest’(Piore). Given the effect that loneliness has on our mind and overall well-being, we do understand its importance as a sensitive issue.

Loneliness related data

Loneliness is often considered to be a silent killer in the medical world. One of the reasons for naming it so is because it doesn't have any visible symptoms and leads to the rise of other

well-being related issues. Supporting these statements, New York Times released an article which went on to define the symptoms of Chronic loneliness. As per the article, "Chronic loneliness is also linked to heart diseases, Alzheimer's disease, suicide and even death"" (Piore). My research data procured from The Centre for Addiction and Mental Health (CAMH). The people being represented in the data are the Canadians who anonymously took part in the CAMH survey to shed light on how anxiety, binge drinking, loneliness and depression have affected them during the lockdown period[9].

Loneliness has affected people irrespective of the age-group they belong to. Study in Scientific Reports by British researchers have shown us that older people who had reportedly fallen and were later hospitalized after the fall had very few social contacts. When they were surveyed, the results showed that 'people who lived alone were 18% more likely to have reported a fall than those who lived with others'. These older patients were surveyed, which revealed that higher scores on the social isolation scale had a 24% more chance to undergo a fall. These statistics show us a staggering picture of the way loneliness affects other aspects of our mind and body leading to some disastrous end results (Bu et al. 4).

The problem we are trying to solve - Fostering empathy.

To help reduce the feeling of loneliness, we can be present to help and empathize with those suffering. Across a number of studies, its seen that people with 'strong social relationships had a higher probability of living longer than those with weaker connections.'Dr.Holt-Lunstad, a Professor of Psychology at Brigham Young University, shares that 'just knowing

[9] More details about the CAMH data can be found under Prototyping and making.

that people are there for them, leads to a reduction in stress' (Sohn). A lot of us are desensitized to the problem, which isn't acceptable when looked at from a critical standpoint. To achieve this goal, I am trying to reduce the statistical numbing effect on our minds so that the viewers feel more connected to the subject of loneliness. Being fully aware of people's emotional capacities, this research understands the limitations in terms of fostering equal amounts of empathy in everyone.

Empathy

Fostering empathy in the audience is one of the primary goals of my thesis project. Empathy, is the natural capacity to share, understand, and respond with care to the affective states of others (Decety et al. vi). It's a feeling that generates when one wishes to help those in need. It gives humans the ability to fully understand, mirror, then share another person's expressions, needs and motivations (Gibbons). This type of reciprocal behaviour is also found in nonhuman primates but limited to individuals living in close proximity (Decety et al. 25). In the book 'Empathy: From Bench to Bedside', we see that the human mind intrinsically considers empathy to be a morally positive disposition. Although there are different ways to empathize, the primary three ways are: when the response mirrors the sufferer's distress, when the response feels pity for the sufferer but does not mirror the suffering and when the observer takes pleasure in the sufferer's condition (empathic cruelty) (Decety et al. 29). Though humans are innately empathic, sometimes undesirable attitudes such as spitefulness, cruelty, etc. creep in as well (Decety et al. 32). Empathy and compassion have evolved over ages, especially given the social nature of human beings. Sharing, caring and cooperating became crucial for survival as a group. To this date, these aspects have influenced the way social groups are formed. Empathy is an important part that contributes to the fitness of the group (Decety et al. 55). Through this book, I have learnt more about the facts and effortless way our minds can determine an emotional stimulus to be appetitive or aversive. Depending on the determination, the sympathetic nervous system activates the empathic understanding built in the perceiver's mind (Decety et al. 58). For the purpose of creating a data visualization pertaining to a subject that requires the perceiver's empathy, these concepts

have helped in creating a more human-centred design[10]. Along with using humanized data as one of the key elements in representation, to inculcate empathy I chose to create a narrative around the subject of loneliness. The narrative model makes more sense developmentally. 'It requires the ability to recognize others in the detailed pragmatic and social contexts that are other than my own, and to understand the other's actions and affective states in that context, in a narrative way' (Gallagher 26). We as the perceiver's gain the ability of understanding others through a narrative practice, which is very similar to the way children listen to stories and gain familiarity with the characters, the situation and the actions appropriate for those situations (Gallagher 20).

With the focus on the research and its development, understanding the person in the context of their situation, having a sense of their situation, is crucial to form an empathic attitude towards them. And this attitude of affect and empathy works only when both the people being represented, and the empathizer experience an affective state (Gallagher 23). Though every empathizer viewing the data visualization comes from a different affective state, but then one can understand empathy not as necessarily taking up a secondary affective state. It simply means that the feeling of empathy involves the feeling of being with the affected person in a certain spirit, with regard to the empathizer's situated experience. Taking from this, it may or may not lead to solidarity, and then continue to a reciprocation, but by feeling for the affected person in any form still counts as a feeling. This feeling is often elevated when the data seems personal to them wherein both the empathizer and the affected person have faced a similar

[10] The philosophy that proposes that end users be at the center of technical system designs, to create meaningful and usable information and communication technology. For more detailed information, refer to the journal article 'Human-Centered Design in Practice: Roles, Definitions and Communication - https://journals-sagepub-com.ocadu.idm.oclc.org/doi/pdf/10.1177/0047281616653491

situation (Gallagher 24). This aspect of feeling for others, and having emotions helps in understanding the subject of loneliness to a greater depth.

Critical Stance

Sensitive data representation case studies

For knowing more about the COVID-19 pandemic, and keep ourselves abreast about the protocols, severity of the situation, the symptoms, rate of spreading, etc. everyone's go-to news platforms were some forms of social media or news channel platforms. This implies that we hold the way data is conveyed and represented to us in utmost power, because we rely on it every day. What is shown in these platforms becomes our source of knowledge. Taking this idea forward, I decided to study the way the COVID-19 pandemic was represented on three major news platforms – CBC news, Al Jazeera news and BBC news from the period of June-July 2020. The goal of this exercise was primarily to see the frequency of certain words being used in an article that were opposite in nature (E.g. – loss and recover radiate negative and positive affect respectively). To see how news was portrayed I segregated these articles on the basis of the vibe they gave the audience – ranging from 'Good news' to 'Bad news'. The five categories were –

1. Good news,
2. tending to good news,
3. neither good nor bad news,
4. tending to bad news and
5. bad news.

Every day during the selected time period, I picked an article to place it in either of these five categories. The articles selected were the most recent article for that day. And I continued this process across all the three news platforms. This was a personal scope of line that I explored, without the use of external sentiment analysis libraries.

Case 1: CBC News

CBC news is a division of the Canadian Broadcasting Corporation that is primarily a Canadian news channel. They are one of the primary sources of news for all the people living in Canada. From the period of mid-June to late July, I picked up one article every day that was the most followed article in the entire platform related to COVID-19. As I started categorising these news pieces, I could see the way that that CBC news has a fair distribution of news across articles that are good and bad. Through this small sample it is interesting to note that the articles published by CBC News reported the news in a more balanced way. These articles didn't show any particular bias in terms of positive or negative emotions in order to convey the information.

Figure 14: Non-exhaustive list of articles published by CBC News in the month of July 2020, being categorized under the five categories for evaluation (Compiled by Author).

As per the above table (Figure 14), we see categorized news articles based on the headlines that were provided to them. The distribution of news articles on the CBC Digital platform[11] seemed to be uniformly distributed in terms of coverage by including COVID-19 news equally from outside Canada.

After conducting the first part of this exercise, I decided to pick up one relevant article from each of these five categories that was most global in terms of the content. For each of these selected articles, I counted the number of times these keywords were used- 'lockdown', 'loss' and 'recover'. The reason I chose these three words were to their frequency of usage in any to give an idea of which direction, negative or positive , was the content tending towards. 'Loss' pointed towards negative, whereas 'recovery', 'recover' or 'recovered' were pointing towards the positive. And the word 'lockdown' was selected to show how much emphasis was laid on it being a 'tending towards negative' action. 'Loss' and "lockdown' were both considered as tending to negative in terms of the context and usage, but they necessarily not considered to be negative (in terms of the feelings they emote).

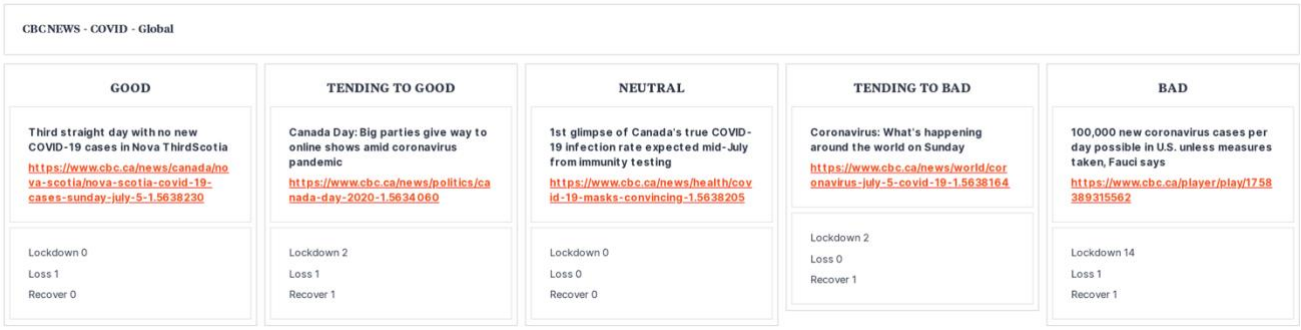


Figure 15: The selected CBC News articles under each category to show the usage of the words 'lockdown', 'loss' and 'recover' (Compiled by Author).

In the neutral category, the article that I selected is highlighted in green (Figure 15). We can witness that it has neither 'loss' nor 'lockdown' nor 'recover' used in it. Despite the headline

[11] For more details about the CBC digital platform: https://www.cbc.ca/

of the article being about Canada's COVID-19 infection, it manages to convey the content without the use of the above words. The same table shows us articles under the bad news category having 'lockdown' used fourteen times whereas the word 'recover' has been used just once whereas in the good news category, we see that 'lockdown' and 'recovery' have not been used at all. The word 'loss' has been used just once here. This exercise was a way to check and see how accurately the content of the news article matched with the emotion conveyed by the headline of the same article.

Case 2: BBC News

BBC news also known as the British Broadcasting Corporation news is one of the most trusted news platforms of the UK. For the COVID-19 first wave period, I performed a similar exercise with the BBC news articles available on their digital platform and found out some interesting observations in terms of news coverage.

Figure 16: Non-exhaustive list of articles published by BBC News in the month of July 2020, being categorized under the five categories for evaluation (Compiled by Author).

From the figure shown above (Figure 16) with the small sample set of articles from BBC[12] news covers a lot of global news. During the COVID-19 coverage, they not only showed the updates of the disease, but they also had articles about technology, tourism, business during the COVID-19 pandemic. This shows us how they gave a more wholesome picture of what was happening in the month of July 2020. We can also see that the news is moderately balanced in terms of articles under each category, but overall, they have maintained a better balance in terms of diversity in the subject.

Once we get onto the analysis of the word's 'loss', 'recovery' and 'lockdown' being used in these articles, we get a clearer picture of the feel of the selected articles.

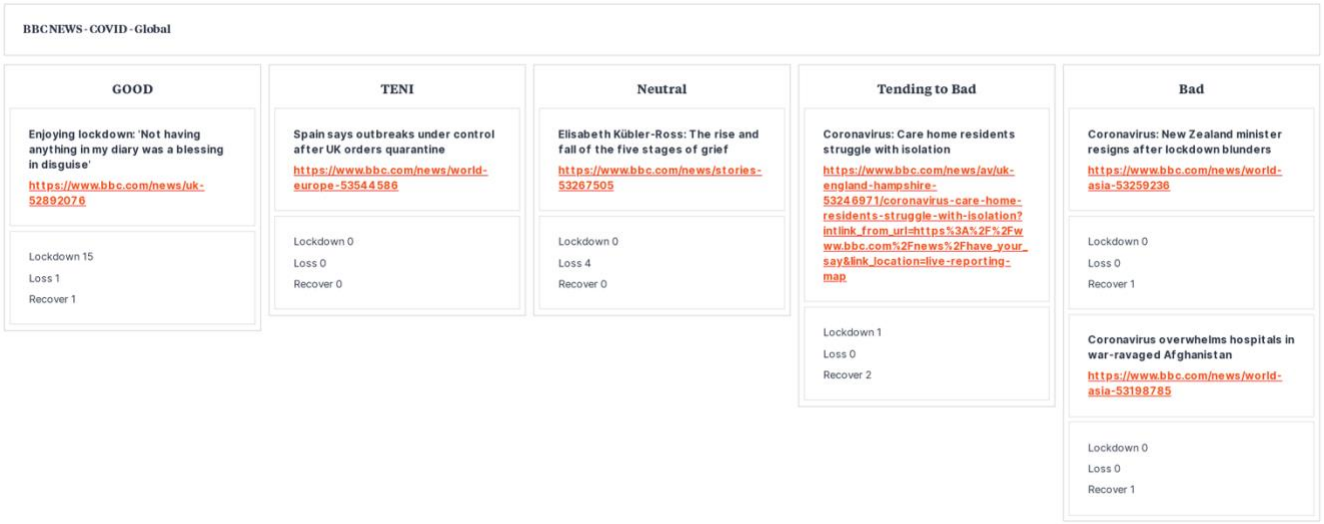


Figure 17: The selected BBC News articles under each category to show the usage of the words 'lockdown', 'loss' and 'recover' (Compiled by Author).

In Figure 17, we see that the feel is more mixed, as we see that good news contains more of the relatively negative words. And when we move to the bad news, we see 'recover' is used more comparatively. So far, I would say that though the frequency of feel words used gives

[12] For more details about the BBC Digital news platform: https://www.bbc.com/

an opposite result when compared to the tone of the respective news headlines, we see that that overall emotion from the articles is slightly biased in terms of tone. This is because the good category article has majority ‘lockdown’ usages whereas the bad category article has put focus on just the positive word ‘recover’. This maybe a bit confusing, given that the article headline tends to be lean towards a more negative tone.

Case 3: Al Jazeera News

Al Jazeera news is based in Doha, Qatar and is one of the biggest news platforms in the Middle East. By trying to perform a similar experiment with Al Jazeera digital news platform I began with the same categorization. I took one article each day and placed them under the five categories mentioned before.

Figure 18: Non-exhaustive list of articles published by Al Jazeera News in the month of July 2020, being categorized under the five categories for evaluation (Compiled by Author).

From the distribution table representing the small sample set of articles above (Figure 18) we can see that Al Jazeera news platform[13] has a decent distribution of news across all the categories. They cover more global news articles which involve countries across different continents. Though the number of articles falling under the 'good news' category is really less, we still get to see a fair distribution in terms of the topics covered and the feel set in the news platforms. For the second part of the exercise I began categorising all the articles collected under the Al Jazeera news using the words 'lockdown', 'loss' and 'recover'. From the table above you can see that the world 'lockdown' has been used more in the categories towards the right (towards bad), whereas the word 'recover' has been used a greater number of times in the categories towards the left (towards good). After selecting one prominent article from the five categories I performed a similar word usage analysis and the results are shown below.

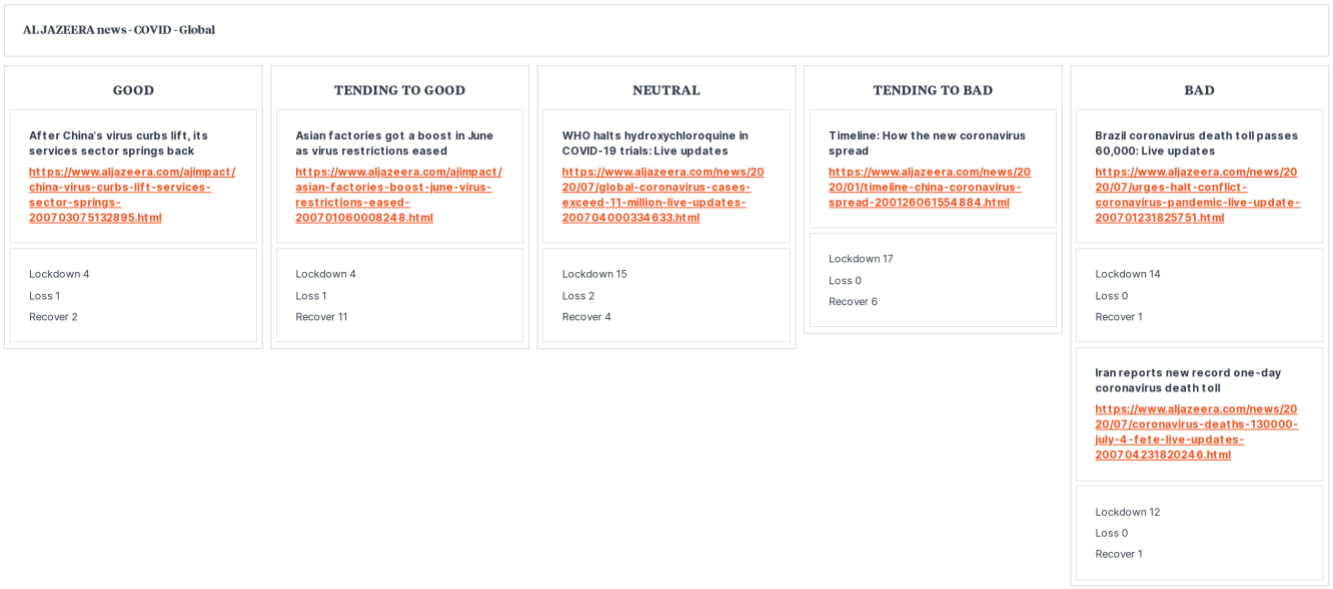


Figure 19: The selected Al Jazeera News articles under each category to show the usage of the words 'lockdown', 'loss' and 'recover' (Compiled by Author).

[13] For more details about the Al Jazeera Digital news platform: https://www.aljazeera.com/

In the table above (depicting the small sample of articles by Al Jazeera news – Figure 19), we see that even the most prominent articles in every category have a more balanced distribution of tone or feel words. The word ‘lockdown’ has been heavily used in the negative categories and the word ‘recover’ is more heavily used in the positive categories as the news tends to go towards the negative end, the words lose empathy and positivity by reduction in the usage of ‘recovery’ and ‘loss’. The usage of ‘lockdown’ increases as we move towards right (towards bad) in the table in order to depict the details of global news with greater effect.

The issue that emerges: A description of what is going wrong with the way sensitive data numbers are represented.

Sensitive data representation, given its nature, representation holds immense value. Though the number of articles may not be big enough to create determinate judgements, but the idea was to see how the frequency of usage of certain words can influence the way we perceive the feel of an entire article. This is also crucial in showing us how feel words are important affect inducing elements in an article. Some theorists have argued that 'what influences behavioural decision making is the essential "goodness" or "badness" of how one feels' (qtd. in Ekkekakis p. 49). This goodness or badness is what defines affect. For this project as well, trying to create the appropriate visual metaphors would lead to the desired affect and emotions from it.

Another issue is Information Saturation. The people who are consuming the information are often bombarded with a lot of it. And it's generally more than the human ability to comprehend, thereby reaching a critical limit (Illing). The list of devastating news is endless, leading to a 'reduction in our ability to understand, process and take action in the flood of news'(Ravenscraft). Given the accessible nature of news, the news cycles often struggle to keep one topic in focus for long. With so much news being thrown at the viewer, they have started avoiding the news, as it is relatable. Psychology Professor Graham Davey from the University of Sussex goes onto to add that this sort of stressful relatable news can be concerning when it comes to the negativity it brings along in terms of the viewer's mood. It is seen to impact the viewer with stress and anxiety.

Another aspect is the human ability of adaptation. Elke Weber, a professor of psychology and of energy and the environment at Princeton University shares her insights into how people get

used to dangerous situations and start adapting to them. She mentions how the human mind only responds to change (Chang). Even during the COVID-19 pandemic, we witnessed an observation wherein we initially had fewer cases of deaths. This took all of us by surprise. And as the cases rose drastically, our minds could not fathom the jump from barely a hundred to as much as 2.3 million death cases. Our brain understands the empathy needed for one person, but 2.3 million is beyond picturization, especially when we cannot put a face to these 2.3 million people. One of the reasons for the inability to relate and empathize with the situation involving more than one human being is the lack of forming a connection with them. This happens when the people viewing the data do not have a personal relation with the people, and neither with their description. In such situations, a proper contextual framework around the stories of the lives lost provides much more meaning and helps the people empathize with those who suffered. This proved to be one of my motivations - to humanize the data being represented.

