Accessible Gaming Wearables: Opportunities for Players with Upper Limb Motor Disabilities

by

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Abstract

There has been increased interest in how wearables can offer new avenues of interaction in video games. However, understanding how wearable devices can support accessible gaming is missing. My research aims to explore this potential with users with upper limb motor disabilities to understand their experiences with video games and wearable devices. My thesis is divided into two parts. Firstly, I interviewed gamers with upper limb motor disabilities to understand their lived experiences in playing video games and using wearable technology. Secondly, I explored the design space of accessible gaming wearables using participatory design fiction sessions to envision the future of wearable technology and accessible video games. My study also offers methodological contributions to the HCI community by demonstrating how dialogic/performance analysis can be applied to participatory design fiction research. Though narrative inquiry is often used in HCI, specifically using the method of dialogic/performance analysis to analyze narrative inquiry data is less often used. This research provides a detailed example of how this analysis method can be utilized in HCI research.
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Lastly, I want to thank my study participants whom I could not have done this project without! I am grateful for the time and effort they took to teach me about gaming accessibility, and the insights they willingly shared with me. I hope that in advocating for video game accessibility through research I am able to give back to the disability community as much as they have given to me through the knowledge and experiences shared by my participants.
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Chapter 1.

Introduction

1.1. Overview of Problem Space

The Entertainment Software Association reports that 53% of Canadians play video games regularly [1]. Video games have many benefits, including positive creative, emotional, and social benefits for players [2]. There has been extensive innovation in accessible designs for in-game content and adaptive controllers. For instance, the XBox Adaptive Controller [3] and the newly announced Playstation Project Leonardo [4] make it easier for people with motor and cognitive disabilities to play video games. The XBox Adaptive Controller is unique because it can connect accessories through its 19 jacks and 2 USB ports on the wireless controller [3]. This makes the controller ideal for creating a customized controller for people of many abilities.

Though devices such as the Xbox Adaptive controller and Sony’s Project Leonardo are excellent, they still only scratch the surface of addressing the needs of gamers with disabilities. Therefore, we, the lead researcher (Georgia Loewen) and the supervisory research team, wanted to explore further video game hardware accessibility specifi-
cally for the user group with upper limb motor disabilities. We aim to better design
game interaction for users with limited fine and gross motor skills, tremors, sensory
deficits, chronic pain, fatigue, and other factors [5], which make it more difficult to
play video games than their able-bodied counterparts.

Though there is extensive research on the use of wearable technology for people with
disabilities [6–11] and wearable technology for games for rehabilitation [10, 12–16],
limited research has explored the potential of accessible wearable accessories and
controllers for entertainment-focused video games. This study aims to understand
the lived experience of gamers with upper limb mobility disabilities and the future
potential of wearable technology to support their hobby.

1.2. Research Questions

This thesis explores the following research questions:

RQ 1. What design guidelines for an accessible gaming wearable can be formulated
that capture the needs of players with upper limb motor disabilities?

RQ 2. How can a design fiction archetype be used to represent the future of accessible
gaming wearables?

RQ 3. How can personas as a research activity be used to understand our user group
of individuals with upper limb motor disabilities to inform future designs of
accessible gaming wearables?

To answer our research questions, we conducted a two-phase study. The first phase
explores the user base of gamers with upper limb motor disabilities to understand their
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experiences playing video games and their needs in wearable technology. This phase of the study utilized the phenomenological method of semi-structured interviews. Eleven participants with upper limb motor disabilities were interviewed. These interview sessions focused on understanding participants’ needs for gaming interaction and experiences using wearable technology. The first phase was analyzed with reflexive thematic analysis [17].

Through the first phase, we were able to discover possible technologies, but participants were unable to give the nuances needed to build and design a gaming wearable or visualize how it could be used in practical gaming applications. We wanted more nuanced information on the experience of using a gaming wearable while playing video games, so we applied participatory design and design fiction to explore this experience with four participants. Design fiction is a design method that uses diegetic prototypes to visualize future technologies and understand the implications those technologies have on everyday life [18]. We combined this method with participatory design, allowing participants to collectively create narratives on fictional characters, fostering an inclusive and open dialogue without the fear of discrimination. Design fiction has been successfully used with different marginalized groups to elicit stories of lived experiences [19–22]. In these instances, using design fiction allowed the research on marginalized groups to focus on their ideal futures and how technology can support them. This directly applies to our study on the ideal gaming experience for users with upper limb motor disabilities and how wearable technology could support that gaming experience.

We engaged with four individuals with upper limb motor disabilities in a pair of
Chapter 1. Introduction

participatory design fiction workshops. During these sessions, the participants collaborated to develop a design fiction archetype representing an accessible gaming wearable device. The second phase was analyzed using the narrative inquiry method of dialogic/performance analysis, which is novel in its application to participatory design fiction HCI research. Dialogic/performance analysis focuses on participants’ lived experiences as they arise through conversations between participants, and participants and researcher [23]. These narratives are restoried and retold through a framework [24], which provides the bounds through which the narratives can relate to each other. Dialogic/performance analysis is best used for conversation-based research [23], which makes it a natural fit with participatory design fiction research.

1.3. Contributions

We provide three main contributions through the research we conducted:

1. We present a methodological contribution by showing the application of dialogic/performance analysis to HCI research. Though narrative inquiry is often used in HCI research, the specific use of the method of dialogic/performance analysis to analyze narrative inquiry data is not widely used. In this study, we present a detailed account of how we applied dialogic/performance analysis to our research on gaming wearable accessibility to provide future HCI researchers with an example of how to use this analysis method in their research.

2. We present an innovation and creative design fiction archetype which shows how wearable interaction could be used by users with upper limb motor disabilities
In the future. We utilized design fiction and participatory design with users with upper limb motor disabilities to envision the implications that wearable interaction could have for them in playing video games. The final archetype is represented through a tech review YouTube video. In this video, we present both the positive usability implications of gaming wearables for users with upper limb motor disabilities and the negative repercussions of fully realizing and exploring this interaction modality.

3. Lastly, we present a contribution to understanding the needs of the user base of players with upper limb motor disabilities as it applies to wearable gaming interaction. Substantial research has been done on understanding the needs of the gamer user group for creating video game wearable interaction [25–27], however, this level of exploration has yet to be done for the user group of gamers with upper limb motor disabilities. The needs of disabled gamers differ significantly from the needs of able-bodied users. Therefore, we find it valuable to understand the user group of gamers with upper limb motor disabilities and formulate an understanding of how to design accessible wearable gaming interactions based on their needs.

1.4. Thesis Outline

This thesis is comprised of eight chapters. This initial chapter overviews the problem space and the research questions being addressed. The second chapter provides a literary review of existing research on accessible gaming, gaming wearables, accessible
Chapter 1. Introduction

wearables, design fiction and participatory design research in HCI, and narrative inquiry and its use in HCI research. The third chapter provides an overview of the methodology for the study’s first phase, and the fourth chapter delves into the study’s results. Similarly, the fifth chapter provides an overview of the methodology for the study’s second phase, and the sixth chapter provides the results. The seventh chapter discusses the implications of the findings from each study phase, and discusses insights into the limitations of this project and possible future work in the area of accessible gaming wearables. Lastly, the eighth chapter concludes by revisiting the research questions and concluding the thesis.
Chapter 2.

Related Works

In this section, we will introduce definitions for concepts related to the content of the study as well as overviews of different areas of related works which establish the research gap that this study aims to address. Upper limb motor disability concepts are defined and discussed alongside recent research in HCI, which pertains to motor disabilities. A definition of wearables, as well as an exploration of the current research on wearables and accessibility for users with upper limb motor disabilities. An overview of video game accessibility and significant design developments for players with disabilities is discussed, and we review studies on wearables and creative interaction for video games. Next, we define and discuss participatory design and design fiction and how they are applied in HCI research. Lastly, we end with defining narrative inquiry and identify how this methodology is applied in HCI research.
Chapter 2. Related Works

2.1. Upper Limb Motor Disabilities

Motor disabilities that affect the upper body are diverse and can interfere with one’s sensations, movement, and coordination [28]. It includes both neurological conditions (such as cerebral palsy) [29], or amputated, and congenital limb anomalies [30]. These disabilities can specifically affect fine motor skills, which require “precise, voluntary, and coordinated movements with their hands” [31]. Our user group represents upper limb motor disabilities through conditions including Parkinson’s, cerebral palsy, hypermobile type Ehlers-Danlos syndrome (hEDS), limb differences, tremors, difficulty with fine motor movement, muscle weakness, and nerve damage in the hands and fingers. hEDS can cause joint pain, instability, hypermobility, and fatigue in the upper limbs [32]. Parkinson’s disease can cause tremors, lowered coordination, and muscle stiffness [33]. Cerebral palsy is a group of disorders that can affect the upper limbs through muscle weakness and coordination limitations, muscle spasms, and reduced range of motion [34]. Though diverse, our participant group represents only a small portion of the full spectrum of disabilities that affect the upper limbs.

We must directly involve individuals with upper limb motor disabilities throughout our study. In disability studies, a key value is the concept of ”nothing about us without us” [35]. This concept describes how research on disability should not be pursued without individuals with disabilities being directly involved in the research [35]. We incorporated this concept into our study by having participants with upper limb motor disabilities directly involved in both phases of the research and by keeping participants updated on the results between phases.

To increase the independence of people with upper limb motor disabilities, HCI
Chapter 2. Related Works

researchers have developed various projects which support the user's independence, such as social interaction supported through eye-gaze-controlled telepresence robots [36, 37] and improving the use of keyboards [38–42]. In terms of interaction methods, a significant amount of recent research focuses on utilizing eye-tracking technology [36–39, 43–45]. In addition to eye-tracking devices, individuals with upper limb motor disabilities may use other assistive devices for computer interaction. These include sip-and-puff devices, accessible switches, footpedals, soft switches, and joysticks [46]. These devices are widely used and have drastically increased accessible human-computer interaction, however our goal is to explore further computer interaction accessibility through bodily-worn wearable devices.

2.2. Video Game Accessibility

Along with integrating accessibility standards into the gameplay and user interfaces in video games (for example, XBox’s Accessibility Guidelines [47]), researchers and game developers are beginning to develop physical devices to support disabled players. Recently accessible controllers such as the Xbox adaptive game controller [3] (see Fig. 2.1) and the Logitech adaptive gaming kit [48] (see Fig. 2.2) showcase that developers are beginning to think about how to support the disabled gaming community better. Sony just announced Project Leonardo, which is the new accessible PlayStation controller [4]. The focus on accessible gaming controllers is a significant step in controller design. However, the presented solutions, though intended to eliminate barriers, often create new barriers. For example, the Xbox Adaptive controller has been criticized for not providing independent video gameplay to disabled users.
Chapter 2. Related Works

Figure 2.1.: Xbox Adaptive Controller.

as much as it advertises itself to [49].

