Bodies of Empathy: A Data-Driven Approach to Fashion Design

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Abstract

Bodies of Empathy aims to explore the role of fashion design and wearable technology in data physicalization for enhancing empathy. By mapping data into the physical form of garments, this research attempts to bring data back to the physical world and make it relatable to the people from whom it has been collected. Data can be too complex for non-experts to understand. It is necessary for information designers to find new and engaging ways to communicate the insights from this data to everyday people so they can be empowered to understand and act on it for the betterment of society. The field of fashion design, which considers garments/clothing as an extension of the body, can give insight into how designers can leverage on the affordances of garments in the communication of complex information. Wearable technology garments have the power to extend our embodied senses, enhancing our understanding of data and inspiring empathy. Through engaging in an alternative fashion design process, devised from combining research through design, data visualization and soma design methods, the project maps African Immigrant data onto garments. These data-based garments created are aimed at inspiring empathy in wearers to improve emotional connectedness.

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Chapter 1 Introduction

Data has always been very daunting. Like many, I have always shied away from trying to comprehend it beyond what is necessary to get by. Not only can figures be overwhelming to consume, but pie charts and bar graphs can be so boring. Data is everywhere and technology has made it possible to collect and store more data than we could ever consume. Efforts aimed at the proficient analysis and comprehension of this data have traditionally been designed for the benefit of those with expertise in the area. In the last couple of years, I was introduced to the growing field of data visualization where many practitioners have endeavored to make data more relatable and accessible. Giorgia Lupi (2017), in her manifesto, asserts that it is time to "question the impersonality of a merely technical approach to data and to begin designing ways to connect numbers to what they really stand for: knowledge, behaviors, people." But why is it important to make data relatable? Data is collected from real life and "numbers are always placeholders for something else" (Lupi, 2017). This research is concerned with data that has been collected from people and thus aims to make data more relatable to people. Understanding this data can be empowering to the humans which it concerns. Visualization designers are constantly looking to improve engagement and value for audiences.

Data visualization designers have begun to be more interested in finding new, innovative, and engaging ways of sharing the insights in diverse forms, leveraging their unique skill sets. One such emerging approach involves the creation of physical data objects - what I will largely refer to as data physicalization in this document. Data physicalization is a growing field of study that offers opportunities for professionals from different fields to make meaningful contributions to experiences of data. Data physicalization has opened by up doors to explore the more embodied and material interactions in data design. Physicality can be exploited for its ability to extend data communications into embodied, material and performative experiences. Data experienced beyond digital screens has the potential to engage us beyond our senses of

vision and touch; we can embody data, feel it and live with it. Physicality offers opportunities for designers and artists from different fields to make meaningful contributions that can redefine our relationship with data.

As a fashion designer experienced in the garment design process, I have endeavored to explore how data can be encoded into garments as data physicalizations. Clothing and its close relationship to our bodies can be used to help us understand and communicate data about humans who possess bodies. Representing data in the physical form of garments can go a long way towards humanizing data, encouraging engagement of audiences as they can draw on and make comparisons to their lived experiences as clothed bodies, reducing mental conversions required to understand information.

There is currently limited research into the ways in which data can be mapped onto garments or used to shape and influence our interactions with data. The field of fashion design can give insight into how designers can leverage on garment affordances in the communication of complex information. Wearable technology have the power to extend our bodies through clothing, “reinventing our relationships to our bodies, our experiences of spaces, social interactions, and self-representation” (Lamontagne, 2017, p.1). This research leverages on knowledge from data physicalization, fashion design and wearable technology to create data-based garments through an alternative design process. The alternative design process incorporates strategies that prioritize iterative testing, autobiographical design, slowing down and involving others. The data-based garments are aimed at enhancing empathy to improve emotional connectedness.

Research Questions

Garments as data physicalizations are underexplored. There exists no unifying approach to creating data physicalization owing to the newness of the field and the interdisciplinary

nature. By engaging in an alternative design process, I attempt to explore the following questions:

How can embodied garments be used as a site for Data Physicalization to enhance empathy?

What role can data-based garments play in the communication of complex information?

How can data be mapped onto garments and wearable artifacts, as extensions of the body, and how does this impact our interactions with data? How does this impact our interpretation of data?

Scope and Limitations

Drawing on embodiment, materiality and performance as practice, the intended scope and outcome of this project is to create a collection of data-based-garments exploring how mapping and experiencing data through fashion design and wearable technology can enhance empathy. The data in question relates to African immigrants in Canada and is sourced from open data sources. As a qualitative exploration, the research is subject to my interpretations and biases as the researcher and designer.

The alternative design process prioritizes physical making practices, material explorations and iterative investigation making it a very expensive and time-consuming process. As such, a few limitations arise. These constraints in budget and time forced me to prioritize idea generation over the replication of designs for inclusive sizing. I was restricted to designing for the female body of a dress size 6 to 10. The garment fittings described in this research were conducted on a small group of people calling for more extensive testing for future research.

Overview of Document

In this chapter, I have introduced my research project and emphasized the key questions driving my investigation. In the next, I describe my motivation for embarking on an alternative design journey where I attempt to humanize open data through garments using my fashion

design expertise. I then conduct an in-depth literature and contextual review of data physicalization, fashion design and wearable technology theories that shed light into the potential of garments as data objects. I aim to highlight how physicality offers opportunities for alternative data encodings and to address empathy as the goal for garments as data physicalizations. The methodology chapter outlines how I have applied three methodologies (research through design, data visualization, and soma design) to devise an alternative design process, as documented in Chapter 4, to answer my research questions. The next chapter outlines how I have used this alternative design process to create a series of iterative prototypes through data analysis, sketching, making and garment fittings. I then outline and reflect on key findings from my alternative design process and conclude my thesis by proposing potential future directions for garments as data physicalizations.

Chapter 2 Motivation

The line “fashion is a collective cultural phenomenon generated by the individual but linked to actions of a very large number of garment designers aiming to create distinctive but similar clothes,” Eckert & Stacey's (2001, p. 1) summarizes the sameness of mainstream fashion. When designing garments for commercial viability, “newness” is rarely ever accomplished. Style is seen as largely a collective experience and thus bound by the confines of what is deemed acceptable. By taking you briefly through my process as a fashion designer, I would like to explain why I ended up embarking on an alternative design process.

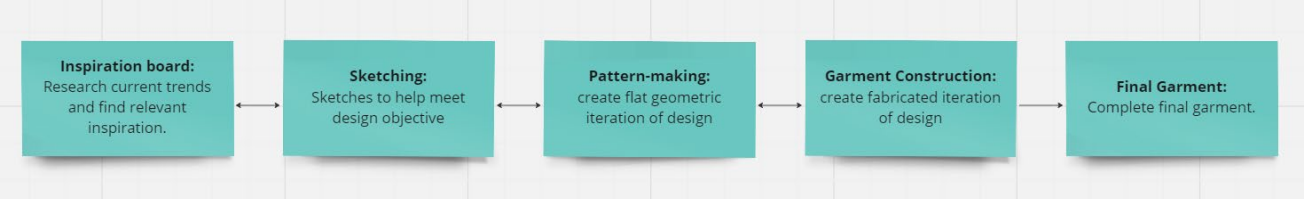

Figure 1: Key steps in my fashion design process (Author's image).

To achieve perfection in garment quality, I have always followed a very strict linear design process from researching the latest fashion trends to realizing a physical garment. The diagram above is a process that has been reduced to as few steps as possible to save on time and production costs. It is based on the basic premise of defining the concept, “developing sketches, selecting materials and block patterns […] while referring to a mannequin or the body, stitching, and, finally, fitting the design on the human body” (Saleem, 2022, p. 26). Defining the concept refers to researching the latest trends to find the appropriate inspiration for designs. The main sources of inspiration include runway shows and trend reports generated by commercial design research companies. When finding the right source of inspiration, designers “tune the tacit perceptual skills they have developed for recognising what is and is not fashionable, what cultural connotations a garment will have, and in what way a garment design needs to be modified to conform to fashion, as well as provide themselves with the set of garment type concepts and other memories that they need to create new designs” (Eckert &

Stacey, 2001, p. 9). This carefully controlled process results in trend lifecycles that change very slowly. For example, you may find that a trending color in one year may only be separated by a shade of the same color in the next year.

The next step in my process is to methodically compile my research into a visual inspiration board, serving as a reference point for the following stages of the design process. Subsequently, I begin the sketching phase, turning the concepts into feasible design ideas. Although there are now many drawing applications, I still feel most comfortable, expressive and efficient sketching with pencil and paper. However, Computer Aided Design (CAD) software has been revolutionary in saving me time and reducing materials used in other areas of the design process. Pattern-making is the process of creating a template for cutting fabric that ensures the accurate fit of a garment to achieve a desired style. While I was traditionally trained to make these by hand, I have grown to make these patterns almost entirely digitally using 3D pattern-making software. For example, Clo3D is a software that allows you to prototype a pattern in 2D and simultaneously drape the pattern onto an avatar in another 3D window to assess the fit. The patterns in the 3D window simulates real fabric and the avatars are customizable to true-to-life body measurements. This was game-changing for me, saving me a lot of time and resources and ultimately the physical garments I created from these digital patterns fit more accurately to the body, reducing the need for alterations. Through this process, I have reduced the number of physical prototypes and iterations I need to make to realize a commercially viable garment.

Although this design process works well to help me meet my professional goals, it rarely ever encourages out of the box ways of thinking. When I worked on a data physicalization project for the first time over a year ago, I was completely stressed and exhilarated at the same time having no idea what the final data-based object would look like after my analysis of the data. By using data as my source of inspiration, I attempt to distance myself as much as possible from the collective cultural influences that typically shape style inspirations in fashion.

My aim is to encourage alternative modes of thinking that can foster the creation of innovative designs. Data has the potential to facilitate the creation of richer designs imbedded with meaning, benefiting not only those who interact with data but also those who create them. Designers can have renewed understanding of their own practices and process, as well as understand data through a different lens.

Data, a raw material, "is names, amounts, groups, statistical values, dates, comments, locations" (Kirk, 2019. p. 32). In this project, I am concerned with data that directly corresponds to people. More specifically, I look at datasets available on open data websites relating to the experiences of African Immigrants in Canada. As a newcomer to Canada, who has been a temporary resident in two host countries for the better part of the last decade, matters related to relocating in search of better opportunities are close to my heart. I was born and raised in Zimbabwe, and, like many from there, I had to leave my home country by the age of 20 in search of better education and employment opportunities. I am familiar with feelings of separation from loved ones and the constant cycles of starting anew in unfamiliar surroundings. I have always expressed myself through design. I am always seeking to understand how my own identity and experiences shape my design thinking. I attempt to understand my experiences through analysing immigrant datasets available on open data websites. These datasets have been collected from me and people like me. Much of the data used in this project has been collected from Canadian open data websites such as Statistics Canada[1]. Open data is "data collected within the context of the actions of public administrations that are subsequently made available, reusable, and openly accessible to the community, allowing citizens and stakeholders to gain direct insight into the knowledge of certain public affairs" (Catone, 2023,

[1] Available at: https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=9810034901

p1). Many governments, organization and other authorities make this data available to citizens with the aim of empowering them, tackling social issues and enhancing transparency. Through analysing these datasets, I could understand my experiences from a different lens. What I understood from my preliminary analysis of this data is that:

- I am not alone in my experiences; there are others who share similar journeys, whether they are African or not.
- There are experiences of others that I am not aware of.
- There are details that I and others are not aware of that can shed a different light on our individual and collective experiences.

Chapter 3 Literature and Contextual Review

This research considers garments and wearable technology garments as physical data objects. Garments are considered as “the frontier and the connection between the body and the environment around it” (Hrga, 2019, p. 127). As designers move towards making data physical, we must consider the role that our bodies can play in our experience of it. The body and embodiment have become important areas for consideration when reimagining the relationships humans can have with technology. The body here refers to the physical structure of the human beings often considered as a separate entity from the mind by Cartesian ontology. Embodiment connects the body to more abstract human bodily experiences and meaning. Our bodies can be a valuable resource for meaning making as “we have relearned to feel our body; we have found underneath the objective and detached knowledge of the body that other knowledge which we have of it in virtue of its always being with us and of the fact that we are our body” (Merleau-Ponty, 2011, p. 239).

New materialist thought calls for a move away from disembodied technology, from the dualistic notions of body and mind, seeking to “put back into the picture the flesh that continues to be erased in contemporary discussions about cybernetic subjects” (Hayles, 1999. p. 5). The idea of the mind as distinct from the body has frequently downplayed the significance of the body in technology, ultimately neglecting the essential concept of embodiment. In what she terms the *invisible interface*, Ryan (2014, p. 95) argues that the body in wearable computing has been erased through its suppression “in favor of the mind or intellect, or the body itself is comprehended as biometric data.” The body is reduced to its information which is considered separate from it. Thus, data is dissociated from bodies from which it has been collected. For Ryan, this can be ascribed to the oversight of incorporating dress and its cultural connotations in the conceptualization of wearable artifacts. Wearable technology interacts directly with our bodies and thus, should work to integrate seamlessly with our physical lived experiences. In this

project, I am concerned with how fashion, data and wearable technology can inspire empathy, a thought I will elaborate on later in this chapter.

Defining Data Physicalizations

Data physicalization is not an entirely new concept. Ishango is an example of a tool used to create tally marks as far back as 35 000 BC. Ancient civilizations such as the Mesopotamians used “objects to count, combine, and visually organize types and quantities of trade goods, as well as create durable physical records of transactions” (Huron et al., 2022, p. 17) suggested in the discovery of clay tokens dating back nearly 10 000 years ago. Physical ways of quantifying then grew to include abacus for counting, tokens to vote and thermometers to measure temperature, to name a few examples. The digital era has obscured this physicality of data and the physical tools and fabrication techniques they brought with them. In another lens, digital technologies open up new ways of approaching physical making. Huron et al (2022, p. 22) argue that “digital tools have made it easier than ever to continue to make data physical.”

In recent years, owing to moves towards data humanism, the practice of encoding data into physical objects emerged as a research field and adopted the term data physicalization in 2015 (Chiang, 2018, p.12). The many definitions of physicalizations highlight artistic and functional qualities as an essential part in conveying meaning to audiences through physical artifacts. I will consider three key definitions of physical representations of data that most closely relate to the attributes of this research. Simply put, data physicalization is defined as the mapping of data into physical materiality (Bae et al., 2022, p. 1). A data sculpture is “a data-based physical artifact, possessing both artistic and functional qualities, that aims to augment a nearby audience’s understanding of data insights and any socially relevant issues that underlie it” (Zhao & Moere, 2008, p. 343). Data physicalization and data sculptures are terms that are used interchangeably and whose definitions are constantly evolving owing to the multi-disciplinary nature of the field. Artists and designers deploy different approaches leaning on

knowledge from their practice to create engaging artifacts. The myriad of contributions from the different communities that make up data physicalization mean that designers and artists must work to understand the values, biases, and assumptions of each community to redefine notions of data and the way we interact with it.

Building on the notion of data sculptures, Starrett et al (2018, p. 384) coined the term data materialization to describe “the intersection of data communication and design” where design is prioritized over the accurate and clear representation of data. Thus, the data-based physical artifacts of materializations can often be more design-oriented, rooted in the design process.

Physicality: Bringing Data to Real Life

Physicality provides another dimension by which visualization can democratize access to information. Data has been and is collected from the real world, where real people with real stories and lived experiences reside. Making data physical is a huge step towards ensuring data and its insights are available to those from which data has been collected. It is important that “insights from the field of information visualization can be used to effectively inform, educate a non-expert audience, or even capture their attention, sufficiently engage their interests and maintain their curiosity” (Zhao & Moere, 2008, p. 343). This is particularly important when the data in question is about and concerns them. Even with significant efforts made to make visualizations that are understandable even to the un-trained eye, the saturation of information has made it increasingly difficult to keep the attention, engagement, and interest of an audience.

Audiences can leverage the affordances of their environment to experience, engage and understand data. Representing data in physical form provides audiences with “tangible connection between their knowledge and experience in the real world” (Zhao & Moere, 2008, p. 344), reducing cognitive load, enabling them to understand data more easily. For example, “data tactility supports continuous engagements with data as people live alongside materialized

artefacts [where] textures and material qualities of the artifact are revealed, may be contemplated, and reflected upon through a direct experience of touch" (Desjardins & Tihanyi 2019, p. 48). Physicalizations that are designed for and in relation to the body have the potential to further reduce mental conversions in understanding information as they offer us a way to concretize abstract concepts depicted by numbers.

Embodiment, as practiced in data physicalization, fashion design and wearable technology, is concerned with engaging the senses. Traditional visualizations, as well as human computer interaction and aesthetics, have focused on those senses that can be understood as largely external to the body, such as vision and hearing. Embodied senses, also known as secondary senses, have received little attention due to their highly subjective nature and difficulty to measure and understand. Some of these senses include "haptic, olfactory, kinesthetic, and proprioceptive perception are phenomena that are experienced more subjectively, on or within the body, with sense receptors distributed internally or across the body" (Joseph et al., 2017, p. 9). Fashion and garments can extend the sensorial considerations of visualizations to weight, scale, movement, texture etc.

Wearable technology designers recognize "the fundamental importance of engaging and reconceptualizing technology through the experience of the body and its senses, emphasizing engagement and practice rather than symbolic, disembodied rationality" (Joseph et al., 2017). However, dress and fashion theory has only recently been recognized as a valuable area of investigation to build knowledge towards wearable technology. Wearable technology designers believe that wearable technology has the power to turn clothes into multisensorial experiences, extending and augmenting the capabilities of the body. Garments can instantly drift between categories of experiences. These performative qualities of wearable technology garments challenge the "spatial and temporal limits of body/dress or body/costume" (Hrga, 2019, p. 126)

that have been previously emphasized by fashion theorists such as Roland Barthes and Pierre Bourdieu.

Physicality serves as an expressive tool for designers and artists. Through a hands-on process, designers give data life. This embodied process of making physical visualizations creates opportunities for designers and artists to redefine and rethink their own relationship with the datasets they work with through the associations they make. Fashion has always served as an expressive and communicative tool for fashion designers. Dress and fashion aid in “self-expression or identity [reinforcing] symbolic and communicative dimensions of fashion and costume design” (Joseph et al., 2017). By representing data in new physical form, embodying it, through fashion and wearable materializations, designers and artists can redefine their own and our relationship with and understanding of data.