CHAPTER III

METHODS AND METHODOLOGIES

Analysis of Data

Quantitative data is identified as data which can be measured and numerically manipulated (Meirelles 205). The research project investigated the effect of the COVID-19 pandemic on people, with a focus on loneliness. For bringing this matter into light, The Centre for Addiction and Mental Health (CAMH) through Methodify, provided survey results conducted amongst the people of Canada to gain perspective and valuable data about this issue (See Table 1). In Canada, Methodify uses AskingCanadians, a sister company and consumer panel with access to over 1 million Canadians profiled against over 500 variables ("Where Does Methodify Get Its Audience?"). They gathered data during the COVID-19 pandemic covering the first and second wave of COVID-19. For this project, I have used the first wave data as my raw data which spanned from May 2020 to September 2020 ("COVID-19 National Survey Dashboard"). The survey was a window into people's lives during the COVID-19 pandemic, the way it affected them and their families and how the effect translated into their mental health. The survey was conducted amongst the people of Canada across all provinces, across different age groups and gender groups. Though the shared CAMH data consisted of responses from around 1000 participants for every survey month who anonymously provided details about the way the COVID-19 pandemic and the lockdown affected the way they lived, worked and moved. The survey consisted of 29 questions which revolved around the participant's exposure to COVID-19, how it has affected their loved ones, their mental health, their financial worries, substance use, family commitments, family members and career changes in the past couple of months.

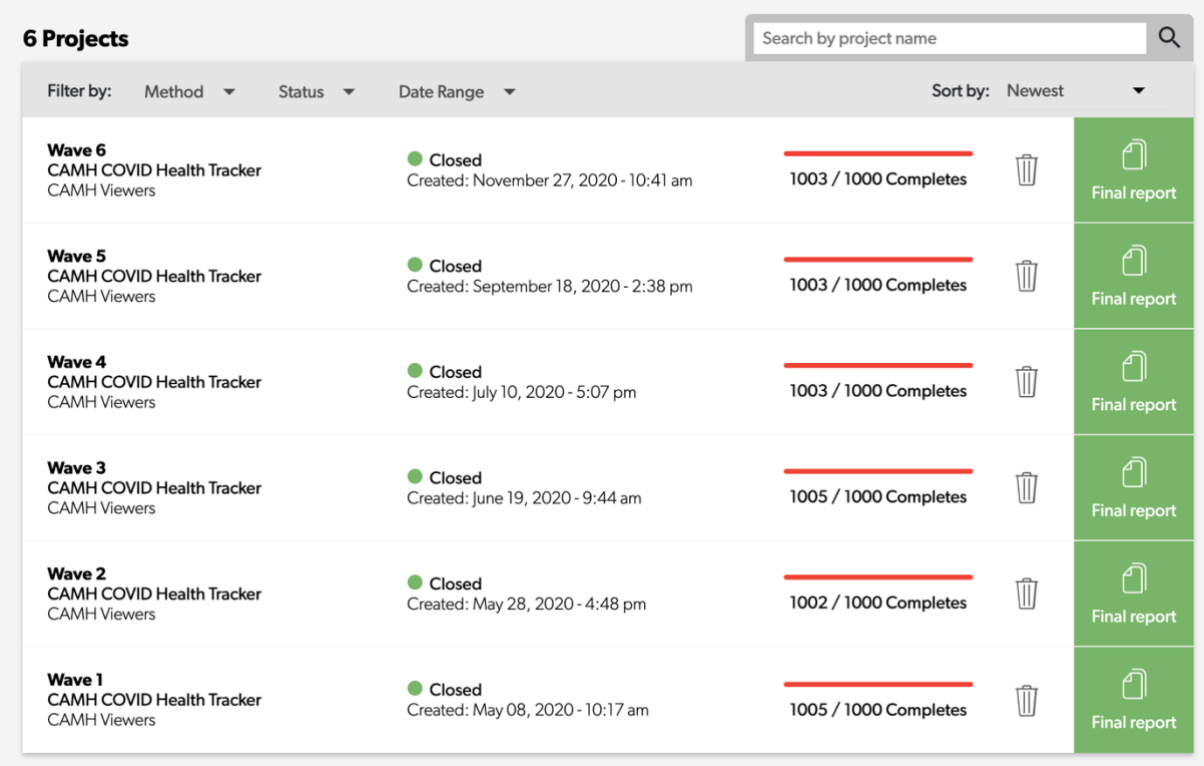


Table 1: Methodify by CAMH provides the responses for the 1000 participants for the survey months. Link for the Methodify platform. Link - https://www.camh.ca/en/health-info/mental-health-and-COVID-19/COVID-19-national-survey (Accessed 11 February 2021).

For analysing the data, I referred to a 'three-step context detective' proposed by Catherine D'lgnazio's 'Putting data back into context'. I used this when analysing and then contextualizing the data (*Putting Data Back into Context | DataJournalism.Com*):

1. **Download the data and get oriented**[14] - For this purpose, it's like getting a good look at what the data contains and get acquainted with all the rows and columns in the spreadsheet. This is helpful for getting oriented and noting down all the points relevant to the goal at hand and that one wishes to cover when streamlining.
2. **Explore all available metadata** – This step helps form a sub data set after properly analysing the original data. This is crucial for forming a context. This step helps us to focus on what is really needed from the data. I focussed on the responses pertaining to

[14] The text has been made bold for emphasis. Similar styling is followed throughout the thesis.

how people were affected by loneliness, depression and alcohol consumption in the Ontario region of Canada. I started comparing the responses to loneliness with depression to see how the mental well-being was impacted.

3. **Background the dataset** – This step is about creating a sort of 'data biography' which details out the organization from where the data is collected, the timeline, the background, who collected the data, etc. This step is important for being aware about the regulatory environment associated with the data.

Following the steps, I began with my contextualization process. I focussed on how alone people felt and how depressed they were in the recent past as the two filters to shed light on the problem of loneliness. The idea is to take data for each month, analyse them separately to represent all the participants who took part in the survey. Below is the detailed step-by-step methodology used to solve the overbearing numbers for easier interpretation.

For the easier understanding of the approach, I will be using the concept of variables for sorting and filtering the data for the purpose of representation. The CAMH data has close to 1000 participants for all the three months[15] with different set of participants each time. I begin with the people belonging to Ontario region and continue filtering based on gender and then the age-group they belong to. Here gender and age-group come to be known as 'independent variables'[16]. From a statistical perspective, they do not influence the responses of the participants (Mcleod). Whereas criteria's such as depression and loneliness are counted

[15] The data for the months of May, July and September of 2020 can be found in the Appendix section. Link to the CAMH website from where the data was procured: https://www.camh.ca/en/health-info/mental-health-and-COVID-19/COVID-19-national-survey

[16] Independent variables are variables used in the statistical and mathematical modeling, which do not depend on any other variable in the scope of the experiment in question. Some common independent variables are time, space, density, etc. Link - https://en.wikipedia.org/wiki/Dependent_and_independent_variables

as 'dependent variables'[17]. Most of the times, independent variables have an influence on dependent variables, for example allocating participants to either alcohol or drug conditions (independent variable) in order to measure any changes in the intensity of their depression (dependent variable). At times these independent variables get accounted in the filtering and sampling for their 'potential compounding effect on the dependent variables ("Dependent and Independent Variables"). The dependent variables generally get tested and measured in an experiment, and is 'dependent' on the independent variable (Mcleod).

Approach

Beginning with the month of May 2020, I started by selecting the data columns relevant to the data visualization – the region (Ontario was selected), the gender, the age-group, how lonely and depressed the participants felt during the COVID-19 pandemic which was rated on a scale of 1 to 4. The scale ratings correspond to 1-Rarely or none of the time (less than one day), 2-Some or a little of the time (1-2 days), 3-Occasionally or a moderate amount of the time (3-4 days) and 4-Most or all the time (5-7 days). I began by selecting my base of representation for the first stage of filtering. With our current focus on the Ontario region, we get 418 participants belonging to that region. So, in this case, I had to represent 418 people for the month of May 2020. This gives us the ratio of 418:100. Given that there were three gender groups, three age-groups, four scales of depression and four scales of loneliness to showcase, the total number of possible use cases that one would encounter considering all

[17] Dependent variables are variables used in the statistical and mathematical modeling, whose values are studied under the supposition or hypothesis that they depend, by some law or rule, on the values of other variables. A common dependent variable is observed in the value of interest (e.g., Human population size) to predict future values (the dependent variable) Link - https://en.wikipedia.org/wiki/Dependent_and_independent_variables

permutations and combinations would be 144 (3*3*4*4=144) use cases in total (See Table 2 for the categories).

Gender	Age Bracket	Depressed	Lonely	Total possible combinations
Female	18-39	Rarely or none of the time (less than 1 day)	Rarely or none of the time (less than 1 day)	
Male	40-59	Some or a little of the time (1-2 days)	Some or a little of the time (1-2 days)	
Other	60+	Occasionally or a moderate amount of the time (3-4 days)	Occasionally or a moderate amount of the time (3-4 days)	
		Most or all of the time (5-7 days)	Most or all of the time (5-7 days)	
3	3	4	4	144

Table 2: All the options or choices to choose from for the participants under the selected categories in the survey.

I began with the sampling using the independent variable of 'gender.' This consisted of males, females and others. This gave us 208 females, 207 males and three people from other gender category. They constitute of 49.76%, 49.52% and 0.72% of the 418 participants, respectively. By applying these percentage values, we obtain 50 females, 49 males and one person from the other gender group. The breakdown can be seen in the table below (Table 3).

Gender	% Distribution	Value Distribution	Rounded Value (100 Total Flowers)
Female	49.76	208	50
Male	49.52	207	49
Others	0.72	3	1
Total	**100**	**418**	**100**

Table 3: The breakdown of 418 Ontario participants with % distribution to match the 100 representational flowers based on gender.

Continuing with this drill-down sampling process, now let us begin with the female population from our sampling data. We have 50 females of the total of 100. Using the criteria of independent variable 'age-group' next, we now get a further division of the females

belonging to the age-groups of 18 to 39, 40 to 59 and 60 and above. The percentage values are 40.38%, 29.81% and 29.81% respectively (Table 4).

Age Bucket (Female)	% Distribution	Value Distribution	Rounded Value (100 Total Flowers)
18-39	40.38	84	20
40-59	29.81	62	15
60+	29.81	62	15
Total	**100**	**208**	**50**

Table 4: The breakdown of 418 Ontario participants with % distribution to match the 100 representational flowers based on age-groups (for females).

So as seen in the above table, we get 20 females in the 18-39 age group, 15 females in the 40-59 age group and 15 females in the 60 and above age group. Below, we can see how the age-group criteria is related to the gender criteria (Table 5).

Gender	% Distribution	Value Distribution	Rounded Value (100 Total Flowers)
Female	49.76	208	50
Male	49.52	207	49
Others	0.72	3	1
Total	**100**	**418**	**100**

Age Bucket (Female)	% Distribution	Value Distribution	Rounded Value (100 Total Flowers)
18-39	40.38	84	20
40-59	29.81	62	15
60+	29.81	62	15
Total	**100**	**208**	**50**

Table 5: The correlation shows how we distributed the total number of females (chosen as an example for explanation).

So, combining all the age groups, we get the initial value of the total number of females, which is 50 in number. This continues further onto the independent variables. Let us continue the sampling by taking the case of females belonging to the 18 to 39 age group. By using 'depression' as the next sampling criteria, we have four sub-criteria as mentioned earlier. We take forward the percentage values and the actual values of the females under these categories.

Depression Level (Female: 18-39)	% Distribution	Value Distribution	Rounded Value (100 Total Flowers)
Rarely or none of the time	51.19	43	10
Some or a little of the time	16.67	14	4
Occasionally or a moderate amount of the time	21.43	18	4
Most or all of the time	10.71	9	2
Total	**100**	**84**	**20**

Table 6: The breakdown of 418 Ontario participants with % distribution to match the 100 representational flowers based on depression level (for females, belonging to the 18-39 age group).

The above table (Table 6) shows us the different categories and their value distributions, which total up to 20 participants. We can see the relation between the two tables below (Table 7).

Age Bucket (Female)	% Distribution	Value Distribution	Rounded Value (100 Total Flowers)
18-39	40.38	84	20
40-59	29.81	62	15
60+	29.81	62	15
Total	**100**	**208**	**50**

Depression Level (Female: 18-39)	% Distribution	Value Distribution	Rounded Value (100 Total Flowers)
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Occasionally or a moderate amount of the time	21.43	18	4
Most or all of the time	10.71	9	2
Total	**100**	**84**	**20**

Table 7: The correlation shows how we distributed the total number of females in the 18 to 39 age group using the depression scale (chosen as an example for explanation).

This sampling process finally leads us to the last criteria of ‘loneliness’. When we streamline further with females in the 18-39 age group, who face depression rarely or none of the times, we again get four categories like the ones under the depression criteria.

Loneliness Level (Female,18-39, Depression: Rarely or none of the time)	% Distribution	Value Distribution	Rounded Value (100 Total Flowers)
Rarely or none of the time	55.81	24	6
Some or a little of the time	37.21	16	4
Occasionally or a moderate amount of the time	4.65	2	0
Most or all of the time	2.33	1	0
Total	**100**	**84**	**10**

Table 8: The breakdown of 418 Ontario participants with % distribution to match the 100 representational flowers based on loneliness scale (for females, belonging to the 18-39 age group).

After reaching the last stage of sampling, we again get percentage values as well as actual values when the total is counted as 100 (Table 8).

Depression Level (Female: 18-39)	% Distribution	Value Distribution	Rounded Value (100 Total Flowers)
Rarely or none of the time	51.19	43	10
Some or a little of the time	16.67	14	4
Occasionally or a moderate amount of the time	21.43	18	4
Most or all of the time	10.71	9	2
Total	**100**	**84**	**20**

Loneliness Level (Female,18-39, Depression: Rarely or none of the time)	% Distribution	Value Distribution	Rounded Value (100 Total Flowers)
Rarely or none of the time	55.81	24	6
Some or a little of the time	37.21	16	4
Occasionally or a moderate amount of the time	4.65	2	0
Most or all of the time	2.33	1	0
Total	**100**	**84**	**10**

Table 9: The correlation shows how we distributed the total number of females in the 18 to 39 age group who rarely face depression under the loneliness scale (chosen as an example for explanation).

This sampling process is applied across all the criteria to get the number of participants under every use case (Table 9). From this data, we derive - for the month of May 2020, only 93 use cases had participants, the remaining 51 use cases had no participants in it. This entire approach uses the percentage drill-down sampling method to get values for a defined total set by the individual. The survey responses that are being analyzed have been shown in the

appendix in detail. The numerical values deduced after the quantitative analysis are taken forward in the visual representation of the data.

Research for Creation

'Research for creation' is a method to gather research for a "future revealing, enabled through an artistic perception of technology as a practice or craft" (Chapman and Sawchuk 15). This method leads to well-defined research into the related histories, concerned journals and papers, existing theories, to make informed choices about the media that need to be used in order to create. In this case, learning about mediums was an important part of the research process. Using this method, the 'result' that comes out of the process may not be a "full-scale production of a final product" (Chapman and Sawchuk 16). Although the outcome may very well be considered as an experimental product of this process. This method proves to be useful for my thesis given its nature of research being similar to 'gathering', through journals, articles, references, interviews, etc. And this is directed towards a future 'revealing' (Chapman and Sawchuk 15). The learning involved in this method helps to lead into a guided outcome made from informed choices.

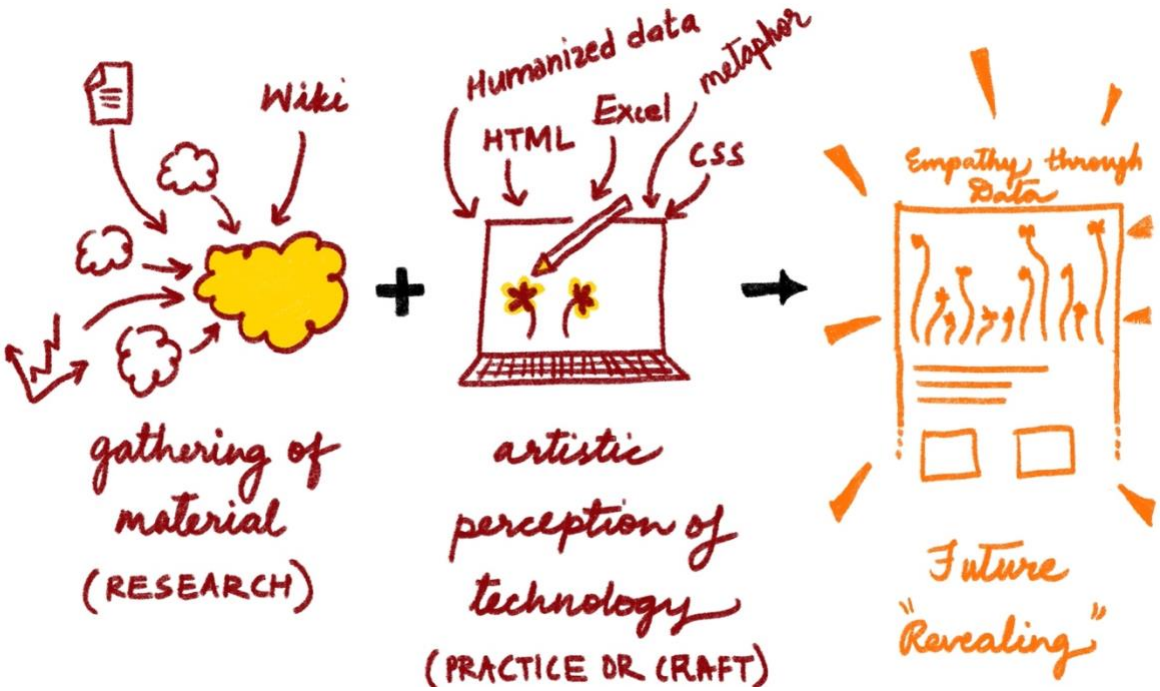


Figure 20: The Research for Creation process that leads to a future 'revealing' that may remain an experimental prototype (Chapman and Sawchuck's theory).

This thesis employs an iterative development process that comprises three primary phases – Examination, Definition and Creation (Goodman et al.). The examination phase for the thesis includes looking at the problem. This phase is the ground for detailed research into the existing problems, the various solutions already present to these problems and analysing them thoroughly. I examined the concepts that included data representation through the mediums of visuals, sound, and visuals and sound combined. Given that these representations covered vast topics, my focus was to cherry-pick the ones that showed sensitive issues and how they managed to handle these delicate issues in terms of the storytelling medium. Once the examination phase helped gain a good idea of what areas were necessary to keep in mind, these were taken forward to the Definition phase. The definition phase began with looking at the topic in focus – loneliness as the sensitive topic, and then mapping out the various aspects that define it, especially in terms of – the people involved, the way it affects them, the symptoms or the telling points, the way these people react, how they can be assisted, the dos and the don'ts, etc. This stage also included gathering the CAMH data that was necessary to shape the picture of loneliness for the thesis. In this phase, I used mind mapping of the different keywords which were crucial to the theory. I deconstructed well-being and social issues and interconnected them by the focus being on loneliness. Not only this, but I also saw the general forms of data representation, especially data with a purpose or message and how it helps in creating social awareness or helps fight for a cause or take action (Figure 21).

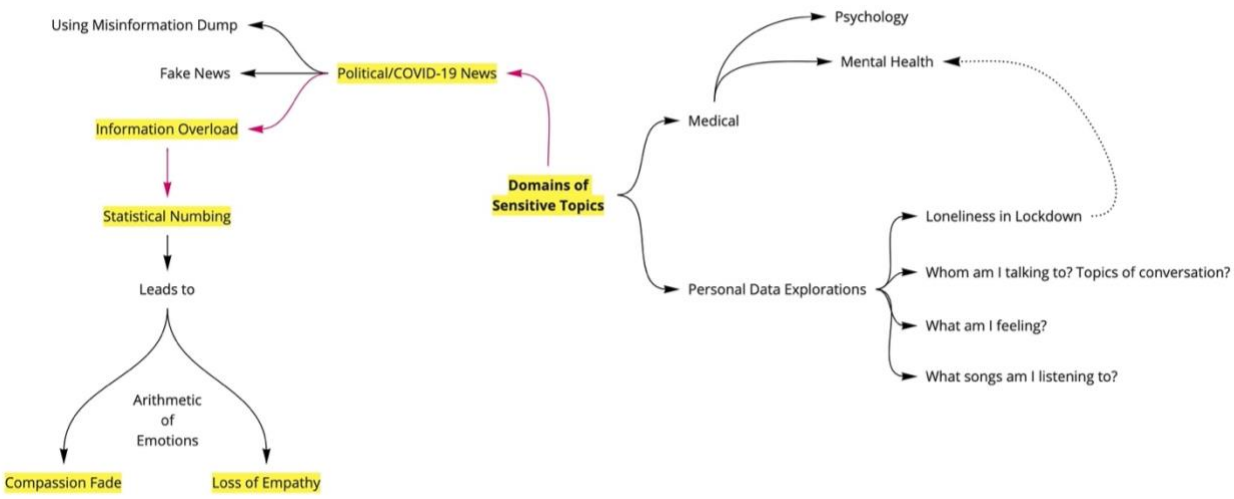


Figure 21: The mind map that shows the connections among the topics of investigation. This map covers the sensitive issue at hand, the problems that lead to a loss of empathy and the path of exploration chosen to show loneliness through data (Created by Author).