Additionally, the Xbox Adaptive setup is cumbersome with all the alternative buttons and switches needed, and the options for compatible buttons, switches, and joysticks is still minimal [49]. Lastly, the Xbox Adaptive and devices like it only represent one interaction alternative for players with disabilities and innovation in accessible interaction is stalled [49]. Though these projects are significant, responses to these developments from the larger gaming community see them as the final answer to gaming accessibility [50]. In reality, these developments serve as the introduction to addressing accessibility needs in gaming.

Further understanding of the user demographic of gamers with disabilities can be found in the literature by Porter and Kientz [51] and Wentzel et al. [46], with the latter study focusing specifically on gamers with limited mobility and physical disabilities. A core barrier to access for gamers with disabilities is the incompatibility between video
Chapter 2. Related Works

Figure 2.2.: Logitech Adaptive gaming kit, which features accessible switches.
game interaction hardware and the user’s assistive technology [51]. This is similarly reflected by Wentzel et al. [46] in establishing that gamers with limited mobility were primarily tasked with configuring accessible interaction methods by themselves, whether that be through hardware methods or through changing how they use gaming hardware, partially due to lack of compatibility with assistive technology [46]. Devices like the Xbox Adaptive or the upcoming Project Leonardo, which allow users to connect their adaptive switches and similar assistive devices easily, are valuable in addressing this issue. However, they should not be treated as the only solution. Further exploration into how gaming hardware can be made more accessible for the player base with upper limb physical disabilities is needed.

In terms of research directed at designing accessible interactions for users with upper limb motor disabilities, many studies propose novel devices. These include hands-free based devices that utilize eye-gaze [52–54], voice control [53,54], or biosignal-based interaction [55, 56]. Other studies include touch-based interaction for accessible gaming [57], as well as utilizing accessible switches [58], and one study that did utilize a wearable interaction [59]. However, this device was specifically designed for users missing upper limbs for use in esports. Research in this area also looks at how to adapt existing video game interaction methods to make them more accessible [60,61]. On the industry end, organizations like AbleGamers and SpecialEffect aim to both advocate for players with disabilities as well as help facilitate the creation of accessible interactive devices for users on an individual basis. These types of adaptations and customization of devices are valuable to solving interactions on an individual or specific case study basis, however, it is not feasible to solve video game accessibility
on this level of individual cases. Additionally, not every user may have access to acquiring custom devices. Moreover, players with disabilities may change their interaction needs over time or even during a gaming session. Therefore, it is valuable to look beyond these custom solutions to solutions that work for a wider number of upper limb motor disability experiences and game contexts.

### 2.3. Accessible Wearables in Human-Computer Interaction

Though there is a debate about categorizing wearable computing, this thesis defines it as an interactive device worn and not carried [62]. Wearables offer a unique platform for creative interaction methods that integrate the body with technology—this can be observed in how smartwatches and fitness integrate heart rates into interactions or how virtual and augmented reality systems utilize body movements for interaction. Studies focused on wearable interaction and accessibility with users with physical disabilities show that this demographic has a different lived bodily experience compared to individuals without disabilities, which leads to a different experience when using wearable technology [7, 10, 11]. These bodily experiences can affect movement-based interaction typically used with wearable technology, and research on wearables and users with physical disabilities illustrates the different interaction adaptation methods used to circumvent experienced interaction barriers.

It is also worth noting that recent research on accessible wearables for users with motor disabilities are seen as disproportionately directed towards exploring their use
Chapter 2. Related Works

in the context of rehabilitation or therapy [6, 63–66]. While rehab, exercise, and therapy are all valuable for individuals with disabilities, so are leisure activities and hobbies. Such contexts should be met with as extensive research as a rehab context. Even in video game contexts, researchers preliminary focused on designing games for rehabilitation [67, 68] and serious games [69]. This work aims to address this gap by exploring the use of wearables and lived experiences of gamers with upper limb motor disabilities through the hobby of gaming.

2.4. Wearables and Creative Interactions for Video Games

Wearable interaction offers the advantage of opportunities for creative and engaging interaction. This aspect is especially beneficial for gaming interaction where increased immersion, engagement, and embodiment of characters are valuable [25–27]. However, commercially available gaming wearables are limited in their meaningful interaction. Exploration into how gaming wearables can be designed to be more playful [26] and innovative [25, 27], and how costume aspects [70] and customization aspects [71] can further the creativity of wearables have been extensively explored. These studies establish what non-disabled users desire in wearable interaction: customization, playfulness, sociality, and performance. However, the inclusion of accessibility is lacking. As discussed earlier, individuals with disabilities have a different lived experience with wearable technology [7–9, 11, 72, 73]. Our study focuses on players with upper limb motor disabilities and their experience with wearable technology. Specifically,
we are interested in better understanding the lived experience of disabled participants through current and future technologies. We use interviews and participatory design fiction to understand their current experiences and the potential of future accessible technologies.

2.5. Participatory Design Fiction

Design fiction is a design method which combines research, storytelling, and design speculation to create diegetic prototypes of objects that do not exist, but could feasibly exist in the future [18]. The diegetic prototypes (archetypes) that arise from design fiction are artefacts representative of the future world where the fictitious designs explored in design fiction exist [?]. As Bleecker et al. describe in the Manual of Design Fiction [18], design fiction is a highly collaborative design method that thrives on the input and perspective from multiple perspectives to contribute to design research. Design fiction and a similar method of future design speculation, speculative design, have been found to have particularly successful applications in bringing marginalized groups into design research and providing space and opportunity for these groups to design their ideal futures [22]. Marginalized groups design fiction and speculative design have included the black community [19, 20], the trans community [21], and the queer community [22]. Our study aims to extend this method to include the disabled community and envision how this marginalized community envisions the future of gaming wearables.

A common way to develop dietetic prototypes alongside design fiction is to use participatory design [74]. The participatory design strives to incorporate users into
the design process and focuses on areas of conflicts or barriers [75]. Unlike design fiction, participatory design requires the participation of not just any stakeholders but the would-be users of the design [75].

Combining design fiction and participatory design methods has become increasingly popular in HCI research, including in wearables research [76], intimate artefacts [77], and UTI treatments [78]. Nagele et al. [78] particularly identify the value of using participatory design fiction methods with vulnerable users by better representing and valuing the opinions and experiences of individuals whose experiences lie outside of the societal “norm.” As individuals with disabilities are vulnerable users, Nägele et al. identify that designers must “consider disability as a source of valuable perspectives that needs to be extensively explored to relate to the phenomenon and from which to design—not only for the disabled individual but for everyone.” [78]. Here, Nägele et al. [78] identify that designing with the express input of individuals with disabilities not only benefits the disabled community but could also have beneficial design ramifications for other users as well. This is precisely the perspective we use to explore accessibility and gaming wearables and what we found to lack in other gaming wearable research. To further highlight the experiences and opinions of players with upper limb motor disabilities, the participatory design method was chosen for the follow-up study to explore the design space of accessible gaming wearables. Participants were involved in the participatory design process at the collaborative level through generative reflection. Generative reflection, as described by Farias et al. is when participants provide reflection and feedback on the speculative designs and this feedback is applied to the design [74].
Chapter 2. Related Works

Participatory design and design fiction research are often used in HCI research and narrative inquiry. Participatory design has been used with narrative inquiry to explore creating narratives in video games [79], designing e-textiles [80], studying under-resourced communities [81], social media privacy [82], studying stigma [83], and individuals who have had strokes [84]. Design fiction has been used with narrative inquiry to explore sustainable strategies for communities [85], soft sensors in artistic research [86], and exploring silly design fiction [87]. We further apply narrative inquiry to our participatory design fiction research and outline narrative inquiry and its application in HCI research in the following sections.

2.6. Narrative Inquiry

Narrative inquiry is a method of qualitative data analysis originating in the humanities [88]. This method focuses on participants’ lived experiences through stories about their lives [23]. This methodology is highly collaborative between participants and researchers since the stories told by participants are re-framed and retold by the researchers, thus combining “views from the participant’s life with those of the researcher’s life in a collaborative narrative” [88]. The bounds through which the participant’s narratives are retold depend on the framework chosen to view the stories through [89]. The process of retelling the participant narratives through the bounds of the chosen framework is called restorying [24]. Clandinin and Connelly identify the three-dimensional narrative inquiry space (inward and outward, backward and forward, and situated in place) as one possible narrative inquiry framework [89]; however other frameworks that fit the goal of the research can be used, or researchers
can choose to create their own framework. This framework helps to identify key elements of the narratives told by participants [24] and further allows them to be placed into the context of the research.

It is helpful to see how Riessman [23] identifies different narrative inquiry analysis types in defining how narrative inquiry is used in HCI research. Riessman identifies thematic narrative analysis, which focuses on the content of the narratives; structural analysis, which focuses on how narratives are told; visual analysis, which focuses on the visual aspects (gesture, body language, etc.) are expressed; and lastly, dialogic/performative analysis which combines elements of thematic and structural analysis [23].

Dialogic/performative analysis specifically looks at how “talk among speakers is interactively (dialogically) produced and performed as narrative” [23]. This aspect makes dialogic/performative analysis a natural fit for participatory research and explains why it is specifically applied to our participatory design fiction research as an exercise in proof of concept. The conversational and collaborative nature of participatory design research aligns with the dialogic/performative analysis theory that conversation between speakers (or, in participatory design, participants) creates narratives between speakers. This means that even if the content of the participatory design activities is not directly asking for narrative stories from participants, these narratives will naturally arise through conversation.
Chapter 2. Related Works

2.7. Narrative Inquiry in HCI Research

Narrative inquiry is gaining popularity in HCI participatory design and design fiction research. In HCI co-design and participatory design research, narrative inquiry has been used on research exploring stories of social stigma [83], online privacy conflicts [82], stroke patients [84], lived experiences of under-resourced communities [81], knee replacement surgery patients [80], and player experience in video games [79]. In these cases, the narrative inquiry methods used with thematic analysis [79, 82, 83], visual analysis [84], affinity mapping [80], or co-analysis [81]. In speculative and design fiction research, narrative inquiry is still sparsely used; however, dialogic/performative analysis is rarely represented where it is used. The few papers that did refer to this type of analysis [85, 90] lacked valuable details such as the framework used. As narrative inquiry is not as common in HCI as other qualitative methodologies, they often requires more detail so others can use similar research processes. However, we found that the paper’s methodological processes that use narrative analysis are challenging and lack essential information (such as naming the frameworks with which the narratives were restoried). Therefore, this work will showcase a detailed design and analysis process highlighting the benefits of participatory design fiction, narrative inquiry and dialogic/performative analysis, including critical information to support other HCI researchers for future projects.
Chapter 2. Related Works

2.8. Summary of Related Works

This chapter explored the existing HCI research on upper limb motor disabilities, video game accessibility, wearable accessibility, gaming wearables, participatory design and design fiction, and narrative inquiry. These studies helped inform our own research on the design space of accessible gaming wearables for users with upper-limb motor disabilities. Our research on accessible gaming wearables strives to create an understanding of the user base of players with upper limb motor disabilities and how to design wearable interaction for video games for this user group. Our research also applies participatory design, design fiction, and narrative inquiry further to establish these methods and methodology to HCI research. In the following chapters, we outline the methodology and results for each of the two phases of our study on accessible gaming wearables for players with upper limb motor disabilities.
Chapter 3.