To contextualize the potential impact of physicality on data experiences, we turn to a data physicalization example. *Wear your heart on your sleeve* is a project that makes use of digital knitting to capture body sensor data as a form of artistic expression. 20 participants were recruited, their heart rates measured and the data was mapped into personalized wearable shrugs using a hacked knitting machine (Jones et al., 2023).

Figure 2: Wear your heart on your sleeve (Jones et al., 2023)

What is fascinating about the outcome of the project is how the physicality and materiality of data objects produced went a long way in humanizing the data to participants involved. The initial raw data in the form of figures held little meaning or value to participants as they could not understand it. However, once these figures were mapped into yarn and knitting patterns that created a unique physical aesthetic and embodied qualities that could be felt, the numbers became less intimidating. The artistic qualities of the objects made participants more open to an emotional connection with the data and additionally leading many to attach sentimental value to them. This is also particularly powerful as the data in question was their own. Witnessing the collaboration of the designer with the knitting machine highlighted the physical effort involved in creating artistic objects. The results were of a very hand-crafted quality that was not as perfect as expected from a digital machine and data. The perfection typically produced by digital technologies tends to obscure the influence of the designers using them. Thus, physicality and its imperfect products serve to humanize the design process, making the hard work involved more evident. Having “more of the maker’s hand [makes the

result] more attractive" (Jones et al., 2023) and designers can value their own work more. The unique one-of-a-kind hand-crafted qualities of the shrugs also served as great conversation starters. This highlights the power of physical data objects as story tellers and their ability to foster engagement.

Crafting Meaning: Towards Embodiment, Materiality and Performance

As we begin to contemplate how data can be encoded into garments, it becomes evident that approaches in fields like data physicalization, fashion, and wearable technology often lean towards grounding in communication theory, phenomenological theory, or both.

In data materializations, abstract data is understood to be expressed and mapped onto artifacts using metaphors. (Zhao & Moere, 2008) propose a model for embodiment in data sculptures rooted in the deconstruction of metaphors. In this model, semiotic theory is used to measure how closely an artifact reflects the data *(metaphorical distance from data)*, while tangible interaction is used to measure how easily people can understand an artifact based on their experiences *(metaphorical distance from reality)*. Metaphors are believed to be "pervasive in everyday life, not just in language but in thought and action" (Lakoff & Johnson, 2003). Metaphors are so ingrained in our understanding of the word that we barely notice them. Metaphors comprise of "under-standing and experiencing one kind of thing in terms of another" (Lakoff & Johnson, 2003, p. 5). Metaphors help us conceptualize ideas that may seem to abstract. For example, we may associate positive emotions such as happiness with the spatial metaphor of being "high."

As a process of embodied cognition, our bodies act as a constraint allowing us to use metaphors to make sense of the world around us. The embodied cognition thesis argues that "bodily states and mordality-specific systems for perception and action underlying information processing and that embodiment contributes to various aspects and effects of mental phenomena" (Foglia & Wilson, 2013, p. 1). The body is central to our conceptualization of the

world as it acts as a distributor of cognition with the aim of reducing “the burden of initial data collection, [and easing] the requirements on learning and memory” (Norman, 1993, p147). The bodies we have influence how we perceive and experience the world. Our bodies help us conceptualize the world as we hypothesize, test and adjust our ideas. If we had different bodies, the orientation metaphors we would use would be quite different as we can only “behave with respect to the things we can look at and feel, or smell and taste, and events we can listen to” (Gibson, 2014, p.5). The body and the environment are mutual entities and thus, as humans we are proficient in understanding the affordances of the world around us. The physical world is a rich source of knowledge as it has a vast amount of data readily available to help us navigate. Our experiences are, therefore, inseparable from our conceptions of the world. The environment, or physical world, provides the body with affordances. However, these affordances can only have real value to us if the affordances are perceptible within our human scales. Presenting data in physical form can be profound as “affordances have the capacity to be interpreted in a functional way, thereby conveying informational meaning, as they forego higher-level visual abstraction” (Zhao & Moere, 2008, p. 343).

Oehlberg & Willett (2018) argue that “the material qualities of three-dimensional forms [that] offer new data encodings that are unique to material objects” have been neglected by much of data physicalizations and sculptures. The focus of physicalizations should be on finding new material encodings. Physicality can offer new opportunities for data encodings extending beyond mere 3D renditions of 2D graphical representations. This can explain why fashion and dress have rarely been considered in data communication. Digital fashion, that is virtual fashion worn by digital avatars, is not concerned with data visualization.

In fashion theory, when we experience the world, we are not simply bodies in the world, but we are dressed bodies. Dress is our *second skin,* and it is almost too strange to think of ourselves as naked in any given context. Dress is considered a part and an extension of our

own bodies and through “dress and adornment […] bodies are made social and given meaning and identity” (Entwistle, 2015). Similarly, dress itself “cannot be separated from the living, breathing, moving body it adorns [and] encounters with dress divorced from the body are strangely alienating” (Entwistle, 2015). It is therefore incomplete to consider the body without dress and dress without the body. Our experiences and understanding of the world are not only influenced by our bodies but the clothes and artifacts we dress them in and vice versa. Entwistle (2015) turns to structuralism and phenomenology to situate the body as a “*socially constituted and situated object* [and] dress as an *embodied experience*” respectively. The body as a cultural object is based on systems of representation that are concerned with power where “the body acquires meaning and is acted upon by social and discursive forces and how these forces are implicated in the operation of power” (Entwistle, 2015). Clothing situates the body within the cultural context. For Entwistle, this approach fails to consider the body as an experienced biological entity through which our minds can conceptualize the world. It is important to move away from viewing the body as simply an object but an embodied experience as well. Dress must also be understood as a “situated bodily practice […] emphasizing all human experience [including] socially constructed categories of experience” (Entwistle, 2015). Dress is constituted by both time and space, both acting to regulate when and how we dress.

Similarly, wearable technology designers deploy a phenomenological approach to design drawing on lived experiences to understand embodied interactions. Our own bodies are the center of our experiences of the world and phenomenology is places emphasis on lived experiences. Cultural wearables are those that are mainly concerned with a situatedness in cultural context in the same way that clothing and dress participate in cultural visibility. Situatedness can bring context, not only to clothing but to data as well. Approaches to understanding these wearables have focused on analysing them through a semiotic lens, based on categorizable signs and symbols. Phenomenological wearables are concerned with bodies in

action; bodies present in the world, acting and perceiving. Theorists focus on “role for the body in perception and engagement with the world, breaking with a long tradition of privileging consciousness as the central source of knowledge” (Lamontagne, 2017, p. 77). Knowledge and understanding of the body is built through understanding the way it interacts with interfaces and other objects building experience. Lamontagne (2017, p.79) argues that where these approaches fall short is that “embodiment too often refers to representations of bodies in technology—and a semiotic model ossifies wearables (or fashion, bodies, and technology) into static and categorizable symbols—phenomenology casts the body as preeminent and other apparatuses (fashion, technology) as secondary,” thus negating the role of materiality. For Lamontagne (2017, p. 4), performance in wearables is a key framework in democratizing the interplay between the body, technology and fashion as it “can encompass the convergent aspects of wearables equally from the standpoint of the lived body, the dynamic technology, and its expressive aesthetics.” In this research, we refer to performance as social and cultural performance that is influenced by our context. Performance is the act of wearing fashion (how we wear it, when, where) that carries meaning with it.

Alternative Data Encodings

Fashion employs a wide array of textiles and other materials that can provide contextually relevant encodings. These properties can be leveraged in both data physicalizations and wearable technology to enhance meaning, understanding and encourage engagement. By dissecting how data can be mapped into material properties, we can also begin to understand how embodied experiences and performative qualities of garments can be imbued with meaning. Additionally, designing for the body, considering wearability, aesthetic and comfort, requires a renewed perspective on encoding data and meaning into material properties. Thus, it is beneficial for designers to consider the “more experiential and ephemeral material properties whose potential to encode data has only been peripherally explored [as]

alternative encodings provide opportunities for designers to create new kinds of aesthetic and embodied data-driven experiences" (Oehlberg & Willett, 2018).

Figure 3: Mapping out where embodied, material and performative qualities might be applicable in data-based garments (Author's image).

Material properties are understood to be either *intensive* or *extensive properties*. Intensive properties "are properties of the material itself, independent of how much of a material there happens to be" (Oehlberg & Willett, 2018) while extensive properties have more obviously perceivable or observable indicators of variation, such as dimensions, structure, and shape.

Visual variables are the most used in data physicalizations as they translate more easily from traditional screen-based visualizations. They usually involve direct two-dimensional to three-dimensional translation such as shape, size, value, color, position etc. Although this approach only scratches the surface of how data can be encoded into physicalizations, visual and aesthetic qualities remain important as the first line of contextualizing an artifact. They are also important factors in driving engagement and memorability in data physicalizations, fashion design and wearable technology.

Experiential material properties are those that are difficult to convey into two-dimensional mediums. These include *tactile*, *ephemeral*, *static* and *dynamic* properties. Tactile properties are “material characteristics that can be perceived via touch” (Oehlberg & Willett, 2018). These properties can be visual, such as texture or position, or non-visually perceptible such as weight, thermal diffusivity or stiffness. Ephemeral properties are concerned with showing destruction or decay. Such data physicalizations are more performative in nature. Most data physicalizations are *static* in nature. Dynamic physicalizations “can dynamically vary the values that it represents over time” (Oehlberg & Willett, 2018). These can be achieved through mediums such as electrical resistance or thermal expansion. In the context of fashion, data physicalizations, wearable electronics can add kinetic and shape changing qualities to the experiences and understanding of data.

Figure 4: Tremor raises awareness on the deaths of women due to unsafe abortions. A collaborative design by Melissa Coleman and Leonie Smelt. Photographed by Claudia Rocha.

Tremor is a collaborative design developed by artist, curator and creative technologist Melissa Coleman and fashion designer Leonie Smelt. It is a political piece meant to raise awareness on the deaths of women due to unsafe abortions. It is “inspired by our ability to

measure the seismic waves produced by an earthquake all across the planet" (Coleman et al., 2017). The dress shivers every 11 minutes with a corresponding light to symbolize the death of 1 woman every 11 minutes due to lack of access to a safe abortion.

The dress is an example of a way in which "the numbing of numbers" can be tackled. Firstly, rather than speaking of the large numbers of women affected, audiences and wearers can digest this insight one victim at a time. The repetitive shivers and light serve as a reminder of the matter at hand without the mental workload of adding up the numbers. Secondly, the use of *temporal proximity*, based on the notion that events depicted are more affecting when they are nearer in time, makes the data more relevant to those experiencing it. Rather than depicting past numbers of victims, the data is more meaningful as it speaks to what is happening right now, in real time. The use/simulation of an earthquake through the shiver is also an effective way of illustrating the connectedness the creators strive for. When one falls, we can expect the ground to tremble and the vibration to be felt by others. Thus, the wearer can feel that a woman has fallen in real time, every 11 minutes, and the rest of the audience can see it.

Apart from a timed visual shiver and light, the *extensive qualities* of the garment do not appear to be encoded with the data in any other way. However, they do serve to contextualize the data. The flesh tone knit fabric hugging the model's body speaks to the fleshy humans to whom the data reflects. The reflective mirror hard exterior of the dress speaks to sharp, hard, and unsafe medical tools used in the abortion procedures. The sharp folds, shapes and angles speak of the dangers and harm involved while simultaneously aiding the kinetic mechanism of the dress. This movement further reinforces the idea of danger looming. The choice of a female model and the feminine silhouette of the garment also speaks to the subject matter, women.

Crafting Empathy: Towards Data Feminism and Social Interaction Design

The goal of the garments created in this project is to inspire empathy in the wearers and audiences. Thus, it is important to address whether design should inspire emotion at all.

Traditional views on information visualization have emphasized that data must remain neutral and objective, consisting of plain styles to evoke as little emotion as possible. Data presentation remains objective so that audiences can interpret the meaning of the data for themselves. Data feminists argue that *rhetoric* (the use of persuasion in communication) is present in all design, even more so in that which claims to be objective. For example, design consists of decisions to emphasize certain elements and obscure others, known as “framing effects.” These “framing effects” “have an impact on how people interpret the graphics and what they take away from them” (D’Ignazio & Klein, 2020, p.41). Additionally, audiences are more likely to accept these designs as fact and truth if they are presented as objective, as they “can convey a sense of authority and accuracy that may not always be warranted by their underlying data” (Campbell & Offenhuber, 2020, 71). Visualizations are therefore highly persuasive in nature and their emotional effects are hard to avoid. We may even go as far as to say it is reckless to leave design open to interpretation. It is much more responsible to approach our work fully aware of the power we have to influence. If we leave design open to interpretation, we run the risk that no interpretation is made at all, as it becomes overwhelmed by the multitude of possibilities. As designers we “should embrace each of our standpoints as valuable perspectives that can frame our work [as they] can generate creative and wholly new research questions” (D’Ignazio & Klein, 2020, p. 42). Open data websites made available by governments and other authoritative organisations hold vast amounts of datasets which can make it hard or time consuming to find meaning in them. Designers can help guide interpretation in more meaningful ways by guiding attention to and in very specific ways embracing “emotion, and other forms of subjective experiences [are] legitimate ways of knowing and producing knowledge about the world” (D’Ignazio & Klein, 2020, p. 42).

As designers begin to devise ways to humanize data, they must find ways to tackle what Campbell & Offenhuber, (2020) call the “numbing of numbers.” The phenomenon occurs when

dealing with large amounts of data that depict more than one-person, leading audiences to feel less emotionally connected to the information presented. In their study into how proximity techniques might be used to enhance emotional connection, Campbell & Offenhuber (2020, 84) found that “people feel greater interest towards a topic when the visualized data are more relevant to them, and that data representing events closer in time are more affecting.” By leveraging our lived experiences as clothed bodies in this research, I aim to make this data physicalization more relevant to the audience, who not only possess bodies but are also depicted in the open datasets we are handling. Furthermore, it is important to note that all the datasets utilized in this study have been sourced from the year 1980 onward. This deliberate selection aims to uncover insights that still directly impact Canadian immigrants today.

Interestingly, Ryan also delves into the realm of feelings and emotions, which closely aligns with the concept of empathy that is important to this research. Due to disembodiment of technology “emotions became part of a lost corporeality [and the implications] permeated our culture, especially our notions of the body” (Ryan, 2014, p. 100). Even in clothing, dress has been influenced by western ideals with a predominant focus on the cultural dimension of dress. This emphasis has often overlooked the personal aspect of the self and lived experiences associated with dressing.

For Dagan et al (2019, p. 1002) design aimed at “enhancing co-presence, focusing people’s attention on one another rather than on their devices, and providing opportunities for people to interact with each other through using technology” is an area that has been neglected in wearable technology. When we consider empathy, it may be beneficial to contemplate how social interactions might play a role in inspiring this emotion. Some social Interaction designers in wearable technology focus on highlighting “the psychological power of shared experience in public spaces, a feeling share commonality that is often lost in the crush of urban life” (Ryan, 2014, p168). What Ryan proceeds to point out here is that we often don’t have the best

perceptions of our bodies, so we so easily treat them as though they are not even there. We should instead be actively cultivating a shared awareness of our bodies and how they interact with each other and the environments they inhabit. We have already established that fashion and dress have always been vehicles through which one can present themselves to the greater society. (Dagan et al., 2019) argue that “computation can augment cues that people use to present themselves as individuals and social beings, invite social interaction, bring people together, and support physical and emotional closeness.” Thus, interaction through clothing and technologically enhanced garments can be a powerful tool for enhancing empathy.

The fashion garments created in this project can be considered as those that both extend social signals and those that aim to intervene in social situations. Some wearable technology and garments can enhance or extend non-verbal social cues by using “computational power to extend, or augment the aesthetics of existing, non-verbal communication tools” (Dagan et al., 2019, p. 1003). Wearable technology garments that intervene in social situations have the power to inspire empathy and collective thought among individuals. These kinds of wearables usually invite people to interact in playful ways which can be memorable.

Designers of wearable artifacts need to consider if their ‘device operate[s] in a way that is respectful of people’s time and attention’ (Dagan et al., 2019, p. 1006). Here, designers must consider the level of attention that their technology enhanced garment requires from its wearers and those who interact with it; whether it is necessary, a good use of their time or good for their physical/psychological/emotional health. In this project, the critical garments have been “intentionally designed to draw to a particular element people take for granted, or usually try to ignore” (Dagan et al., 2019, p. 1006). Audiences are encouraged to stop, think and consider each other’s experiences. They are also empowered with insight from the Open Data that is available to them.

Designer should also consider the social implications of technologies that live on our bodies. This relates to catering to the comfort of both the wearer and the audience. In most cases, designers should rather make interactions secretive or make use of ‘socially acceptable body areas of interaction [that do not require] too much intimate contact’ (Dagan et al., 2019, p. 1007). Additionally, designers of wearable technology can refer to garment design practices to seamlessly integrate technology into familiar clothing experiences. Designers must ask themselves what computational affordances bring to the experiences of all those affected by them. What this suggests is that computation should be used only to the degree that it is necessary.

Chapter 4 Methodologies

In previous sections, I have argued that data represented in and experienced through garments has the power to educate, encourage engagement, build empathy and foster excitement. I have discussed how data physicalizations can redefine the relationship that both designers and audiences have with data. I have highlighted the importance of exploring possibilities for new material encodings better suited to the context of dress and wearable technology, given the current lack of substantial research in this area.

In this chapter, I outline how I have drawn on research through design, data visualization and soma design methodologies to devise an alternative design process to better suit data driven design objectives. I discuss each methodology in depth, highlighting key features that will be adopted to create a holistic alternative design process.

Research Through Fashion Design

Many design fields, including fashion design and wearable technology, use research through design methodologies to create novel designs and evaluate them. While there are many approaches to the methodology, common practices such as iterative testing and concept development are employed as methods for realizations of their design goals. Research through Design is concerned with *wicked problems. Wicked problems* are those without a single identifiable solution as they investigate complex social and cultural issues. Wicked problems “approach suggests that there is a fundamental indeterminacy in all but the most trivial design problems” (Buchanan, 1992, p. 15) making the *quest for certainty* impossible. The term itself was first coined by Horst Rittel and Melvin Webber in 1973 in their work "Dilemmas in a General Theory of Planning." Research is understood to produce theory which is abstract and generalizable while design is the realization of a specific solution for a specific context (Stappers & Giaccardi, 2017, p. 1). In research through design (RtD) “design researchers focus on real world problems by making things that force both a concrete framing of the problem and an

articulation of a specific, preferred state that is the intended outcome of situating the solution in a context of use" ((Zimmerman & Forlizzi, 2008, p. 5).