Further deconstructing 'loneliness' gave me the various ways to look at it and how I could use these affective qualities to show them visually in my data representation. Furthermore, I streamlined my subject of enquiry and tried to focus on the way statistical numbing in sensitive issue representation creates a lack of empathy because of the way people interpret it (Figure 22).

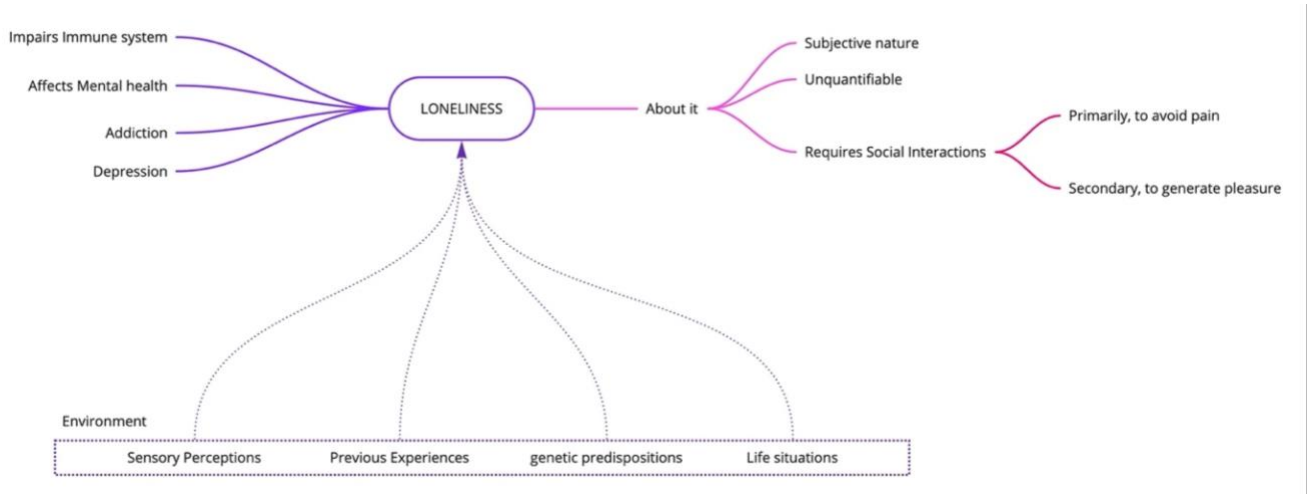


Figure 22: A mind map to show the various aspects of loneliness that are important for exploring the affective side for its representation (Created by Author).

This point defined my problem statement and helped me take it to the Creation stage. This stage was essential for reaching to the final output. With the data from the Definition phase, I created the relational analysis among the keywords derived at this stage. After creating these links and connections, I used them to trickle down on how to – a) Avoid Statistical Numbing b) To foster empathy c) humanize data. By using metaphorical representations of the data, I created aesthetic visuals that went along with voice to help enhance the affect (More details can be seen in Figure 23).

The collaboration of visuals and sound

Through the research, I learnt that eliciting different senses would help in achieving my goals. As the examination and definition phase led me into the worlds of my inquiry subjects, I could very well learn the necessity of appealing to the senses of hearing. Intending to create a data visualization, which attempts to avoid statistical numbing as much as possible, engaging more than one sense in perceiving the output seemed appropriate. Through the medium of sound, the experience of visualizing data can be made more personal. Though sound isn't the same as hearing (Lupton and Lipps 83), mastering the process of creating desirable and pleasing sounds to befit the category for everyone maybe a challenge. Despite this, I have looked at sound, how sound can be visualized in its most basic forms – be it particles, waves of even vibrations, and carefully selected various sounds – musical piece that goes along with the sensitivity of the visualization and in the form of voice for bringing in a human element into the output. The sound in addition to the visuals will help bring an intimate experience that will personalize the emotions that need to be associated with the data.

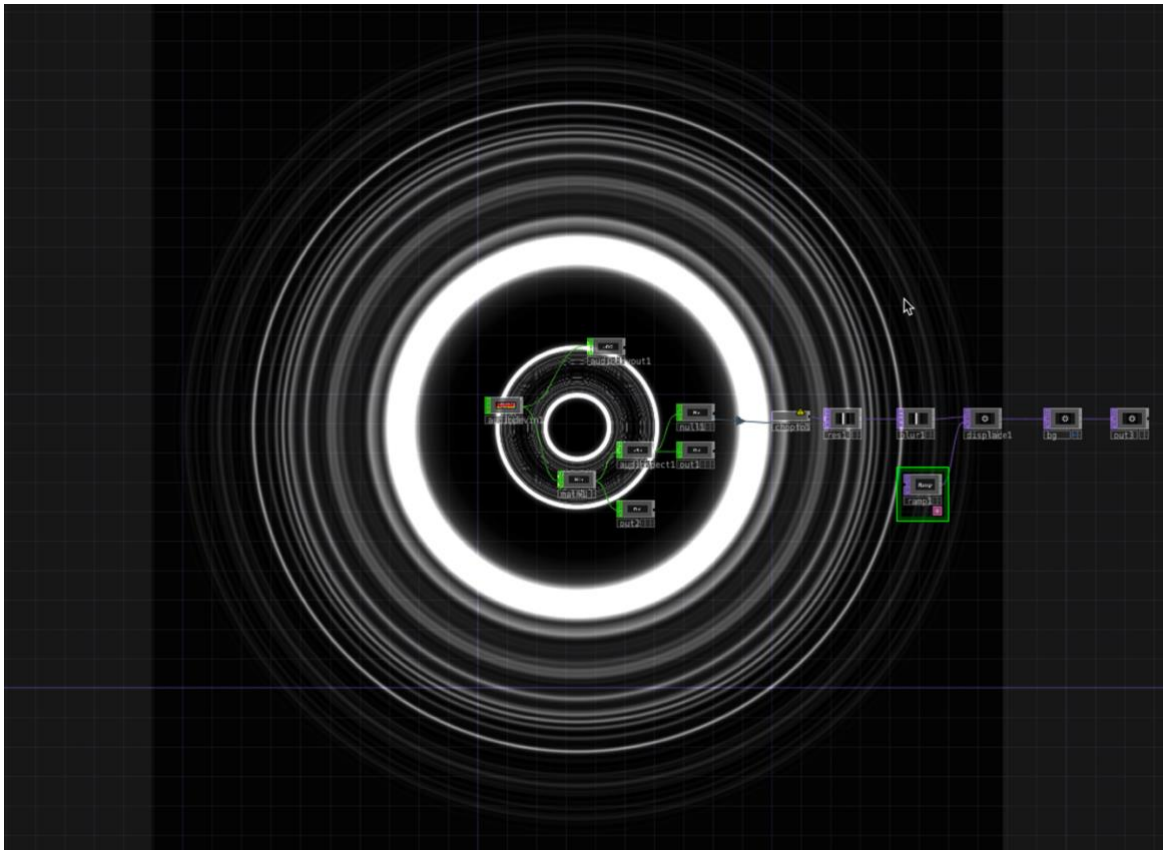


Figure 23: Using Touchdesigner to take audio input and create concentric circle and particle generated visualizations. These visualizations are sound-sensitive (Created by Author).

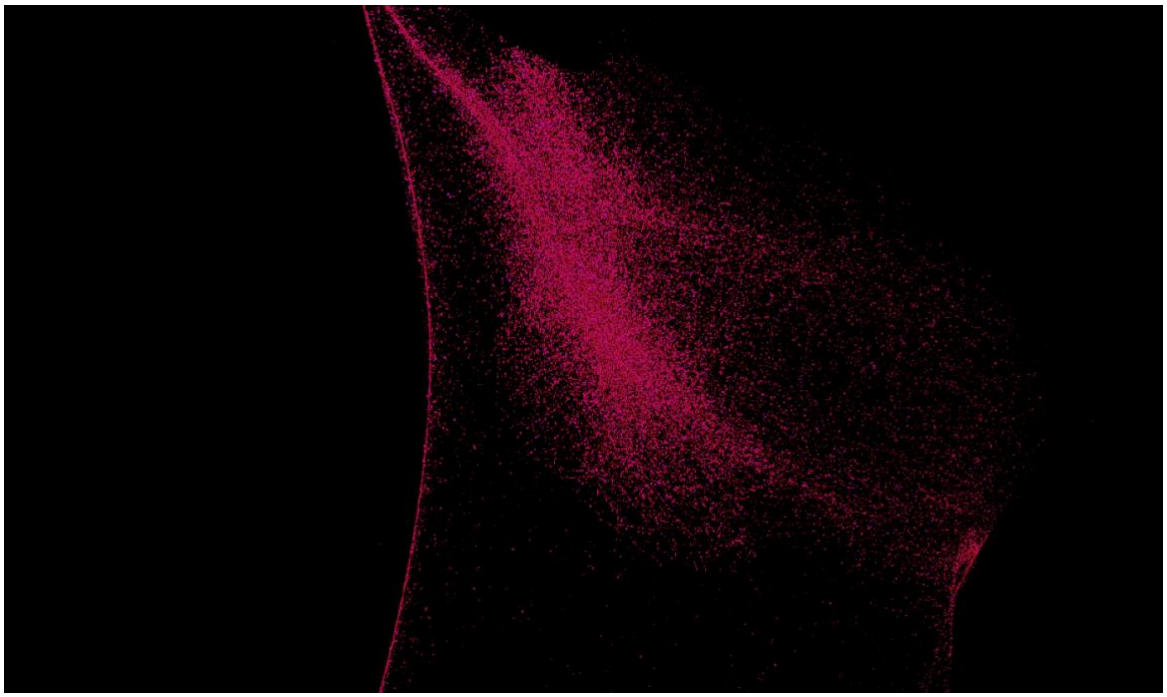


Figure 24: Using Touchdesigner to take audio input and create concentric circle and particle generated visualizations. These visualizations are sound-sensitive (Created by Author).

I work this collaboration of visuals in the form of metaphors and sound in the form of voice to create a narrative about loneliness. This has been shown in a webpage[18] dedicated to helping the viewer understand the subject, its delicate nature and the fact that loneliness is not that uncommon.

[18] For more details, please refer to Chapter IV – Section: Prototype 3.

Visualization Methods

Design Principles

The visuals used to represent the data work on the principles of design communication – colour, composition and gestalt theory. Being from a Graphic design background, these three elements are starting cues that help shape up any design. Other design strategies such as metaphors and the expressive qualities of the visuals along with these principles added to the visual quality of the represented data.

The Gestalt principle refers to the inbuilt mechanism in the human brain to perceive individual elements as a whole. Colin Ware, the Director of the Data Visualization Research Lab at the University of New Hampshire, in his book 'Information Visualization' emphasizes the importance of the visual brain as a powerful pattern-finding engine. German psychologists, in 1912 defined the Gestalt law as 'robust rules that describe the way we see patterns in visual displays, and, although the neural mechanisms proposed by these researchers to explain the laws have not withstood the test of time, the laws themselves have proved to be of enduring value'. Under the umbrella of Gestalt laws, we have the 'Law of Proximity'. The proximity of visual elements or things that are close together are perceptually grouped together (Ware 204). This law describes how the human eye perceives connections between visual elements" (Soegaard). I used this principle to form age group relations within the data visualization. The oldest participants were a part of the upper region of the landscape, whereas the youngest ones occupied the lower region. For reference, kindly look at Figures 35, 36 and 37 in the Table of Figures.

Another vital aspect is choosing the colours for the data visualization. Colour is frequently used to encode values in visualizations. The mapping between colours and values must

preserve important differences in the data (Szafir 1). On the lines of the 'Colour theory' principles, contrast effects also make it desirable that larger regions should be less strongly coloured in general (Ware 161). The vibrancy you choose for your design is likewise crucial to provoking desired emotional responses from users" ("What Is Colour Theory?"). In the data visualization that I created, choosing colour to create proper contrast for differentiation between the gender groups was an important step. The colours and their luminance variations showed the different states of loneliness in my data visualization.

And finally coming to the composition of the entire visualization, it needs to be a balanced piece altogether in terms of colour, contrast, positioning of elements within the picture, the size and trying to bring out the elements in focus that convey the essence of the image ("Improve Your Designs With The Principles Of Closure And Figure-Ground (Part 2)"). With the help of these principles, the visual representation can be perfected to a point where it stands for the data taken into consideration.

Another article used for reference in terms of visual representation was the Ten Perceptual Tasks model by Cleveland and McGill (Cleveland and McGill) which helped me to visualize data by choosing appropriate graphical elements. This concept proves to be helpful given that the human brain comprehends graphical or visual elements much better and changes in them are also noticeable by the brain. This is an important learning to keep in mind while making visualizations.

Humanizing the Data

The combination of visuals and sound aimed to achieve the goal of fostering empathy. One of the key aspects that can be tapped into is 'personalization'. The human touch to elements

makes them much more relatable and less robotic in nature. With this purpose in mind, I decided to choose the method of hand-made visuals. This is heavily inspired by Giorgia Lupi's concepts of Data Humanism. Lupi emphasizes on the importance of intentionally hand-crafted representation, as they may look imperfect in comparison to others, but they tell more compelling stories. She goes on to add that they create more value as a design tool ("Giorgia Lupi"). Humanized data takes us beyond the design principles into a more expressive form of representation that focuses on the nuances of the elements and visuals. These finer details enhance the visual perception of the representation.

Giorgia Lupi and fellow Information designer Stefanie Posavec worked on communicating with each other using hand-crafted data visualizations that would help them know each other better in their book 'Dear Data'. By using drawing instead of coding and computing, they used this as a form of expression. They chose to answer a simple question through this process – "**Can you get to know another human being through data only?"** This 365-day long project that used postcards with hand-drawn representation that were sent to each other and could be read to gain information about each other ("Dear Data, The Book"). This simple yet powerful way of representing data with human elements instead of the algorithms to generate a visualization help more in terms of data interpretation.

With the growing number of articles, news pieces and information every other day, the need to simplify and humanize data is a priority. Not only does it help people connect more, but it also proves to hold a more empathic attachment to it. This type of data visualization is more intimate, relatable and human. The representation requires a touch of humanity in order to convey the affect and emotion behind it. Giorgia Lupi, a renowned Information designer and one of the partners at Pentagram design agency, works on the humanist approach towards

data ("Data Humanism"), which has helped her in discovering the beauty and humanity in the way data is represented. I have tried to recreate a similar humanist approach for representing data. With the issue of Statistical numbing arising as well, humanizing data representation becomes a key element to help avoid that by 'embracing the complexity, going beyond the standardized ways of representation and contextualizing the data ("Data Humanism").

Visual Interpretation

Data analysis is influenced by interpretations. These interpretations may be prone to assumptions, perspectives, intuitions and biases which influence the way they are designed. 'Beyond selecting and collecting a data set, the way we display data is the result of decisions that can carry political or cultural weight. Even small visual elements can have significant meaning' (Groeger). I used visual metaphors as one of the ways to represent the entire data, in the form of a scenic garden lake. Metaphor is for most people a device of the poetic imagination and the rhetorical flourish (Lakoff and Johnson 10). They help the viewers in laying focus on the concepts that align with the visual metaphorical language. In the case of my thesis, my choice of leading with a scenic garden lake with flowers which symbolize life. Every flower stands out individually and represents the different states of loneliness and depression faced by the people of Ontario in the form of opening, closing, blooming and wilting. The visual elements of the flower, such as colour and stem length represent the gender and age-group it belongs to. The flower as an entity symbolizing life helps the viewers 'to refer to it, quantify it, identify a particular aspect of it, act with respect to it, and perhaps even believe that we understand it (Lakoff and Johnson 30). The use of such conventional metaphors is based on the correlations formed with the experiences we perceive (Lakoff and Johnson 137). Not only this but, the use of such metaphors helps to understand the abstract concepts in terms of familiar and well-understood visuospatial phenomenon (Risch 2).

Jacob Harris, a software architect working at New York Times, mentioned that some of the ways to bring in the feeling of empathy in data visualizations are – using icons instead of dots and zooming in on a singular slice of a larger issue. He also added on about focussing on the humane side of the topic being visualized (Bui). This shows us how crucial empathy is in terms of creating a better and more relatable relationship with those who need to be represented. Empathy builds trust (Bui) amongst those suffering and the audience who reads about it. 'Empathy in this context is seeing a person's actions and motivations from their point of view. It is not to be confused with sympathy, which is mirroring your own feelings with another's to aid understanding' (Bui). One of the ways to elevate affective empathy is the way we choose to use categorization of the data being represented to our advantage. Categorization may seem simple but has complications that one needs to understand. Lam Thuy Vo, a BuzzFeed journalist shares that 'Every categorization is so flawed. What you need to do is understand it's limitations and the scope of the categorization and present that fully to the audience, in a way that is clear and somewhat easy to understand without taking away the complexity. It's this bizarre dance' (Bui). Through her approach of categorization, we learn that understanding the data, by looking at a single data point through the lens of a person or by working on something beyond charts and making use of graphics and visuals. These approaches emphasize on the human connection, or the humanity in data.

Iterative Design Development

The creation phase of the thesis worked on the iterative development process. This is extensively used in creating user experiences in the digital world. Goodman et al., shared with us that an Iterative development works by continual refinement through trial and error. "Rather than trying to create a perfect vision from the beginning, iterative development hones

in on the target, refining its focus and improving the product until it has reached its goal" (Goodman et al.). Iterative development can be used in any stage of the design process. Coming from design background myself, I was familiar with the method as it creates a repetitive cycle that helps in improving on the output made by incorporating the inputs. For this purpose, I created the data visualization with my design skills and incorporating the design principles described above.

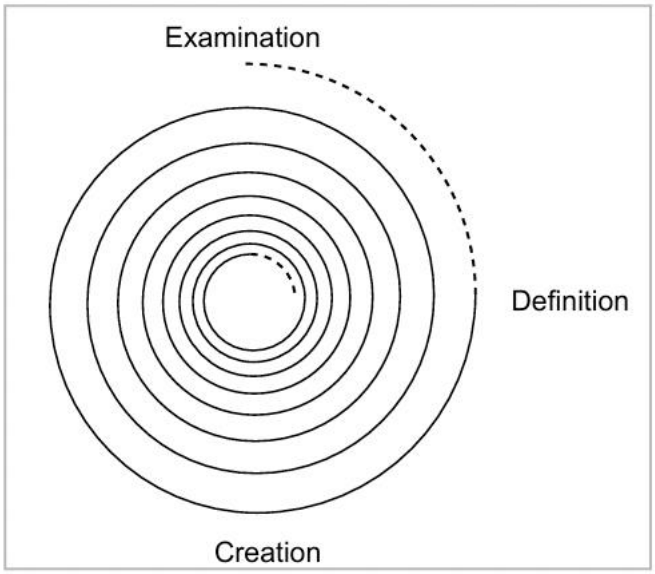


Figure 25: Iterative development – The final product is at the centre, and the development orbits it, adjusting as it goes along (Ware).

The Iterative development method was most applicable at this stage of my design process given the nature of its goal. The uncertainty of fostering equal levels of empathy in people for the same issue is humanly impossible because of the way we are wired and brought up or the circumstances that each of us have lived through. Every individual has had a unique experience when they define 'Life'. Hence, with this in my mind, the Iterative development of the visualization works best, especially because this process works on a evaluate and improve model. This method of development also has benefits – 'Flexibility', 'Adaptability' and 'Shared Vision'(Goodman et al. 33):

Flexibility - When it comes to using the knowledge gathered in the examination and definition phases which sets the contextual framework to actually implement them in the creation phase. This gives the visualization ground to stand on from its first prototype itself. This process helps uncover the needs and limitations of the project. The idea of having a scope for change and improvement right from the beginning helps create good products.

Adaptability – The idea comes into the picture the moment your project is out for speculation by the audience. This helps one see how well it fares when the project is faced with real-life challenges. With an iterative framework, this sort of understanding is essential for the survival of the outcome.

Shared Vision – What this means is the collective vision of the individual designing and the audience that is interacting, they both, through a chain of improvements and feedback help create a better experience overall.

INITIAL PLANNING

- choosing the direction of research: visualizing data
- issues that move me: sensitive issues, psychology, well-being
- areas of interest: music, visuals, technology

PLANNING and REQUIREMENTS

- look at existing projects dealing with data visualizations
- look at how sensitive data is represented
- find relevant articles, journals, case studies, etc.

ANALYSIS and DESIGN

- finalize on the subject, and the problem I am trying to solve
- get more resources on loneliness, empathy, data visualizations
- finding the problem - enable data visualizations of sensitive issues to foster empathy
- find the reasons for exisitng problems - statistical numbing, compassion fade, information overload, usage of appropriate visual metaphors, representation, etc.
- conduct small experiments or create prototypes to solve the issue at a small level
- worked on the CAMH data, analyzed it and used percentage drill-down to create the data representing a 100 people from Ontario

IMPLEMENTATION

- upon self critique, and incorporating concepts and theories learnt, try to create a solution.
- include the concepts that are needed to solve the problems in the earlier phase: humanizing data, metaphorical representation, colour theory, visualizing and encoding, affect theory

USER TESTING

- pose the questions that you are trying to solve and use your prototype as a solution: conducting a user testing to get insights on the design, appropriateness of the visuals used, accessibility, suggestions and feedback

ITERATIONS CREATED UPON EVALUATION

- work on the feedback, incorporate it in the next prototype: created next version of the prototype by improving on the representation of loneliness and depressions, avoided colour contrast issues, enhanced the grouping to show age-groups, etc.