Phase 1 Methodology

In the first phase of the study, we aimed to build a base-level understanding of our user group of video game players with upper limb motor disabilities. Specifically, we wanted to understand their experiences and any barriers the experience while playing video games, and their experiences and preferences around wearable interaction. This was done through semi-structured interviews with eleven participants.

3.1. Participants

This study included 11 participants (nine male, two female) between the ages of 24 and 58 (average age = 34.6). Specific information on the participants can be found in Table 3.1. We recruited participants through forums such as Reddit, Facebook, and Discord, through calls for participants distributed through Parkinson Canada and the Multiple Sclerosis Society of Canada. We also used the snowballing method of participant recruitment.

Though disabilities in the upper limbs (including hands, arms, and joints) were the
## Chapter 3. Phase 1 Methodology

<table>
<thead>
<tr>
<th>Participant</th>
<th>Disability Characteristics</th>
<th>Age</th>
<th>Gender</th>
<th>Years Experiencing Disability</th>
<th>Years Playing Video Games</th>
<th>Gaming Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>Tremors</td>
<td>25</td>
<td>Male</td>
<td>12+</td>
<td>15</td>
<td>PC, Nintendo Switch</td>
</tr>
<tr>
<td>P2</td>
<td>Parkinson’s, difficulty with coordination, and limited endurance</td>
<td>57</td>
<td>Male</td>
<td>11</td>
<td>3</td>
<td>VR, Oculus</td>
</tr>
<tr>
<td>P3</td>
<td>Cerebral Palsy</td>
<td>30</td>
<td>Male</td>
<td>30</td>
<td>10</td>
<td>PC, Nintendo Wii, PlayStation, Mobile, Nintendo GameCube</td>
</tr>
<tr>
<td>P4</td>
<td>Fused right-hand fingers, shortened right arm, limited touch sensitivity and movement in the right hand</td>
<td>31</td>
<td>Male</td>
<td>31</td>
<td>26</td>
<td>PC, Xbox</td>
</tr>
<tr>
<td>P5</td>
<td>Shoulder laxity, chronic pain, intermittent weakness, tremor</td>
<td>36</td>
<td>Male</td>
<td>5</td>
<td>25</td>
<td>PC, Xbox, Nintendo Switch</td>
</tr>
<tr>
<td>P6</td>
<td>Missing hand</td>
<td>31</td>
<td>Male</td>
<td>31</td>
<td>24</td>
<td>PC, PlayStation, Nintendo Wii, Nintendo Switch</td>
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<tr>
<td>P7</td>
<td>Musculoskeletal disorder, fatigue in hands/fingers</td>
<td>26</td>
<td>Female</td>
<td>3</td>
<td>2</td>
<td>PC, Mobile</td>
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<tr>
<td>P8</td>
<td>Difficulty with fine motor movement</td>
<td>24</td>
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<td>PC, PlayStation, Nintendo Switch</td>
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<td>P9</td>
<td>Hypermobile type Ehlers-Danlos syndrome (hEDS)</td>
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<td>Female</td>
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<td>25</td>
<td>PC, Xbox, PlayStation, Nintendo Wii, Nintendo Switch</td>
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<tr>
<td>P10</td>
<td>Parkinson’s</td>
<td>58</td>
<td>Male</td>
<td>7</td>
<td>40</td>
<td>Nintendo Wii, Mobile</td>
</tr>
<tr>
<td>P11</td>
<td>Nerve damage to hands/fingers</td>
<td>25</td>
<td>Male</td>
<td>7</td>
<td>20</td>
<td>PC</td>
</tr>
</tbody>
</table>

Table 3.1.: Participant demographic information.

primary inclusion criteria participants additionally experienced disability characteristics in the joints, head and whole body. Our participants identified the following hand-related characteristics manifesting during video game play: tremors, touch sensitivity, lowered touch force capabilities, lowered hand and finger response time, accuracy of touch, and being left-handed. Joint-related characteristics include joint instability, mobility, and a higher likelihood of dislocation. Head-related characteristics include lightheadedness, vision issues, and dizziness. Our participants who experience these head-related characteristics noted that they appear more often when playing
Chapter 3. Phase 1 Methodology

Figure 3.1.: Diagram of the structure for first phase of study.

VR video games. Lastly, the whole-body characteristics include pinched nerves, pain, and fatigue.

For gaming, our participants used touch-based interactions such as phones and tablets, as well as computer interaction with a mouse and keyboard, and console gaming, specifically the Nintendo Switch and the Nintendo Wii. For wearables, our participants had experience interacting with gaming headphones, microphones, and VR/AR devices, as well as everyday wearables such as smartwatches, phones, or earbuds.
3.2. Procedure

Participants completed an initial demographic survey which asked questions related to study eligibility (e.g. age, gaming history, self-identification of having an upper-limb motor disability) and gaming preferences (e.g. length and frequency of gaming sessions, video game and system preferences). Once we confirmed eligibility, participants participated in a semi-structured interview over Zoom. Interview sessions lasted on average 45 minutes and were audio recorded for transcription and data analysis. Interview questions focused on our participants’ video game history and preferences for game interaction, and their opinions, preferences, and experiences using wearable devices for gaming, as well as other entertainment, hobbies, or everyday life activities. The interview ended with a group of questions centred around the prompt, “if you were asked to design a gaming wearable for yourself, what aspects would you design around?”. This group of questions included questions on how the participant would want to interact with the wearable, where they would want it to be located, how they would want it to look and feel, and other topics along this line of questioning. Figure 3.1 shows the structure for the study’s first phase.

3.3. Data Analysis

The first and second authors analyzed participant interview transcripts using reflexive thematic analysis [17,91]. In this method of data analysis, data is parsed to familiarize oneself with the data. We assigned participant quotes a descriptive code, a latent code, and a code that encompasses how the quotation applies to the study’s research
Chapter 3. Phase 1 Methodology

questions. We repeated this process five times, as per the thematic analysis process outlined by Braun and Clarke [17], to narrow down and create more specific and consistent codes. We then grouped codes into themes and subthemes representing our participants’ values and experiences with gaming and wearable technology.

Once codes, subthemes, and themes were decided on, myself and Dr. Cochrane met to discuss the themes and reorganize them to be more concise and specific to the research questions for the study. Conflicts between how the hierarchy of codes, themes, and subthemes were to be organized were resolved by discussing how the participant quotes were interpreted.

Because thematic analysis takes into consideration the researchers’ own experiences, we disclose the following positionality statement: Myself and my supervisors Dr. Audrey Girouard and Dr. Karen Cochrane are all educated in accessibility and disability research. Additionally, we each have our own personal lived experiences with disabilities.
Chapter 4.

Phase 1 Results

In this section, we present our results from phase 1 of our study. We developed four main themes: preferences, barriers, designing for disability, and disability experience. The preferences theme included the subtheme of aesthetic preference. The barriers theme included the subthemes outcomes of inaccessibility and interaction barriers. The designing for disability theme included the subthemes gaming wearable placement, game context, interaction modalities, attributes, and motivations. Lastly, the disability experience theme included the subthemes problem solving and interaction setup process. Table 4.1 provides a count for the number of participants who’s quotes were coded for each theme, subtheme, and code.

4.1. Aesthetic Preferences

Aesthetic preferences theme focuses on physical aspects of wearable technology and how they influence usability. This theme covers aesthetic preferences, and its codes of personalization, materiality, and general appearance. Fig. 4.1 illustrates the aesthetic
Chapter 4. Phase 1 Results

<table>
<thead>
<tr>
<th>Theme</th>
<th>Subtheme</th>
<th>Code</th>
<th>Participant Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preferences</td>
<td>Aesthetic Preferences</td>
<td>Personalization</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Materiality</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Appearance</td>
<td>5</td>
</tr>
<tr>
<td>Barriers</td>
<td>Outcomes of Inaccessibility</td>
<td>Inputs</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Interaction Barriers</td>
<td>Gameplay</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cost</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Personal Safety</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cognitive Load</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stigma</td>
<td>2</td>
</tr>
<tr>
<td>Designing for Disability</td>
<td>Wearable Placement</td>
<td>Extremities</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Upper Body</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Whole Body</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lower Body</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Head</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gross Motor Movement</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Interaction Modalities</td>
<td>Physicality</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Attributes</td>
<td>Use Cases</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Health</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Escapism</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Community</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Motivations</td>
<td>Independence</td>
<td>3</td>
</tr>
<tr>
<td>Disability Experience</td>
<td>Problem Solving</td>
<td>Adapted Playstyle</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Interaction Setup Process</td>
<td>Button re-mapping</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Social</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Purchase Decisions</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Device Sourcing</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 4.1.: Count of the number of participants who’s quotes fall under each code.

preferences theme.

In terms of personalized aspects, our participants valued customizations including colour options or the ability to match the aesthetic of wearable devices with those they already have. When asked how they would want to consider aesthetics in designing an accessible gaming wearable, P6 expressed, “I would want them to make sure that they don’t have this bland look.” Most of our participants noted that even if the wearable supported them, they would not use the device unless it had some aesthetic qualities that they liked.
Chapter 4. Phase 1 Results

Figure 4.1: Diagram of the subthemes for the aesthetic preferences theme

Our participants noted that the materials should be soft and not bulky. While discussing their joint pain, P9 noted, “Over the joints, on certain joints [the wearables would] have to be softer. Because otherwise pointy pokey digging into things- bad!” Designers should note where their users experience joint pain and be able to design devices and use materials that do not increase discomfort.

Though most devices would only be worn in the home, it is important to note that there is a social aspect in gaming where people might play games at family or friends’ houses. Therefore, general appearance is an important aspect our participants discussed. P6, who uses a bionic prosthetic arm, spoke about their occasional apprehension towards using a piece of assistive wearable technology in public. They specified, “I won’t wear it out in public all the time because it gets too overwhelming.” There exists a fine line in wearable design between a unique and attractively
4.2. Barriers

The barriers theme encompassed the aspects that made wearable and gaming interaction difficult for users and how to improve these barriers. The subthemes include interaction barriers and the outcomes of inaccessibility. Fig. 4.2 illustrates the barriers theme.

4.2.1. Outcomes of Inaccessibility

The codes in the subtheme outcomes of inaccessibility represent what happens to the user and their experience playing video games as a result of experienced inaccessi-
Chapter 4. Phase 1 Results

bility. These outcomes applied to the user’s personal experience of using different inputs for video games through outcomes such as experiencing physical discomfort, the use of third party devices to overcome inaccessibility, shortened gameplay to reduce inaccessibility, and using an adapted playstyle instead of a traditional playstyle to overcome inaccessibility. Outcomes would also appear within gameplay through aspects such as lowered playable game options, frustration with gameplay, increased error rate, and shortened game session length.