A characteristic of RtD is that *design research* and *design thinking* are awarded the same importance; what Zimmerman et al (2007) refer to as *true knowledge* and *how knowledge.* The *true knowledge* is grounded in theory and *how knowledge* involves "an active process of ideating, iterating, and critiquing potential solutions [continually reframing a problem to] attempt to make the right thing" Zimmerman et al (2007, p.497). Research and design must take place at the same time to generate valuable knowledge. While in some contexts of RtD a team of researchers and designers might work together to produce a solution to a problem, the research and design investigation for this project are conducted by the same person. This approach goes a long way towards redefining the relationship the investigator has toward the subject matter, engaging in a more meaningful way with the theories, the data, the technologies, the artifacts and people involved.

Given the diversity of design disciplines, there is currently no agreed upon consensus on how to approach RtD. The fields of data physicalization, fashion design and wearable technology are no exceptions, having varying processes, procedures, and standards. For Gaver (2012) the preoccupation with the standardization of RtD processes may result in overly restrictive research. While Gaver (2012, p.943) points out that RtD already comprises of some common practices that may not be immediately apparent (for example sketching as a form of prototyping), he argues that RtD will "inevitably be characterised by greater diversity and less convergence than the natural sciences because of the inherent nature of its field of study." It is precisely the myriad of approaches that make RtD a valuable source of knowledge.

In RtD, artifacts are an embodiment of the theory. The artifact a designer or researcher makes "functions as a specific instantiation of a model – a theory – linking the current state to the proposed, preferred state" (Zimmerman & Forlizzi, 2008, p. 498). Through creating a design

artifact, in this case a garment, designers gain deeper insight into their practices and process, revealing “both the issues they think are important, and their beliefs about the right way to address those issues” (Gaver, 2012, p. 944). These artifacts produce knowledge and insights that are difficult to express to the same degree in words. They become an embodiment of an alternative form of expression of knowledge.

Sketches in Research through Design (RtD) function similarly, serving as a means to swiftly document ideas before they fade away. Designers use sketching, where “each sketch functions as a quick hunch or proposition as to the problematic situation and the preferred state” (Zimmerman & Forlizzi, 2008, p.6). This process also aids in documenting as many ideas as possible to help decide on the most appropriate direction.

Designs occupy specific space and context making it highly performative. This helps guide focus where “designers can explore the implications of a given design by moving around the point it inhabits to explore new design possibilities” (Gaver, 2012, p. 944). Their ideas also become more easily accessible and readable when confided by the conventions of a context, facilitating smoother transfer knowledge to others.

Annotated portfolios are another way in which designers can generate knowledge through RtD as “multiple examples can start to tease the individual concerns and judgements involved in a single situated design out of the particular configuration to which they were applied” (Gaver, 2012, p. 944). Through comparing multiple instances of ideas embodied through design artifacts, designers can extract valuable insights and identify recurring patterns. Portfolios “can support multiple conceptual perspectives, and similar perspectives can be applied to different portfolios, reflecting the lack of convergence in the field as a virtue” (Gaver, 2012, p, 945). They can support generative knowledge characteristic of RtD holding a place for many new ideas to grow. These annotated portfolios include prototypes and iterations.

Where RtD falls short is that it cannot help us account for the embodied and material experiences of knowledge generated through its artifacts, sketches and portfolios. The tactile, material and emotional dimensions of design practice are an important part of this project. There is a need to complement RtD with methodologies that prioritize experiential learning and integrate bodily engagement, contributing to a more comprehensive grasp of design knowledge.

Data Visualization Methodology

Data visualization methodologies are key guiding principles for data physicalizations. Data visualization methodology is concerned with "representation and presentation of data to facilitate understanding" (Kirk, 2019, p. 31). Data visualization, as a tool for discovery, seeks "to portray data in ways that allow us to see it in a new light, to visually observe patterns, exceptions, and the possible stories that sit behind its raw state" (Kirk, 2012). Data visualization strives to diminish the cognitive burden required for comprehending data while amplifying its communicative capabilities. One of the foundational frameworks that directs data visualization involves applying *gestalt principles* of design. These principles help organize and arrange visual components to improve clarity and coherence, thus enabling more efficient interpretation and communication of information. Whether perceived visually or felt through bodily explorations, concepts of similarity, proximity, continuation, and so on, are effective devices for encoding meaning. It has already become apparent in this study, that perception in relation to garments works in much the same way. For example, fabrics of different color or texture are perceived to belong to different groups.

When we speak more specifically to the design of physical data objects, Sosa et al.(2018) suggest four guiding principles:

1. Physicalization designers should treat data as a new material. Data can be encoded into new or different material properties leveraging the affordances of the physical world.

2. Data objects should be designed for access with the “data set, its presentation, interface and use of symbols […] understood in relation to these conventions” (Sosa et al., 2018, p. 1687) associated with the object encoded with the data. The object must make it easier for audiences to understand the data as they tap into their embodied and lived experience.
3. Recognizing that no information design is truly objective, data objects must aim to engage audiences both cognitively and emotionally. They must aim to communicate different standpoint, improve relationships or enrich individuals’ life, making good use of their time.
4. Data object should be used as tool to “empower people to use the data to rethink and challenge the status quo” (Sosa et al., 2018, p. 1688). These data physicalizations can be used as cultural probes that highlight inequalities or injustices in society.

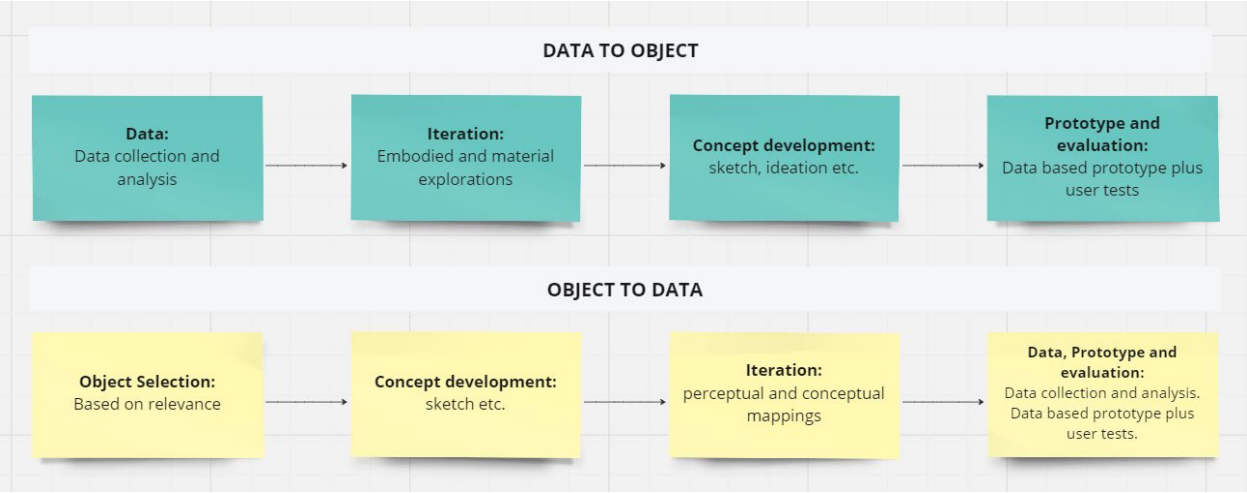

Figure 5: Design methods for physical data objects; data to object and object to data (Author's image).

Sosa et al. (2018, p. 1690) suggest two possible design methods for designing physical data objects: *data to object* and *object to data.* Both methods emphasize the importance of iterations and prototypes and incorporate user testing to facilitate the design process. While

these approaches leave room for flexibility, they do not allow much opportunity to revisit the first steps of the process which may be beneficial to mapping complex experiences associated with physicalizations.

Soma Design

Soma design emerged from the realization that “the actual corporeal, pulsating, live, felt body has been notably absent from both theory and practical design work” (Höök, 2018, p. 11). HCI has primarily focused on either regulating the body or viewing it as body parts that interact with devices and computers. Soma design methodology aims to put bodily engagement at the forefront of interaction design. It asserts that “our bodies and our subjective experiences, feelings, values, meaning-making, and movement-based engagements are altered by the design process” (Höök, 2018, p16). Through an increased awareness of our bodies, we It requires the engagement of both designers/researchers and users to build essential knowledge.

Lived experience “emphasizes a first person, hands-on, active engagement and experience” (Höök, 2018, p 18). Firstly, this is the lived experience of the designer/researcher themself. Through their own bodily involvement in the design process, designers build their own somatic sensibilities, understanding their designs and preferences better. In an autobiographical process, designers assume various roles, transitioning from researchers to actual users themselves. It is important for designers to familiarize themselves with the materials they use to understand the impact and potential of their designs. In this research, this involved creating more opportunities for hands-on, embodied physical interactions with materials, fabrication and processes. Additionally, it involved fitting and experiencing the garments and prototypes myself. Secondly, lived experiences refers to involving other people to understand their bodily experiences. In this study, garment fittings were conducted to further inform the design development and build knowledge.

Slowing Down refers to the process of turning “your attention very slowly from one aspect of your bodily experience to the next to really discern the feeling of each” (Höök, 2018, p. 19). Part of developing more heightened awareness of these bodily experiences lies in the ability to articulate them.

Iterative testing is emphasized in soma design. Material explorations are an important part of knowledge building and design development. Through a process of designing, testing, failing and redesigning, we can begin to understand the *dynamic gestalt* of interaction (Höök et al., 2015, p. 29).

The fashion design process has begun to rely on CAD software to minimize material costs and save time. This process is meant to limit the number of physical prototypes to be made in conceptualizing a garment. While digital avatars and pattern designing software allow designers to visualize garment fit and fabric through simulations; embodied material explorations are not possible until a garment is made physically. To better explore embodied interaction in this research, the fashion design process had to be modified to emphasize more physical prototyping in the process.

Lastly, soma design focuses on the physical experiences we have with digital materials. Designers must aim to design technology in rhythm with our bodies. Digital technologies must be designed in ways that promote body awareness. The embodied self-awareness of the researchers and those being researched is key to generating embodied knowledge.

An Alternative Design Process

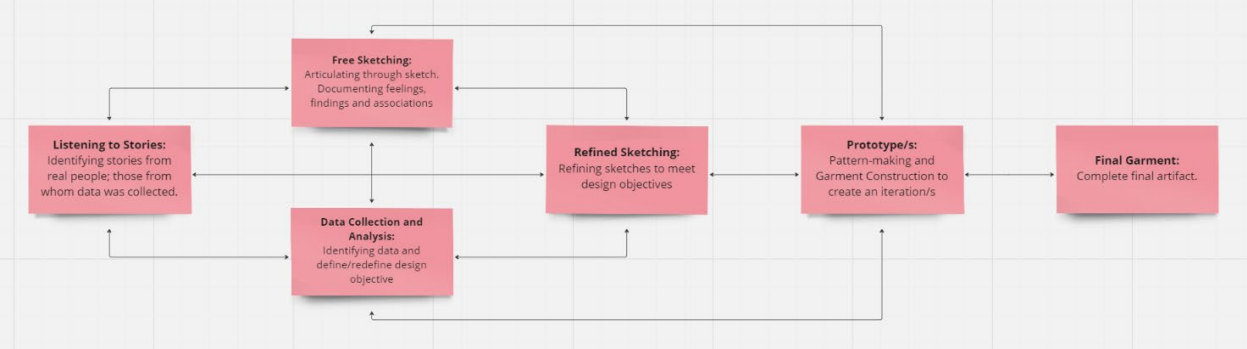

Figure 6: An alternative design process for designing garment data physicalizations (Author's image).

As I embarked on this project, it became apparent that an alternative design process would be necessary to achieve my design goals. Firstly, I needed to consolidate the highly linear strategies of design processes to include more prototyping, iteration and embodied material explorations. Secondly, it became clear that defining the design objectives through data identification and analysis alone was not sufficient to fully capture the stories in the data. I needed to find better ways to humanize the data, finding insights that could better inspire empathy. Both problems were resolved by incorporating soma design methods for designing in rhythm with our bodies such as sketching, autobiographical design and involving other people.

Leveraging Sketch in the Design Process

Sketching was one of the ways in which I engaged in auto biographical design in the research. Auto biographical design involves developing “self-reflective data, in which you journal your reflections about your experience and perceptions related to the topic” (Cooper & Lilyea, 2022, p. 199). In the last fall term, I was working part-time editing the audio interviews of African immigrants in Toronto. These audios were to be part of a museum exhibition in the city. I found myself carrying around a lot of feelings and opinions towards the stories I was listening to. Sometimes the feelings were heavy too. I was unsure what to do with them. I was advised to channel that energy towards fashion sketching, a form of articulation that came naturally to me. As I listened to the real stories from these people who were in fact the people depicted in the

dataset I was analysing; I began to slow down, reflect and articulate my findings through sketch. Listening to these stories and sketching became a crucial and fundamental part of my process.

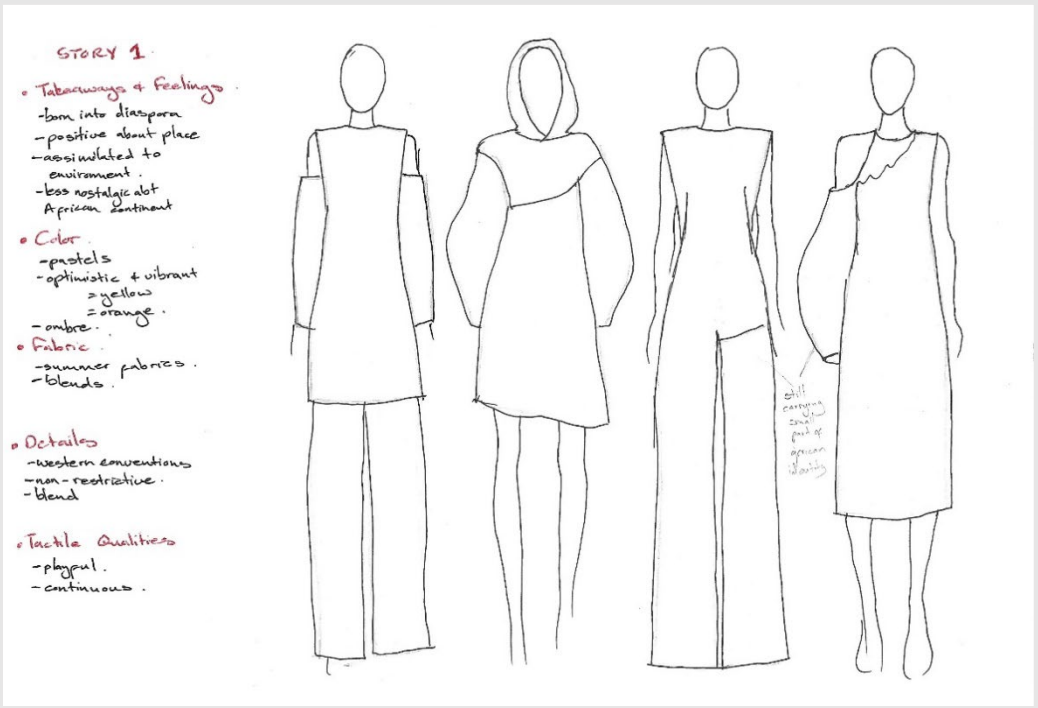

Figure 7: Example of the free sketching exercises (Author's image).

These sketches ultimately became the base of the prototypes I produced from then on. My process was as follows:

Listening to Stories: To begin, I listened to stories of African Immigrants in Canada to get insight into experiences that could be revealed through data.

Document Feelings and Associations: I began documenting feelings and associations influenced by the stories, making associations such as color, fabric, details, actuation etc. This was by simply jotting them down, giving my mind somewhere to start articulating what I was feeling.

Free sketching: Sketching “introduces novel ways of thinking, and leads to designs that are uniquely customized for the specific type of data problems we are working with” (Lupi, 2017). It was often mind-bending trying to conceive what data might look like on a garment.

Oftentimes I was left stuck. Free sketching allowed me to let go of these anxieties channeling my energy towards articulating what the stories might be and what they might look or feel like before I worried about incorporating the data. It was important to free my mind of any obligations and to just let my instincts guide me.

Garment Fittings and Involving Others

Garment fittings are typically conducted in the fashion design process with human participants to assess the fit of garments. Fashion designers and other fashion experts learn to "recognize good fit and fit problems in clothing based on certain criteria and sensory feedback that they learn through experience" (Song et al., 2021, p. 228) by assessing the garment on a body. The bodies used to assess this fit are usually avatars, mannequins, dummies, or real people. While fit remains important in considering the comfort or garment wearers, it is not the primary goal of the garment fittings conducted in this research. Rather, the fittings aim to explore whether embodied experiences of data-based garments can enhance empathy. Therefore, it is important to use real bodies as only real people can provide feedback on embodied experiences of garments. These garment fittings were another way in which I engaged in auto biographical design. The design decisions for creating the data-based garments are based on my own associations as I engage in this creative design process. Human participants serve to confirm or challenge my associations. This serves to inspire new ways of thinking and guide the research moving forward; both within the scope and for future directions.

The Research Ethics Board approval for involving participants in this research was received on December 15, 2023, with REB number 2023-85. Email invitations were sent out to potential participants from January 2024. Participants who responded to the email invitations within 48 hours and met the eligibility requirements were selected for individual garment fittings.

Procedure

Prototype five was chosen for the purposes of the garment fittings. This prototype consists of five faux leather corsets, each representing the % graduate study permit rejection rate in Canada between 2012 and 2021 for each of the continents respectively.[2] Each corset is enhanced with wearable technology to make kinetic movements like a beating heart, with the speed of the "palpitations" corresponding to the % rejection rate of the respective region. For example, the faster the palpitations, the higher the rejection rate. Additionally, the size of each corresponds to the % rejection rate of the region. This prototype is described in greater detail in Chapter 5.

Prior to the fitting sessions with other people, I recorded myself interacting and wearing the garments. Then, I proceeded to note down my own answers to the eight questions I was going to pose to other participants during their sessions.

The participants were asked to try on the prototypes while a camera recorded each session. During the fitting, participants were asked questions relating to the fit of the garment and their impressions of the garment and experience itself. Officially, there were eight questions posed as prompts for the discussion. A small pool of seven participants above the age of 18 took part in these sessions individually.