RE: ANALYSIS, DESIGN IMPROVEMENTS, IMPLEMENTATION

- created final prototype
- worked it into a narrative on a webpage: helps in sharing, creating awareness, easy access and communication

FINAL PROTOTYPE

Figure 26: The Iterative design process being followed. The step-by-step process is shown in the image with details into the Definition, Examination and Creation phase overall.

The Iterative development framework (Figure 26) works very well with digital products given the fact that the *"prototypes can be made and evaluated quickly"* (Goodman et al. 35). Taking this process ahead, I decided to work on the first prototype. And then, to help improve upon the design elements used in it, I moved ahead to the user testing of the visuals created. Given the time constraint it was difficult to incorporate a second user testing to help get feedback on the second prototype of visualizations.

User Testing

The Requirement - After applying the visual design principles and creating a data visualization in the iterative design framework, I continued with the next step of putting it out in front of the audience for them to evaluate and provide feedback. This step required human participation in terms of providing inputs on the design, functionality and accessibility aspects of the data visualization. By working on a 'shared vision' through the iterative process, the goal is always to improve the user experience. And in doing so, I had to involve the REB in order to question my potential audience. I received approval from the REB committee, and the survey questions available in the Appendix D. Given the unique circumstances of the COVID-19 pandemic where lockdown was imposed, I decided to go ahead with a user testing survey to get a glimpse into the thinking of my audience.

The Survey – Carefully considering what I require from my audience or participants in this case, I devised an online questionnaire to receive inputs of my prototype. The survey was divided into three sections with different purposes in mind.

Section A – This section was meant to make the data visualization look like a picture. With the audience having no preconceived notions in mind about my project, given that they weren't exposed to it yet, I wanted to capture the first-hand visual perception. The section began with a simple introduction about the number of sections and the purpose of this user testing – which was to get their feedback on visualizations and the way they are represented. Here I show the data visualization to the participants asking them to carefully observe the different elements, the colours used, the positions of every element in the image and also to try and grasp the affective quality effused by the overall image. This included choosing appropriate words to describe the image and the overall vibe presented by the image.

Section B – This section begins with the context to the image, which is originally a data visualization. The visualization details the topic of loneliness and what every element stands for. The legend is made available to the participants in this section. Once they absorb what the image is actually about, further questions are asked to know more about their interpretation, the appropriateness of the metaphors used, the colour scheme in play and how these are proving successful or failing to pass on the empathic vibe onto them.

Section C – This section holds context-based questions that are about how each participant has felt in terms of loneliness prior to and during the COVID-19 pandemic lockdown. This section is completely optional as it does not affect the design inputs made in the previous sections. They also capture the age and gender the participant belongs to. This section is for my understanding of how the COVID-19 pandemic has affected the participants who took part in my survey. It was an instrument to gauge the surroundings and see for myself how my goal of this thesis might help the potential audience to empathize with those who suffered.

REB Application

The REB consent, invitation and the survey questionnaire described in this section can be found in the Appendix D and E.

CHAPTER IV

PROTOTYPING AND MAKING

Prototype 1

For the creation phase of my thesis, I continued with the information gathered from the examination and definition phases so as to have a strong foundation in terms of the resultant visualization. I investigated the following categories – Age group of the participants, their gender, how badly they were affected by loneliness on a scale of 1 to 4 during the COVID-19 pandemic lockdown and did they feel depressed during the same time rated on a scale from 1 to 4. The data visualization that I intended to create had one primary goal – to foster empathy. Some of the principles that I had kept in mind while designing the prototype were:

Empathic vibe – Keeping in mind the audience and people suffering from loneliness, I decided to maintain the language of the visual elements. The colour palette and the metaphor selection were in line with examples of data visualization that had contextual similarities to my topic. I used my learning and design skills to maintain the sanctity of the sensitive issue at hand.

Human touch – The data visualization, in order to connect with the audience, needs to have organic elements rather than rigid ones, to give a sense of the human touch. The organic forms make it more grounded, especially when it comes to making it look more sympathetic and softer visually.

Easy to interpret – By creating meaning using visuals metaphors, especially to show people in the data visualization, the understanding of the subject becomes much simpler to interpret. Creating these visual connections between the data and the representation makes the visualization simpler.

Meaningful – By trying to work on an alternate way to make data visualizations, this principle provides a more wholesome meaning in the way sensitive data is represented. The importance given to the way individuals are represented in the visualization, instead of representing them in the form of dots (how it has been generally portrayed), is more significant to the process.

User persona

For the development of the data visualization, I decided to prioritize my audience group in terms of a user persona. As described in 'Observing the User Experience,' designer Kim Goodwin in 2005, ‘A persona is a user archetype you can use to help guide decisions about product features, navigation, interactions, and even visual design.’ Personas help to create archetypes of the user, which technically isn't a real person, but it is a synthesis of facts and observations about real users that leads to a memorable character (Goodman et al. 482). The idea is to create this persona that helps us to experiment with every viable scenario with the use case selected. The process is essential to make it more relatable, empathic and recognizable to the potential user.

The persona I selected for my creation phase was that of an International student living away from home. From this persona, let us name him Roger. There are the following things that we can derive:

Figure 27: Persona creation of 'Roger' as an International student who is living away from home. (Created by Author).

1. Roger lives away from home and family.
2. They probably had a hard time making friendships that could reach their inner circle.
3. With the COVID-19 pandemic going on, they aren't able to interact with anyone physically.
4. They have not visited the home for the past 1.5 years.
5. They don't have any close relatives in the current city of study.
6. Due to the lockdown situation, they even stopped going to the gym, which was a good outlet to meet newer people and see new faces.
7. With minimal interactions, Roger being a social person, now feels that he is alone. Despite having a pet cat, he still feels he misses his old friends and family back home with whom he could have heart-to-heart conversations.

By deep-diving into Roger's persona, we see that he feels lonely, despite having friends in his cohort who are studying with him. I tried to design a data visualization to help people know that loneliness is common and can be felt by anyone. The goal was to also let other people

suffering from loneliness know for a fact that they aren't alone and that there are more people like them. I created a water landscape to bring calm and peace for the viewer the moment they set their eyes on the data visualization. Next, I began representing the people as flowers. These were the same people who filled out the CAMH survey for the month of May 2020.

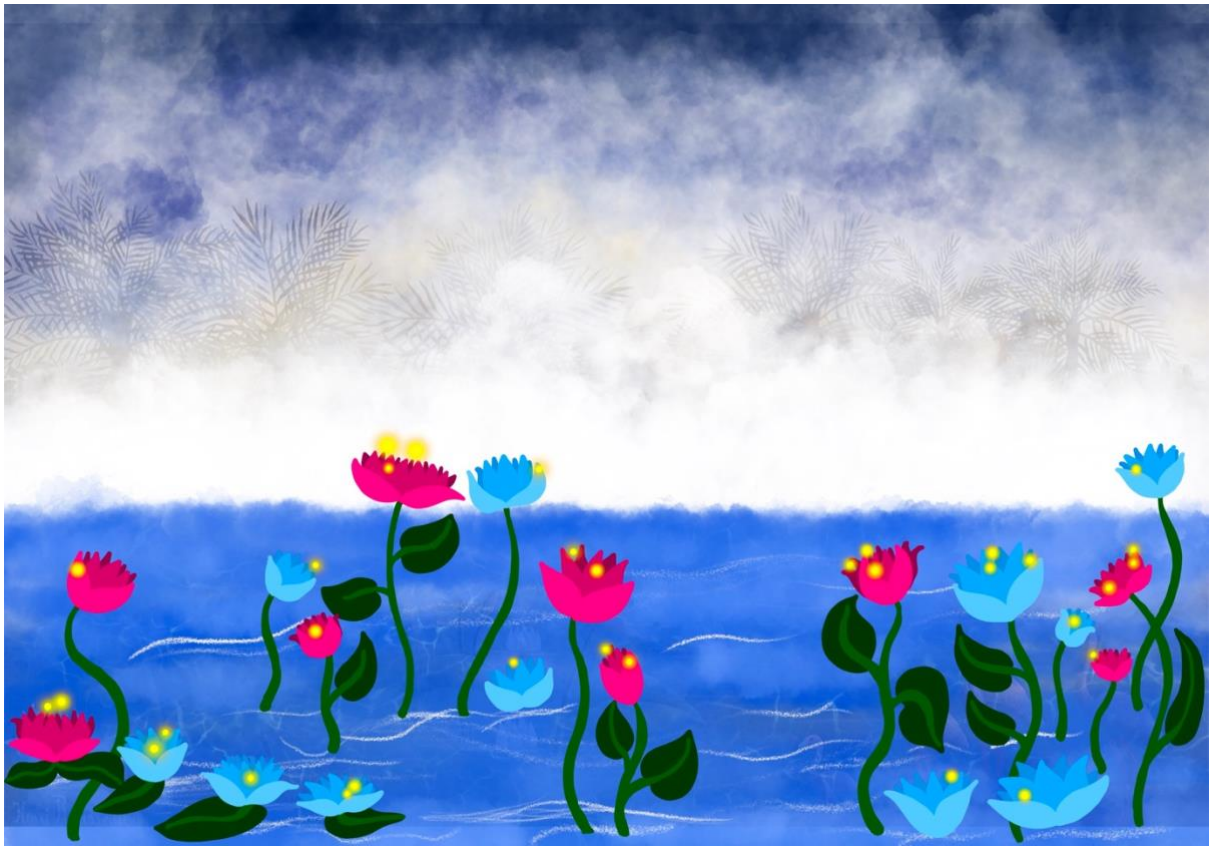


Figure 28: The first iteration of the prototype that was made to convey the data.

Prototype 1: Figure 28 shows the first data visualization I made when I was trying to figure out the landscape, the colour tones and the metaphorical representations. These have been made using Procreate software. In this the:

- The pink flowers represent the females, and the blue flowers represent the males.
- Continuing with the visual representation, I depicted loneliness with the number of fireflies hovering around a flower. The lesser the number of fireflies, the lonelier the person feels. To show depression, I showed the openness of a flower. The more open a flower is, the lesser depressed they feel.

- The flowers without any stem belong to the 18 to 39 age group, the flowers with slightly longer stems belong to the 40 to 59 age group, whereas the longest stems belong to the 60 and above age group.

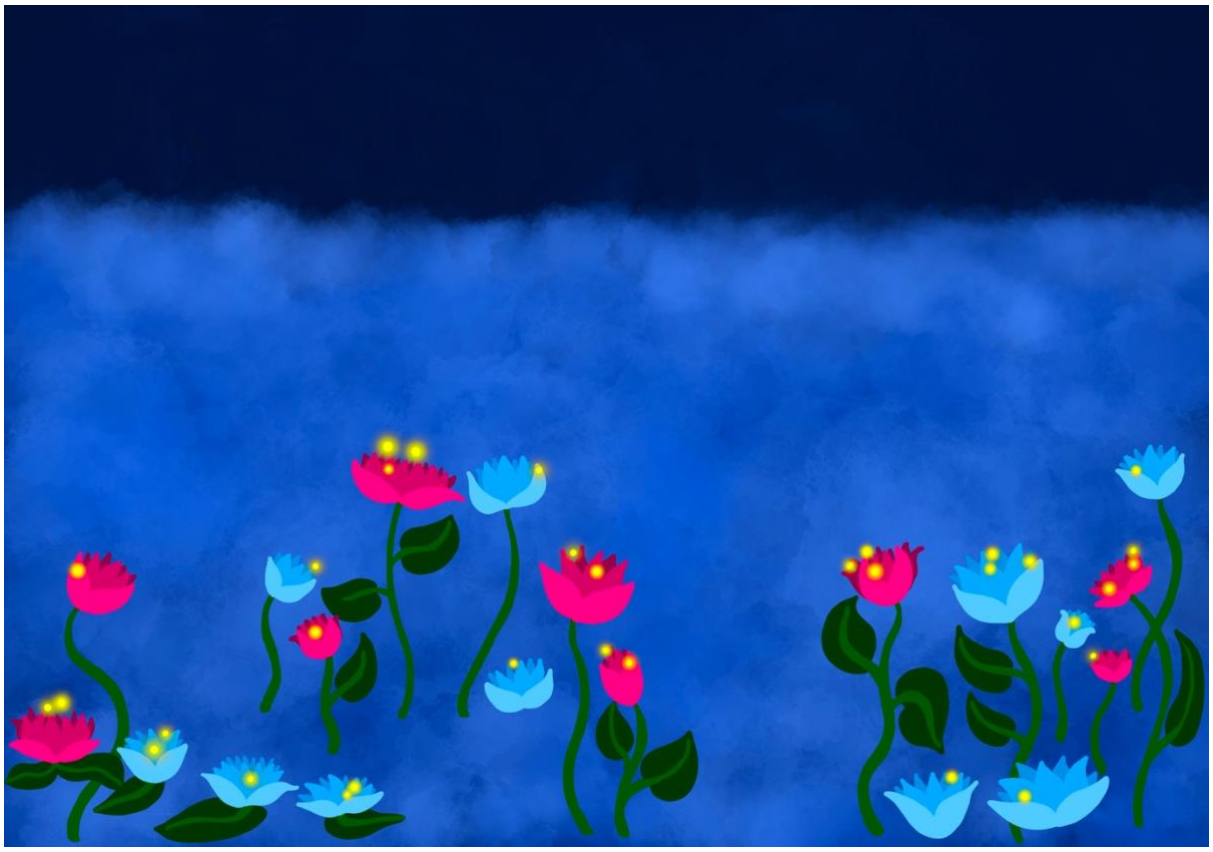


Figure 29: The second improved prototype made that had more subtle features and lesser visual distractions.

Trying out the above visual features for the above landscape was another iteration, in order to sort of have a better colour palette and reduce the number of disturbing elements in the landscape that can pull away focus from the data representation, the background of the landscape was made into a single colour tone. This tone was created to match the overall colour palette as well as bring in the feeling of loneliness visually into the scene. Colour imparts meaning and evokes emotion (Sherin 78).

The changes and improvements incorporated in the first data visualization:

- The fireflies were used as positive annotations, especially to show positive reinforcement. So, they went against the amount of loneliness when they were shown on the flowers. Also, the more the number of fireflies, it felt as if that flower was not lonely given the number of fireflies on it. So, metaphorically it did not fit well.
- The random appearance of leaves on the stem made it difficult to understand the length. Also, the placement of the plants made it difficult to read the data.
- The sky and the sea seemed a bit off in terms of merging and comprising into a frame.
- The colour choices were reinforcing gender stereotypes. They were changed to reflect a more balanced choice. These associations are based on prior experience and may be the result of age, gender, culture, or geography and they can get in the way when trying to isolate people's responses to colour groupings (Sherin 79).

Prototype 2

The next iteration I made was trying to tackle the above challenges that didn't bode well for the first prototype. With the user persona in mind, I tried to incorporate Giorgia Lupi's approach of how to make the data more insightful, complex, yet relatable. This inspired me to create a second iteration of the data visualization prototype.

With a concise version of the original number of participants, below is the data visualization (Figure 30):

[Check Appendix for survey responses – Appendix A, Appendix B and Appendix C]

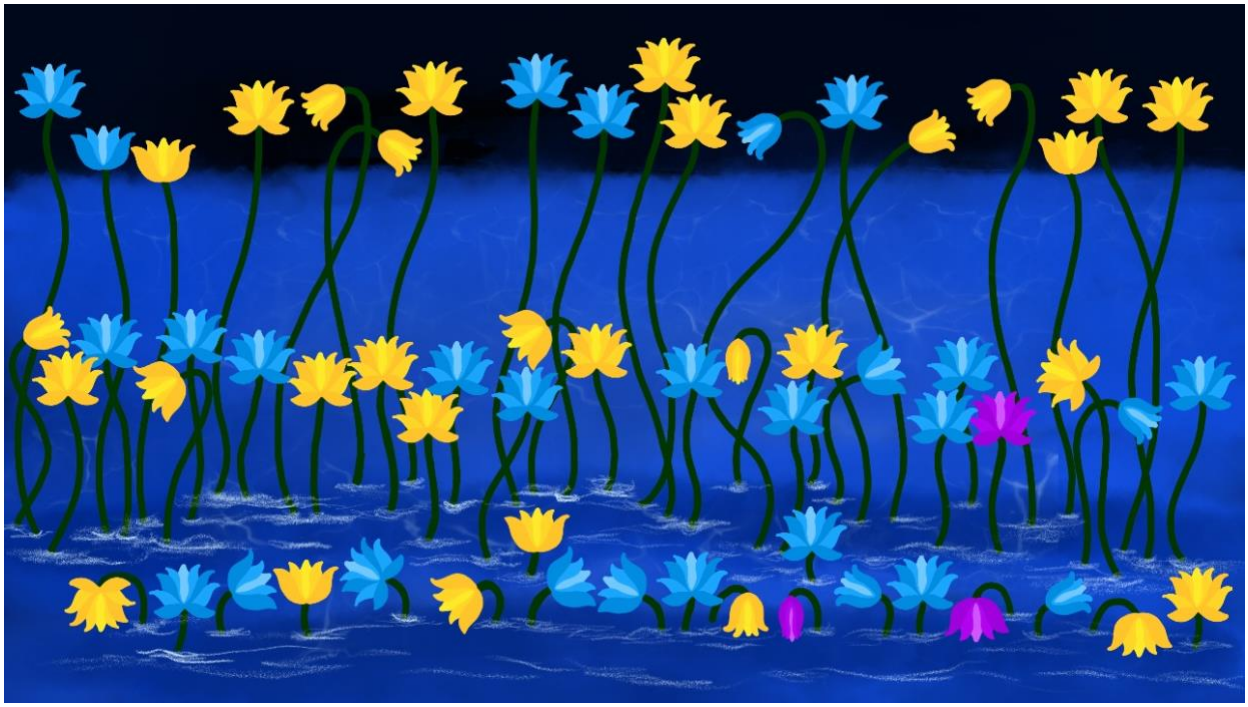


Figure 30: The data visualization prototype that was created. This improved upon the observations made in image 29.

This data visualization portrayed the month of May 2020, which was the beginning of the first wave of the COVID-19 pandemic. Using the quantitative data analysis mentioned before helped me to create the data representing 1000 participants in the form of sixty-five flowers.

The features that solve the previous challenges are:

- The stem length is more visible, which helps to demarcate the age-groups.

- The flowers now represent all genders. Yellow flowers are females, blue flowers are males, and purple flowers show other gender groups.
- The landscape is more balanced with the waves giving depth to the picture as well as the visual grounding of the individual plants.
- The loneliness has been depicted by the openness of a flower. The more closed a flower is, the lonelier the person feels. This is metaphorically showing us how lonelier a person feels, the more closed up and alone they feel.
- The depression is shown with the level of wilting of flowers. A person who is extremely depressed is shown by a full 180-degree wilting facing the ground.
- The leaves have been removed to completely do away with the visual interference and confusion in terms of reading the data.

The legend for the above data visualization is shown below (Figure 31).

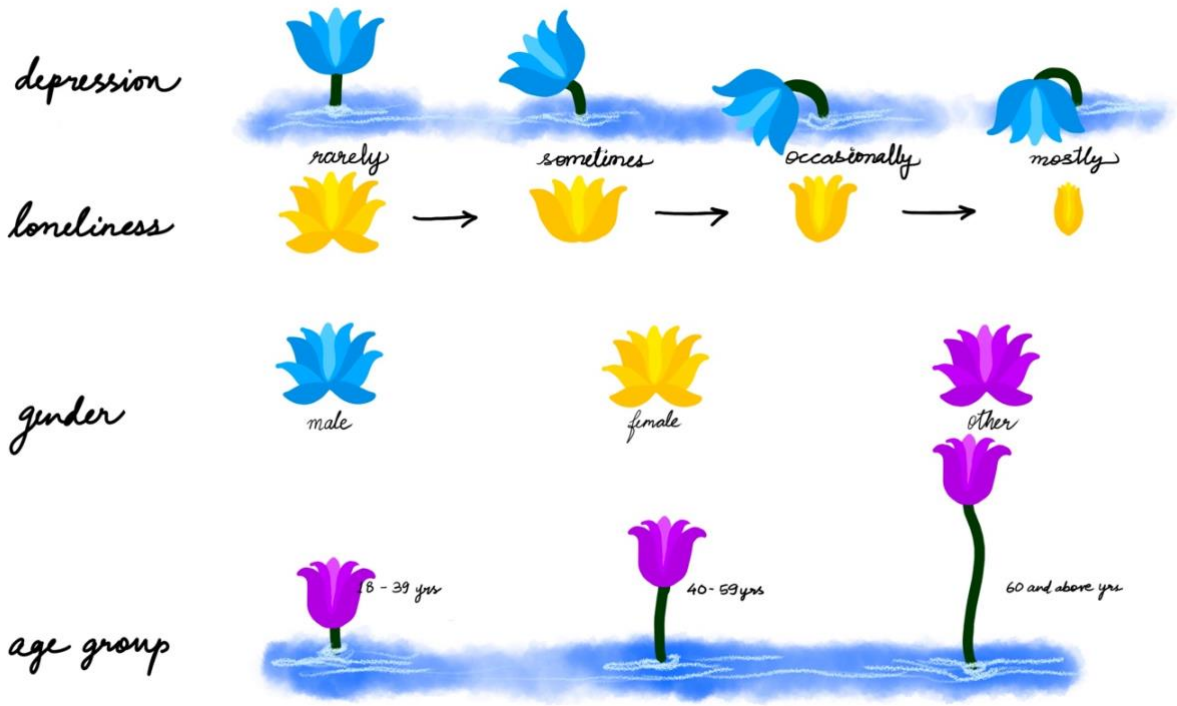


Figure 31: The legend or key created for the data visualization in image 30.