Input device inaccessibility had the effects of physical discomfort for the user, the use of third-party controllers, as well as shortened gaming session lengths. P4 used an adapted playing style with an Xbox controller and used their hand and chin to work the controls instead of two hands. This resulted in physical discomfort and a shorter gaming session for them, as they explained, “if I played for too long, I would...get like a rash on my chin from where I was playing the game, using my chin to work like the thumbstick.” P6, who required one-handed options for using PlayStation controllers opted briefly to use a third-party one-handed controller but experienced barriers, “it was a hella confusing. It was, it was a nice thought, but it didn’t really work.” These results show that, despite our participants searching for ways to alleviate inaccessibility, this inaccessibility still results in negative downstream effects on user experience.

Inaccessibility in the video games themselves results in lowered playable video game options, frustration, increased error rate, and shortened game session length. Though the video gameplay itself is not the focus of this research, it is still valuable to identify how inaccessible gameplay contributes to the barriers that players with upper limb
motor disabilities experience. P10 highlights how they felt that gameplay that was intolerant of their disability lead competitive gaming to be inaccessible to them, “(I) was very, very much not competitive with what my peers had access to because of the shaking and double-clicking and the loss of control.” In this example, P10 experienced increased frustration and error rate when playing video games that are inaccessibly-designed, resulting in limitations in the games they are able to play.

4.2.2. Interaction Barriers

The interaction barriers subtheme describes the aspects of interaction that prevented our participants from partaking in gaming activities or using different gaming devices. Our participants brought up barriers related to financial barriers, barriers around personal safety, cognitive load, and finally stigma around disabilities in gaming.

Our participants noted that accessible gaming controllers are often much more expensive than traditional controllers. P5 expressed: “if I could get, you know, an adaptive controller for the same price that I could get a regular controller, that might be worthwhile to me...to have to pay like a disability tax is not something I would love.” Secondly, our participants noted frustrations in the fast pace of innovation in gaming hardware when they realized that the technology they invested in would eventually have to be replaced. Several of our participants preferred older technology that did not receive many software updates, such as the Nintendo Wii, P10 described how the Nintendo Wii, despite its age, is a vital part of their daily activities, “it’s certainly an end-of-life product. And I’ve reconstituted it for it to be a basic part of my exercise regime.” When asked if they had concerns about their Wii not working one
Chapter 4. Phase 1 Results

day, they said, “one day there’ won’t be a replacement part available, but hopefully by then there’ll be something better as a package in the first place.”

Barriers related to the players’ concern for personal safety focused on how a player’s fear around interaction causes pain or injury and their concern for physical safety. This topic was often discussed about VR systems, especially regarding the cybersickness that VR interaction can induce. Our participants felt a lack of clarity on how new devices might affect their disability, as P1 stated: “with VR, I couldn’t use it that long because I found myself getting very lightheaded and dizzy from the visual input. And that is often a trigger for seizures for me.” Similarly, P5 expressed “I would definitely like to try that [VR], but that one would be- with my lack of coordination I’m a bit worried to try it, um, cause there’s a good chance that I would fall.”

Outside of VR, even screen-based video game interaction could cause our participants to experience fatigue, P7 said “I feel like it’s fatigue feeling and immediately I cannot work anything after playing video games, I need rest after gaming.”

Our participants discussed barriers around controllers and control complexity. P10 expressed: “I tried the settings even on my PC settings, laptop settings, everything out there is just made for sensitivity [of mouse movement] for a regular user. But not ultrasensitive to do something I need for gaming”. Our participants also expressed frustration with the complexity of button sequences for actions in games and the need for 2-hand requirements for games. Video game controls that were complex also added to the cognitive load our participants had to exert in games. P5 spoke about their experience using controllers, “with like an X-Box controller it’s comfortable to use, but it’s too complicated. So there comes a point where I just, I can’t keep up with the
Chapter 4. Phase 1 Results

![Diagram of the subthemes and codes for the designing for disability theme](image)

Figure 4.3.: Diagram of the subthemes and codes for the designing for disability theme

same input requirements that I could when I started.” Similarly, P10 expressed their frustration playing Nintendo Switch games, “there would be things buzzing around my ears, giving me opportunities to collect more points and racing and quad- pages of other competitors in the same race. It’s just it’s just too much for me.”

Finally, our participants explained the need to reduce stigma and increase disability recognition around the disabled community in both the wearable and gaming industry, P6 said, “since I was a kid, when I [got] into PlayStation and any console, I was just trying to play like anyone else.” P6 like many others just wanted to enjoy the game but the designs of the system often alienated them.
4.3. Designing for Disability

In the interviews, our participants looked towards the future to suggest how future gaming wearables could be designed for players with upper limb motor disabilities. It included utilizing specific areas of the body for wearables, genre of video games would best fit wearables, interaction modalities that could be utilized by gaming wearables, game attributes that players value, and finally, motivations users have to utilize wearables and video games. Fig. 4.3 illustrates the designing for disability theme.

4.3.1. Wearable Placement

The most commonly discussed location was the extremities (n=9), followed by the head (n=5), upper body (n=5), whole body (n=4), and lastly, lower body (n=1). Figure 4.4 shows each area of the body discussed, and the frequency they were discussed with participants. It is observable that the hand extremity is already utilized during gaming, so this would be a natural point to utilize a gaming wearable that provides an alternate and more accessible modality of interaction for this body part. The feet extremity was also noted as an underused part of the body in current gaming setups, and could potentially serve as an additional location for interaction.

4.3.2. Interaction Modalities

In terms of input modalities, our participants were drawn towards any method of interaction which prioritized gross motor movement over fine motor movement. Many gaming actions (e.g. use of joysticks, pressing keys) require fine motor movement
Chapter 4. Phase 1 Results

Figure 4.4: Diagram visually representing the areas of the body suggested as a location for a gaming wearable, and the frequency our participants suggested each area.
skills, which can be a challenge for users with upper limb motor disabilities. P5 said on this topic, “anything where I could use like larger muscle groups rather than, like, my fingers would make things easier. So, like an arm sleeve controller I would last longer with that than I would with a handheld device.” For output methods, wearables focused on game feedback were discussed enthusiastically as they showed the potential to increase immersion into a game. P1 outlined, “If [a gaming wearable] was like output related, like if it was like a haptic thing to help me feel what’s actually in the game or something. Sure. Like that would be really cool.”

### 4.3.3. Attributes

Overall our participants valued quality and durability of the devices, P5 describes their value towards quality “if I’m buying something tech related, I want to have the best version of that, or at least what I think is the best version of that possible.” P3 highlights the value they would see in the durability of gaming wearables. “I would want [a gaming wearable] to be something easy to move around but hard enough not to break all the time, maybe similar to a Wii remote.” Flexibility in how wearables and gaming inputs could be flexible in how they were used to fit the user’s specific needs were also valued. P9 values this aspect in their Nintendo Switch, “I remember being so exuberant when I got the Switch and realizing how many different ways there were to play it, because realizing again with my mobility how much that sets me free. So I’m not limited into only one [use] situation.” P6 similarly outlines how this aspect would be valuable in a gaming wearable, “I want to make sure [a gaming wearable] is not only accessible but is also flexible for [user’s] gaming style and the
Chapter 4. Phase 1 Results

way that they play their games.” This code we called physicality.

Our participants also discussed some of the drawbacks that they currently experience with wearables. For instance, could current wearables on the market be used for gaming wearables so they do not need to invest in more technology. This code we called use cases. P6 highlighted this by expressing they would like to use their bionic arm wearable for hobbies like exercising or video games, “where we are with [bionic prosthetic] technology is incredible. And the fact it’s still low cost but, at the same time, there’s certain things I’d like it to be able to do like play video games.”

4.3.4. Motivations

As we were interested in the lived experiences of our participants, we were keen to understand the motivations on why our participants decided to engage with video games and how wearables could be a motivation to play the games.

Many of our participants noted the added health benefits that video games gave them as a motivation to continue playing. P2 recounts their experience with how playing the virtual reality game Beat Saber provided a source of exercise: “I discovered that...once I started...playing Beat Saber a fair bit, my skills and my movement improved, and my family was shocked that I...saw a big progression.”

Escapism is a huge motivation factor for some in the community. To be able to be immersed and embody another character can create an enriching experience for many. P1 imagined how a gaming wearable could utilize immersion and embodiment: “it would be cool if there [were] a wearable that...light up a certain way or changed shape or something. To...match the item you had in a game.”
Chapter 4. Phase 1 Results

Another motivator for some in video games was the community aspect that is often developed inside games. Though it can often be difficult to communicate in games for people with upper limb motor disabilities. P5 expressed, “communication in games for me is virtually non-existent because it usually requires typing, which is...if you’ve done that on a system without a keyboard, it is very difficult”.

Our participants discussed the possibility of independence that wearables could in their gaming experience. P3 expands on this by explaining, “I have to spend a little bit more time and have someone assist me to set it [current gaming interaction] up...But yeah I’d like to hopefully be able to set it up by myself.” In other activities, wearables were already increasing their independence. For instance, P5 described how their smartwatch gave them the independence to go for walks alone, as this particular smartwatch could monitor their health and alert emergency services should they need it, “[my smartwatch] allowed me to go on walks by myself without bringing like a family member just in case this, this allowed everybody to feel more comfortable with me having a bit more independence.”

4.4. Disability Experience

We discussed each of our participants’ lived experiences around playing video games and utilizing wearables in their daily lives. Our participants noted barriers in the step-up process and some problems that they overcame through problem solving. Fig. 4.5 illustrates the disability experience theme.
4.4.1. Problem Solving

Our participants reported that they often had to find creative solutions to overcome physical environmental and societal interaction barriers. Solutions for environmental barriers included adapting their playstyle, changing posture, re-mapping controls, and relocating the interaction to different body parts.

Many of our participants reported adapting the way they used the controller or other devices due to their disability. This was seen with P1 reporting they held their controller more lightly, P4 who used their chin to activate different controls, and P6 who used their knee in similar ways. Comparably, P9 found that frequently changing their posture or re-positioning their body would help alleviate discomfort or pain they experienced when playing video games, “I fidget a lot. I don’t sit statically when I’m playing because of pain levels.” When they could not reposition or change
Chapter 4. Phase 1 Results

their posture, our participants reported relocating interactions away from areas they experienced pain or discomforts. P10 describes, “I’m right handed. But I do some left handed motions to offset the need for the right hand because my left hand is healthy still. My right hand is the one that shakes all the time.”

Our participants also reported that they remapped buttons or changed the default map between a controller button and in-game action. Most video games support button re-mapping, however when not supported our participants found further workarounds through programs like Joy to Key, as P4 explained, “I used to “Joy to Key” or something like that to really custom map like buttons on a controller to correspond to keyboard inputs.”