Data collection and Analysis

Evaluating the experiences of myself and others involved qualitative methods of analysis of videos and notes generated from garment fitting sessions. To account for the challenges of working from memory and alleviate worries of time constraints during the garment fittings, the sessions were video recorded. Video recording is a rich form of collecting data and is an

[2] Available at: https://www.canada.ca/en/immigration-refugees-citizenship/corporate/transparency/committees/cimm-feb-15-17-2022/student-approval-rates.html

essential part of this research as it also serves to capture non-verbal and non-textual communication (body language, facial expressions, and other reactions) essential to understanding the embodied, material and performative nature and effects of garments. Additionally, recording these sessions allows for observation of garments and interactions on their situated context, and facilitates the review and verification of results.

Relational content analysis was used to analyse the garment fittings. Content analysis is generally very time consuming to conduct as it is a reflective process. The researcher must constantly revisit and rework their findings to come to meaningful conclusions. Flexibility is maintained throughout the process until it is “easier to get the bigger picture and see patterns” (Erlingsson & Brysiewicz, 2017, p. 95). Another challenge to content analysis is that the researcher needs to maintain an awareness of their preunderstanding to avoid bias in interpreting the qualitative data. By first conducting an auto ethnographical study of myself fitting and experiencing these garments, I utilized my “preunderstandings to facilitate a deeper understanding of the data” (Erlingsson & Brysiewicz, 2017, p. 95). My preunderstanding also became a valuable source of data.

The following steps were taken to conduct the relational content analysis:

1. The recordings of the garment fitting videos were transcribed into raw text verbatim.
2. After listening to and watching the video a couple of times, the text was divided into smaller meaning units. Simply put, this involved identifying smaller texts that highlight the main ideas while keeping the original meaning.
3. Meaning units were organized into codes which are names “that most exactly describes what this particular condensed meaning unit is about” (Erlingsson & Brysiewicz, 2017, p. 94). These can be one or a few words.
4. Codes were then grouped into even smaller categories/themes.

The results from the fittings are summarized in Chapter 5 under Garment Fittings.

Chapter 5 Design Development

This chapter describes the alternative design process taken to conceptualize a series of data-based garments. Emphasis is placed on the process of making as the key area for knowledge generation. As such, several prototypes were created to explore possible design features, with only one prototype (Prototype 5: The corsets) developed into a polished data physicalization for further testing through garment fittings. Garment fittings are conducted at different points in the design process to help inform design decisions. Only the garment fittings of these corsets were conducted and analysed in greater detail. In the last section of the chapter, I will discuss the main findings from these garment fittings including my own experience. The full set of charts of the initial data coding is available in Appendix 6.

Creating the Prototypes

Prototype 1: The Pursuit of Knowledge

Dataset

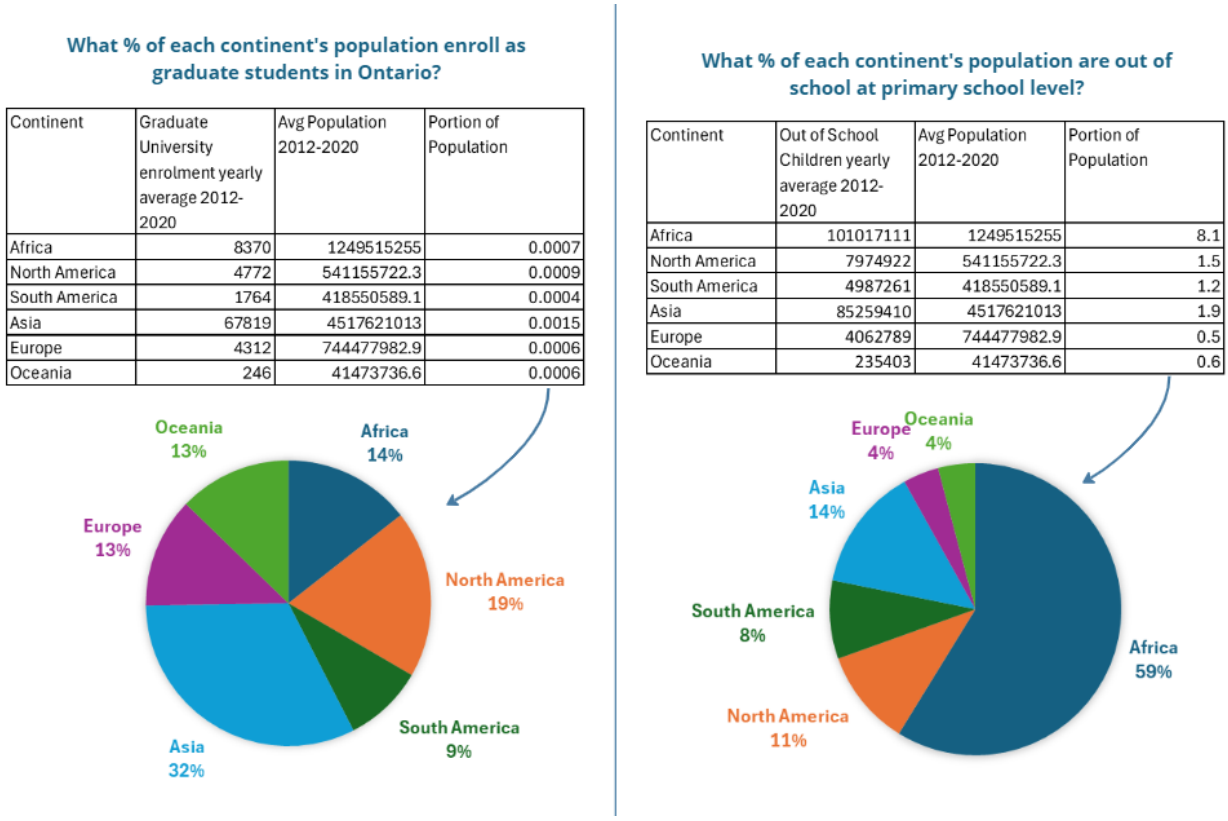

Figure 8: Analysing the dataset (Author's image).

This preliminary data-based garment reflected two sets of data. The first dataset I identified gave a picture of immigrants studying in Ontario from the different continents. The dataset was available on Ontario Data Catalogue published by the Government of Ontario. [3] Africans seemed to have equal opportunities to study abroad as do those from other regions of the world. I decided to search for other data to find a more meaningful story.

[3] Main dataset available at: https://data.ontario.ca/dataset/university-enrolment/resource/59b71ef5-e837-4dc7-a7f4-e4921815871c
World population data available at: https://ourworldindata.org/grapher/population?time=2007..latest

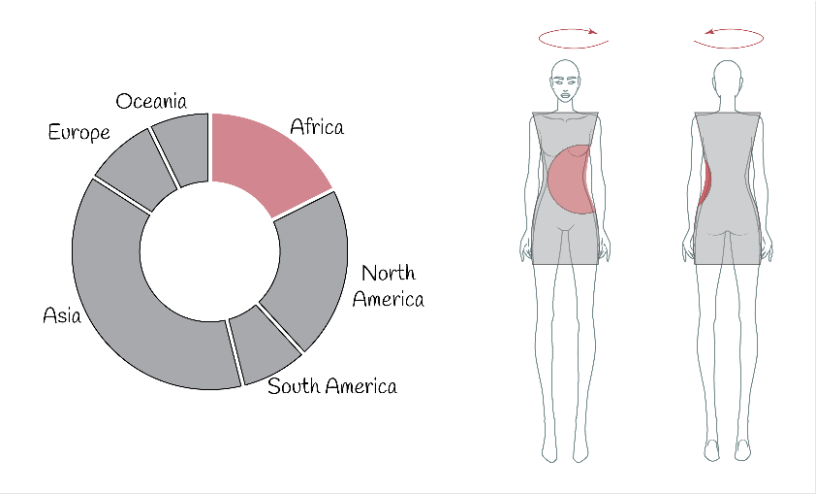

Figure 9: Data shows that Africans make up a fair share of Ontario Immigrant Students at Tertiary level (Author's image). The final design represented this data on the torso of the garment. These diagrams were in the labels as annotations to help people understand the garment.

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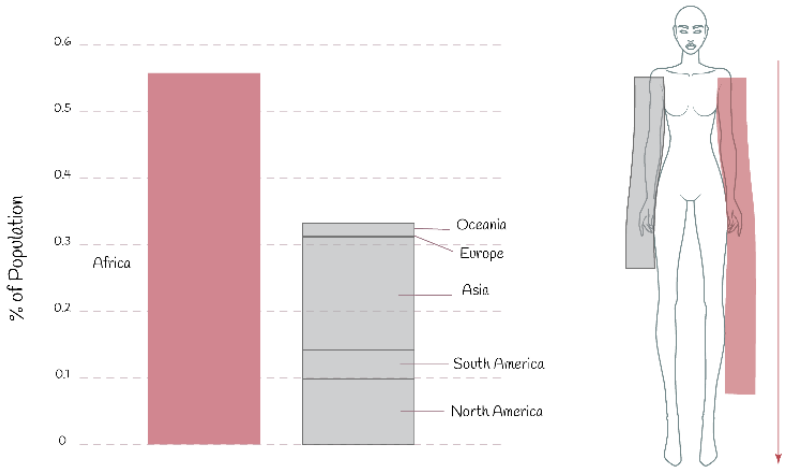

Figure 10: Out of school children in Africa as a percentage the continent's population are nearly double that of all other continents combined (Author's image). The final design encoded the data into the arms. These diagrams were in the labels as annotations to help people understand the garment.

Data relating to Primary school age children who are out of school[4] showed that out of school children in Africa as a percentage the continent's population are nearly double that of all other continents combined. This data was available from Our World in Data (2024), a project by Global Change Data Lab which focuses on allowing "everyone to see the state of the world today and track where we are making progress, and where we are falling behind."

Design Process

The data was then used to sketch ideas for a garment. In the initial explorations, I explored ways of conceiving the body as a globe or map. After identifying the second dataset, I started exploring the arms as vehicles to compare data as we naturally compare with our arms through embodied cognition.

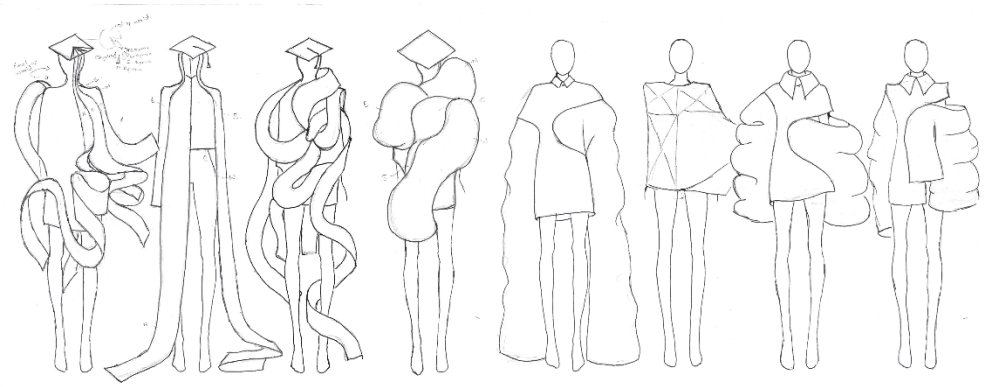

Figure 11: Some sketches produced for the Pursuit of Knowledge prototype (Author's image).

The next stage involved identifying the best sketch for production and creating a 2D sewing pattern. Computer aided design software makes use of the avatar and the block pattern[5]

[4] Data available at: https://ourworldindata.org/grapher/out-of-school-children-of-primary-school-age-by-world-region?tab=table&time=1970..2019

[5] A block pattern is the most basic flat template/pattern that can be put together to create the shape of a garment. It is made to fit a specific body using its body measurements and can be manipulated to create a range of styles.

in creating the pattern. The virtual world allows for infinite possibilities and impossible simulations that can spark creativity, while the basic block grounds these ideas in what is possible in the real world through making use of body measurements and conventions. However, working with the block pattern and screen confined representations of the data to geometric shapes as physical material explorations were nearly impossible on the interface.

While restricted by the dimensions determined by previous steps, the physical iteration of the design allowed for material explorations and other possible ways of encoding data. The restrictive nature of the data inspired me to think of alternative ways of conceiving the design. The final garment, aided by the fabric choices, sparked reflection from peers on the western education system and colonial impact on African and global immigrant experiences. The model remarked that she felt compelled to lift her arms as she could feel the difference in weight on either side.

Presentation

Figure 12: The final garment presented in a gallery setting (Author's image).

Figure 13: Tags used in presenting the final garment (Author's image).

In the final phase, I presented the garment on a mannequin and had a model dress up in it halfway through the presentation. Tags were added to the garment to help communicate the legend of the data physicalization. The model remarked that she felt compelled to lift her arms and she could feel the difference in weight on either side.

Reflection

The final garment sparked reflection on the western education system and colonial impact on African and global immigrant experiences, revealing possible avenues for future investigations. The restrictions of the data forced me devise alternative ways of approaching each design problem throughout the process. Unconventional material, such as the wire used to create the spiral structure, prompted me to think outside of the conventional garment construction methods of fashion. The physical garment itself offered the audience a way to conceptualize the data with one-to-one comparisons, requiring minimal mental conversions from those interacting with the artifact. This is something that is difficult with sketches and avatars in

the virtual world. Sketches and avatars can spark creativity through their ability to achieve the 'impossible' while the block pattern, mannequin, and physical body ground ideas in real world embodied possibilities.

The scotch and striped fabrics were universally recognisable as reminiscent of school uniforms. The arms were found to be a natural and effective tool for an embodied comparison as length and weight of materials could be easily felt and weighed. Overall, translating meaning through the garment was found to be effective in terms of engagement owing to the embodied, material and performative qualities of clothing. Interpretation of the data was assisted by vision, touch and proprioception, making for an experience that encourages participation and is ultimately memorable. However, the prototype had its limitations. Much explanation of the data concept was required to assist in understanding what the prototype was and how to engage with it. Future iterations will investigate appropriate scenes and visual cues to aid in decoding the work.

Prototype 2: The Heartbeat Dress

From Free Sketching to Embodied Making

The heartbeat dress was the first prototype I created after listening to the first set of stories (described in Chapter 4 under Leveraging Sketch in the Design Process) and engaging in the first set of free sketching exercises mentioned in the methodology section. I realized I needed to involve my physical body and felt bodily experiences into the design process and create more opportunities for material explorations. The embodied making process involved spontaneous manipulation of fabric, materials and electronics to experiment with possible ways of expressing findings. This involved revisiting traditional garment design techniques such as physical patternmaking and exploring others I usually shied away from, such as draping. My goal in engaging in this exercise was to explore ways of expressing feelings such as anger, resentment or fear that could be expressed through a shape changing garment. These were

feelings that I had associated with some of experiences of African immigrants in the stories I had listened to.

Figure 14: First iteration of the Heartbeat Dress achieved through an embodied making activity (Author's image).

I 3D printed a rack and pinion servo attachment [6]and experimented through attaching them to different parts of the garment and observing the effects. Initially, I wanted to portray a sense of anger and growing resentment by creating an element in the garment that rises in height and falls. Each servo moves back and forth through 180 degrees for linear motion. The servos are placed at angles from each other, and together with the fabric, create a motion like a heartbeat. The heartbeat could be manipulated to represent feelings or associations such as anger, calm, racing etc. The resulting prototype moved and looked more like a heartbeat.

Reflection

Free sketching turned out to be a great exercise for a few reasons. Firstly, it was therapeutic. Some of the stories were not easy to listen to as this was a subject that was a little

[6] Rack and pinion adapted from linear servo actuator 3D printing files available at: https://www.thingiverse.com/thing:3170748

close to home. Secondly, I was able to associate my feelings and findings with design features by using my first instincts. These associations played a huge role in informing my decisions moving forward. And lastly, I was able to jot down ideas without worrying about whether they will work. The outcome of the embodied making process, a garment that represented a heart/heartbeat would work well to depict emotions.

When I wore the garment, it was comfortable. I could not feel any of the servos or wires against my body. In most cases, servos need a steady base to stop from shifting out of place. The base layer of the garment on which the servos were attached fit snug against the body which helped prevent any shifting. When used correctly, garment construction methods afford the stability and comfort needed for data-based garments.

While wearing a garment that was moving, I was prompted to slow down and take my time. Perhaps, it was because I was cautious of the electronic components inside. I was also prompted to touch, feel and listen to the sounds of the garments. A garment that emulates a heartbeat has the potential to elicit emotions. I decided to explore this concept further in prototype 4 and 5.

Prototype 3: The Search for Warmth

From Dataset to Concept

Initially developed around the same time as the *Heartbeat Dress*, this prototype reflected the dataset of Categories of Immigrants to Canada between 1980 and 2021 organised by place of birth[7]. The prototype focused on emphasizing the ratio of economic immigrants to refugees for the different regions of Africa to emphasize the refugee crisis of East Africa.

[7] Dataset available at: https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=9810034901

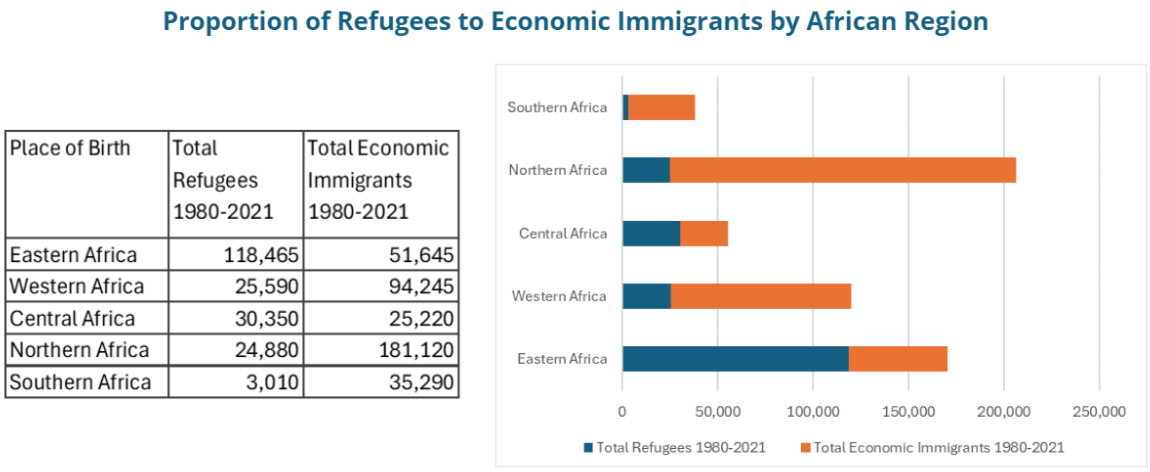

Figure 15: Analysing the dataset.[8] East Africa is the only region in Africa to have more refugees than economic immigrants (Author's image).