With the second iteration, it gave a better sense of having done justice to the way the data is represented. When I presented this prototype to my classmates, I received useful feedback. The first main response focused on the narrative around the flowers shown. I needed to explore the appropriate layout to help create a sense of empathy along with seriousness towards the sensitive issue. I decided to wrap the data visualization along with a voice-sensitive flower in a single frame that would light up when it hears healing words. Sometimes words of care and affection are the ones that one needs to hear the most at the time of need. Apart from this, helping out the people by providing links to known sources of support groups, loneliness helplines, support centres, etc., seemed to pull together a more helpful side to the data visualization. This motivated me to showcase the entire output on a website so that the maximum number of people can benefit from the data and the resources. This will be the primary goal to accomplish in the next iteration.

This prototype was a crucial step in terms of validation as well. After having completed the data visualization, I decided to conduct a user study survey to get feedback from the OCAD graduate community about how they felt about the overall feeling of the data visualization, what they felt could be improved upon and what went well. This was an anonymous survey to get design feedback and insights.

Prototype 3

After having conducted the user testing survey to receive valuable insights into the way people perceived my data visualization, I started evaluating the gaps present. In addition, the process of design and coding, this user testing allowed me to realize the importance of improving the visual design for the data visualization. I got 28 amazing participants who shared their experience and wisdom regarding the design choices. They were primarily staff and OCAD students above the age of 18. They were recruited on a volunteer basis, via an online Microsoft forms survey which was shared by the Graduate Program Coordinator and me. They self-declared the above requirements and provided consent. All the questions in the survey were optional given the sensitivity of the subject.

Insights, findings, what worked and what didn't.

Through the user testing feedback, the following insights were collected:

- The prototype 2 data visualization had successfully connected with 80% of the participants. They found the metaphorical representations to be apt for the topic of loneliness and depression.

Figure 32: The appropriateness scale used in the REB shows that over 80% of the participants (28 in total) found the data visualization to be apt for the data being represented.

- The top five keywords that echoed across the participants after having a look at the image were: Lonely, Emotional, Calm, Gloomy and Hopeful. As one can see, these chosen words cover both the sides of the spectrum of emotions[19] wherein Calm, Peaceful and Hopeful belong to the Positive or 'the state of contemplation' in this case whereas the gloomy and lonely featured in the other side of the spectrum. And the majority of the audience had at least one of the top five keywords (Figure 33).

[19] For more information, you can refer to Robert Plutchik's Wheel of Emotions.

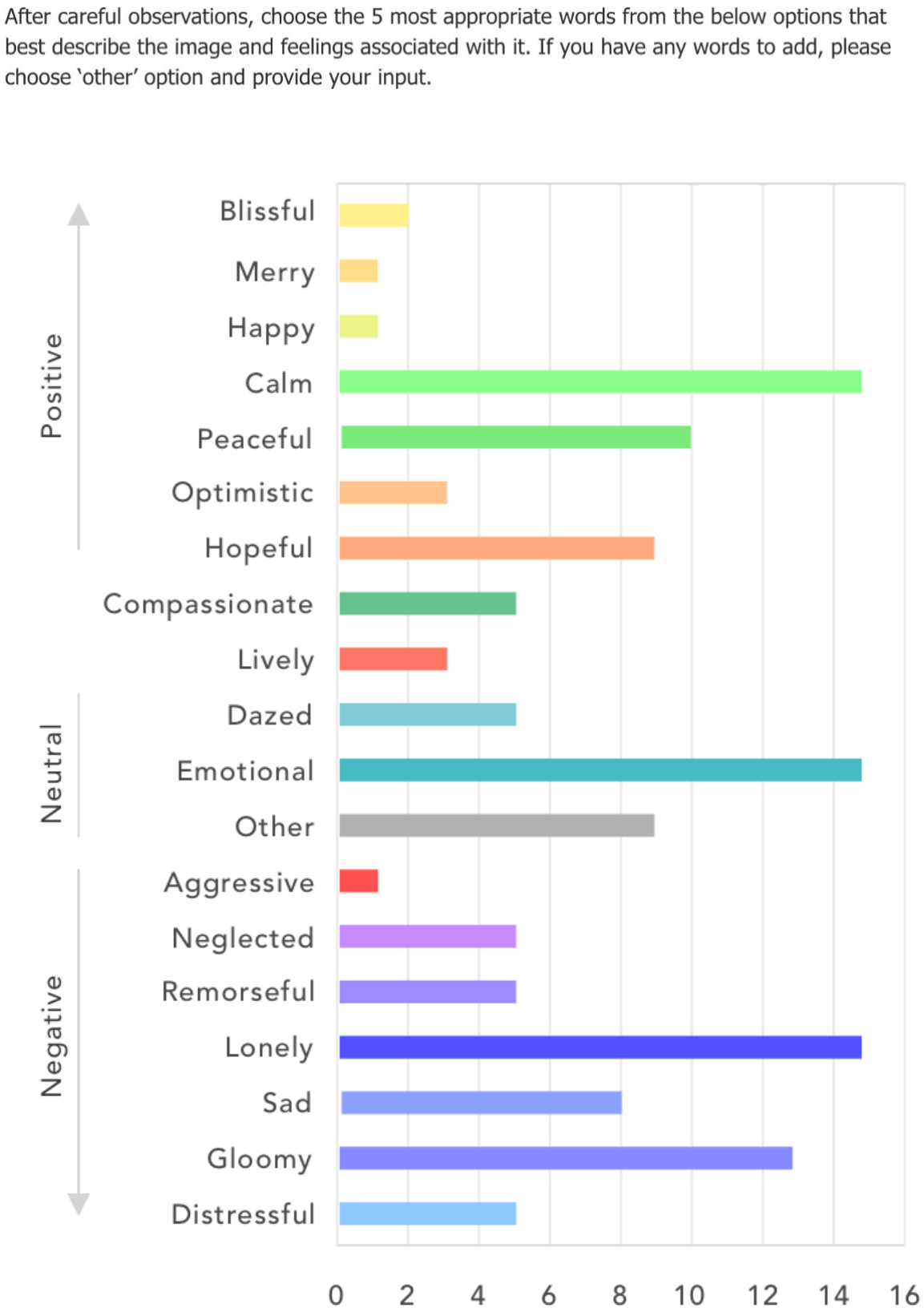


Figure 33: One of the key questions in the survey shows us the words that are most appropriate to the given data visualization in image 32. These words have been colour coded and arranged based on Plutchik's Wheel of Emotions. The number of participants who opted for the words are mentioned on the X-axis.

- Insightfully, some new words came into the limelight, such as Mournful, innocuous and dangerous, which seemed to be bringing out newer emotions into the picture. It was interesting to look at these words and then consider looking at the data visualization from that angle to picture those feelings.
- More than 50% of the participants got a slightly gloomy vibe from the data visualization prior to knowing what it stood for. This insight was helpful and proved to be in my favour, given that I was trying to visualize the loneliness felt by people.
- Visually, the feedback received pointed out that somehow the blue flowers submerged into the blue backgrounds. This was eye-opening as a designer, given that has been working on this data visualization for so long, sometimes one tends to familiarize themselves with such kind of visual mix-ups.
- In certain western cultures, blue is synonymous with depression or feeling low. So, with this input, altering the colour scheme a bit seemed helpful.
- Some participants felt that the loneliness shown in the data visualization could be visually more drastic to show a big change. This was especially directed towards the yellow (female) flowers as they gave a bright and vibrant feeling even when the flowers were completely closed up.
- One of the biggest observations through my survey was the number of people who agreed to be feeling lonely because of the COVID-19 pandemic. From the responses I received, I felt glad as a designer that I was addressing this issue at a thesis level to raise awareness among people. The responses supported and reinforced my thoughts and feelings about how the COVID-19 pandemic lockdown has impacted so many people with loneliness.

Taking from the above observations and insights, I worked on a better version of the prototype that could aid the positive feedback and eliminate the challenges by trying to find a solution for them with changes in visual components.

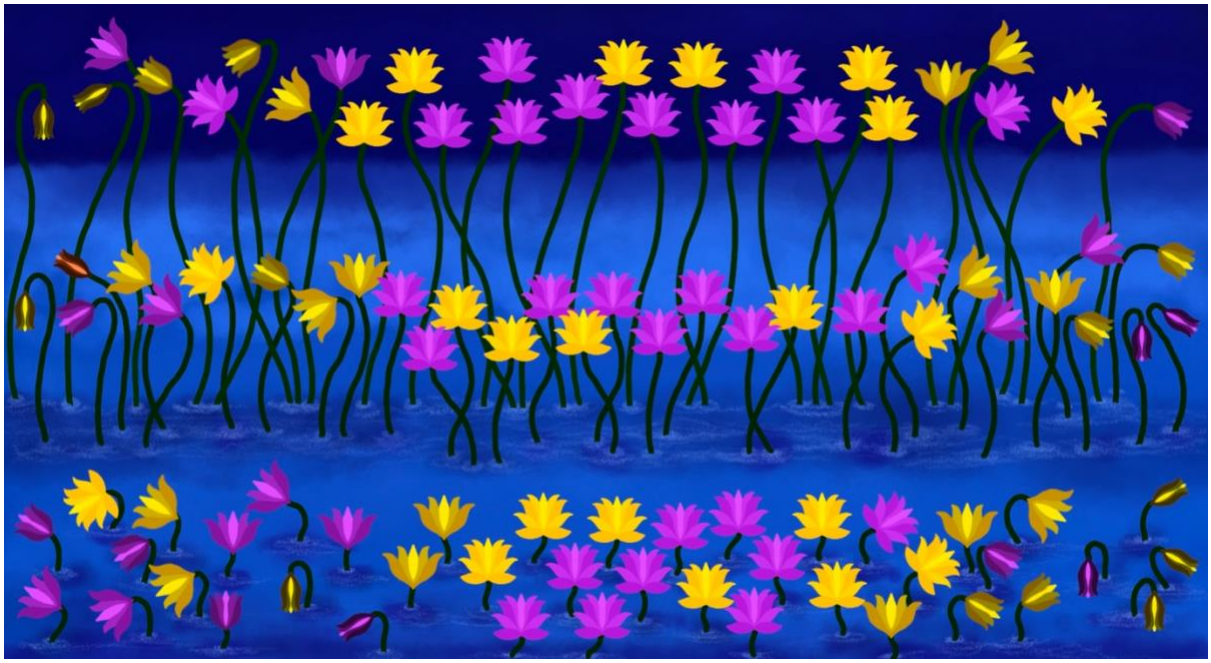


Figure 34: (Above) The final data visualization that was created by representing 1000 participants for the month of May in 2020.

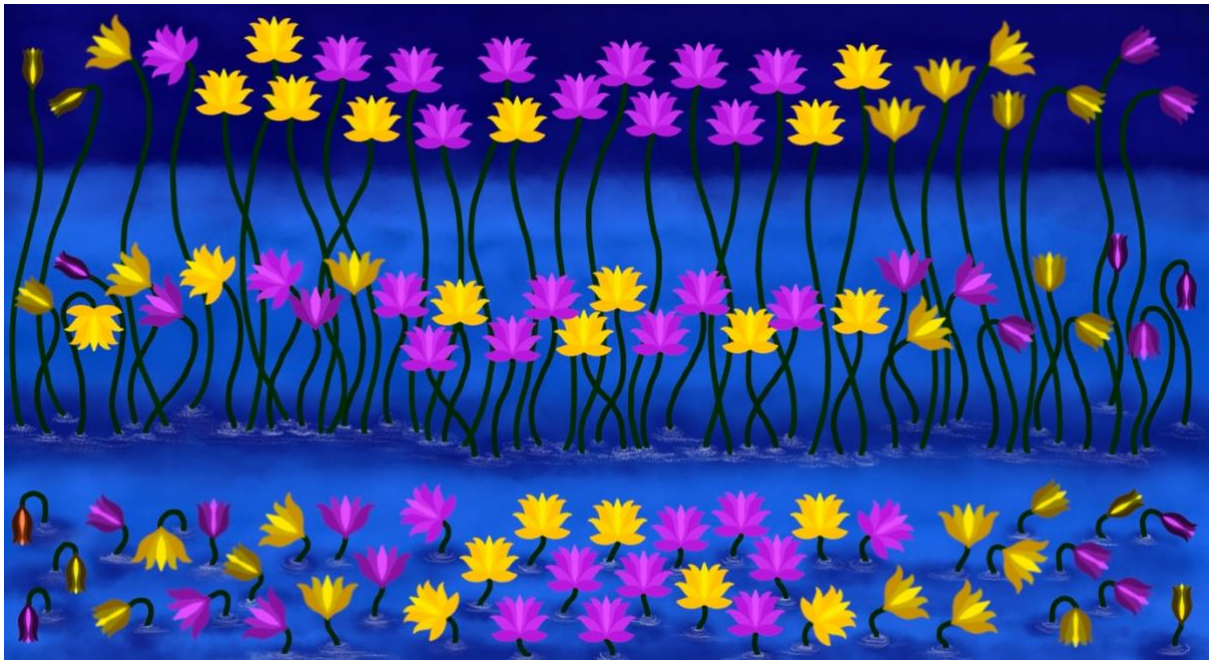


Figure 35: (Above) The final data visualization that was created representing 1000 participants for the month of July in 2020.

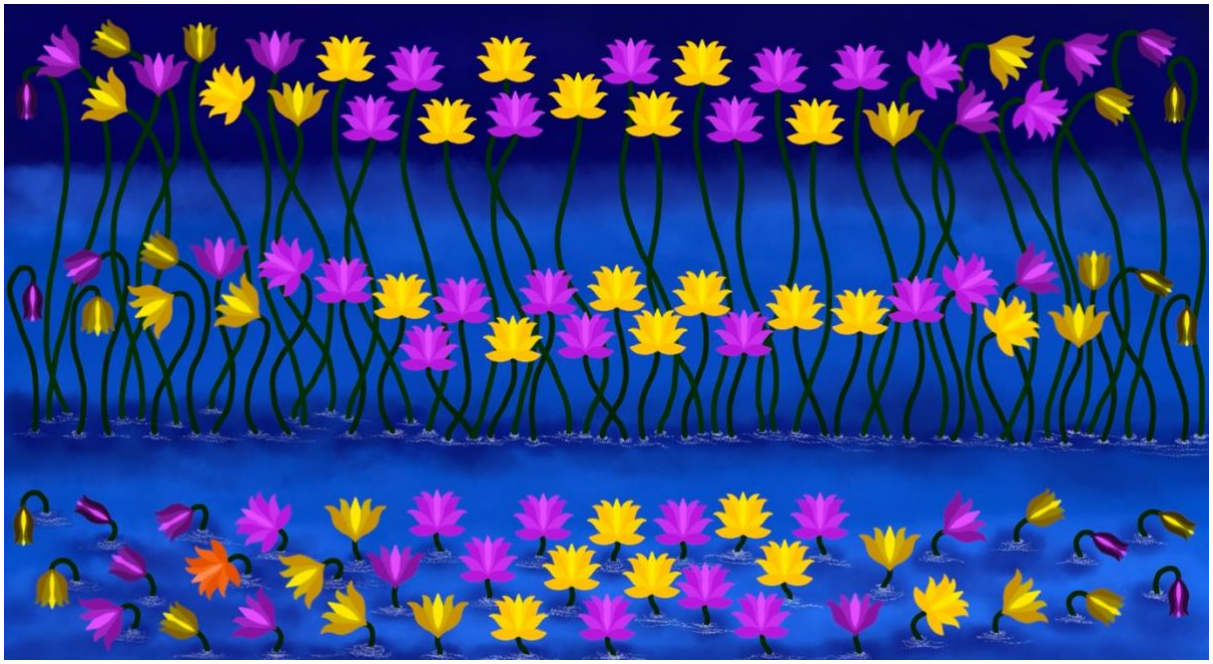


Figure 36: (Above) The final data visualization that was created representing 1000 participants for the month of September in 2020.

Other sub-categories that I decided to include as smaller informational data visualization snippets covered factors such as –alcohol and cannabis consumption, the financial situation and the way their job careers were affected during this lockdown period. These were available in the CAMH survey data. The idea was to see if there is any correlation between the different elements that make one feel helpless, dejected, lonely and resort to addictive habits. In Figures 37 to 42, we see a comparative view between 'loneliness and alcohol consumption and 'loneliness and cannabis consumption' for the month's May, July and September 2020.

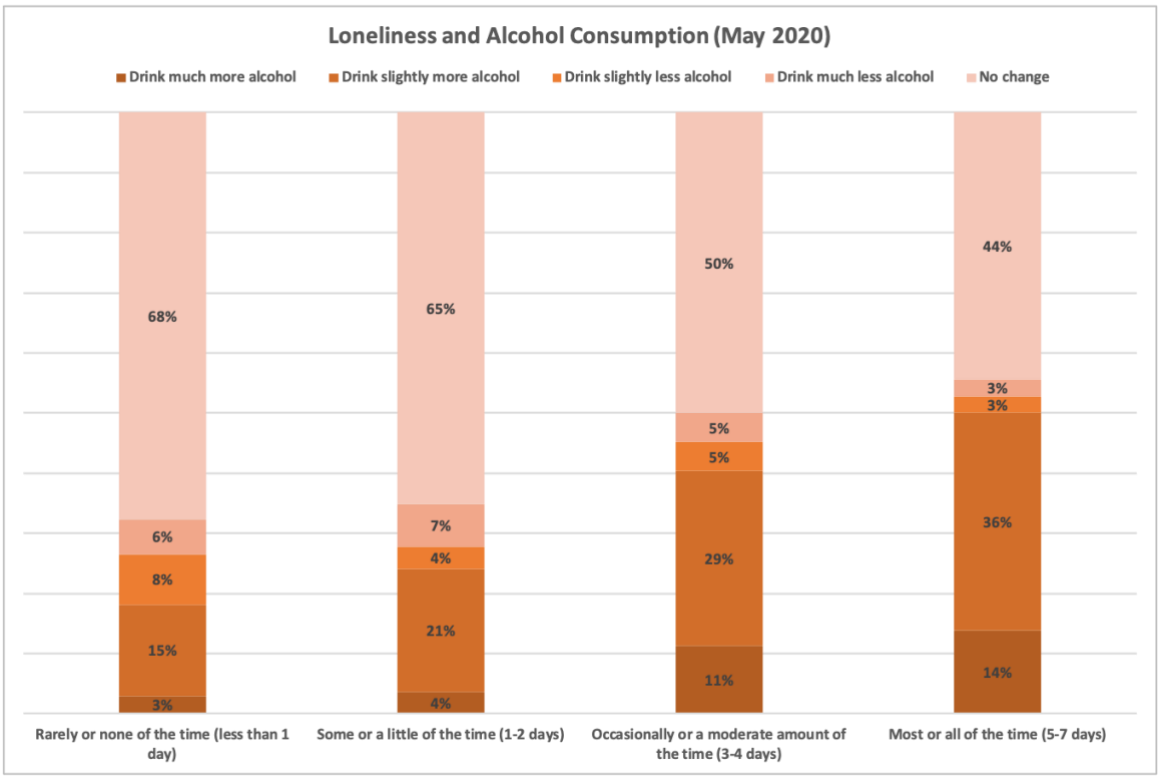


Figure 37: The comparison between loneliness felt and alcohol consumed by the people of Ontario for the month of May 2020.