Social problem solving methods include those involving outside individuals, such as through cooperative (co-op) play, community support, or tech support. Co-op play, as described by our participants, involved inviting friends or family members to assist in gameplay by taking over different controls. P6 specified using this in certain games where they felt they often had game progress halted, “I really like Mario Odyssey, but I got stuck on that. So most time my brother would play and I just use the second Wii remote.” Though enjoyable in a social sense this problem solving method has drawbacks, most notably requiring another person to be available for co-op play. Lastly, when barriers that were more difficult to solve arose our participants turned to community or tech support to seek advice and solutions. Community forums like Reddit offered an avenue for community support as explained by P2 “I quite often end up on Reddit because that’s where a lot of people are social and interacting about specific questions.”
4.4.2. Interaction Setup Process

Our participants sourced their setup process online, through tech news and community sourcing, by researching interaction modalities and finding new technologies to try. Our participants used tech news to keep up to date on new tech that may be of interest, P4 explained, “I try and stay very on top of like tech news just because it interests me as a hobby.” Online sourcing included looking on vendor websites (for instance, Amazon) to find devices of interest. The community sourcing method utilized staying informed on new tech and devices through friends or online community forums, P8 explained their experience with community sourcing, “It was all just try a lot of different kinds until my friend suggested this [keyboard] company and I tried his out. I really, really, really liked it.”

The purchasing processes included how our participants decided on what devices to purchase and why, as well as testing out devices to find what works. Purchase decisions were influenced primarily by how well devices could be used with our participants’ disability, and our participants put extensive research towards determining their accessibility before purchasing. As P10 describes, “I just started buying whatever was the latest fad out there. That’s before I got diagnosed... then I got diagnosed and I didn’t invest too much in that because it was actually, there was some stuff that I was not able to use.” When adequate information was not available about whether a piece of technology was tolerant of their disability, our participants resorted to a process of trial and error. This process is time consuming and costly, but unfortunately necessary when information about technology usability is difficult to find.
Chapter 5.

Phase 2 Methodology

In the study’s second phase, we aimed to envision how gaming wearables would practically be used during gaming. To do this, we conducted participatory design fiction sessions with four participants. The goal of the sessions was to receive feedback from participants about how using gaming wearables could affect their gaming experience, and this information would inform the design fiction diegetic prototype. The diegetic prototype we decided to represent future gaming wearables through was a tech review YouTube video.

5.1. Participants

This study included four participants (one female, three male) between the ages of 25 and 58 (average age 36.3). Table 5.1 shows the participants’ demographic for this study phase. We chose this number of participants as Bleecker et al. [18] outline that the ideal number of participants for a design fiction session is between three and six. We recruited participants from the participant pool from study one. Participants were
Chapter 5. Phase 2 Methodology

contacted only if they consented to be contacted for follow-up studies. The inclusion of the study was individuals who self-identified as having an upper limb motor disability and specifically experienced fatigue in the hands/fingers, lowered finger response time, and difficulty with fine motor movement of the hands/fingers. Additional inclusion criteria for the study included being 18 or older, speaking English, and having at least one year of experience playing video games.

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<th>Participant Code from Phase 1</th>
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<th>Years Experiencing Disability</th>
<th>Years Playing Video Games</th>
<th>Gaming Systems</th>
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<td>P1</td>
<td>Tremors</td>
<td>25</td>
<td>Male</td>
<td>12+</td>
<td>15</td>
<td>PC, Nintendo Switch</td>
</tr>
<tr>
<td>DP2</td>
<td>P5</td>
<td>Shoulder laxity, chronic pain, intermittent weakness, tremor</td>
<td>37</td>
<td>Male</td>
<td>5</td>
<td>25</td>
<td>PC, Xbox, Nintendo Switch, Mobile</td>
</tr>
<tr>
<td>DP3</td>
<td>P10</td>
<td>Parkinson’s</td>
<td>58</td>
<td>Male</td>
<td>7</td>
<td>40</td>
<td>Nintendo Wii, Mobile</td>
</tr>
<tr>
<td>DP4</td>
<td>P7</td>
<td>Musculoskeletal disorder, fatigue in hands/fingers</td>
<td>26</td>
<td>Female</td>
<td>3</td>
<td>2</td>
<td>PC, Mobile</td>
</tr>
</tbody>
</table>

Table 5.1: Participant demographics for second phase of study.

5.2. Proposed Wearable

The design of the accessible gaming wearable proposal was informed by the first phase of the study and the accessible wearable design guidelines that we formulated during that phase. The design guidelines were designed for interactivity, designing for flexibility in use, designing for large muscle movement, and designing for modularity. Figure 5.1 shows a diagram of the proposed accessible gaming wearable.

The goal for the interaction aspect and the large muscle movement aspect were to bring interaction away from the small muscle groups that require fine motor movement and instead involve the large muscle groups and gross motor movement. Participants expressed in the first study that fine motor movement in gaming interaction was an
Figure 5.1.: Diagram of the proposed accessible gaming wearable worn on the hand and arm.

interaction barrier. Therefore, we aimed to require instead a gross motor movement that, along with video game interaction, would allow users to exercise muscle movement. The wearable proposes using a gyroscope to track hand movement in the XYZ plane and rotation. Additionally, it proposes to use EMG sensors to monitor the activation of large muscle groups. Figures 5.2a and 5.2b display the proposed wearable’s interaction points and the degrees of freedom captured by the device.

The goal for designing for flexibility and modularity was to broaden the spectrum of accessible devices and allow the user to use the wearable in whatever way works best for them. Alternative body areas were considered for the interaction to provide versatility in usage. Ideally, the wearable device would possess adaptability, allowing it to be worn on the preferred part of the body. The wearable is intended to be used with the Xbox Adaptive controller to contribute to modularity. This broadens the
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(a) Diagram of proposed accessible gaming wearable with interaction points labelled

(b) Diagram of the different degrees of freedom utilized by the proposed accessible gaming wearable.

gaming applications of the device and builds on tech that users may already have or be familiar with.

5.3. Procedure

Participants completed an initial demographic survey which contained questions related to study eligibility (e.g. age, gaming history, nature of disability, etc). Once eligibility was confirmed, we scheduled participatory design fiction sessions with participants. Two separate participatory design fiction sessions were held over Zoom, where participants could choose to have their cameras on or off, and each participant’s name was changed to their participant code to retain anonymity. Participatory design
fiction sessions lasted an average of 90 minutes and were audio and video recorded for transcription. Figure 5.3 shows the structure of the study’s second phase.

The purpose of the participatory design fiction sessions were to further explore the design space of accessible gaming wearables, and to receive feedback to incorporate into a design fiction archetype representing the potential for accessible gaming wearables as per outlined by Bleecker et al. [18]. The archetype chosen for this fictional technology was a YouTube gaming tech review video similar to those created by YouTubers like Linus Tech Tips [92]. Each session had 5 activities including an ice-breaker activity, an explanation of the purpose of design fiction and the goals for the participatory design session, an introduction to gaming wearable accessibility with examples from research and industry, a persona building exercise, and a critique
of a proposed idea for an accessible gaming wearable. During the sessions, our participants were presented with a Miro board which explained and had visual aids for each activity for the session. The lead researcher (Georgia Loewen) led each session and provided information, background, and instruction for each activity as well as helping fuel conversation.

The ice-breaker activity asked our participants to share their favourite video game, how they were introduced to video games, and what their preferred controller/video game interaction is. Figure 5.4a shows the Miro board slide shown to our participants for this activity. The goals of the design fiction session were outlined to our participants as being about envisioning future technologies for gaming wearables and what that interaction would look and feel like. Our participants were also told that information from each participatory design fiction session would be used to create a tech review YouTube video. A portion of a video of Linus Tech Tips reviewing the Xbox Adaptive controller [92] was shown to our participants so they could be familiarized with this type of YouTube video. Figure 5.4b shows the Miro Board slide shown to our participants. For the introduction to gaming wearables activity, the lead researcher showed three examples of gaming wearables from industry, and three examples from research and explained the use of each as shown in Figure 5.5a. The three industry examples were a Wii controller (a Wiimote), a bionic prosthetic arm, and a KOR FX haptic gaming vest. The three HCI research examples were the “inputs” wrist-worn wearable from from research by Jung et al. [25], the “gaming cloth” fully body wearable from research by Jung et al. [25], and the wig head-worn wearable from research by Jung et al. [25]. Both sets of examples of wearables were chosen to
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(a) Ice breaker Miro Board activity

(b) Miro Board slide explaining goals of study.

Figure 5.4.: First two Miro slides from participatory design fiction sessions outlining activities conducted.
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Consider the gaming wearable examples below, how would you describe their accessible qualities?

(a) Miro Board slide for critique of current gaming wearables.

(b) Miro Board slide for persona activity.

Figure 5.5: Third and fourth Miro slides from participatory design fiction sessions outlining activities conducted.
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(a) Miro Board slide explaining proposed gaming wearable prototype for design fiction activity.

(b) Miro Board slide with discussion points for design fiction activity.

Figure 5.6.: Fifth and sixth Miro slides from participatory design fiction sessions outlining activities conducted.
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(a) Miro Board slide with points about benefits and drawbacks of using gaming wearables.

Figure 5.7.: Seventh Miro slides from participatory design fiction sessions outlining activities conducted.
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represent video game interaction with different parts of the body (e.g. hands, head, arms, whole body). Our participants were given a description of each wearable and how they are used and asked to comment on the accessibility qualities they thought were represented in each wearable.

For the persona building exercise, our participants were shown an persona outline with the categories of name, age, likes and dislikes, personality traits, video game preferences, video game interaction preferences, and experience with accessibility. Figure 5.5b shows the persona characteristics discussed with participants. Our participants were asked to think of the character that would be featured in the YouTube video, and, together with the lead researcher, fill out the persona profile. The design fiction activity for envisioning how wearable interaction would work in practical applications included two parts. In the first part, our participants were told about a gaming wearable of the future (detailed in section 5.2) and asked to consider different usability aspects about the wearable. Figures 5.6a and 5.6b show the two Miro Board slides used for this activity. These usability aspects included how the hand movement would work in video game interaction, how muscle contraction would feel like in video game interaction, and how these aspects could be used elsewhere on the body instead of the hands and arms. In the second part, our participants were asked to reflect on the discussion around the gaming wearable and identify any benefits that a gaming wearable would have over traditional interaction, and any drawbacks that the gaming wearable would have that traditional interaction would not. Figure 5.7a shows the Miro Board slide used for this activity.
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5.4. Data Analysis

We used narrative inquiry to design the study, and utilized the analysis method of dialogic/performance analysis to analyze the data. The narrative inquiry methodology process was informed by Creswell [88], Clandinin and Connelly [89], and Riessman [23]. This research methodology was chosen as it includes the researcher as a participant in the data collection and analysis process which coincides with the method of design fiction which also values the researcher as a participant. Dialogic/performance analysis was chosen as it requires explicit talk among speakers to produce narratives [23]. The participatory design fiction sessions specifically required our participants to discuss the topic of gaming wearables and accessibility, and so...
was a natural fit for dialogic/performance analysis. Dialogic/performance analysis also equally values the content of what is said, and the way in which it was said and so greatly retains the valuable context around each narrative. Our analysis was completed in six steps outlined in Figure 5.8. In the first step, the transcribed data was read through to allow the lead researcher to immerse herself in the data. Following this step, different sections of the transcript were highlighted that represented the stories of lived experiences.