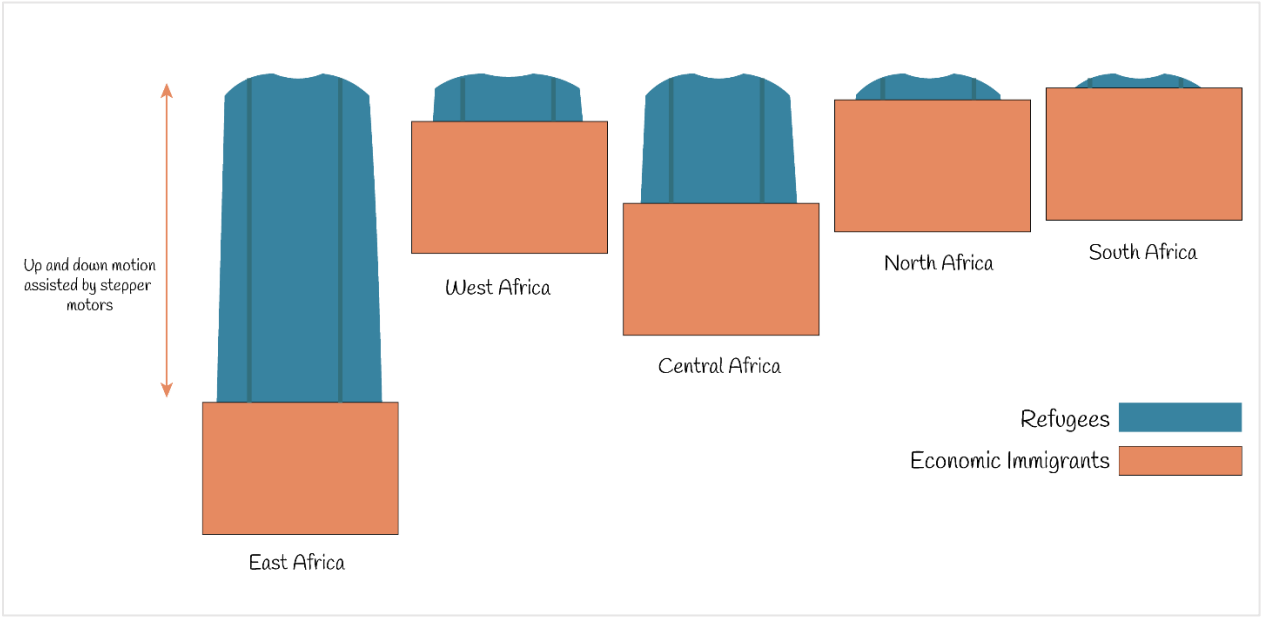

Figure 16: Brainstorming ways to incorporate the dataset into a cape (blue) with a moving overcoat (orange) assisted by stepper motors (Author's image). The garment shifts into corresponding region's position when trigger by 'some sort' of interaction.

[8] Dataset available at: https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=9810034901

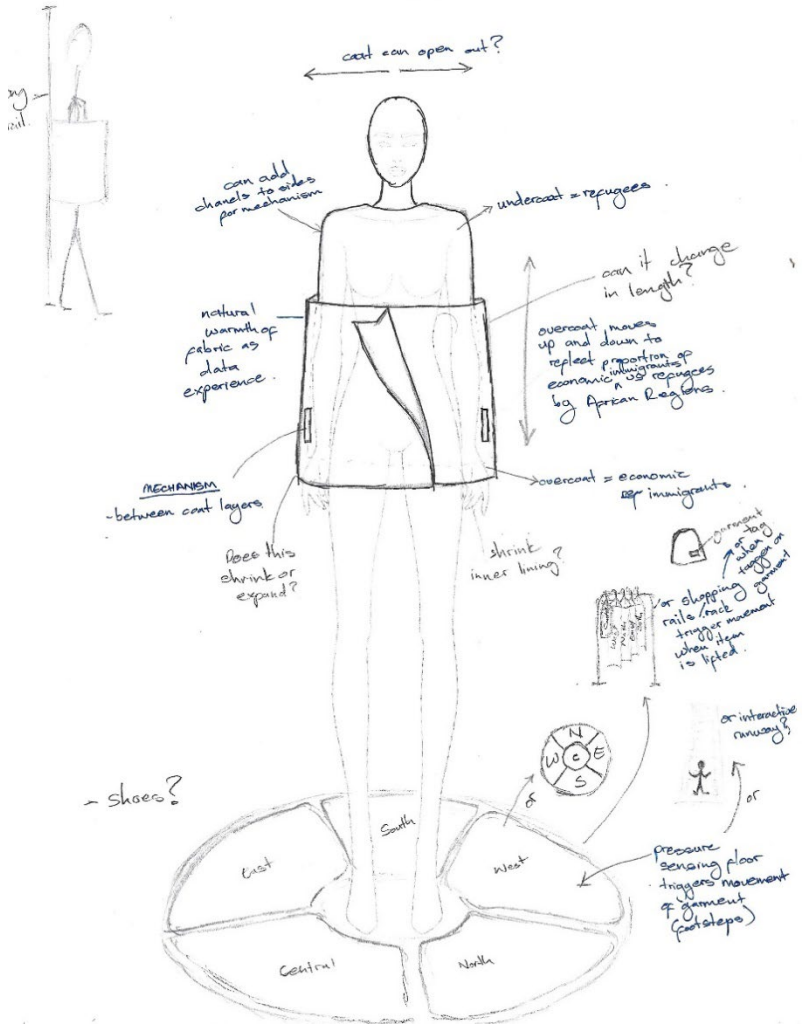

Figure 17: Sketching the ideas for the Search for Warmth prototype (Author's image).

For this prototype, I settled on the idea to use two different layers of the garment to reflect refugees and economic immigrants respectively. Visually, the layers are distinguishable through the choice of fabric and color. The actuation of this mechanism was meant to pull the outer coat (reflecting economic immigrants) up and down to reflect visually the proportions of refugees to economic immigrants of each African Region (North, East, West, South and Central) when triggered by an interaction. As a felt bodily experience, I wanted to use the natural warmth of laying clothing to signal differences. If the number of economic refugees was higher, the outer coat would sit higher up covering the arms making the wearer feel warmer. If the number of

refugees were higher, the outer garment moved further down exposing the wearer to the elements.

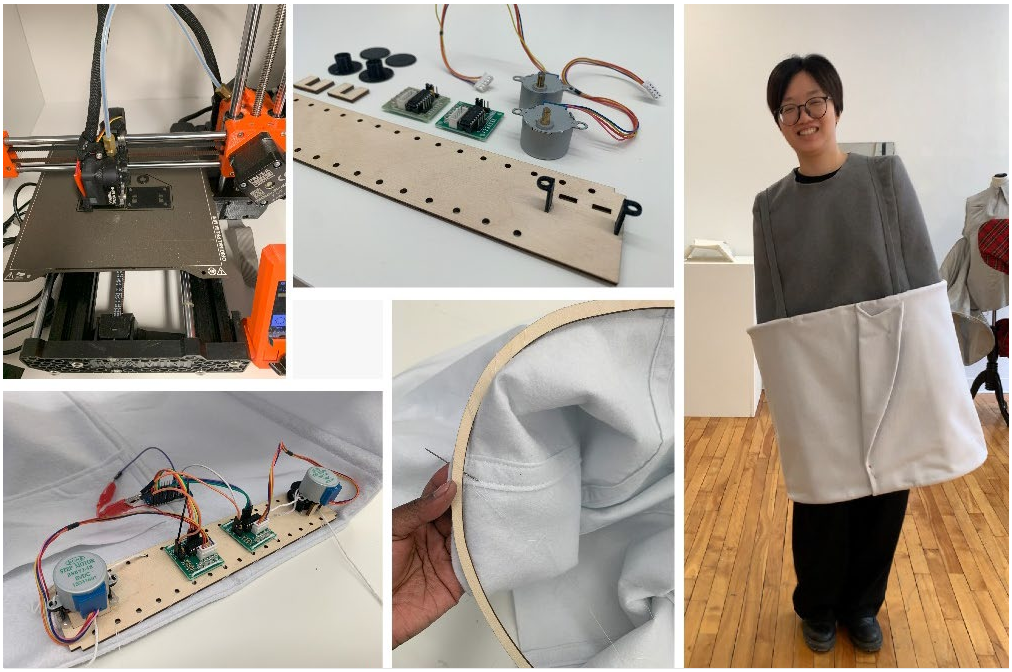

Figure 18: First iteration of the Search for Warmth prototype using stepper motors and creating a frame for the outer coat (Author's image).

In the first version I used pulleys on either shoulder attached to 2 front stepper motors and 2 back stepper motors. The pulleys reel in and out as they pull the outer coat up and down until the coat reaches the desired position. Each stepper motor is attached to its own controller and 2 stepper motors are attached to 1 microcontroller.

Reflection

The garment features worked well to express restriction. Garment fitters reported feeling like they would have trouble sitting or walking especially when the over-coat was sitting at its lowest. However, the garment with its electronic components proved too fragile to carry the weight of the jacket. Overall, the mechanism of this iteration was not as effective or intuitive as intended. The stepper motors needed too many wires, extra modules, coding and testing to achieve the desired kinetic movement. Accommodating all the electronic components resulted

in a garment that felt very rigid; it was like placing a machine over the body. Additionally achieving the desired effect using kinetic movement would have been time consuming. The concept behind the data was also too complex to explain though a garment in this way. The mechanics of the garment overshadowed its materials and fabrication, and the garment did not achieve the same emotional qualities as the *Heartbeat Dress*. For this reason, I decided to focus on developing some of the findings from the *Heartbeat Dress* into the following prototypes instead.

Prototype 4: The Rejected

Dataset

I considered a dataset that reflected some of my own experiences. As an international student who has been moving from place to place for the last decade, I am no stranger to visa application processes. The study permit application process is always very stressful and frustrating, and rejection or hostility from the system is almost certain. The dataset for the percentage of study permit acceptance rate by the IRCC (Immigration, Refugees and Citizenship Canada) was available on Statistics Canada [9] organized by country of residence. I started by conducting an exercise in excel, color coding each country between shades of and red and green based on the amount of acceptance shown in the diagram below. The result was a sort of heat map showing larger rejection rates for African countries. It is here I decided that focusing on presenting rejection rates, rather than acceptance rates would be more effective.

[9] Available at: https://www.canada.ca/en/immigration-refugees-citizenship/corporate/transparency/committees/cimm-feb-15-17-2022/student-approval-rates.html

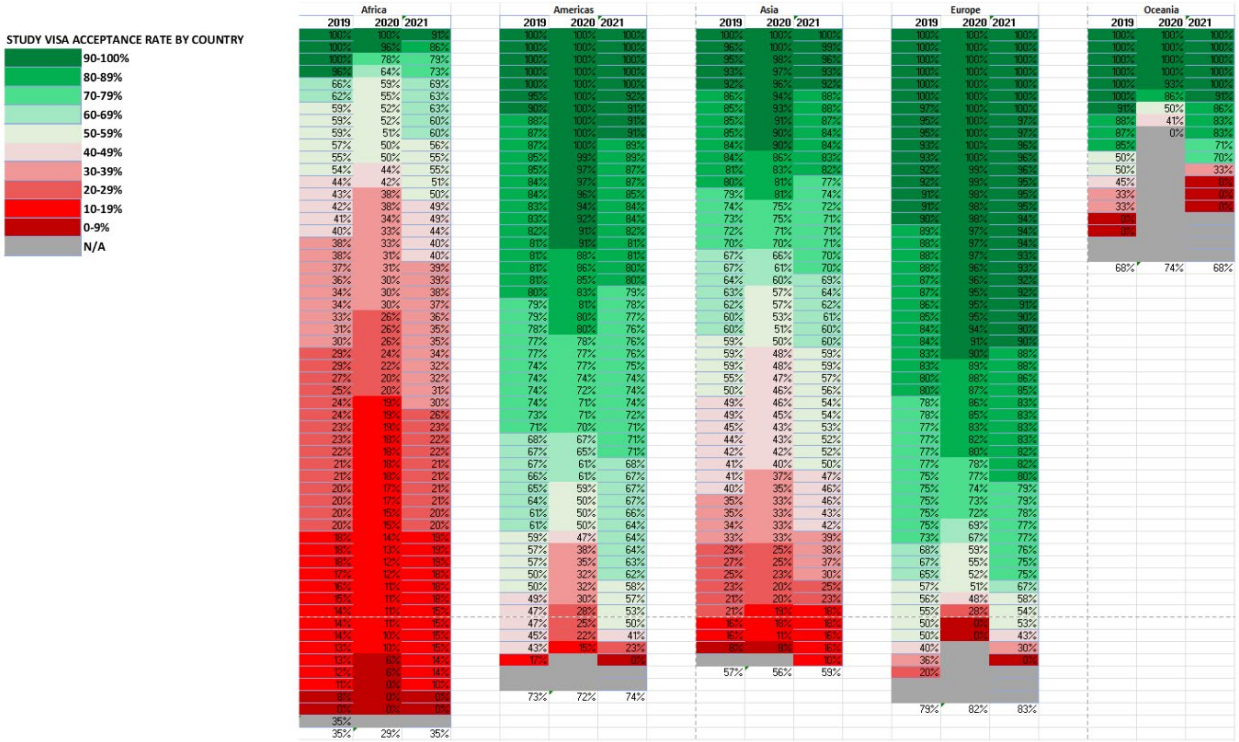

Figure 19: Excel heat map exercise color coding each country by study permit acceptance rate (Author's image).

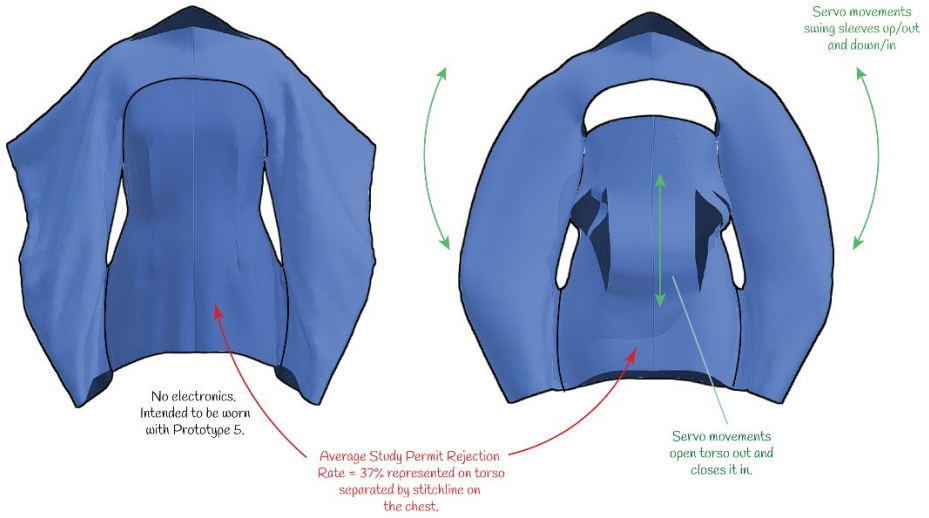

Figure 20: Conceptualizing the idea for representing the overall 37% rejection rate on two similar garments to compare their outcomes (Author's image).

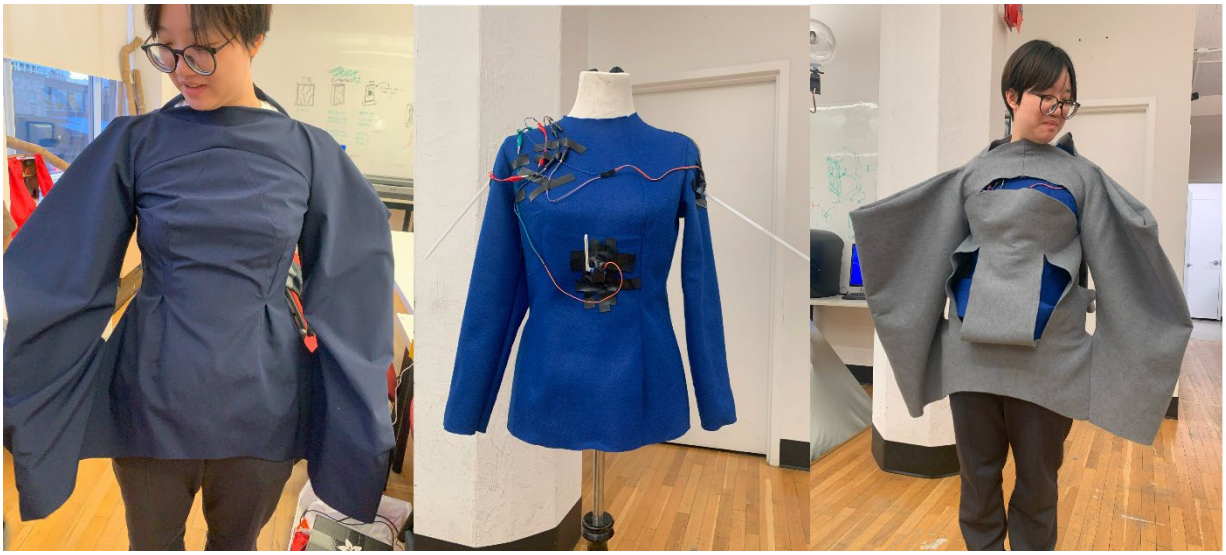

Figure 21: Version 1 of The Rejected (left). The servo mechanism inside version 2 (middle). Version 2 of The Rejected (right) created in a thick felt fabric: seams are left open to see the effect with kinetic movement facilitated by servos (Author's image).