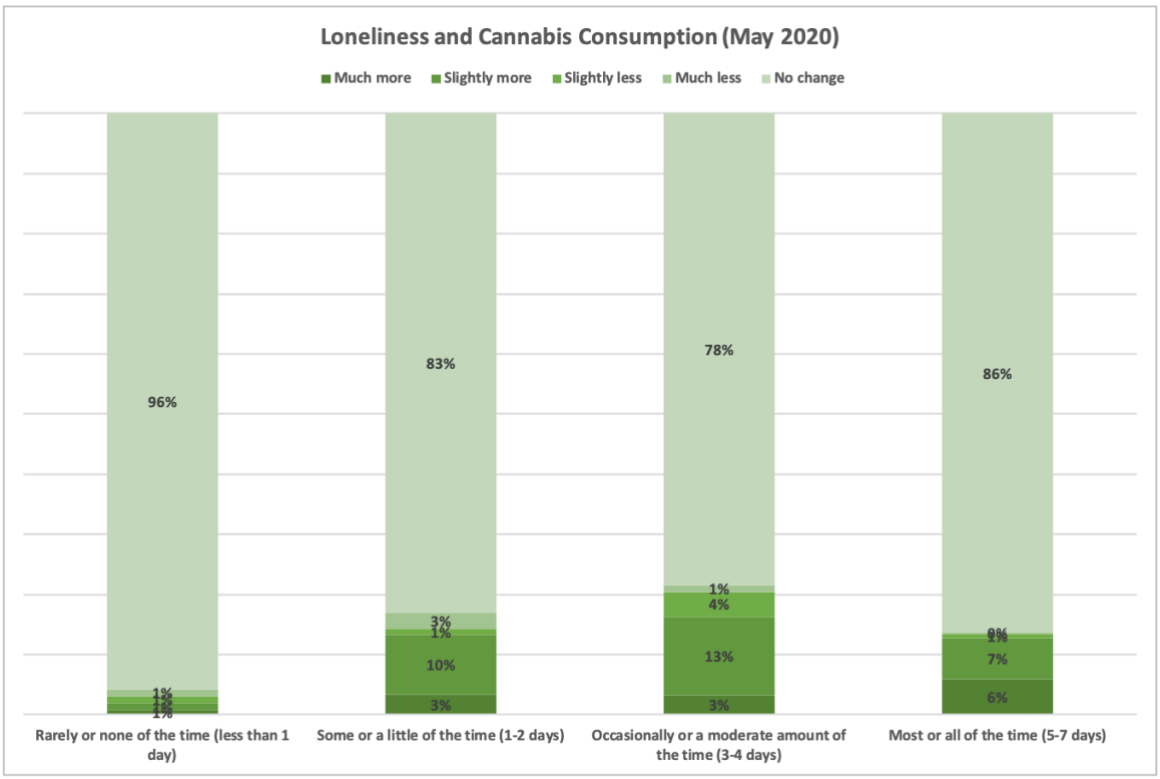


Figure 38: The comparison between loneliness felt and cannabis consumed by the people of Ontario for the month of May 2020.

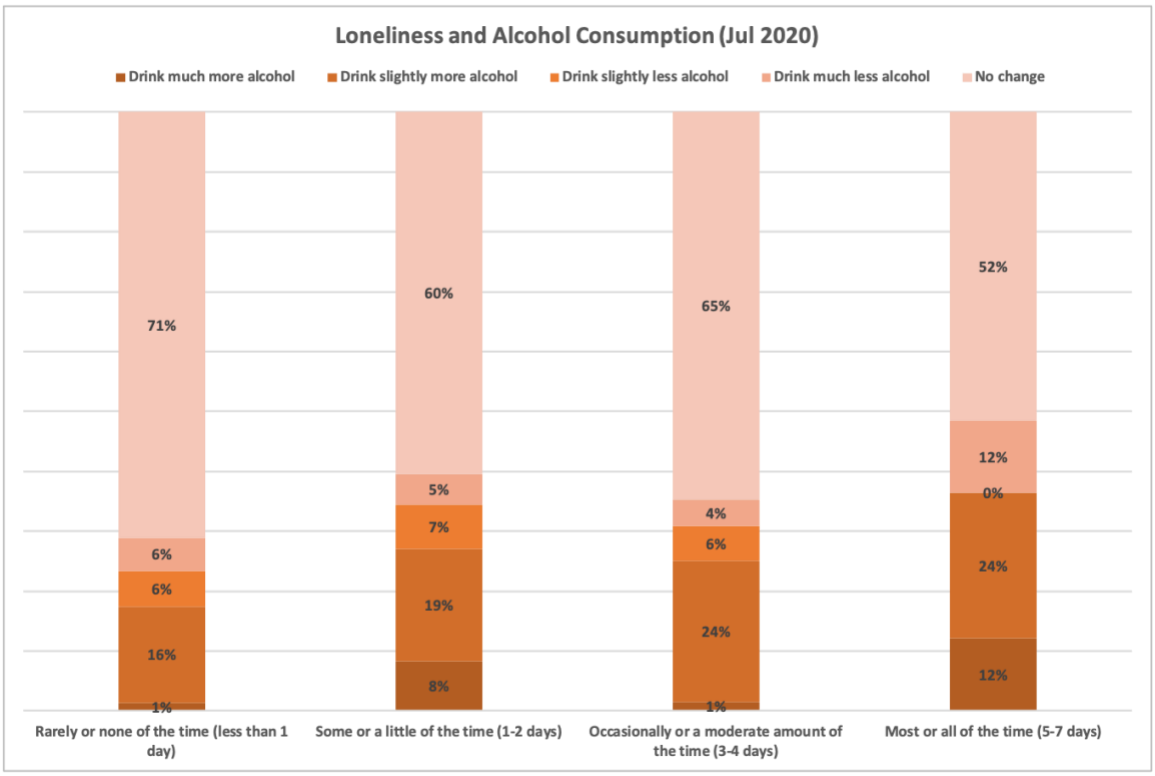


Figure 39: The comparison between loneliness felt and alcohol consumed by the people of Ontario for the month of July 2020.

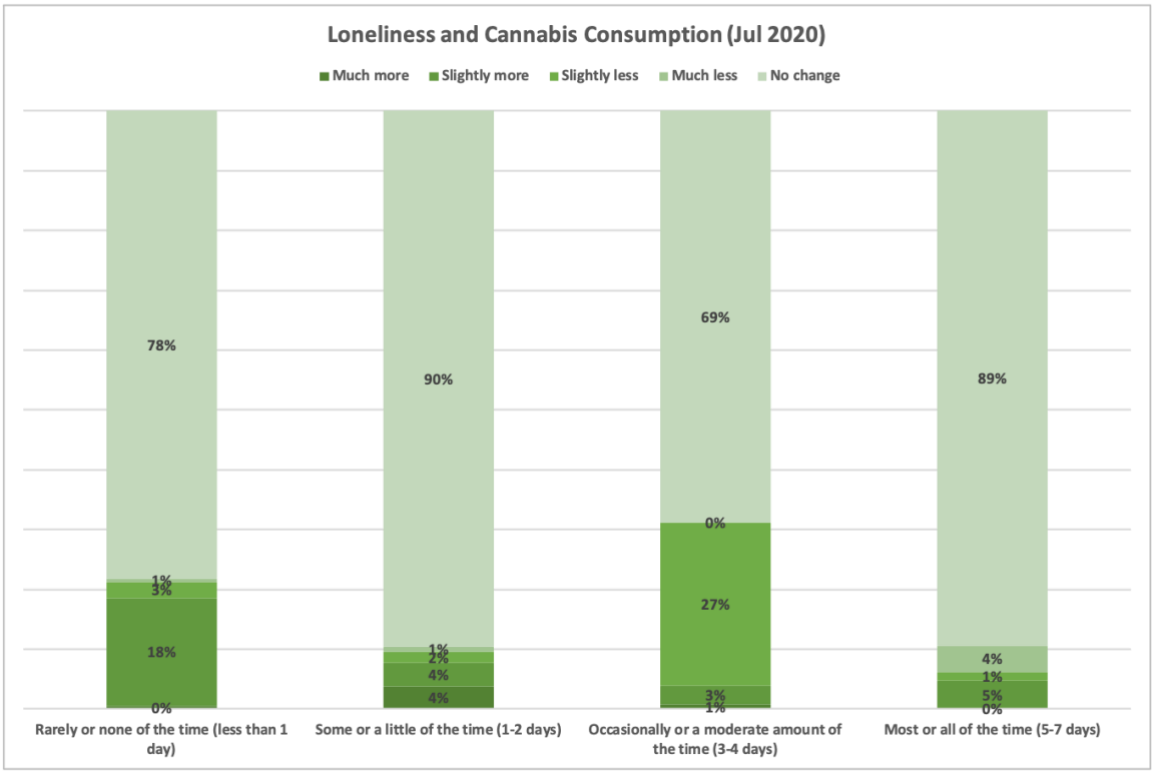


Figure 40: The comparison between loneliness felt and cannabis consumed by the people of Ontario for the month of July 2020.

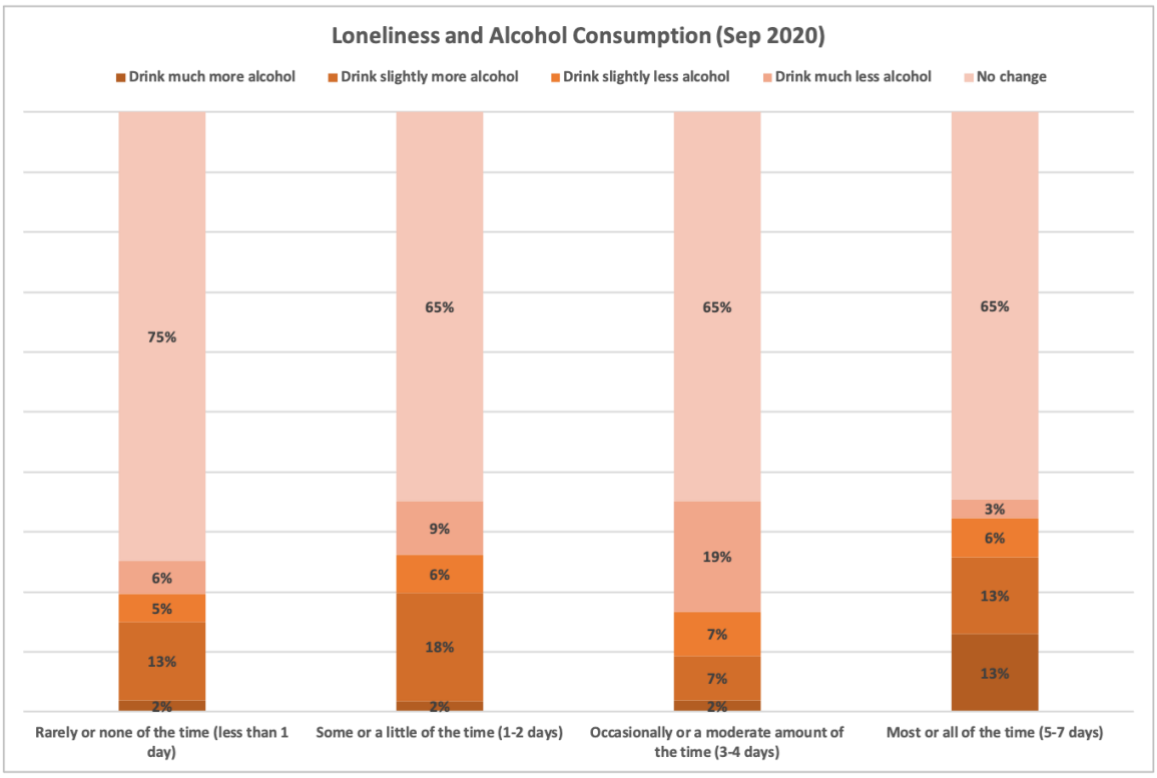


Figure 41: The comparison between loneliness felt and alcohol consumed by the people of Ontario for the month of September 2020.

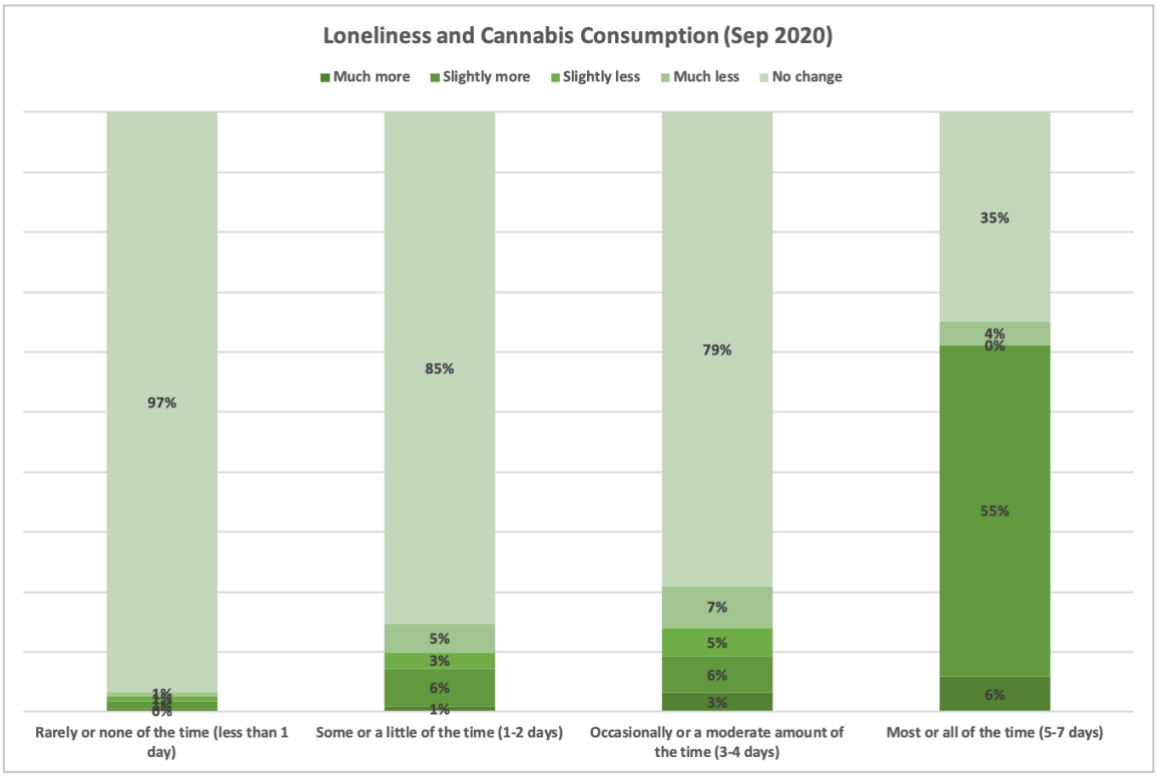


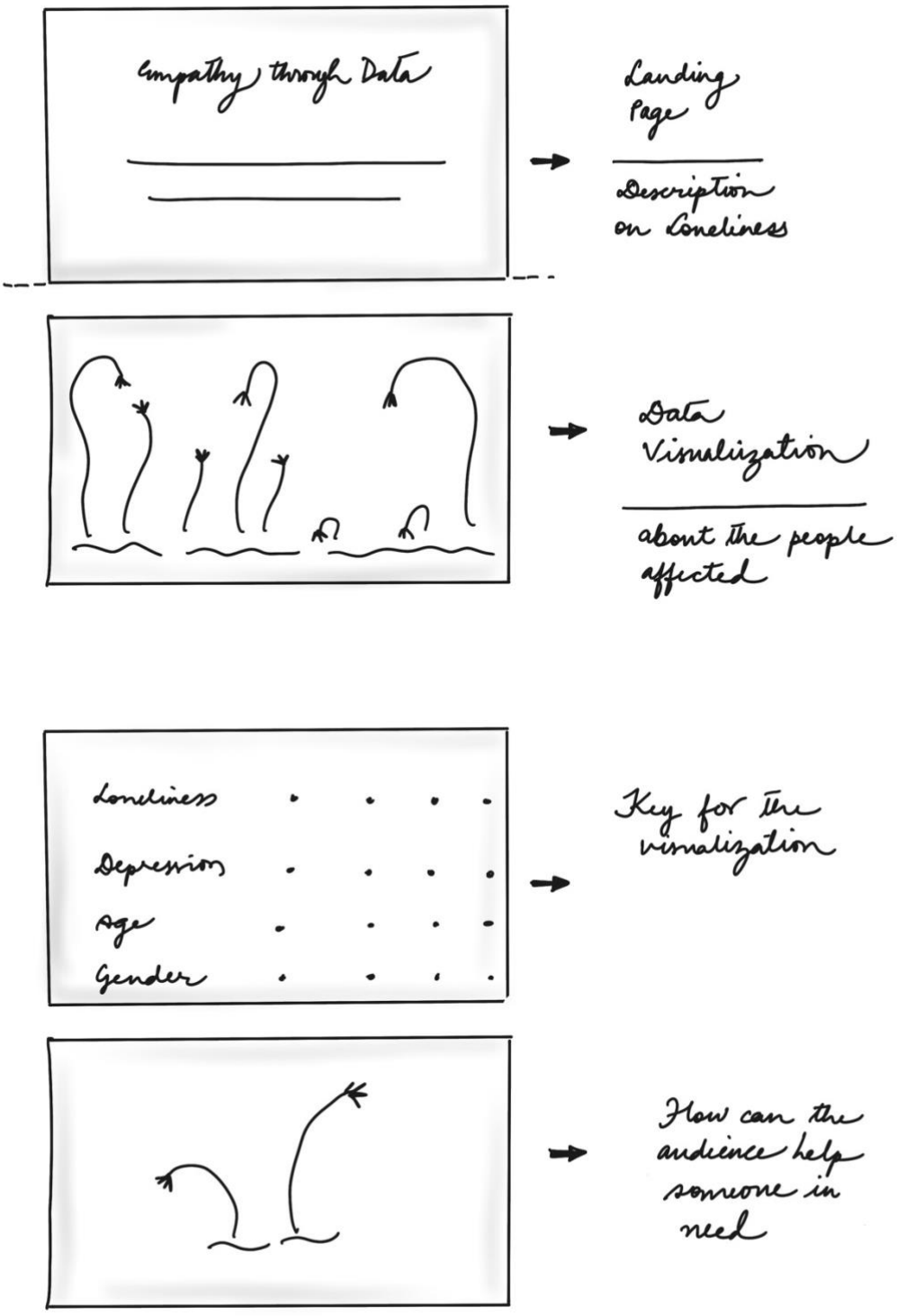
Figure 42: The comparison between loneliness felt and cannabis consumed by the people of Ontario for the month of September 2020.

These graphs show the people suffering loneliness in Ontario and their changes in alcohol and cannabis consumption – if it's much more, slightly more, slightly less, much less or the same as it was before the COVID-19 pandemic. Some of the observations are:

- More than 50% of the people in almost every category have shown no change in terms of alcohol and cannabis consumption during the stipulated periods.
- In the month of September 2020, cannabis consumption saw an increase by almost 61% in the people who suffered loneliness most or all of the time. This needs further understanding, as this is not a trend that was visible in other groups or other months.
- In the month of May 2020, we can see an increasing level in alcohol consumption in terms of percentage from people who rarely feel loneliness to people who feel loneliness most or all of the time

I decided to include these observations derived from these statistical graphs in the final narrative as well. I intend to use them as insights into the effects of the COVID-19 pandemic. With the idea to provide a more wholesome picture to the viewer along with an understanding of possible influential factors, incorporating these would make sense.

Website Narrative layout



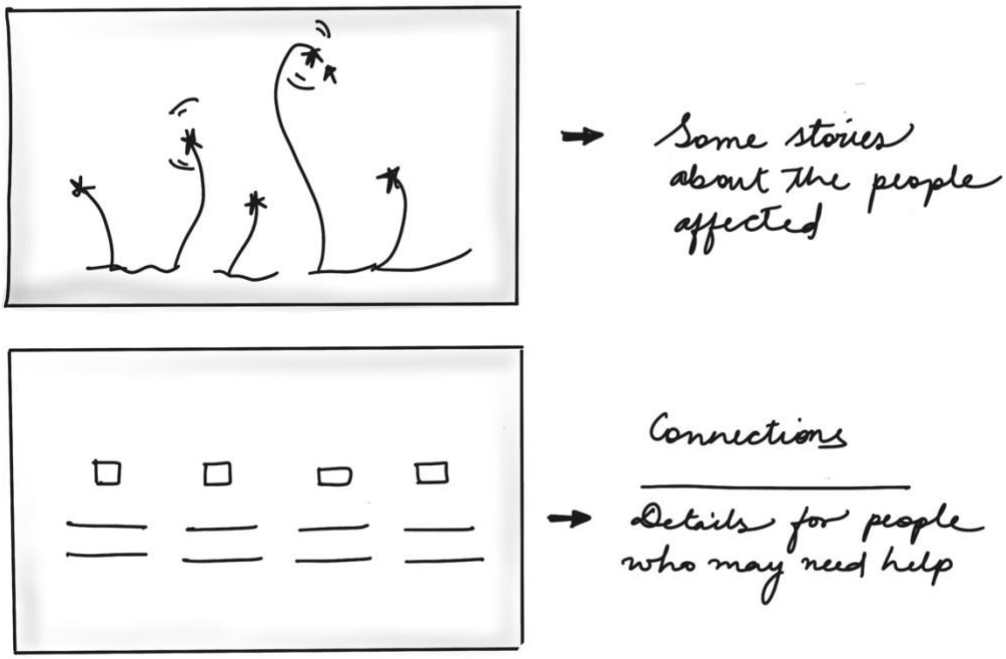


Figure 43(a), 43(b), 43(c): All three images combine to show a vertical scroll layout of the website. The website follows a storytelling approach from the bottom.