In the third step, the highlighted stories of lived experiences were analyzed by the lead researcher and restoried to represent the chosen framework. Narrative inquiry requires a framework to restory the data through [24]. The framework we chose comes from Garland-Thomson’s [93] work on feminist disability studies. The framework Garland-Thomson presents is that lived experiences of marginalized groups (such as the disability community) exist on the spectrum fit vs misfit, and dependence vs vulnerability [93]. The range of fit vs misfit represents how a disabled body and the environment can live in harmony (fit) and how there can be a discrepancy between a disabled body and the environment resulting in a barrier (misfit). The spectrum of dependence vs vulnerability represents how humans desire to fit in their environment (dependence) and how the potential for misfit between the body and environment creates vulnerability. In a practical application of this framework on the lived experiences expressed by our participants, the fit vs misfit spectrum described how physical attributes of interaction created or alleviated barriers. The dependence vs vulnerability spectrum represented how those barriers or alleviation of barriers affected the individual’s emotional experience (i.e. either feeling supported/dependable or unsup-
Figure 5.9: Diagram of the framework used during dialogic/performance analysis. The lived experience quotations highlighted in the transcribed data were then restoried to highlight the aspects of fit vs misfit and dependence vs vulnerability they represent. A diagram of the framework is shown in Figure 5.9. Additionally, as per instruction by Riesman [23], contextual aspects of the lived experience quotations were also noted. These included noting the character (i.e. participant), scene, conflict, asides to the audience, repetitions, expressive sounds, or changes in verb tenses. These aspects were noted to provide context to the lived experience quotation.

After analysis of the data to the chosen framework was complete and story elements were noted, alternative scripts of the participatory design fiction sessions were made, including the lived experience quotations as they represent the framework and the
contextual notes made during analysis. These scripts strictly highlighted the stories of lived experiences expressed by our participants during participatory design fiction sessions. From these framework scripts, it was easier to pull out points of data that were directly related to the research questions, and could directly contribute to the design fiction archetype generated from the data.

The final step of the dialogic/performance analysis process was using the framework scripts to inform and formulate the archetype, in our case the script for a YouTube tech review video. Taking into consideration the persona characteristics that our participants outlined during the participatory design fiction sessions, the YouTube reviewer was created. Both aspects of this persona (e.g. likes, dislikes, personality traits) as well as quotations from the framework scripts were used to inform the content of the script. The goal of the script and the video filmed were to represent the potential for an accessible gaming wearable and to critique its use in practical gaming applications.
Chapter 6.

Phase 2 Results

This section outlines the results from the second phase of the study. We analyzed the data collected through narrative inquiry using dialogic/performance analysis and restored and reframed selected quotes from our participants to fit on the fit vs misfit and dependence vs vulnerability framework. Furthermore, we present a critique of gaming wearable examples presented to participants during the participatory design fiction sessions. Lastly, we present feedback from the design fiction activities which were used to create the review YouTube video design fiction archetype.

6.1. Narrative Inquiry and Dialogic/Performance Analysis

For the narrative inquiry analysis, quotes from our participants were identified and re-framed to fit the fit vs misfit and dependence vs vulnerability framework. Figure 6.1 presents each quote pulled from participant narratives voiced in participatory
Chapter 6. Phase 2 Results

Figure 6.1.: Visualization of the quotes pulled from participant quotes and where they fit on the Fit vs Misfit and Dependence vs Vulnerability spectrums.

design sessions and represents where each quote lies on the spectrum between fit and misfit, and dependence and vulnerability.

From the data, we see that our participants relayed a variety of experiences that represent many different points between fit and misfit, and dependence and vulnerability. Our participants infrequently expressed experiences that made them feel a fit with the environment but also vulnerability. Our participants more often expressed experiences that fit in the misfit and vulnerability quadrant, the fit and dependence quadrant, or the misfit and dependence quadrant. The misfit and dependence quadrant often represented stories of how barriers were overcome, or how different types of interaction could present a barrier to the participant but they suggest methods to design around those barriers.
6.2. Critique of Wearable Examples

To get into the mindset of understanding the gaming wearables market, and the potential for gaming wearables our participants were shown examples of gaming wearables from the gaming and accessibility industry, and those proposed in gaming wearable HCI research. Our participants were shown examples of wearables (described in section 5.3) and asked to comment on their impression of the accessibility qualities of each.

6.2.1. Industry Examples

On the industry side, the Wiimote was particularly praised by DP3 for its simplicity when compared to traditional controllers, “the Wiimote is really simple to use, and simple doesn’t mean bad, it means I have less buttons. I got to figure out how to work and less opportunities for me to double click. And it’s just there’s an A, there’s a B, and I rarely use a numchuck- when I’m boxing, I do.” Our participants also identified certain barriers that they experienced when using it such as fatigue. DP2 voiced, “The Wiimote I struggled with a bit because it required some bigger movements. That tired tired me out quicker” and DP1 echoed “I also had issues with the Wiimote. Growing up, it was a big source of frustration because particularly with pointing and having to remain steady is not something I can do with my upper limbs. So that was always a massive challenge.” For the bionic prosthetic, our participants were specifically asked to consider the muscle activation component of the design as it presents an alternate way to engage bodily movement in interaction. DP2 proposed there were aspects of the concept that could pose positive accessibility qualities, “That
Chapter 6. Phase 2 Results

would be really cool if you could sort of map the controls to muscles that you do have better control over.” DP3 noted the device may be complex to use, but would have ample applications outside of gaming which was a benefit, “But [the bionic prosthetic] would not just be for gaming, it would be for use for multiple uses, non-gaming uses as well. But again, I don’t know how complex a device that would be to control.” Lastly, for the gaming vest DP3 saw accessible value in a device that could spread interaction to other parts of the body beyond the hands, “One that really intrigues me is the wearable vest, because there I’m sharing the responsibility from what was normally just one of my one or two hands...ideally they would come with a headset as well. To partner up with the vest. And then it’s just more about sharing the load with some parts of the body that are unaffected or less affected by my Parkinson’s.” Conversely, DP1 noted a body-worn device like the haptic gaming vest may also pose accessibility barriers for individuals who struggle with dressing activities, “My immediate reaction was kind of it would be it wouldn’t be that accessible, particularly for people who have difficulty either dressing or they don’t have that typical kind of able bodied male figure that seems to be shown.”

6.2.2. Research Examples

On the research side, our participants noted more potential for accessibility barriers. For the “inputs” device, DP1 noted the potential barrier from the fine motor movement required to place each attachment on the wrist “If they just like snap, that’s, that would be easier for me. Like I struggle to get my key in the door, for instance. So if I had to get fine- like line them up and get things into grooves and then snap
it in that way, I would probably have a difficult time doing that. Especially if I only had one hand to put them on with since I’m wearing the device on the other, so I might have to take it off and then use both hands to put on and would just be a nuisance.” For the “gaming cloth” wearable, DP1 noted a similar barrier to the KOR FX haptic gaming vest for individuals who have difficulty dressing, “And somebody who struggles with things like getting dressed might have a problem with the big cloak and having to, you know, coordinate your whole body to- to do things.” Lastly, for wig head-worn accessible our participants noted both accessible and inaccessible qualities. Jung et al. [25] describe the device as using both EEG interaction as well as physical interaction with different parts of the wig (e.g. squeezing horns or tugging on hair tendrils). DP2 valued the EEG interaction “That’s cool. I think EEG would be like the dream for an accessibility wearable”, however DP1 raised concerns about practical aspects like placement of the device on the head “I think it’d be really cool to see how it would be used and how precise you have to be when putting it on. Like if it’s a very delicate thing that has to go in a specific spot or you can just kind of like plop it in your hand almost.” Our participants raised more concerns around the physical interaction portion of the design. When asked about actions like squeezing horns on top of the wig, DP2 voiced “I struggle to lift my arms above my head, so that would not be. Not. Not be something for me.” Similarly, DP1 voiced there was potential for an accessibility barrier depending on how specific movements had to be, “I guess the context, like for me I could use it with, but depending on how like- fine motor it is like if I have to grasp it very tightly and decently, very fine and with it, then that would be a challenge. If it’s just kind of like you knock it so it senses some
kind of interaction that would be- then that would be more accessible to me.” From an overarching perspective, DP3 felt the research examples represented interaction that was too complicated and unrealistically futuristic, “Like I’m hardly able to drive a car and that’s got to pedal and a break and and stay within the lines. So to to think about this kind of stuff is, it’s not only futuristic it’s... it might be fun for somebody, but I’m looking for practical solutions to day to day management.” Furthermore, they noted the interactions presented felt very individualistic and did not have as much opportunity for shared interaction with others, “the [research examples] seem to be focusing on on individual gaming. One one on one with with the terminal. I’m looking for more ways of sharing the fun with with kids, with family, with friends.”

6.3. Design Fiction Archetype

6.3.1. Archetype Content

The characteristics of the character featured in the YouTube review video were informed by the persona activity in the participatory design fiction workshop. As per voiced by our participants, the character represented in the YouTube review video represents an individual who has first hand experience with an upper limb motor disability and experiences fatigue and difficulty with fine motor movement. Other characteristics the YouTube character represents are that they are non-binary, have a smaller subscriber count, speak calmly, and are considerate towards individuals with other disabilities. They like indie games, supporting small businesses, finding new technology, discussing accessibility, and prefer to not use complicated jargon words.
They dislike disingenuous behaviour and being paid to say good things about a product. Figure 6.2 shows the characteristics of the persona created with our participants on the persona outline. These aspects were also considered during casting of the YouTube review character when making the video, and an individual from the lead researcher’s circle of friends who was a person with an upper limb motor disability was chosen. The different characteristics of the YouTube character were also reflected within the script. For example, it is written that the character found the accessible gaming wearable through a Kickstarter program and chose to support the small business and encourage new technology.

The YouTube review video includes four parts: the introduction to the product and how the reviewer found the company, an overview of how the product works in practice, discussion on the benefits and drawbacks of the device, and their conclusive
thoughts on the device. In particular, the aspects of the video where the reviewer critiques the accessible wearable are informed by lived experiences voiced by our participants. For example, DP2 voiced “The Wiimote I struggled with a bit because it required some bigger movements. That tired me out quicker” and DP1 voiced “I also had issues with the Wiimote. Growing up, it was a big source of frustration because particularly with pointing and having to remain steady is not something I can do with my upper limbs.” These were jointly represented in the YouTube script by the character voicing “I did always struggle a bit when using the Wiimote and having to have my arm extended for long periods of time and feeling very fatigued, so I’m hoping I don’t have that issue with this device.” Table 6.1 and Table 6.2 show a comparison between the quotes from our participants in participatory design fiction sessions and how those descriptions were represented in the YouTube script.