I decided to represent the overall study permit rejection rate of 37% on a dress with large sleeves. The main torso would represent the rejected area and is separated from the rest of the garment (the sleeves and the upper part of the torso) by a seamline (the joining line where two separate fabrics are stitched together). While I worked on the pattern in my design software[10], I accidentally forgot to “sew” my seams. The resulting simulated garment had a surprisingly interesting effect. I decided I would make another version of the garment with these features. In the first version I used a lightweight fabric and incorporated no electronic components. In the second version I used a thicker fabric and manipulated it to “shrink” and “expand” with the help of a servo mechanism. I inserted two servo mechanism on either side of the arms to lift the large arms of the garment up and down. A higher rejection rate would trigger the servos to open out, extending the sleeves of the garment and the chest. This idea of growing bigger would signal

[10] Computer aided pattern design software allow you to simulate the garment design process in virtual reality on avatars. I used Clo3D.

growing resentment and anger. A lower rejection rate would close the mechanism, pulling the garment closed back into a sense of safety and security.

Reflection

The two versions of the garments turned out differently even though the same foundation was used. The lighter fabric created a softer, more fluid silhouette while the thicker one created a more dramatic effect. The servos could have enhanced this, but they were not powerful enough to lift the heavier fabric. The dataset itself would have been more prominent if two different fabrics had been used to contrast the 37% rejection from the 63% acceptance in both garments. The arms of each garment were connected to the skirt, communicating restriction which is an important part of this story.

Prototype 5: The Corsets

From Dataset to Concept

This prototype expanded on the idea of mapping heartbeats to immigrant experiences. It used the same dataset as I did in *The Rejected* prototypes reflecting the percentage of study permit rejection rates by the IRCC available on Statistics Canada.[11]

[11] Available at: https://www.canada.ca/en/immigration-refugees-citizenship/corporate/transparency/committees/cimm-feb-15-17-2022/student-approval-rates.html

Average Study Permit Rejection Rate by Continent of Birth (IRCC)				
Continent	2019	2020	2021	Average
Africa	65%	71%	65%	67%
Americas	27%	28%	26%	27%
Asia	43%	44%	41%	43%
Europe	21%	18%	17%	18%
Oceania	32%	26%	32%	30%
				37%

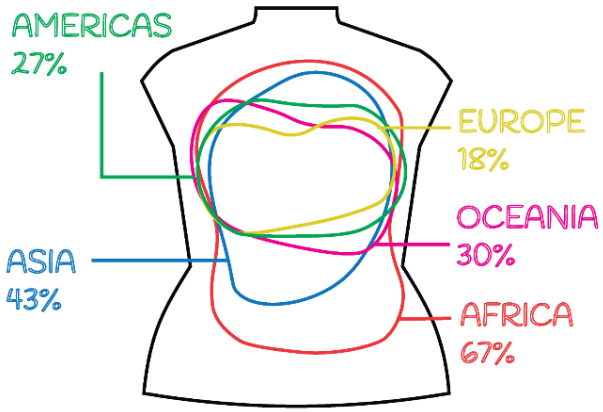

Figure 22: The corsets prototype mapped average study permit rejection rates by continent onto corsets (Author's image).

Figure 23: Cutting, sewing and draping. CAD software used to create the pattern for the base garment. Free form draping to create each corset. A corset was created for each continent with its size corresponding to the rejection rate (Author's image).

This prototype was intended to encourage more social interaction among the audience. I created individual corsets for each continent whose size corresponded to the average study permit rejection rates for that region. Each corset was fitted with one or two servo mechanism to move the fabric in the motion of a heartbeat. Corsets seemed the right fit as they also relate with

closeness to the body and organs such as the rib cage. Corsets also fit snug to the body so that the mechanism could be felt by the wearer. A higher rejection rate was mapped to a higher heartbeat while a lower rejection rate was mapped to a lower heart rate. The corsets were fabricated in a faux leather material initially intended to be associated with the military, which I associated with growing resentment. However, the material resulted in corsets that looked more like body organs.

Design Process

When working with servos, it is important to give them a steady base so that they do not shift around when their motor is powered. Using corset interfacing[12], I managed to create a firm enough base that was still soft enough to allow more organic movements and provide comfort to the wearer. There was at least 1 servo in each corset placed under the left breast, close to where the heart is located on a real body.

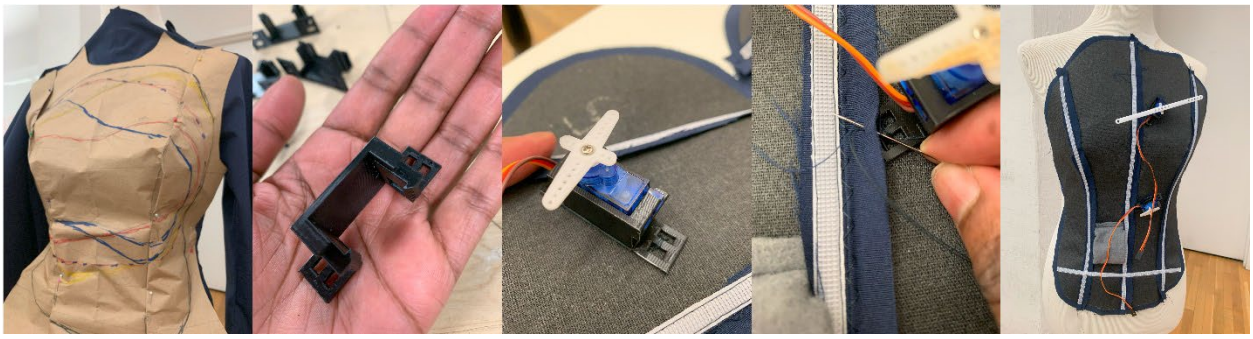

Figure 24: Creating a corset base for each "heart" and attaching the servo mechanism (Author's image).

I had to rely on draping as the fastest way to achieve an organic organ shape, while ensuring enough fabric covered the servos and allowed them to move freely. Straps were attached above the waist area to assist in attaching the corset to the body.

[12] Interfacing is a fabric with glue on its wrong side allowing it to attach to other fabrics when heat is applied. This is a technique used to make fabrics more rigid. Interfacing specifically designed for corsets is harder and more rigid.

These corsets turned out to be the best outcome of the process as a data-based garment. They were fabricated to completion and garment tags were attached ready for in depth garment fittings. During these fittings, the corsets were displayed on a table and individual wearers had the opportunity interact with them and try them on. These garment fittings are discussed in greater detail in the next section.

Garment Fittings

After a considerable amount of progress in my alternative design process I decided to conduct a more extensive set of garment fittings targeted towards understanding the role of empathy in these data-based garments. This set of fittings were analysed more deeply to:

- investigate whether some of these garments I had created could indeed invoke feelings of empathy.
- identify which design decisions had contributed to invoking empathy, if any, and which ones needed to be reconsidered, both within and outside the scope of this research.
- determine whether these design choices and their potential empathy-inducing qualities could facilitate better understanding of the data.

I determined that the corsets were the most suitable to conduct these further investigations as the open back structure with adjustable straps meant the corsets could accommodate more body sizes and shapes. Additionally, the material choices and the way in which kinetic movement had been incorporated into the corsets made for a strong concept for communicating the data and potentially influencing empathetic responses.

A total of seven participants attended these fitting sessions: six female and one male. The kinetic movements had not been incorporated into the corsets at the time of Participant 1's fitting. As it quickly became evident in my first scan of the transcripts that the wearable technology had played a significant role in how the corsets and experience were perceived, I decided to disregard the findings from this fitting from this analysis to make more reliable deductions. Each session was recorded and transcribed verbatim. Although the structure remained flexible, participants were more comfortable engaging in the questions prompted by me, rather than simply being watched and recorded. Having participants verbally express their

thoughts and experience meant that I could rely on transcribed text to confirm observed behavior, for the most part.

Hearts, heart rates, organs and flesh.

Figure 25: Garment fitting results. Participants made strong associations to hearts and organs (Author's image).

In general, participants made strong associations to hearts, heart rates and body organs. Four of the six participants expressed that the corsets reminded them of a heart, organ or flesh found inside the human body. Five out of six participants said that the corsets looked like heartbeats or heart palpitations. The former result shows us that the *extensive properties* of the corsets played a significant role in relating the corsets to body organs, largely due to the visually perceived faux leather fabric, the choice of color and the kinetic movement provided by the wearable technology. The latter serves to confirm that it was the wearable technology that contributed the most to these bodily associations. Furthermore, sound was mentioned as a

contributing factor to perceiving a heartbeat by some participants. Thus, overall, it is largely the *material qualities* of the corsets that contributed to the initial recognition of the concept of hearts and heartbeats.

For the most part, wearing the corsets enhanced with wearable technology influenced participants' body perceptions. Four of the six participants remarked that wearing the corsets and embodying them made them feel some connection to their own body or body function. One participant expressed they felt the "heartbeat" could influence their own. Another felt the "heartbeat" was their own, while two others felt like they may be in someone else's body. This show that embodying these corsets, that many felt were "alive" in one way or the other, had an impact on body or body function, or the perceptions of them. Of the other two participants, one felt strongly that each corset was a living entity on its own. Wearing the corsets and feeling its embodied qualities did not alter this participant's perception of their own body. From this analysis, we can speculate that the *embodied qualities* facilitated by the wearable technology of the garment served to make participants more aware of their clothing and their own bodies. Perhaps it was feeling the movement against the chest that produced this effect.

From anxiety to empathy.

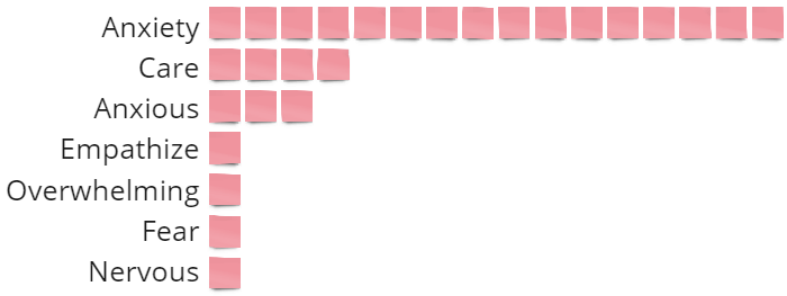

Figure 26: Garment fitting emotion keyword extraction selection from transcripts showed that the word anxiety was used about 16 times (Author's image).

To evaluate the effect the corsets may have had on emotions, I looked further into the occurrences of key emotional words during the sessions. Five of the six participants used words

such as “anxiety”, “fear” and “nervous” to describe their emotional experience. The word anxiety appeared a about 16 times during the garment fittings. The preoccupation with feelings of anxiety was tied to the faster and bigger corsets. Although all participants had noticed at the start that the corsets were moving at different speeds, with some moving slower, they tended to remain more aware and refer to the bigger and faster corsets during the conversation. This suggests that bigger, and more exaggerated qualities of design draw more attention to themselves or that contrasting elements (e.g. fast versus slow) can work to emphasize certain aspects of the design. Four of the six participants expressed that it was the speed of the kinetic movements that contributed most to their associations with anxiety, with one of them adding that the sound had been an additional contributing factor. The concept of “bigger” had been encoded into the garment in a different way, through exaggerated movements, accelerated speed, and louder sounds. Thus, wearable technology served to augment the garment qualities facilitating the impression of an emotion. Had it not been for the kinetic movement of the corsets, participants would have had a harder time making connections to the concept of being “alive,” let alone having an embodied experience that connects their bodies to the concept.

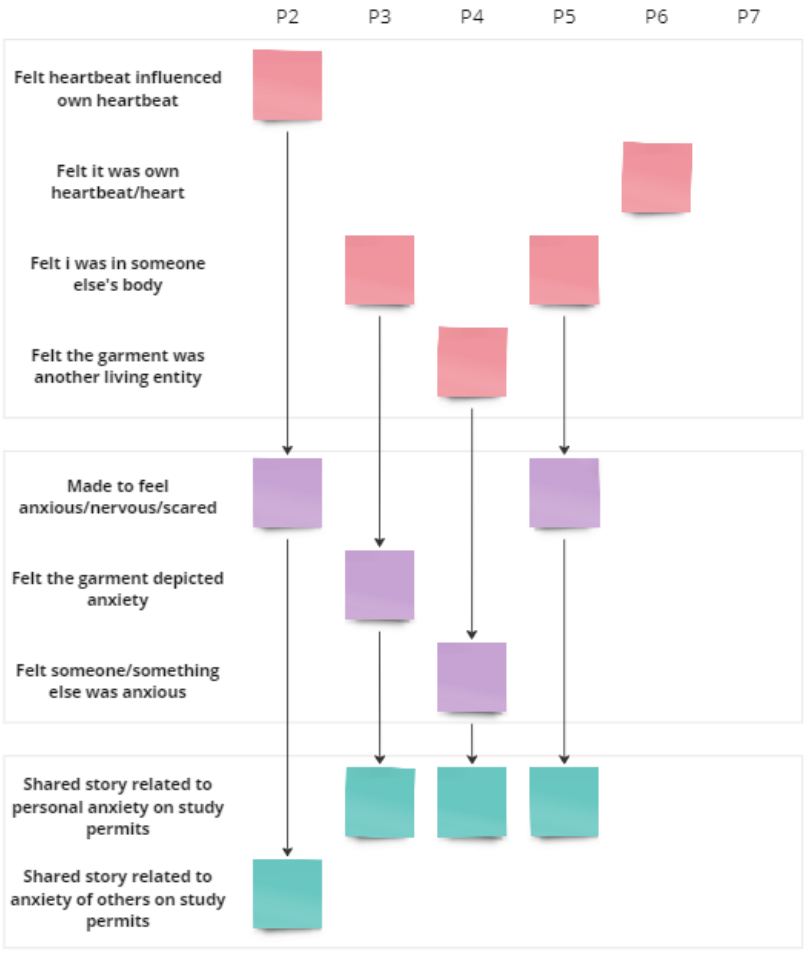

Figure 27: Garment fitting results (Author's image). Emotional connection to the corsets facilitated connection to personal stories. Participant 7 did not express feeling a heartbeat or experiencing feelings of anxiety.

The diagram above shows that participants who felt their bodies or body perceptions had been influenced by the embodied experience of the corset were likely to feel the emotion they had ascribed to the garment. These two participants expressed feeling this anxiety themselves. Two others felt it was the corset itself that was anxious. All four of these participants proceeded to share personal stories or their feelings towards the stories of others related to anxieties around study. Sharing stories points to showing signs of empathy. Some prominent remarks relating to empathy include:

It's like I'm feeling the rejection fear in my heart. When I applied, I was so nervous.

(Participant 5)

> I feel like there's always an anxiety when you're applying to anything. And I think it's especially true for us who kind of don't feel very represented. For a woman of color, for an immigrant from outside the country. Are we worthy or enough to be here in North America, to this school? And I'm reminded of going to lots and lots of forums, and YouTube videos, and people talking about their study permit experience, and trying to reassure myself that I can get in, or making sure that I don't make any mistakes so that I don't get rejected. So that's how I interpret the phonetic energy of this, like the heart beating fast and maybe you're breathing. (Participant 4)

The garment had depicted and elicited an emotion associated with the experience of applying for study permits. Connecting the emotion in question to a real body, whether one's own or belonging to someone/something else, increased the chances of experiencing empathy towards the subject matter.

Taking care of other things; an interesting case of Tamika's empathy.

It was particularly interesting how one participant who had exhibited signs of empathy had perceived the corset to be a living organism, much like an animal or pet. I will refer to her by her name, Tamika, in this section of the analysis only, as she expressed through the consent form that she would like to be attributed for her contribution. For her, the corset seemed like something she was "in charge of" and needed to take care of. It was through wearing the garment that she became aware of these feelings:

> I was surprised because I never thought about this about your project before, but wearing it on my body, it made me feel like I'm taking care of a living thing. And it does feel like a part of me, and I know we talked about that prior to this, but it feels even more salient now that I'm wearing it on my body. (Tamika)

Tamika later revealed that she owns a chihuahua, which accounts for her instinctive association. This also explains why she seemed to dwell more on positive feelings of calmness

and gentility rather than the negative notions of anxiety, unlike other participants. She was also the only participant to express that she would be comfortable wearing this corset for a long time. Thus, Tamika's signs of empathy seemed to be fostered by her associating the corset with a living thing that she cares about.

The garment fitting sessions were conducted such that participants had the freedom to interact with the corsets in a way that felt most natural and comfortable for them. They could try on the corsets in any order they wished and were not obliged to try all or any of them on. Tamika expressed that she appreciated this process and that it made her feel even more obliged to care for corset.

> I like that you kind of go through it on your own pace, and even of your own initiative or volition, putting it on your own. There is a transaction. I see it as a transaction, like I take this and put it on my body, and what that means is that I am consenting to taking care of this item. So, the action of putting it on my body means that I can take care of it. (Yamamoto, Tamika)

Tamika's experience highlights the power that connecting concepts to bodies can have in facilitating the understanding of them. It is the performative aspects of wearing the corsets that deepened Tamika's interpretation and appreciation of the experience. Through wearing the corset, she felt a deeper connection to another body eliciting feelings of empathy that she could relate to her own experiences applying for a study permit.

Visual and textual aspects of data communication remain important.

The insights I have mentioned so far highlighted the potential emotional value of data-based garments. While I could deduce that the corsets had the potential to elicit empathy from wearers, it was much more difficult to determine whether the experience of embodying these corsets facilitated better data communication. Four out of six participants expressed that they understood the data but there was a consensus that more information would have improved the

communication of the data. I had provided labels on the garments that summarized the data in a visualization and named (by continent) and color coordinated each corset. I then proceeded to explain verbally what the data physicalization before the start of each session. Participants expressed that more labels, texts, printed out visualizations and access to the datasets would have improved their understanding of the data. The need for extra information associated with common data visualization strategies leads me to believe that it was not the experiences of the corsets that contributed to the understanding of the data in the first place. Rather, it was the verbal information I had provided to participants and the existing labels that participants relied on most to understand the data. This shows that communicating data through garments and wearable technology remains very complex and relies on more familiar data visualization strategies to enhance the understanding of the insights. It also stresses the importance of informing people about the data, as participants seemed eager to know more about the data.

In two of the garment fitting sessions, the participants had expressed that they felt the medium sized corsets were moving the fastest. After wearing the corsets, they realize that it was the bigger corset was moving the fastest. While there may be factors relating to the fabrication and construction of the corsets that contributed to this initial impression of the speed of the kinetic movements, it revealed that alternative data encodings can be challenging and complex to implement. For example, what we perceive visually can be interpreted differently when we feel it through touch, and what we feel through touch can be interpreted differently when we feel it on our chest.

Garments construction practices facilitate comfort and acceptance of wearable technology.