Some of the website prototypes of the data visualization that had interactive elements were tried out using HTML, CSS and javascript coding. After working out some samples of the ways the flowers could be made more interactive in terms of movement and narrating a story bring in. Hence, I created a separate interactive section which would narrate the data represented by certain flowers. These show the people and their state during the COVID-19 pandemic using voice to represent the data. The data visualization alone was given primary focus and as we scrolled down to the website page, we saw smaller elements of interactions that helped the viewer in relating with the subject.

For the development of the website, I worked on the narrative that engages the viewers and makes them aware of what loneliness means, along with an example of a personal anecdote. I share my personal struggle with the viewers, which helps in bringing my experience into the narrative. I continue by showing the data visualization of May, July and September 2020 in a

carousel form. I lead into the legend that lets the viewers know about what they just saw, so that they can have a look and understand the flowers more personally. As we move further on, we find a demonstration of the some use cases from CAMH survey in the form of interactive flowers. Finally, the website takes the viewer to helpful resources, links and helpline numbers for helping those in need.

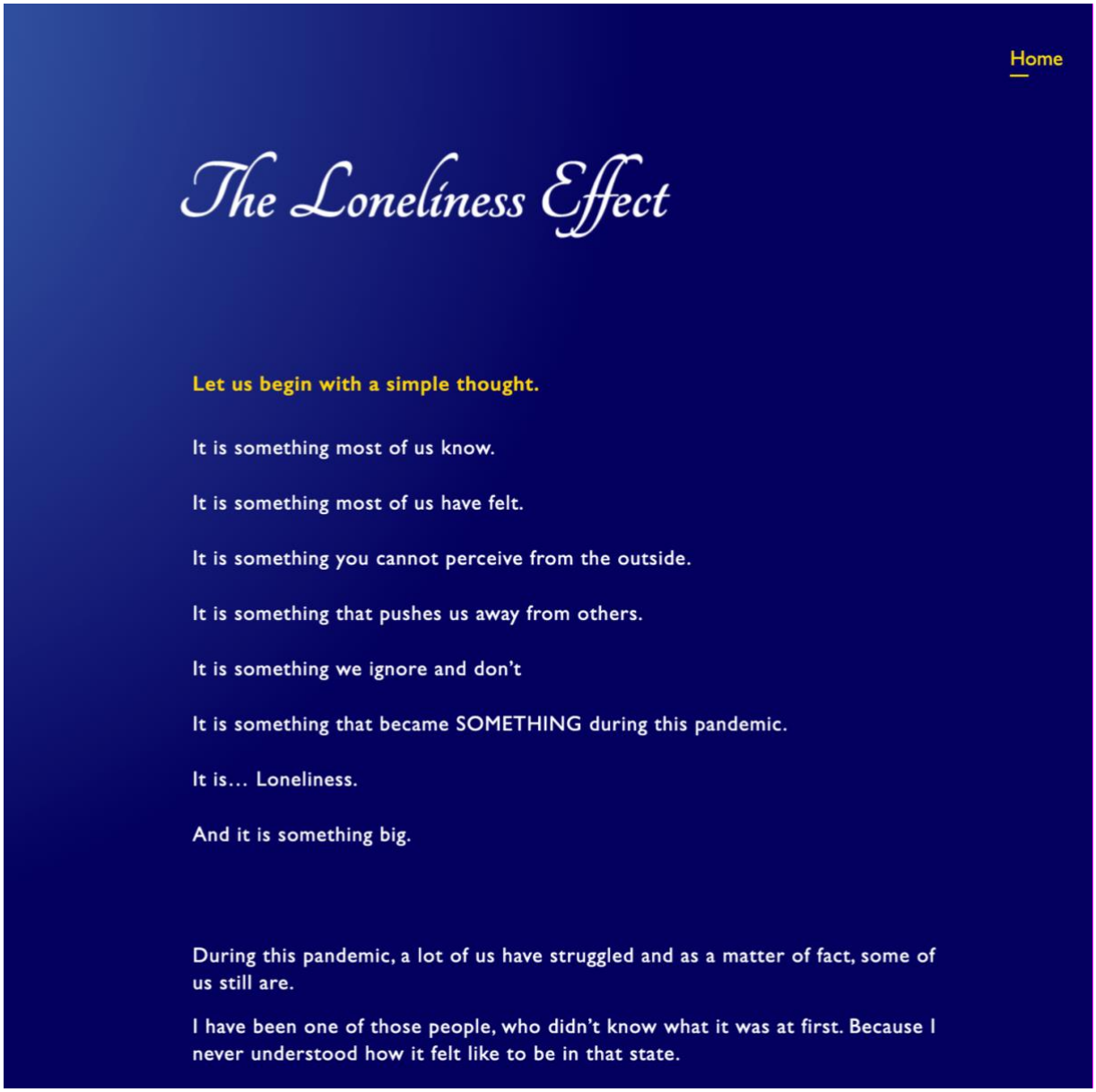


Figure 44: The beginning to the website. This shows the narrative storytelling layout being followed to share experiences about loneliness.

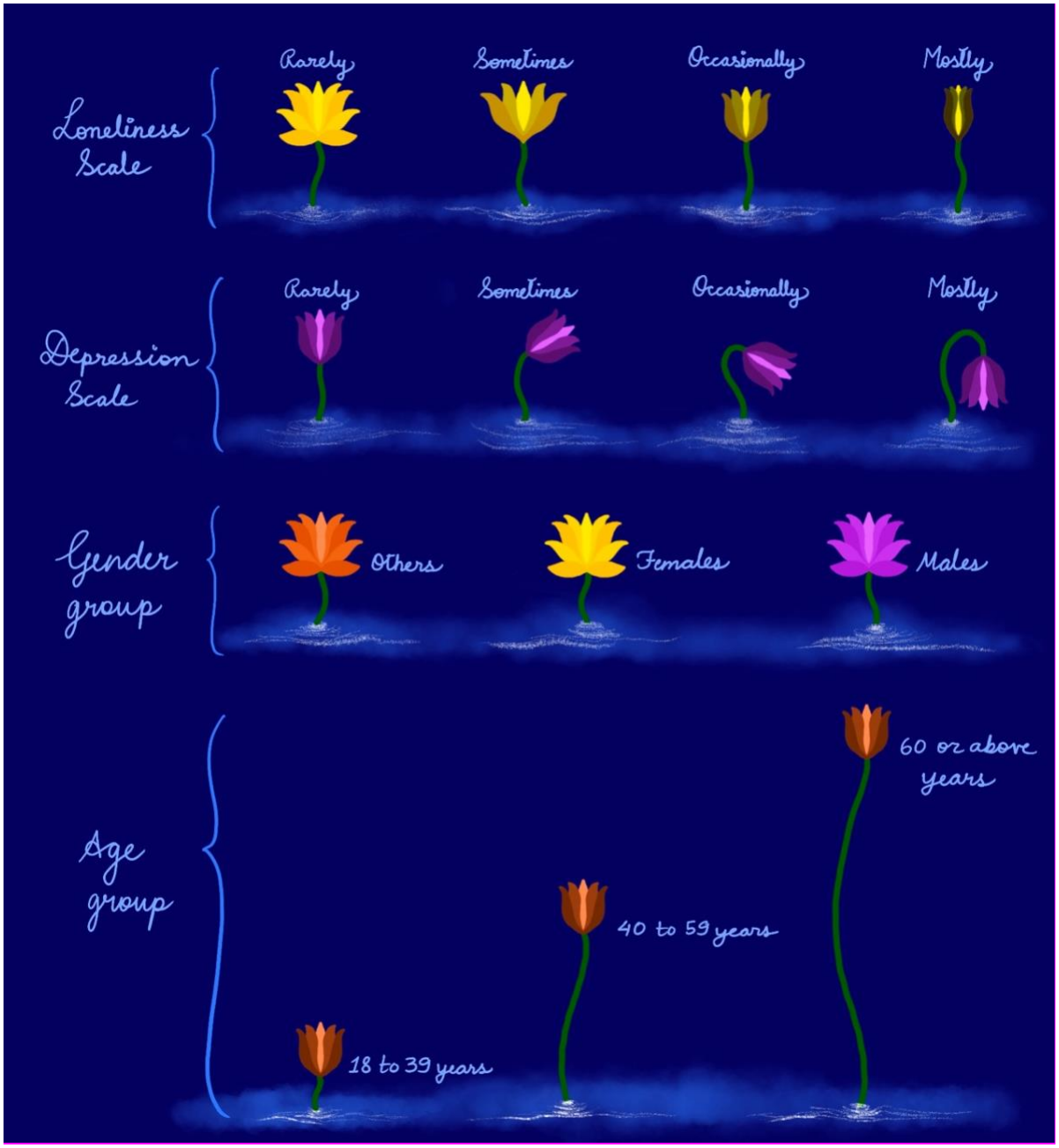


Figure 45: The legends created for the website to help the viewers understand the data visualization better.

The above images (Figure 44 and 45) are an introduction into the 'The Loneliness Effect' website. For the final prototype, I also decided to include ambient sound along with the voice based video and interactive clickable demo, as that would help foster empathy while viewing the data visualization. This piece was created by Scott Buckley, a music composer and arranger. He composed this piece called 'Hiraeth' which means - a longing for a home you

can't return to, or one that was never yours. The piece uses calm synth pads, strings and yearning solo cello. As the description of the piece suggests, it acoustically represents the same feeling that I wanted to bring out in the persona that I was designing for. As the music plays along, it is meant to transform the viewer into the world of feelings and emotions. The calm and grim nature of the music adds onto emotional yet steady theme of the data about the COVID-19 pandemic lockdown and how it brings loneliness and despair into the lives of some of the people.

Link to ‘The Loneliness Effect’ demonstration: https://eager-shaw-9988ef.netlify.app/

CHAPTER V

LEARNINGS AND REFLECTIONS

Learnings: What worked and what didn't and why?

After gaining perspective from the participants who took part in my survey, I learnt that the data visualization did convey majority of the data, but it required some tweaks in terms of the overall colour scheme. The process of designing the prototype to meet the thesis goal and executing the user testing feedback presents challenges and directions for future research. With my participants also being the audience of my data visualization, I felt that their opinion helped me in shaping the outcome in a much better way, to be precise in the way the audience would perceive the data. With my participants ranging across different age groups and gender group, the feedback received was wholesome and apt for the way they felt about the COVID-19 pandemic affecting people. Some of the opinions and feedback that helped me improve upon my prototype are shared below:

- After analysing the response from the survey, almost all participants expressed that they felt empathic towards the people who were affected by loneliness. A lot of them had themselves undergone something similar during the lockdown giving them the ability to relate and understand the sentiments associated with the data visualization. The participants also expressed their concern towards those suffering and expressed their desire to be helpful in ways possible that can make them feel better. These kinds of inputs put a beam of smile on my face, as they were some of the valued responses in terms of what I was trying to achieve through my thesis project. Some of them even expressed concern over how loneliness affected females and younger people comparatively more than the others. This was not only proved through the survey, but we also find evidence through the raw data and articles such as which shows us that

'women worldwide are nearly three times more likely than men to report mental health impact from COVID-19' (Youn).

- The participants felt that the visual metaphor of the flower being used to represent the people was very appropriate, especially the way the flowers behaved – the blooming and wilting and the opening and closing. These visual metaphors and the actions along with them brought the real picture into the limelight. Though, one of the suggestions was to make these actions even more drastic so as to represent extreme loneliness and depression.
- Colour changes based on shades or exaggerated wilting were some of the suggestions in this regard.

To summarize, the user testing session was invaluable. It gave me the direction to improve and chart the future trajectory for my final prototype. Through their feedback, I learnt about the various perspectives that came into light which sometimes may get overshadowed. The survey provided me with a deeper understanding of the role of visual elements, its importance in terms of representation and the ability to capture the audience's attention and use it in a positive manner to address something important.

More often than not, researchers make mistakes in studies dealing with the abstract terms like affect, mood and emotion, which get used indiscriminately and inconsistently on a regular basis (Ekkekakis 551). But to simplify things, according to Gray and Watson (2007), compared to emotion and mood, ‘affect is a broader, more inclusive psychological construct that refers to mental states involving evaluative feelings, that is, states in which a person feels good or bad or likes or dislikes what is happening’ (Ekkekakis 1014). By being mindful of the way affect plays a role in making people feel emotions, I made sure that I make the entire

experience more humanized and personal. I relied on creating a connection with the viewers by telling them about those affected. And this helped me to warm myself towards the entire process of emotional creation.

Reflections

Over the course of my work, I had initially thought of something which was more of an interactive showpiece to be put up for display. But over time, with the given COVID-19 pandemic lockdown situation, the level of outreach necessary and the time constraints, the best decision was to create something that was easily accessible, shareable, informative, meaningful and eye-opening so as to create awareness among the audience. These criteria were met by a website, that could be shared with people for them to gain knowledge about the ongoing issues of loneliness. When I look back at my year-long journey of working on the thesis research and creation, I feel that sometimes it's just that the people need to be given a more appropriate form of the content to help them understand the subject thathelps in reciprocating feelings. Through my process of learning, I realized the power of visual and metaphorical representation, the power of data and how it makes a difference in the way perceive it based solely on the representation and the power of empathy.

Apart from addressing the research question of alternate ways to represent sensitive data, the final prototype helps minimize the effects of statistical numbing by focussing on the individuals rather than compounding and showing them as dots on visualizations. As Jacob Harris, senior software architect at the New York Times mentioned in his article, ‘Dots or people – what do you want your readers to think?’ (Connecting with the Dots). Similarly, we see how dots rather make the visualization look less compelling in terms of what it's trying to convey. The way we represent people is crucial when it comes to showing data about them.

Giorgia Lupi says ‘Data represents real life. It is a snapshot of the world, in the same way that a picture captures a small amount of time. Numbers are always placeholders for something else, a way to capture a point of view – but sometimes this can get lost’ ("Data Humanism").

And this is essential at what most of us are trying to achieve today. She encourages everyone to embrace complexity, contextualize the data and break through the norms of data representation. One of my other inspirations, Sonja Kuijpers of Studio Terp, was highly influential in the ways in which sensitive data can be represented. Her work and artistry in conveying the data to people is astounding.

This entire design process journey has got me thinking about the future. I see hope and I see empathy in people. But the only thing lacking is a proper channel and outlet for the people to know, understand, express and take action. With so many people impacted by the COVID-19 pandemic lockdown, it is important for us to practice empathy as well as feel compassion for others. Through this journey, I have become much more open as a person to how others might feel. And one thing I realized is, it's never too late to start the helping process (*How to Be More Empathic*). Through my thesis, I shared my vulnerable side with those who were or are in a similar situation. And I hope this thesis benefits those suffering, or the people who know someone who is suffering or has suffered loneliness in the past. Stay strong friends. This too shall pass, as they say.

Scope & Limitations

Through my research I realized a couple of things as I progressed through the iterative development of the prototypes.

1. The raw data procured from CAMH is based on a survey conducted among the people of Canada. Though the response statistics should have been imbalanced as per expectation, they were not so. By imbalanced response statistics, I mean - unknown number of males, females and others during every survey, as the participants who are responding aren't the same set of people every time. But, after careful analysis of the initial data, what I found out that the data was probably manipulated. The ratio of male:female:other gender groups is consistent across all the results shared from the surveys conducted throughout the first and second wave of COVID-19. This goes onto prove that though the surveys were completely random, but the data available to the public, was manipulated to maintain the gender ratio.
2. For incorporating the touch of personalization and giving a more organic feel to the data visualization, I resorted to a hand-drawn experience. But, hand-drawn data visualizations can be tedious, especially with a one-person army. Hand-made drawings bring in a more natural feeling to the overall data visualization, which bodes well for the topic in hand. But, with the time constraints and the iterative nature of incorporating inputs, it may seem overwhelming at times. Although the result is extremely rewarding.
3. With 1000 participants in the original CAMH survey, it was difficult to represent all of them in the same data visualization. That's why for this approach, quantitative analysis using the percentage method was applied, so that every individual voice could be represented accurately with a touch of personalization.

4. The measurement of affect – in terms of the empathy that is fostered in the audience by viewing the data visualization is a gray area. There is no said methodology of tapping the emotions and affect that is generated. This makes it difficult to set a level or threshold that the data visualization needs to match in terms of how successful or not it is. Given the abstract nature of emotions and affect, it is difficult to find a measuring technique that works on a universal level to help quantify them. As per Gray and Watson (2007), compared to affect, emotion and mood are "rarely universally agreed upon and they do not remain invariant over time." (Ekkekakis 1030).
5. Due to the nature of this thesis, the visualizations have not been created from a commercial approach. They are more inclined to connect the audience on a personal level. Despite the prototypes made for this thesis, there is always a room for improvement in terms of insight and testing prior to being shared globally (Veda 19).
6. From the user testing survey conducted for this thesis, only the unanimous and majority inputs have been included to reflect in the final prototype of the data visualization.

CHAPTER VI

CONCLUSION AND FUTURE WORK

With my research and creation through my thesis journey, I hope to have moved a step closer to the goal of fostering empathy in people through data visualizations. I feel confident in continuing my future work in the field of analysing data to create empathic data visualizations that humanize data. This research came to teach me the different ways to analyse data. Through my iterative process, I realized the importance of some of the things like emphasis, emotion, suffering and most of all people's opinion about how they felt about loneliness. Though a precise outcome for the future of my research work is unclear at this point, I have made sure to create and work on analysing various data visualizations that look at sensitive issues, study them and create variations that better reflect the same data. This will not only help me as an individual to improve upon my Information designing skills but will also help me in finding newer ways of representing data in terms of the ongoing trends.

Given my learnings through this beautiful journey, I wish to take some of them ahead with me in my future work.

1. I intend to be more mindful of the way data is represented. Every element going into a data visualization has a meaning. And this representation gives rise to various interpretations. Which brings me to a big thing I learnt in this process – Sometimes the simplest approach is the best approach. With the idea of eliminating multiple possible interpretations, one needs to not complicate things in order to help the people understand it better.
2. ‘A visual appealing design can catch the audiences' attention and increase their interest in a topic." (Feng 62). The visuals help drive the context of the data, the

narrative and the way it is interpreted. Visuals hold a lot of potential in terms of appeal for the audience and this is important for data visualizations.

3. Another thing would be trying to work more on representing sensitive issues using different mediums and use other platforms as well. One of my desired outputs for the final prototype was a Virtual Reality experience of the data visualization. The idea could be to have the audience enter the space and have themselves standing in a lake filled with the different flowers. Though, I feel this could work out as an extension of using a different medium and providing a completely new experience for the audience, something that I would love to consider in my future work. With experts in the field, such as the Accurat studio who have created similar experiences using Augmented Reality (AR) and Virtual Reality (VR), I wish to drive my curiosity into other mediums of expression and learn more about them, their benefits to humankind and their ability to make data representations easier to understand and read.

Figure 46: A Dataviz Mural for Starbucks' first store in Italy. It makes use of an AR experience. Link https://www.accurat.it/work/starbucks ("Accurat").

4. I realized my love for data and data visualization. It is something so simple yet powerful. Through my journey I came across this quote – ‘Data is imperfect. (As we are)’ by Giorgia Lupi. This teaches us that just like humans, data too is imperfect. Keeping this in mind, I would venture more into the aspect of 'data humanism'. This concept refers to fact of reclaiming "a personal approach to how data is captured and analyzed and displayed proving that subjectivity and context play a big role in understanding even big events and social changes—especially when data is about people" (PrintMag). I also joined the dear data community of pen pals who share their daily messages through data visualizations. I feel this is a beginning to a new outlook on data.

CONTRIBUTIONS TO THE SOCIETY AT LARGE

As I began this project, I knew that I wished to help those who were also victims of loneliness in the COVID-19 pandemic lockdown. Though my output maybe a small-scale representation of the actual problem, I hope it justifies the reason behind its origin. This project is my tribute to people like me, who can help those suffering or even themselves.

1. I believe that my research delivers a **strong message** to the data visualization industry to help and make them look and reconsider the alternative ways to represent data, especially with respect to sensitive issues. It also focuses on one important thing – empathy. In a way, this research acts as a step into one of the ways in which empathy can be elicited through a data visualization.
2. My research is an example of an **alternative approach** to visualize data especially focusing and relying on personalization, human elements and making it relatable for the people to understand. This lays emphasis on the significance of understanding data, contextualizing it and representing it with a thoughtful mindset which requires an in-depth understanding of the data at hand.
3. My research is intended for **individuals to consider the perils of loneliness**. It is a small way to let everyone know the agony behind it and how it affects people around them.

My only hope is that people are kinder to each other, stay more connected with their friends and family and reach out to people when in need or even otherwise. I hope we all find it in ourselves to empathize with others. Sometimes, there is no harm in asking for some help or assistance. The only fact is that one needs to accept the fact that they need help. Through this data visualization, I hope to pave the way for people paying more attention to sensitive issues, work with alternate media in terms of representing data and also be mindful of the

way they represent the data. With this newfound drive, I wish to continue on the path of learning more about ‘about how to design visualizations, but also about what visualization is, why it is the way it is — and what it could be’ (Cairo). Data visualizations hold the ability to interpret data in more than one way. With some really inspiring pieces when it comes to sensitive data, such as – the U.S. gun deaths in 2013 by Periscopic shows a gut-wrenching data visualization of the deaths of those who died young and how long they could have lived if they weren't killed by guns (*United States Gun Death Data Visualization by Periscopic*).