6.3.2. Feedback on Using Accessible Gaming Wearable

To receive feedback on how an accessible gaming wearable would be used in practical gaming sessions, we presented our participants with a proposal for an accessible gaming wearable. This feedback includes an overall discussion on the design of the proposed wearable and how it represented accessible features and how accessibility could be improved and the benefits and drawbacks of using a gaming wearable over traditional controllers.
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<table>
<thead>
<tr>
<th>Participant Quote</th>
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<tbody>
<tr>
<td>DP2 “The Wiimote I struggled with a bit because it required some bigger movements. That tired me out quicker.”</td>
<td>“I did always struggle a bit when using the Wiimote and having to have my arm extended for long periods of time and feeling very fatigued, so I'm hoping I don't have that issue with this device.”</td>
</tr>
<tr>
<td>DP1 I also had issues with the Wiimote. Growing up, it was a big source of frustration because particularly with pointing and having to remain steady is not something I can do with my upper limbs.</td>
<td>“Okay, so it’s nice that it works when I just need to rest my hand on my lap, or even my desk between movements so that does eliminate some fatigue concern I had.”</td>
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<tr>
<td>DP2 “For me, hand rotation would be like holding up my arm to use as a pointer also wouldn’t work, but like to have my hand on my lap and then just be able to sort of bend my wrist to down to move forward, for example. That would be a lot easier for me.”</td>
<td>“Let’s try out the muscle sensor part, I feel like this part is a bit more intimidating and maybe a little less natural. Like my initial reaction is how much like mental effort am I going to have to put towards moving individual muscles?”</td>
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<tr>
<td>DP1 “My initial thought would be like hesitant to use it as like a main interaction technique as something you have to kind of like consciously do. And I don’t know why, but I would I would get kind of like, wrapped up in trying to flex something or contract a muscle to try to do something important in a game.” “I was just sitting here trying to flex various muscles to see how easy it would be to do.”</td>
<td>“I’ve configured [the wearable] so clenching my hand is my item action like punching or hitting with my pickaxe, lifting my ankle off the ground is jump, and moving my shoulder is selecting different items in my hot bar.”</td>
</tr>
<tr>
<td>DP2 “If you sort of tied them to the motions, that would make sense in the game. Like, like a jump would be like lift lifting your heel off the ground. So like contracting your calf or whatever.”</td>
<td>“I do kinda like that you can choose which muscle groups you want to use in games and map them to different actions.” “I really like that it is customizable to whatever part of the body you feel you have the most control of.”</td>
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<tr>
<td>DP2 “I think it would be cool if you had a device that was sort of like you could you could put it on whatever part of your body best works for you, but that the controls would be. Like you could, like, sort of customize the controls.”</td>
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Table 6.1.: Part 1 of Participant quotes from participatory design fiction sessions and accompanying quotes derived from them in YouTube script.
Chapter 6. Phase 2 Results

<table>
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<tr>
<th>Participant Quote</th>
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<tbody>
<tr>
<td>DP3 “It’s just more about sharing the load with some parts of the body that are unaffected or less affected by my Parkinson’s.”</td>
<td>“I really like that it spreads interaction all over the body instead of just being confined to fine motor movement in the hands.”</td>
</tr>
<tr>
<td>DP1 “It would be a cool way to, I guess, bridge the gap for me personally to experience a certain level of immersive like virtual reality...I think if it interacted with like my muscles and my body, like kind of like how it’s shown here.”</td>
<td>“I also feel like on some level it gives me a bit more immersion in game? That’s a really hot topic in gaming since VR, but for me and many other members of the disabled gaming community VR can be inaccessible, so this is a kinda cool way to bridge the gap in gaming immersion and involve more of the body in gaming like VR does.”</td>
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<tr>
<td>DP1 “And it’d be interesting to see, like, let’s say if, if I was playing a game where this wearable was used and after a while I got really tired because it required a lot of physical activity, how easy it would be to just drop the wearable from use and pick up like a standard handheld controller or something.”</td>
<td>“I also like that it’s modular, and I feel like if I got tired using it on my arm I could switch it to a different part of the body and keep playing, or even switch to a regular controller.”</td>
</tr>
<tr>
<td>DP1 “I tend to look at it like I’ll eat while I play video games, just like I’ll have my hand one hand on the controller and do something with the other. So now I would feel like I wouldn’t be able to necessarily like pick up and drop the game super quickly. I would have to be really committed to that play session.”</td>
<td>“The setup is kinda involved. Like going through the configuration process is a bit intense, and even just making sure the sensors are in the right place.”</td>
</tr>
<tr>
<td>DP1 “I would be really interested to see how I could use this and kind of like customize it or like modify it to be kind of like expressive.”</td>
<td>“I do also feel like looks wise, it’s a little boring. I would prefer to see a bit more aesthetic customizability, but maybe that will be something that comes in time.”</td>
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<tr>
<td>DP2 “With a lot of mobility, aids or those types of accessories, there’s- they’re often really clinical looking</td>
<td></td>
</tr>
<tr>
<td>DP3 “But if there was something out there that would give me an ounce of improvement, I’d spend it in a moment.”</td>
<td>“I think if I knew for sure that this device was gonna improve my gaming and be accessible to me it would be worth it.”</td>
</tr>
<tr>
<td>DP3 “It’s like that experience is only understood by people who have [an upper limb motor disability] or know somebody who has it.”</td>
<td>“I feel like with a lot of advertised accessible devices it’s hard to know if they’re gonna work for you without trying them first or watching others with similar disabilities to you use them.”</td>
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Table 6.2.: Part 2 of Participant quotes from participatory design fiction sessions and accompanying quotes derived from them in YouTube script.
6.3.2.1. Design

Regarding positive accessible features of the presented gaming wearable, our participants valued that the proposal drew interaction away from solely involving the hands and fingers and spread interaction to other parts of the body. DP3 voiced about the proposal, “So this would be exactly what I was hoping - what I was visualizing you’re sharing the load with other parts of the arm.” Our participants also proposed the same type of movement interaction could be used on other parts of the body to create a more customizable and adaptable experience that could be used by a wider variety of individuals. DP2 suggested, “if you had a motion sensor, like that could be controlled by hand rotation. If it could also be worn, say, on your chest in a vertical orientation so that you could go with your torso or put it on your leg, if that’s what you have...Seems like it would be sort of adaptable to a wider range of disabilities.”

Our participants expressed more hesitance around the muscle contraction interaction also used in the proposed wearable but suggested alternate ways this interaction could be included to make the interaction more accessible. DP1 voiced, “But my initial thought would be like hesitant to use it as like a main interaction technique as something you have to kind of like consciously do...I would get kind of like, wrapped up in trying to flex something or contract a muscle to try to do something important in a game.” A significant barrier our participants noted was the mental effort required to contract specific muscles, even for muscles in larger muscle groups. Instead, DP2 suggested utilizing muscle contraction but linking the action to a muscle movement, for example “if you sort of tied them to the motions, that would make sense in the
game. Like, like a jump would be like lift lifting your heel off the ground.” All of our participants also emphasized the importance of being able to configure the sensitivity of a wearable to correspond to their needs. DP3 outlined how their Parkinson’s can cause muscle excitement when focusing on something like a video game, and so a wearable would have to be able to account for such a change in disability characteristic over the course of a gaming session. They said, “When we are in the game and getting excited for the game. I get a lot more of this shaking than when I’m not in the game. So again, during the experience, it’d be cool if it was configurable enough to tone it down or turn it up a notch, depending on where I am in the game.”

6.3.2.2. Benefits

Our participants identified that the accessible gaming wearable presented a way to customize interaction to include whatever body parts they had the most control of; as DP2 voiced “the benefit for me getting a wearable like this would be to utilize muscles that aren’t as easily fatigued.” Similarly, DP3 highlighted the ability to exercise more parts of the body in gaming with a gaming wearable, “It would allow me to- to exercise parts of the body that aren’t currently exercised through gaming.” This aspect was highlighted as especially important as DP3 utilized gaming as exercise and physical therapy.

Additionally, wearable interaction represented an opportunity for a modular system, whether switching out the place on the body where the wearable is being worn or switching out the wearable with a traditional controller when fatigue began to set in. DP1 stated, “if I was playing a game where this wearable was used and after a
while I got really tired because it required a lot of physical activity, how easy it would be just to drop the wearable from use and pick up like a standard handheld controller or something.”

Due to the unique type of interaction, DP1 also proposed that gaming interaction with a wearable may also offer a new gaming experience when playing old games, “it would make me want to revisit a lot of games that I’ve already played and kind of experience them for the first time all over again.” This unique type of interaction also presented a potential to bridge a gap between regular gaming immersion and the level of immersion felt in VR games. DP1 highlighted, “It would be a cool way to, I guess, bridge the gap for me personally to experience a certain level of immersive like virtual reality.” VR can be inaccessible to individuals with disabilities, but including more parts of the body in video game interaction, akin to how the body is used in VR games, allows that heightened level of immersion without the negative accessibility aspects of VR.

6.3.2.3. Drawbacks

A notable drawback raised was the cognitive effort needed to don and doff a wearable, DP1 described “I would I would also imagine...like having to take it off and store it. It would have to be a very like cognitive, to be like okay I am blocking off X amount of time today to use this.” Similarly, the presented proposed wearable was noted as taking more space to use that would make it difficult to multitask, DP1 described “I tend to look at it like I’ll eat while I play video games, just like I’ll have my hand one hand on the controller and do something with the other. So now I would feel like I
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wouldn’t be able to necessarily like pick up and drop the game super quickly. I would have to be really committed to that play session.”

What was noted as a drawback was the novelty of wearable interaction and its potential to be widely adopted, and how well it would integrate with existing games. DP4 expressed, “How many games you can play with this wearable... Will people buy it? What’s the future of this?” DP2 speculated the best route would ideally be for games to be developed for the device, “sort of adapting anything, you’re already at kind of a disadvantage unless somebody is developing the game specifically for use with this system or wearable.” On the question of the types of games that our participants could see being developed for a gaming wearable, concern arose around if games would be too directed towards the exergame genre. DP1 voiced, “if it was something that was marketed as for like, like exergames or something, I would be less willing to purchase that. I would want it to be something that I could make my own and use in whatever context made the most sense for me.” Related to exercise with the device, DP3 brought up the issue of energy they are able to spend on activities. DP3 used Wii boxing as their primary method of gaming and exercise, they voiced “If I’m gonna box, I’m doing it not only because I enjoy it, but because it helps me. I’m not able to do anything else that day if I boxed. So if I spend 20 to 30 minutes on that, it’s got to be the right thing for me to spend my money, my exercise money on..it better be the right activities to keep me, to give my best return on my investments, my time investment.” Here it is important to consider how fatigue affects not only the user’s gaming session but also potentially their energy distribution for the rest of the day.
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The last potential drawback identified was the cost. Concerns were voiced about how much additional cost a wearable such as this could pose when consoles typically come with a traditional controller. DP1 explained, “it seems like nowadays it would have to be something additional that was purchased. So there’s a financial kind of requirement there, whereas most controllers, not all, but most and least ones I think I use and like to use, come with the console already.” Contrary to this, DP3 voiced that if they were certain an accessible gaming wearable would present a gameplay advantage to them that it would be worth the investment, “I play a lot of Wii boxing, so I’m not a big spender. But if there was something out there that would give me an ounce of improvement, I’d spend it in a moment.” Therefore, there needs to be a balance between ensuring such a device can provide an improvement to the user and how much that device will additionally cost the user.
Chapter 7.