Notions of comfort generally tend to be associated with perceptions on fashion largely related to fit. Participants associated comfort with whether the corset supported the shape and size of their body and allowed them to move with ease, or whether the corsets could be

incorporated into their personal style. conformed to their idea of style. Five of the six participants reported that the corsets were comfortable. The remaining participant stated that the reason for their discomfort was because they do not normally wear corsets. Participants also expresses that the corsets could have been a little tighter for added security and to help feel the motion in the garment more. This feedback could be incorporated into the design without changing the garment. Using fabrication techniques associated with garment construction served to assist the adoption of wearable technology into the corsets. The materials and construction served to conceal the electronics while maintain comfort on the body. What is interesting about this is that none of the participants expressed feeling uncomfortable wearing electronics even though it was obvious they had been incorporated into the garment. Additionally, this relative comfort and acceptance of the wearable technology could be observed through participants' behavior. When prompted to interact with the corsets in a way that felt most natural at the beginning of the session, participants proceeded to instinctively touch the corsets and lift them to examine them. It is important to note that during these fitting sessions, the corsets were connected to USB cables. This did not seem to deter participants from feeling comfortable enough to pick them up. I had expected some level of hesitation, but this was not the case. Perhaps it should not be that surprising given that most participants were familiar with wearables, and thus unafraid of interacting with the corsets.

Only one of these participants expressed that they would wear the corsets for a long period of time. This can be attributed to the anxiety inducing qualities of the data-based corsets showing that, when designed to disrupt the normal rhythms of our bodies, wearable technology can be difficult to adopt.

Designers have a hard time empathizing with the target wearers of their garments.

Lastly, I will reflect on my own experience fitting these corsets. I am accustomed to trying on my garments as I make them throughout the construction process. My own body is the

one I have the most immediate access to; therefore, I take advantage of that. Constructing a garment is a laborious process. I am usually too concerned about my next stitch or cut to take more than a couple of minutes assessing the garments on myself. It is very rare that I try on the completed garment as I am usually just relieved to be done.

Taking the time to record myself forced me to stop, slow down and let go of construction pressures for a moment. This shed a whole different light on how others might experience or be influenced by my garments. I was trying the corsets on for the first time with the electronic components incorporated into them and turned on. Suddenly, the corsets felt like they were alive. I became more aware of them. One participant remarked on this in a previous fitting related to Prototype 2. The kinetic movement of the garment had made her more aware of this garment she was wearing. Clothing is always there, but we are not always aware of it showing that we perceive it to be a part of our bodies. Wearable technology enables us to become more aware of our clothing.

Another key insight was that my own body perceptions tended to influence my design choices. For example, I made the choice to place at least one servo right underneath the left side of the bust because I believed this to be close to the heart. This was not a hard rule I followed as I wanted to maintain an organic embodied approach to the making of the corsets. While I was fitting the corsets, I felt I could feel the “palpitations” of one corset against my body more than the others. Several participants expressed the same sentiment. I realised that this was because the servo in this corset had been placed just above the bust in a happy accident. This position was closer to the heart than the position I had originally assumed. As a woman with breasts, I am used to working around these obstructions on my chest. My instincts were to assume that I would feel my heart underneath my breast. Involving others helped to identify that my own conceptions of my body affect my design choices.

Slowing down and involving others helped shed light on the aspects of my project that worked and those that needed more work. Working too closely to a project for a long period of time, I became numb to some its qualities. I felt I knew too much to engage with the dataset during this fitting. It was hard to assess whether I felt any empathy during the session because I had been biased towards it from the start of this research project. The emotional impact of the corsets was better understood through analysing the experiences of others.

Chapter 6 Closing Thoughts

This research has contributed to the fields of data visualization, fashion design and wearable technology by proposing an alternative design process for designing data-based garments. Informed by this alternative design process, I was able to respond to the main research questions:

How can embodied garments be used as a site for Data Physicalization to enhance empathy?

Garments are not only embodied, but they have material qualities and performative connotations. The embodied, material and performative qualities of garments can be used to experience complex concepts and elicit desired emotional reactions by connecting with our bodies or other bodies.

What role can data-based garments play in the communication of complex information?

Garments live on bodies, making them personal. When the data is about people, garments serve to communicate this information by connecting insights to bodies, humanizing the data. Through garments, we can draw on and make relational comparisons to our experiences as living clothed bodies to understand key concepts.

How can data be mapped onto garments and wearable artifacts, as extensions of the body, and how does this impact our interactions with data? How does this impact our interpretation of data?

The physicality of garments calls for incorporating alternative data encodings that leverage the embodied, material and performative qualities of garments and wearable technology. These alternative encodings engage different body senses which elicit different ways of interacting with data. We are forced to slow down, taking time to feel, touch, smell etc. to understand what is being communicated. The value of such experiences is not in communicating data accurately, but in giving an overall sense of it. As seen in the garment

fittings, this serves to spark enough curiosity in participants to want to learn more about the data.

On making data physical

When I first started this research project, it was hard to conceive what a data physicalization might look like as garment. Through implementing data visualization, research through design and soma design methods, I was able to devise an alternative design process for designing data-based garments. Working with data served to ground my designs in a richer concept that is more relevant to real people rather than relying on what runways and popular culture dictates is to most trendy. By distancing myself from these common fashion design approaches, I was able to create something "new." I had to rely on the key insights from the data to determine what my designs would look like, forcing me to be remain open minded, a very stressful but worthwhile process. Engaging with the stories of real people helped to humanize the data in question. The data helped to give quantifiable explanations of real people's experiences while the stories from these people helped determine the most meaningful insights from the data by making connections to their real experiences.

Going back to more physical practices in garment making revealed aspects of technology that can be stressors. Much of technology is not as intuitive as it could be yet. Design softwares are constantly crashing or taking too long load. Physicality helped remove some of these stressors from my process improving my productivity. I was forced to creating more opportunities to touch, feel and manipulate tools and fabrics helping me realize viable designs for my intended purpose more quickly.

The garment fittings revealed that physicality demands that we slow down to leverage knowledge from the experience of physical objects. Embodied senses require time to feel, touch, listen and explore if we are to gain valuable insight through them. It is important to consider alternative data encodings if we are to leverage the affordances of physical objects.

However, alternative data encodings are challenging to implement as sensorial experiences are complex to understand. Thus, the visual aspects of design remain an important aspect of data-based garments. The largely visual *extensive qualities* of garments help wearers and audiences form an initial impression of a data-based garments which can impact how they perceive and experience them.

On slowing down with soma design

Soma design forces us to rethink the role of technology in design. If technology is to be incorporated into our processes and into the artifact we make, it must work in rhythm with our bodies. Owing to technology and pervasive media, we are accustomed to consuming media and information at a fast pace. We have forgotten that our physical bodies do not work the same way. Our bodies are constantly trying to keep up with technology when technology should be working to meet our needs and improve our well-being. Anything out of sync with our bodies disrupts them.

Through implementing the soma design strategies of this alternative design process, designers can engage in a process of empathizing with the intended wearers of their garments. Slowing down, allows them to experience their garments in the way that others would. When artifacts are designed to live right next to us on our bodies, they become very personal. It is the responsibility of designers to design in rhythm with the bodies that encounter their work. Designers have bodies, and their bodies influence their design choices. Involving others in the design process helps them uncover insights they may have missed because of their own body perceptions and biases.

On tackling complexity

Wearable technology provided unexpected affordances to the conceptualization of data-based garments. Initially, I was anxious that wearable technology would complicate a process

that was already complex even further. However, the opposite turned out to be true. Wearable technology makes us more aware of clothing perhaps because it is not a normal aspect of everyday wear. It can work to draw attention to deeper concepts in garments through augmenting their qualities and steering our attention away from conceptions of contemporary style. The wearable technology in garments created in this research helped to enhance their emotional qualities. One of the biggest challenges with the first prototype was that extensive explanation was needed to help audiences understand the concept behind it. This prototype had no electronic components incorporated into it. The prototypes that were enhanced with electronics tended to require a little less explanation. Thus, wearable technology worked to remove some of the complexity of conceiving and experiencing data-based garments.

Challenges of the alternative design process

A drawback of the alternative design process is that it is very time-consuming and expensive to implement. It is the many iterations that will lead you to a design that best meets your intended goals. Garment design is already very expensive and time consuming. Wearable technology and data further add to these challenges. While not a commercially viable data-based garments can serve as critical design pieces that to help us understand complex data about people.

Future directions/Nextsteps

Data-based garments are still too new and complex to understand. There is a need for more extensive studies to conceptualize how data can be effectively mapped onto garments and to understand how these garments affect interactions and interpretations. Five of the six participants in the garment fitting that were analysed had been through the Canadian study permit application process. It would be beneficial to conduct a study that assesses the emotional impact of the garments on individuals who do not share this experience. Observational studies can shed light on the behavioral impact of data-based garments. This

involves conducting studies that facilitate more natural behavior (unmonitored) to allow for more natural behavior and interactions to be observed from participants. Other research can focus on understanding how those with visual impairments, who rely solely on embodied experiences, might interpret data-based garments.

Future studies can also assess the impact of data-based garments on larger groups through focus groups. An example would be to investigate the concept of collective thought. Groups can reveal the potential impacts that new forms of data representations can have on society and communities. They can help us investigate how people in communities and society can think together, learn from each other, and empathize as they reflect over data that is represented through clothing. Below is an extract of how I would have conducted a focus group should the scope of the research had allowed:

> Two focus groups will take place in an exhibition space, each with a different set of participants. Each focus group will consist of 6 participants. One participant in each focus group will be invited as a Focus Group Garment wearer. They will be asked to wear the garments during the session where needed. A camera will record each discussion and interaction around a garment. Participants are encouraged to engage with the garment, the wearer and other participants in whatever ways feel comfortable. The researcher will make prompts and ask questions, steering conversation and guide the experience. Each focus group will take approximately 90 minutes.

Lastly, and most importantly, future work should strive to build a framework for data-based garments. There are still many possibilities for encoding embodied, material and performative qualities into experiences to add to the body of knowledge for data-based garments. This research represented a very tiny fraction of them.

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Appendices

Appendix 1: Thesis Exhibition

Figure 28: Audience members wearing the corsets and interacting.

Figure 29: Audience members approaching the exhibited corsets and interacting through touch.

Figure 30: Audience members wearing and interacting with the corsets and me.

Figure 31: Polished versions of the Heartbeat Dress and the Rejected on display.

Appendix 2: Garment Fitting Consent Form

Date: _____
Project Title: Bodies of Empathy: A Data Driven Approach to Design
Subtitle: Garment Fitting Participant

Student Investigator:
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Primary Faculty Supervisor:
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Secondary Faculty Supervisor:
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PURPOSE

The purpose of this project is to assess how garments can be used to reveal insights from data, telling stories and educating people. Data/statistics can be too complex for non-experts to understand and therefore, it is necessary to find new and engaging ways to communicate these insights to everyday people. Garments have a close relationship with our bodies and our experiences as clothed bodies has the potential to help us understand complex information more easily.

The garments created in this project express data through:

- the materials and construction methods used.
- engaging multiple body senses such as vision, touch, hearing, movement, balance etc.
- sensing and movement facilitated by wearable electronics, in some cases.

The garment fitting will assess how meaning is understood and interpreted through wearing a garment that is a representation of data. Additionally, the fitting will evaluate the general fit and aesthetics of the garment.

5 participants will be selected. Each participant will attend 1 or more garment fittings. To be eligible to participate, you must:

- Be above the age of 18.
- Be able to fit into a US women's dress size 6 to 12.
- Have the means to visit 205 Richmond Street West.
- Be willing to be photographed and video recorded.

Email invitations will be sent out to potential participants by the researcher. Participants who respond to the email invitation within 48 hours and meet eligibility requirements will be selected for the study.

The results will contribute to my senior thesis project.

WHAT'S INVOLVED

As a participant, you will be asked to try on a garment which may or may not be fitted with wearable electronics. The fitting will take place in a private room at 205 Richmond Street West. You will be given privacy to change in this room, and you may ask for assistance where necessary. A camera will be set up and will begin recording when you are comfortable. You are encouraged to engage with the garment in whatever way feels comfortable. You will be asked questions relating to the fit of the garment and your impressions of the garment and experience itself. Some photographs will be taken during the fitting. Once completed, the camera will stop recording and you will be given privacy to change back into your own garments. Participation will take approximately 15 minutes of your time for each garment.

Your visual data will be collected in this process. Video recording and image capture is essential to the research as it helps to capture non-verbal cues, such as body language.

POTENTIAL BENEFITS

Possible benefits of participation include:

- The opportunity to contribute to community knowledge.
- The opportunity to guide future research activities.
- The opportunity to contribute to your own knowledge.
- The ability to influence and inform future research in data experiences, garment design, embodiment, performance, materiality and technology.

It is possible that you will not experience any or all of the potential benefits or risks listed above.

POTENTIAL RISKS

There also may be low risks associated with participation:

- The garment fitting focuses on the body/body awareness which may trigger body anxieties.
- Engaging in the subject matter can trigger hard or personal memories. You are reminded that you can share as much or as little as you would like with the researcher.
- You may experience minor discomfort related to materials and components used to construct the garment. You are free to remove the garment or terminate the fitting whenever you wish.

- Some very light motion may be required while engaging with the garment. How much you engage with the garment is entirely up to you.
- The fittings will make use of cameras to record and capture moments, which may pose a risk to your privacy.
- You may experience pressure to participate due to academic, personal or professional relationships with the researchers. Please be assured that participating or declining participation in the research will not impact these relationships.

CONFIDENTIALITY

Please be aware complete confidentiality is highly unlikely due to the nature of the research activities. This project collects two different types of data: content data generated by the research activities described above which will not be fully confidential, and raw data that will be kept strictly confidential. Raw data includes personal information and contact details obtained through the recruitment process. Content data will be used mainly for educational purposes, however, select footage and images will be chosen for publication. Participants have the right to review this content and to decide the extent to which their content will be published. Before the research is published, a link will be sent to participants containing all materials for their approval.

No real names will be used in published work unless participants wish to be attributed. Options for anonymity are as follows:

- Participants can choose to not appear in published visual documentation.
- Participants can choose to blur their faces or modulate their voices in any published visual documentation.
- Participants can choose to be attributed in any published visual documentation.

I, Mufaro Mukoki, will keep all raw data and content (videos, images, notes, transcriptions etc.) generated through this fitting in my Ocad U One Drive account which I will access only through my password protected computer. I will be solely responsible for editing and analyzing all data collected. I may seek the opinions of my research advisory team, Isabel Meirelles (Primary Advisor) and Kate Hartman (Secondary Advisor), as their expertise will help guide my process.

Raw data and content data used for educational purposes will be kept for 1 year, after which time all the data will be deleted.

Access to this data will be restricted to myself, Mufaro Mukoki.

INCENTIVES FOR PARTICIPATION

Participants will not be paid to participate in this study.

ATTRIBUTING WORK

If you consent to participate in this study, you can choose whether your name will appear alongside images/videos of you should they be published. Should your images/videos be

selected for use in other contexts, you will be contacted via email prior to publication with examples of usage.

VOLUNTARY PARTICIPATION

Participation in this study is voluntary. If you wish, you may decline to answer any questions or participate in any component of the study.

Further, you may decide to withdraw from this study at any time, or request withdrawal of your data prior to data analysis and you may do so without any penalty or loss of benefits to which you are entitled. Your choice of whether or not to participate will not influence your future relations with OCAD University or the investigators, Isabel Meirelles, Kate Hartman and Mufaro Mukoki, involved in the research.

To withdraw from this study, you may contact Mufaro Mukoki by email at mmukoki@ocadu.ca.

To withdraw your data from the study, please contact Mufaro Mukoki by email at mmukoki@ocadu.ca no later than 15 March 2024. Any of your data that will have been collected at this point will be deleted. This includes images or video moments in which your visual data is present.

PUBLICATION OF RESULTS

Results of this study may be published in student theses, and/or presentations to conferences and colloquia. Non-confidential data will also be shared for online project documentation, as well as to participants, and the larger community. In any publication, data will be presented in aggregate forms. Quotations, images or footage will not be attributed to you without your permission.

CONTACT INFORMATION AND ETHICS CLEARANCE

If you have any questions about this study or require further information, please ask. If you have questions later about the research, you may contact the Student Investigator, Mufaro Mukoki or the Faculty Supervisors, Isabel Meirelles or Kate Hartman, using the contact information provided above. This study has been reviewed and received ethics clearance through the Research Ethics Board at OCAD University [2023-85].

If you have questions regarding your rights as a participant in this study, please contact:
Research Ethics Board c/o Office of the Vice President, Research and Innovation
OCAD University
100 McCaul Street
Toronto, M5T1W1
416 977 6000 x4368
research@ocadu.ca

AGREEMENT

I agree to participate in this study described above. I have made this decision based on the information I have read in the Information-Consent Letter. 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 I may withdraw this consent at any time.

General Participation

Yes, I consent to participation in this study. I understand that some of the results and documentation (including photos, videos etc.) will not be confidential and may be published in student theses, presentations to conferences and colloquia, online project documentation, participants, and the larger community.

No, I do not wish to participate in this study.

Images and videos of You

Yes, I consent to appear in published videos and photos.

Yes, I consent to appear in published videos and photos provided my face is blurred.

Yes, I consent to appear in published videos and photos provided my face is blurred and my voice modulated.

No, I do not consent to appear in published videos and photos.

Attribution

Yes, I wish to receive attribution for my contributions. You may use my name as listed below alongside images and videos of me.

No, I do not wish for my name to be used in images or videos generated by my participation in this study.

With your agreement, I would like to contact you again for another fitting. You may decide at that time whether you wish to participate in that part of the study.

Yes, you may contact me.

No, I do not wish to be contacted.

Name:

Signature: Date:

Thank you for your assistance in this project. Please keep a copy of this form for your records.

Appendix 3: Garment Fitting Invitation

Date:

Dear

You are invited to participate in a research study for Bodies of Empathy: A Data Driven Approach to Design. The purpose of this study is to assess how garments can be used to reveal insights from data, telling stories and educating people.

As a participant, you will be asked to fit a garment that is a representation of data and express your thoughts and impressions of the experience. The garment may or may not be fitted with wearable electronics. This session will be recorded.

Participation will take approximately 15 minutes of your time.

Possible benefits of participation include:

- The opportunity to contribute to community knowledge.
- The opportunity to guide future research activities.
- The opportunity to contribute to your own knowledge.
- The ability to influence and inform future research in data experiences, garment design, embodiment, performance, materiality and technology.