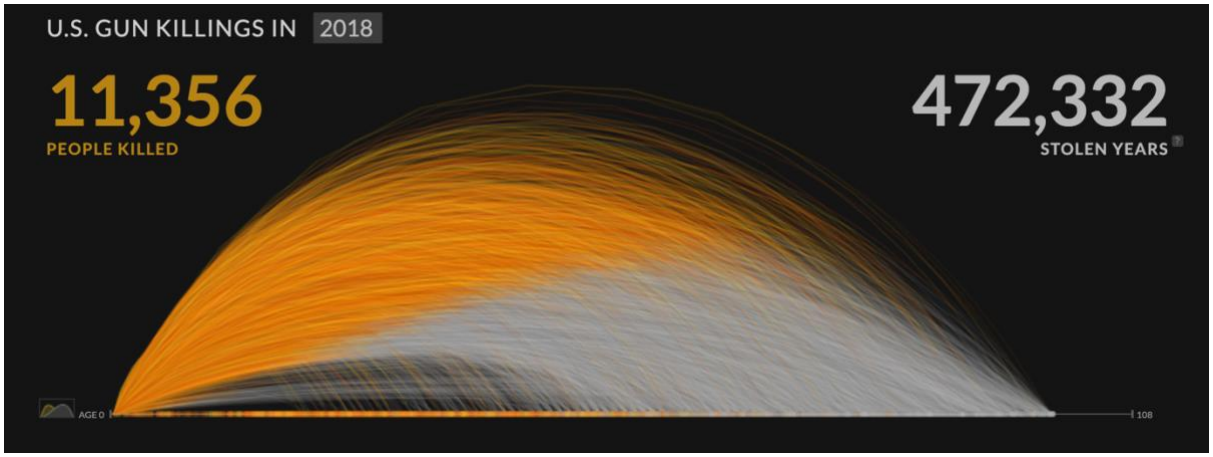


Figure 47: An Interactive data visualization that shows us the U.S. gun deaths in the year 2018, with the victims who could have lived longer (shown in the form of stolen years) if not killed.

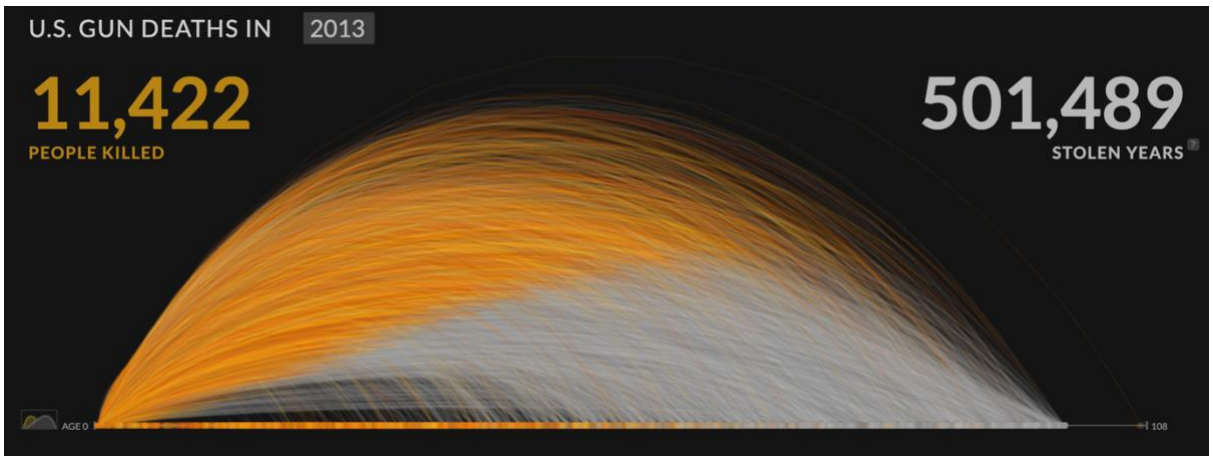


Figure 48: An Interactive data visualization that shows us the U.S. gun deaths in the year 2013, with the victims who could have lived longer (shown in the form of stolen years) if not killed.

My intention is to create something that is equally informative and helps the audience realize what's happening. With so much numerical data, misinformation doing the rounds and fake news that troubles people with what the reality actually is, my future goal is to work on creating data visualizations by a self-collecting model.

Future Collaborations

For my thesis project, one of the biggest intentions was to make the audience understand loneliness. I understand that my outreach may be limited in terms of the number of people who come across my website to learn more about loneliness. But, taking this further, I wish to collaborate with organizations such as CAMH, Wellness Together, HelpAge Canada, etc., so that they can share relevant data in a more compelling way. The idea of contributing to society little by little is a matter of motivation for me. And I hope that these collaborative efforts help make the world a better place.

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APPENDICES

Appendix A

All the 144 use cases formed when we chose the criteria of loneliness and depression. The data shared below is for the month of May 2020. Please check the additional documents attached with the thesis document.

Link to the Methodify CAMH portal from where the data has been procured:
https://www.delvinia.com/camh-coronavirus-mental-health/?utm_source=CAMH%20Landing%20Page&utm_medium=button&utm_campaign=Camh-Delvinia

Appendix B

All the 144 use cases formed when we chose the criteria of loneliness and depression. The data shared below is for the month of July 2020. Please check the additional documents attached with the thesis document.

Link to the Methodify CAMH portal from where the data has been procured:
https://www.delvinia.com/camh-coronavirus-mental-health/?utm_source=CAMH%20Landing%20Page&utm_medium=button&utm_campaign=Camh-Delvinia

Appendix C

All the 144 use cases formed when we chose the criteria of loneliness and depression. The data shared below is for the month of September 2020. Please check the additional documents attached with the thesis document.

Link to the Methodify CAMH portal from where the data has been procured:
https://www.delvinia.com/camh-coronavirus-mental-health/?utm_source=CAMH%20Landing%20Page&utm_medium=button&utm_campaign=Camh-Delvinia

Appendix D

The survey questionnaire which was filled up by 28 participants.

---------- *Survey Text begins from here* ----------

Hello there!

Thank you for being a part of this user testing survey. Your feedback is most valuable to this project.

PURPOSE

- The responses collected through this survey are strictly for improving the design outcome of this project. The questions are primarily to get your inputs on the design aesthetics, functionality and accessibility.

WHAT'S INVOLVED

- As a participant, you will be asked to consider some visuals and answer design related questions about them. The questions are a part of the user testing, which is meant for design improvements only.
- Participation will take approximately 10-15 minutes of your time.

POTENTIAL BENEFITS

- Through this survey, you will understand the importance of data representation in the form of a visualization. We will also look into some of the sensitive issues that have been prevalent during the current pandemic lockdown and learn about some of the statistics that have been shaping our surroundings.
- Also, as a participant you get the opportunity to provide valuable feedback in terms of design decisions to the researcher's thesis project.

POTENTIAL RISKS

- During the user testing survey, if certain elements or data trigger unpleasant thoughts or experiences, you may kindly take a break from the survey or choose to withdraw participation at any moment. In case of any feelings of continued uneasiness or unpleasantness, kindly reach out to the Student Wellness Centre through this link [redacted]. Their assistance will be helpful in this regard.

CONFIDENTIALITY

- Throughout the survey, your identity remains anonymous. There will be no personal identifiers used during any part of the survey and anonymity will be maintained.

- Once the responses are collected, they will be stored in a secure and password-protected cloud storage platform of Microsoft Onedrive. The data will be kept for a period of three months after the final research is completed. Post the stated period, the data will be deleted permanently from the cloud storage drive, with no copy present elsewhere.
- All the responses collected through this survey will be available only to the principal student investigator and the faculty advisors on this project.
- While we are not capturing any personal identifier data, it is recommended that you log out of any 365 OCADU accounts before filling out this survey, or that you use "incognito mode" in your web browser. This will ensure there is no trace of your OCADU identity in the responses you submit.

VOLUNTARY PARTICIPATION

- Participation in this study is completely voluntary. If you wish, you may decline to answer any of the questions or quit without submitting responses at any time.
- Once your responses are submitted, it is not possible to remove an individual's information as the participants will remain anonymous.

PUBLICATION OF RESULTS

- Results of the survey will contribute to the researcher's final thesis project by helping them revise and refine the visualizations introduced here. Results of this study will be published in the thesis document, including direct quotations captured from the survey responses. In any publication, data analysis will be presented in aggregate forms.
- The final thesis document will be available on the OCADU portal probably around June or July 2021

CONTACT INFORMATION & ETHICS CLEARANCE

If you have any questions about this study or require further information, please contact the Principal Investigator or the Faculty Supervisor . This study has been reviewed and received ethics clearance through the Research Ethics Board at OCAD University OCADU [REB approval: 2020-91].

If you have any comments or concerns, please contact the Research Ethics Office

Please carefully read the text outlined above and provide your agreement & consent by accepting below.

AGREEMENT AND CONSENT ** Required to proceed to the survey*
(This is counted as Question 1 as per the Microsoft Forms)

I confirm that I belong to the age group of 18 years or older. I agree to participate in this study, as described above. I have made this decision based on the information I have read above in the introduction to the survey. I have had the opportunity to receive any additional details I wanted about the study and understand that I may ask questions in the future. I understand that by submitting this survey, I may not be able to retract information as my identity is kept anonymous.

Yes, I accept and wish to provide my consent.

('NEXT' button gets activated once the user agrees and provides consent above. If not, then the survey does not proceed further)

ABOUT THE SURVEY

This will be a two-part survey, which contains an image (Part A) and what it represents (Part B). The objective of this user testing is for you to provide your insights and share your inputs about how the visualization can be improved to be made more effective in terms of what it represents.

(Options for going 'BACK' or moving ahead by clicking on 'NEXT')

Part A

Have a close look at the image shown.

Carefully observe the different elements in it – the flowers, the stems, the different positions of every flower, the color of the flower and the overall color of the scene.

Take your time in going through these elements and trying to understand the affective quality of the image.

2. After careful observations, choose the 5 most appropriate words from the below options that best describe the image and feelings associated with it. If you have any words to add, please choose 'other' option and provide your input.

- Dazed
- Compassionate
- Lonely
- Lively
- Peaceful
- Optimistic
- Neglected
- Agnostic
- Happy
- Remorseful

- Calm
- Merry
- Emotional
- Distressful
- Hopeful
- Gloomy
- Blissful
- Sad
- Others, _____

3. How would you describe your overall feeling or vibe after looking at the image?
(Select the most appropriate option)

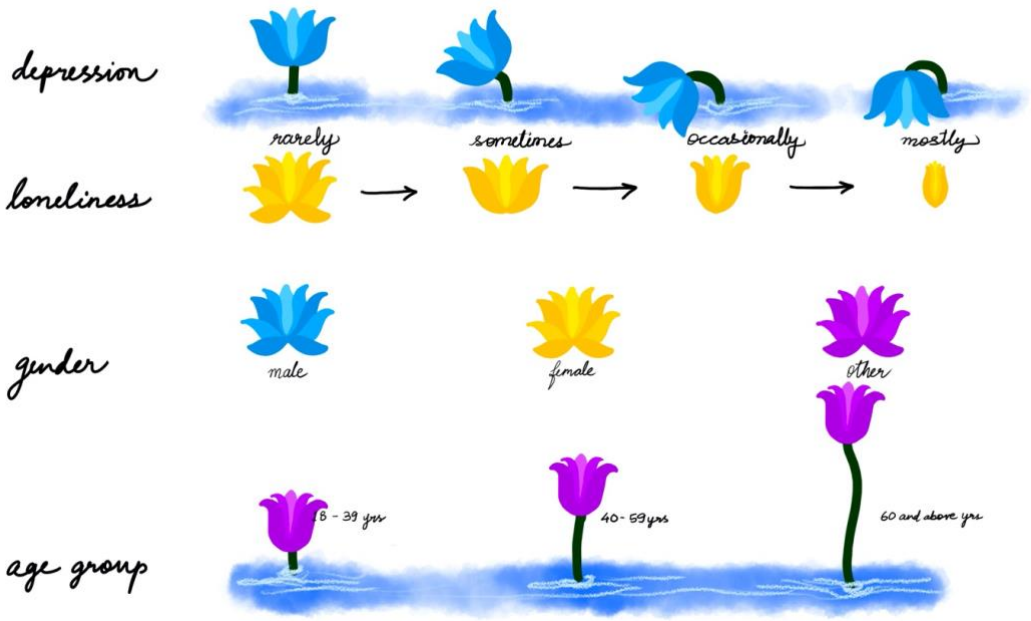
- Gloomy
- Slightly gloomy
- Neutral
- Slightly optimistic
- Optimistic

(Options for going 'BACK' or moving ahead by clicking on 'NEXT')

Part B

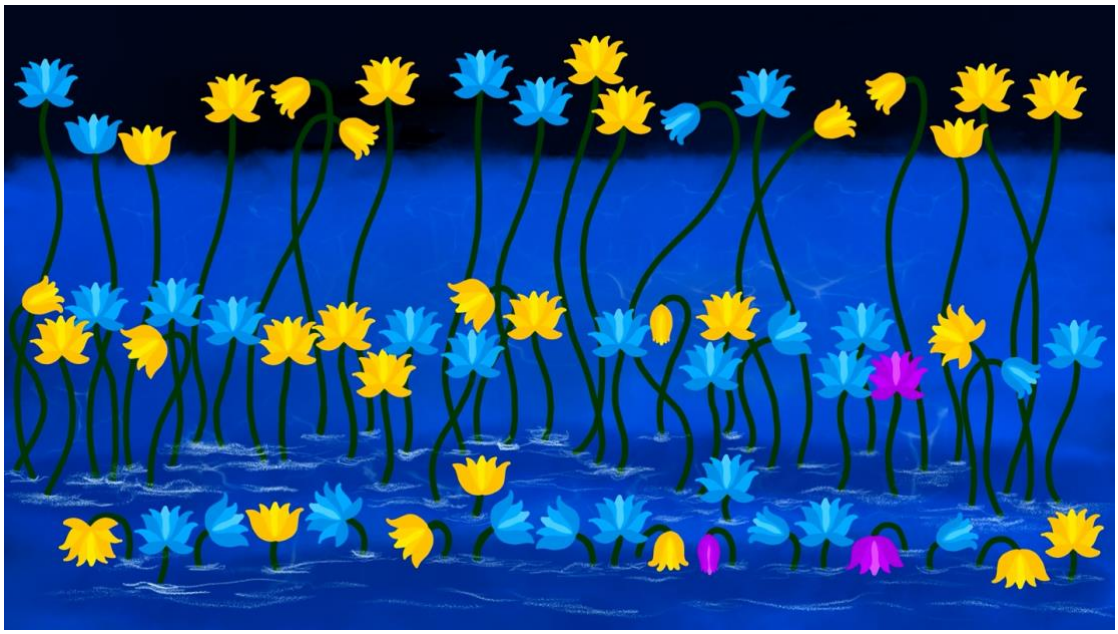
To give a little context about the image shown previously and what it represents -
The image shows us how lonely and depressed people were feeling during the pandemic lockdown. It is a data visualisation and representation of how every individual has been suffering in this isolation period.

In the data visualisation, the elements shown in the visual are associated to different things. Below is the key to the visualisation.



4. As you can see, the data (procured from CamH or better known 'The Centre for Addiction and Mental Health') shows us the reality of how Canadians are feeling. Each flower represents an individual. The length of the stem shows us the age-group they belong to. The colour scheme shows us how different gender groups are affected by the two silent yet deadly illnesses – loneliness and depression.

Now have a look at the data visualisation once again, now that you know what it represents.
(There is no need to answer question 4. This is simply an explanation paragraph for the participants.)



5. As per your understanding, how appropriate do you think is the metaphorical representation of the sensitive issues such as loneliness and depression, in this data visualization?
(Select the best option)

- Mostly inappropriate
- Slightly inappropriate
- Cannot really say
- Slightly Appropriate
- Very appropriate

6. What element of the data visualization can be improved in terms of representation? Also, provide a reason for what made you choose the option.

- Overall composition
- Metaphorical Representation
- Stem Length
- Blooming and wilting of flowers
- Opening and closing of flowers
- Colour scheme
- Others _____

7. Based on question 6, kindly provide a reasoning for the option(s) chosen above. What made you choose them?

_____

8. Does the data visualization make you feel sympathetic towards the people represented, who are suffering from loneliness and depression?

- Yes
- No

(Options for going 'BACK' or moving ahead by clicking on 'NEXT')

Optional Context-based questions

The following questions are not about the visualization, but about you. They are to help guide the researcher to contextualize the responses made in the survey.

These questions are totally optional. And it's completely up to you whether you choose to answer them or not.

9. Have you felt lonely at any time during this pandemic lockdown?
   - Yes
   - No

10. Have you ever felt lonely before the pandemic lockdown?
   - Yes
   - No

11. What gender group do you identify with?

   - Male
   - Female
   - Other

12. What age-group do you belong to?

   - 18 to 39 years
   - 40 to 59 years
   - 60 years and above

(Options for going 'BACK' or moving ahead by clicking on 'NEXT')

Thank You!

Thank you for being a part of this survey.

This survey is a part of Sananda Dutta's thesis project 'Empathy through data'. Your feedback and inputs will help in improving the final product.

If you have any further questions about the study conducted, the research or have anything else to ask, you can reach out to me.

(Options for going 'BACK' or submitting the survey by clicking on 'SUBMIT')

Appendix E

The Invitation template sent out to all OCAD University Graduate students and faculty.

Invitation Template

Date: 21st December 2020

Dear Participant

You are invited to participate in a user testing study for **Fostering Empathy through Data visualization**. The study explores an alternative way to represent data, with the use of visuals and sound to generate empathy. It examines our experiences during the pandemic lock down in Canada. In particular, I am looking at sensitive issues such as loneliness, depression. In this case, my research question is: *How can sensitive data be represented through visualizations and sound to foster empathy?*
Kindly read below, as the text outlines the various aspects of the user testing session.

PURPOSE

- The responses collected through this survey are strictly for improving the design outcome of this project. The questions are primarily to get your inputs on the design aesthetics, functionality and accessibility.

WHAT'S INVOLVED

- As a participant, you will be asked to consider some visuals and answer design related questions about them. The questions are a part of the user testing, which is meant for design improvements only.
- Participation will take approximately 10-15 minutes of your time.

POTENTIAL BENEFITS

- Through this survey, you will understand the importance of data representation in the form of a visualization. We will also look into some of the sensitive issues that have been prevalent during the current pandemic lockdown and learn about some of the statistics that have been shaping our surroundings.
- Also, as a participant you get the opportunity to provide valuable feedback in terms of design decisions to the researcher's thesis project.

POTENTIAL RISKS

- During the user testing survey, if certain elements or data trigger unpleasant thoughts or experiences, you may kindly take a break from the survey or choose to withdraw participation at any moment. In case of any feelings of continued uneasiness or unpleasantness, kindly reach out to the Student Wellness Centre through this link [redacted]. Their assistance will be helpful in this regard.

CONFIDENTIALITY

- Throughout the survey, your identity remains anonymous. There will be no personal identifiers used during any part of the survey and anonymity will be maintained.
- Once the responses are collected, they will be stored in a secure and password-protected cloud storage platform of Microsoft Onedrive. The data will be kept for a period of three months after the final research is completed. Post the stated period, the data will be deleted permanently from the cloud storage drive, with no copy present elsewhere.
- All the responses collected through this survey will be available only to the principal student investigator and the faculty advisors on this project.
- While we are not capturing any personal identifier data, it is recommended that you log out of any 365 OCADU accounts before filling out this survey, or that you use "incognito mode" in your web browser. This will ensure there is no trace of your OCADU identity in the responses you submit.

VOLUNTARY PARTICIPATION

- Participation in this study is completely voluntary. If you wish, you may decline to answer any of the questions or quit without submitting responses at any time.
- Once your responses are submitted, it is not possible to remove an individual's information as the participants will remain anonymous.

PUBLICATION OF RESULTS

- Results of the survey will contribute to the researcher's final thesis project by helping them revise and refine the visualizations introduced here. Results of this study will be published in the thesis document, including direct quotations captured from the survey responses. In any publication, data analysis will be presented in aggregate forms.
- The final thesis document will be available on the OCADU portal probably around June or July 2021

CONTACT INFORMATION & ETHICS CLEARANCE

If you have any questions about this study or require further info rmation, please contact the Principal Investigator or the Faculty Supervisor This study has been reviewed and received ethics clearance through the Research Ethics Board at OCAD University OCADU [REB approval: 2020-91].

If you have any comments or concerns, please contact the Res earch Ethics Office

AGREEMENT

Before you proceed to the survey, you need to confirm that you belong to the age group of 18 years or above and that you agree to participate in this study as described above. Please carefully read the required agreement and consent form to proceed. Consent will be mandatory, and the consent form will be present prior to taking part in the survey.