It is possible that you will not experience any or all of the potential benefits or risks listed above.

There also may be risks associated with participation:

- The garment fitting focuses on the body/body awareness which may trigger body anxieties.
- Engaging in the subject matter can trigger hard or personal memories. You are reminded that you can share as much or as little as you would like with the researcher.
- You may experience minor discomfort related to materials and components used to construct the garment. You are free to remove the garment or terminate the fitting whenever you wish.
- Some very light motion may be required while engaging with the garment. How much you engage with the garment is entirely up to you.
- The fittings will make use of cameras to record and capture moments, which may pose a risk to your privacy.
- You may experience pressure to participate due to academic, personal or professional relationships with the researchers. Please be assured that participating or declining participation in the research will not impact these relationships.

Kindly reply to this email by attaching the signed consent form by

If you have any questions about this study or require further information, please contact the Student Investigator Mufaro Mukoki or the Faculty Supervisor Isabel Meirelles using the contact information provided above. This study has been reviewed and received ethics clearance through the Research Ethics Board at OCAD University (#102482). If you have any comments or concerns, please contact the Research Ethics Office through research@ocadu.ca.

Appendix 4: Garment Fitting Prompts

Inform the participant that the camera will start recording.

1. How does it feel wearing the garment?
2. How would you describe your level of comfort wearing the garment?
3. How does the material and color make you feel? What do you think of the shape of the garment?
4. How are you prompted to act, move and interact with the garments?
5. How does the kinetic movement of the garment make you feel? How do you feel about the garment sensing/garment movement qualities of the garment? (if applicable)
6. In what ways has wearing the data influenced your understanding of African Immigrant experiences?
7. What would have helped you understand the story/dataset more?
8. How do you feel about the overall experience?

Inform the participant that the camera will stop recording.

Appendix 5: Transcript Sample

Okay, you can face this way. I think he says this is supposed to be intuitive, even good at all. No, not really, but I would be terribly true on that. Okay. So, how does it feel wearing a garment? It is the first time I am interacting with one of your pieces because of carefully install. Which is good. Which is actually, it's completely new for me so I think it’s interesting. And I'm curious to know more as to how the data is coming through and how you talk about it, like, I have an idea, but not, as to how it is developed. So I'm very curious about that, to see how that's translated. Okay, so just to give you some background, this piece is supposed to represent acceptance rates for study departments here in Canada. So each of the pieces is basically actually the rejection rate. So the bigger the piece, the more the rejection. The smaller the piece, the less the rejection. And I'm also trying to map like, because I want them to look like little hearts. So I'm trying to match the rhythm to the level of rejection as well. So like, this is supposed to be the fastest of them because it's like a higher rejection rate, resentment or whatever and others are supposed to be slower as well. So trying to make that into like that embodied experience. That was my first impression when I saw them on the tables and how it looks like flesh and I was like, okay it looks like, it does look like an organ, like the heartbeat, because it looks like it's living and breathing and nothing. And I definitely felt like this one was going too fast, so I was like, that was making me feel a little anxious. The other one was more calm, so I wanted to like touch it and see I wanted to see how its moving... And this one probably because of the sound and probably the size of it, it was a little intimidating.well. Okay. Interesting. Interesting. How would you describe your level of comfort? You've mentioned anxiety with this one. Yeah, I think if I had to wear this for a

long long time there would be some syncing happening with my heartbeat and
The sensors and servo motors and the other things in there.
I don’t know if I would be comfortable with that. Because, like, just as this, they were
okay to look at it but I don’t know how I would feel if I had to wear this for a long
long time with the motion and the sound. okay interesting how does the material feel like both
the one
that you're wearing the bigger one and the smaller one I was more curious to interact
with this one more because this feels more of just like a layer (corset vs shirt) yeah it
feels like a layer before Interesting.How were you prompted to act, move, or interact? Which
you can be moving however
you feel like you want during the course of this as well. I was curious to see
what's happening with the fabric itself and also that my hands aren't . I don’t know.
Maybe because I know this is a piece of technology so I don’t move that much.
I know Im cautious. Maybe it is just my bias.Knowing how difficult it is to get them
to work. So maybe, I am being cautious right now Interesting, okay. Cool.
We don't have kinetic
movement. How do you feel? You mentioned you got anxious about the movements, is
there anything else you can say about the sensing and actuating aspect of the
Garment? The first thing I wanted to do was to at least touch and feel and
understand the motion because it's again not something that's very
obvious, It's very organic, it's hidden, so I'm trying to feel the surfaces to see
what is happening, and all of that. Yeah, because I feel like
I was more of comfortable interacting with the small one because, again, the motion and the
sound, yeah, this one was a little scary. Interesting.
In what ways has wearing the

data influenced your understanding of what the data is? Has it knowing what I told you, has wearing it enhanced your understanding of it? Just because of what is currently happening right now; there are a lot of issues happening with Canada and India and I know there are a lot of study permit rejections this year. I know there are a lot of students who are aspiring to come here for a better life or start something on their own. And the number has gone down drastically. So people who do come from smaller places look forward to this. This is their escape for life. This is what they've been dreaming of. So I think wearing this piece, it's like you can feel the pain in your heart. It's so close to you. You can sort of understand what we'll be going through. The struggle is real. Some of us are really lucky but there are a lot of people who sacrifice a lot of things to do that so they can support their family in hopes for a better life. I don't know if it's fair

that they don't have the opportunity or they don't have the infrastructure and resources to do that. Yeah. Yeah. Just because of all of that, I could sort of engage with this piece even more, and I can sort of understand and feel it a little better. Okay.

Cool. Interesting. How do you feel about the overall experience? It's quite exciting because, as I said, I did the first time I've seen great pieces of action, I wasn't around for the once. I'm actually curious to see them. And it's a very different experience because as a spatial designer, my design space is and things to do in this space and I've never used the body as a space. It's the thing, it's the space. If the body is never the space, you do stuff around the space you interact with things, you interact with other bodies around all of that is there. This is really personal because you are using your body as the medium for experience. Do you think this, me interviewing you, it's not supposed to be like an interview,

it's supposed to be, I actually didn't want to talk to you as much, which would you have preferred me? ask a new person, or should I just have let you just do whatever, really, okay. Reaching whether I have any type of purpose, but not really sure what specific aspects of the data I'm talking about, or what specific issues. But I think once you do that, it creates more sense, and without knowing that, I think that makes more sense. Yes, okay, okay, okay, thank you, thank you.

Appendix 6: Garment Fitting Coded Analysis

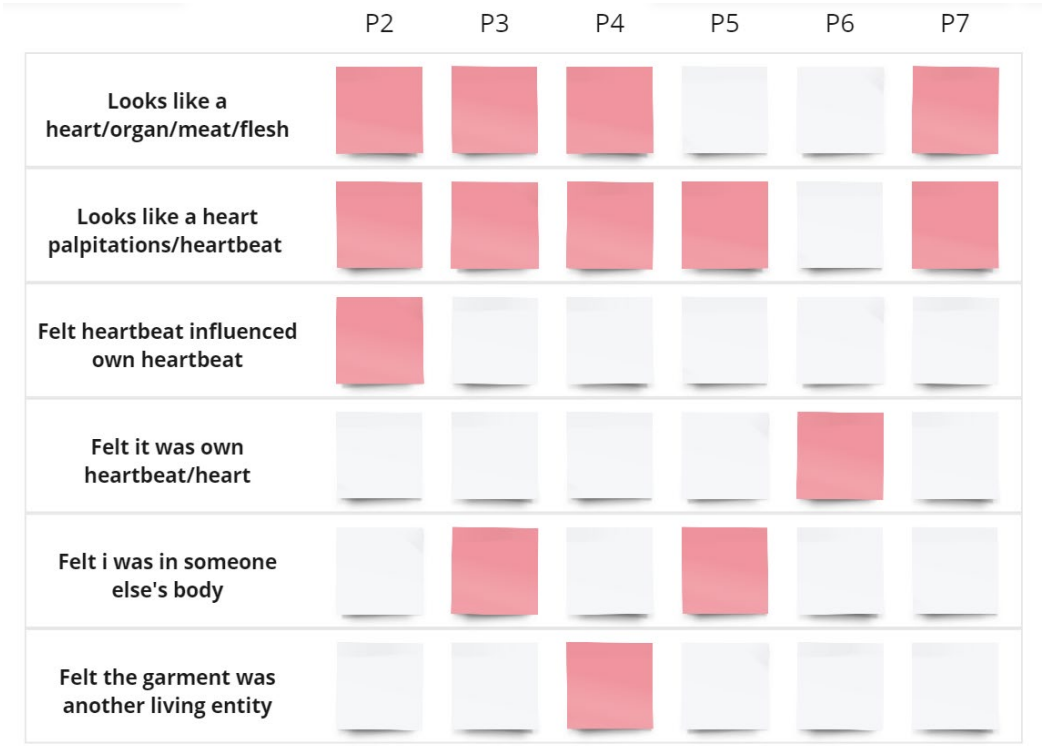

Figure 32: Garment fitting data analysis 1 (Author's image).

Figure 33: Garment fitting data analysis 2 (Author's image).

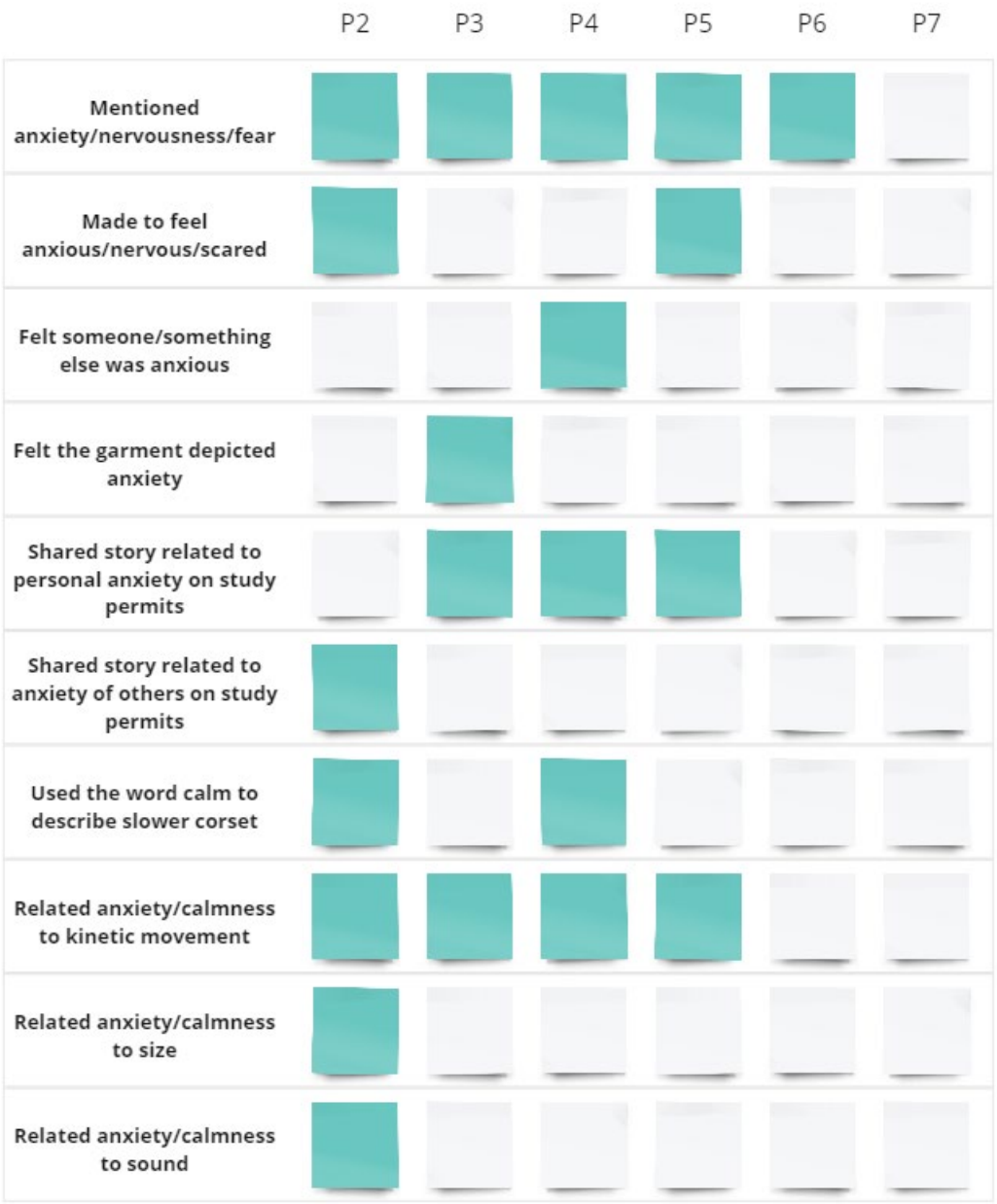

Figure 34: Garment fitting data analysis 3 (Author's image).

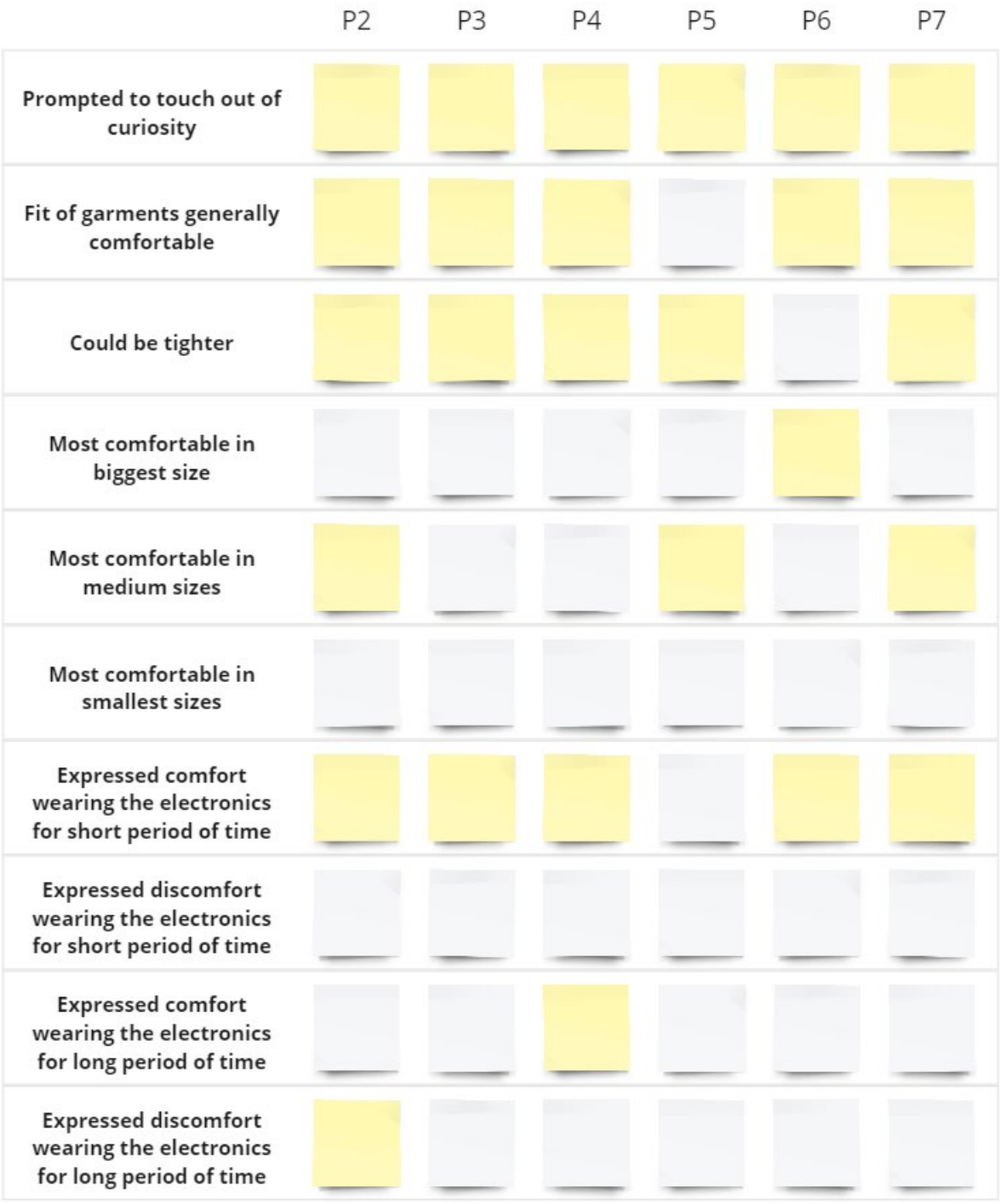

Figure 35: Garment fitting data analysis 4 (Author's image).

Transcript keyword generation steps:

1. Chat GBT Prompt: Extract keywords from this text. Include emotion only. Organize according to the number of occurrences.
2. Compile list of words.
3. Select word relating to emotions.

Anxiety: 16
Feel: 7
Curiosity: 4
Comfort/Comfortable: 4
Movement: 4
Care: 4
Appreciation: 4
Anxious: 3
Engage/Engaging: 2
Fair: 2
Sacrifice: 2
Exciting/Excitement: 2
Restrictive: 1
Rigorous: 1
Depicting: 1
Feedback: 1
Empathize: 1
Overwhelming: 1
Fear: 1
Embarrassment: 1
Surprise: 1
Fragility: 1
Alive: 1
Responsible: 1
Nervous: 1
Maternal: 1
Paternal: 1
Worthy: 1
Reassure: 1
Deepen: 1
Gentleness: 1
Consent: 1
Anthropomorphize: 2
Promising: 1
Disturb: 1
Natural: 1
Useful: 1
Organic: 1
Nice: 1
Resentment: 1
Militant: 1
Animalistic: 1
Fascinating: 1
Concern: 1
Satisfaction: 1
Contentment: 1
Fascination: 1
Apprehension: 1
Relief: 1
Intrigue: 1
Interest: 1
Confusion: 2
Amusement: 1
Openness: 1
Puzzlement: 1
Frustration: 1
Discomfort: 1
Skepticism: 1
Analytical: 1
Anticipation: 1
Indecision: 1
Reluctance: 1
Inquisitiveness: 1
Clarity-seeking: 1
Impatience: 1
Ambivalence: 1
Abstractedness: 1
Reflection: 1