Discussion

Through the two phases of the study, we aimed to explore the needs of video game players with upper limb motor disabilities as they relate to accessible gaming wearables. In the first study, we conducted semi-structured interviews with eleven participants to understand how users use wearable technology and how they experience barriers in video game interaction. The second study furthers this exploration by using participatory design fiction sessions with four participants to envision how using gaming wearables would affect their gaming experience.

7.1. Understanding the User Base

Through the semi-structured interviewers, we explored the lived experiences of people with upper limb motor disabilities and we developed an understanding of the accessible devices and strategies these players use when playing video games. Additionally, combining this knowledge with prior research on the valued aspects of wearable and video game interaction, we outline strategies for accessible wearable controllers. These
strategies are further outlined in the proposed design guidelines for accessible gaming wearables.

7.1.1. Strategies for Accessible Gaming Technology

This section outlines the primary strategies that our participants put into practice to overcome interaction barriers they experienced in gaming as explored in the first phase of the study. We discuss how future strategies for solving video game interaction barriers could be supplemented through DIY research with disabled communities.

Our participants tended to utilize adapted playstyle methods, which use controllers and input devices in different ways to make interaction more accessible. These included using body parts other than the hands and fingers, frequently changing how they interact to avoid triggering discomfort or switching between hands depending on which hand felt better. This differed from previous research by Wentzel et al. [46] that discussed aspects of multimodal input or using many devices in tandem to create accessible interaction. For participants who did not use adapted playstyle methods, they tended to find consoles or systems that presented the least barriers and use those platforms. This shows a different facet of how players with upper limb motor disabilities find interaction accessibility for video games. This also highlights how the gaming experience and the ways that users choose to interact with video games differ greatly among users with upper limb motor disabilities. To address the high level of preference and persisting existence of video game interaction barriers, organizations like Makers Making Change put effort towards creating low-cost augmentations to existing video game controllers, as seen in their one-handed Xbox controller modifi-
Chapter 7. Discussion

cation [94] and their PlayStation 4 controller case [95]. They are, however, limited in that they are only able to design these adaptations on a case-by-case basis by volunteer designers. This shows there is value in video game players with upper limb motor disabilities to be able to adapt and DIY their own game interaction that is customized and adapted to their own preferences. DIY culture and disability have been explored extensively in HCI research [96–99]. Applying these types of DIY strategies to gaming applications could benefit gaming accessibility by allowing gamers with disabilities to create their interaction solutions instead of having to wait for others to assist through organizations like Makers Making Change. Moreover, devices like the Xbox Adaptive could be a powerful tool in DIY solutions. Any interactive device with a 3.5mm mono jack is compatible with the Xbox Adaptive controller. Therefore, it presents immense potential as a conduit between DIY interaction hardware and video game software that should be further explored.

7.1.2. Strategies for Accessible Gaming Wearables

This section addresses opinions and experiences raised by our participants as they relate to the design space of accessible wearables. We delve into how current research on gaming wearables and the values users want from them relate to our findings and what users with upper limb motor disabilities need from gaming wearables.

Research on gaming wearable design highlights interactivity, socialization, and performativity [25–27]. Our participants confirmed the value of wearables that offered interactivity and socialization but did not see a significant value in performativity. Our participants instead valued the interaction that additionally provided an avenue
for movement. Incorporating movement into video game interaction is not new to disability research, and is in fact the subject on many studies focusing on rehabilitation and exercise (or “exergame”) applications [6, 64, 66, 100]. However, a number of these studies focus on creating new exergames for users to play [64, 66, 100]. It is additionally valuable to explore how to add a high level of physical movement as interaction to games that users already have or want to play. This was explored by Ahmetovic et al. [6] in a rehabilitative/exergame context, as well as Hassan et al. [59] for esports applications. However, Ahmetovic et al. [6] focused on rehabilitative and exergame applications of physical movement for game interaction, which our study shows not all video game players with upper limb motor disabilities are interested in. Though incorporating physical movement in video game interaction is beneficial to users with disabilities, focusing game interaction entirely on rehabilitative purposes does not fulfill the needs of gamers with disabilities and should be balanced with game interaction for entertainment purposes. This concept was explored by Hassan et al. [59] for users with limb differences who played esports. This represents one disability demographic and one entertainment video game genre and should likewise be explored with further disability demographics and video game types.

7.2. Critique of Gaming Wearables and the Need for Accessible Design Guidelines

As gaming wearables are becoming a higher area of interest in the gaming industry and gaming research, it was valuable to explore the accessible qualities of a select
number of industry and research examples with our participants with upper limb motor disabilities. We explored these examples during the second phase of the study to additionally help our participants enter the mindset of discussing gaming wearables and accessibility. The industry examples were the Nintendo Wii controller (Wiimote), a bionic prosthetic arm, and the KOR FX gaming vest. The research examples were taken from research by Jung et al. [25] and were a wrist-worn device called “inputs”, a whole-body device called “gaming cloth”, and a head-worn wig wearable.

From the industry examples, our participants valued the simplicity and practicality of the examples. Compared to the research examples chosen, the industry examples represented more realistic interaction solutions, whereas the futuristic nature of the research examples created some frustration for our participants. A primary concern around the KOR FX gaming vest used as an example was how easy it would be to use for individuals who experienced barriers with dressing. This aspect highlights how far-reaching accessibility considerations must be when designing gaming wearables. Not only do we need to consider how the interaction is made to be accessible, but also how the entire experience of preparing, wearing, and removing the wearable is made to be accessible. Additionally, though there is ample praise for the gaming industry for the existing focus on gaming accessibility through devices like the Xbox Adaptive, this critique of existing industry examples of gaming wearables shows that many disabled users are still being excluded. This highlights the need for further consideration of accessibility when designing gaming interaction and the need for creating more interaction options designed specifically for users with disabilities.

Jung et al. [25] research example highlights creative and diverse interaction options
for gaming wearables. Participants raised many concerns about accessibility with these proposed wearables as outlined in section 6.3. The examples from this study resulted from following wearable design guidelines that value interactivity, sociality, and performativity [25]. Feedback from our participants with upper limb motor disabilities about a select number of wearables explored in this research shows that these design guidelines for gaming wearables do not describe or capture the needs of players with upper limb motor disabilities for gaming wearables. Therefore, this highlights the need for identifying and testing design guidelines for accessible gaming wearables with explicit input from players with upper limb motor disabilities.

### 7.3. Design Guidelines

Considering participant input from both phases of the study, we propose the following design guidelines for accessible gaming wearables for users with upper limb motor disabilities. These include designing for interactivity, designing for large muscle movement, designing for flexibility in use, and designing for modularity. Though these concepts are not new in the area of accessibility research, they are distinctly different than the design values commonly expressed in gaming wearables research. Therefore, to explore the accessibility potential of wearables for video games it is important to understand how these design guidelines apply.

#### 7.3.0.1. Designing for Interactivity

Gaming wearables should be designed first for direct interactivity with video games. Our participants valued the connection between the player and the game through
interactivity—both input interactivity and output and feedback-based interactivity. Past work [25–27] supports this emphasis on designing meaningful interaction into gaming wearables.

Furthermore, our participants expressed the importance of social interaction in gaming wearables as well, confirmed by previous research [25–27]. However, the social aspect may be even more valuable for players with disabilities. In an in-depth study on accessibility barriers in video games, Porter and Kientz [51] reported that players with disabilities engaged with multiplayer games far less than single-player games. In video games, multiplayer games offer significantly more social interaction than single-player games. From Porter and Kientz’s [51] findings, it is evident that players with disabilities are not benefiting as much from the level of social interaction that multiplayer games offer. Therefore, it is understandable why participants in this study would put so much value on social interaction aspects of wearables and why the design of accessible gaming wearables should consider social interaction benefits.

During the participatory design fiction sessions, additional insights about the designing for interactivity guidelines were identified. When presented with the gaming wearable proposal, our participants noted potential drawbacks and concerns around the practicality of the interaction. Particularly, our participants noted the device’s novelty and how that could make gameplay for games designed for traditional interactivity less enjoyable with a novel interaction device. Our participants cited examples like the Wii Fit board, which utilized very novel interaction but was not useful nor enjoyable to use outside of the games specifically designed for it. This offers a second consideration for the interactivity guideline presented in the study’s first phase.
In designing for interactivity, it is not only valuable to design for wearables to be playful, as highlighted by Buruk et al. [27] and Jung et al. [25], but also to consider how the chosen interaction would merge with existing games and their gameplay. Interestingly, the novelty of interaction was also highlighted as a benefit of the device as new modes of interaction could make replaying games more enjoyable. This aspect highlights the importance of this new angle for designing for interactivity, that if done well, can not only merge well with existing gameplay and potentially create motivation for experiencing new gameplay interactions.

7.3.0.2. Designing Large Muscle Movement

In phase one, our participants both valued video games as an avenue for physical movement and showed a preference towards moving interaction away from the smaller muscle groups of the hands and fingers. Instead, our participants proposed the use of larger muscle group movement, such as arm movement or muscle activation in the shoulders and core. Utilizing these larger muscle groups in video game interaction provide our participants with the exergame element without the entire gaming experience being geared towards delivering exercise as with games such as RingFit Adventure by Nintendo. This exercise aspect of interaction is especially relevant for movement-based interaction that was challenging and enjoyable to the user without distracting from gameplay or being too strenuous. These aspects are already utilized in systems like the Nintendo Wii or VR, but further adoption of larger muscle movement-based interaction into gaming wearables could extend these interactions to systems beyond the Nintendo Wii or VR. We implore HCI researchers that design
video game controllers for people with upper limb motor disabilities to focus on designing add-ons that specifically target large muscle groups and limit the use of fine motor skills in movement-based interactions.

In phase two, the participatory design fiction sessions, our participants provided feedback on how large muscle movement could be incorporated into the proposed gaming wearable, and how to improve the application of this design guideline. The primary movement suggestion made by our participants was to connect the muscle sensor interaction of the wearable to specific body movements and not to the activation of individual muscle groups. For example, the user is told to lift their ankle to complete a jump action in the game and have the muscle sensor sense the muscle movement associated with that movement (e.g. contraction of the gastrocnemius). Figure 7.1 shows another example of this muscle interaction from our YouTube design fiction archetype. In this example, shoulder movement means choosing different items from the Minecraft hotbar. This feedback furthers the design guideline of designing for large muscle movements. Initially, the proposed wearable used the hand motion interaction aspect to represent the large muscle movement design guideline. Still, our participants also identified that the muscle sensor interaction aspect could also be easily tied to large muscle movements.

7.3.0.3. Designing for Flexibility in Use

Accessible gaming wearables should be designed to allow flexibility in how they are worn and used. This stems from the findings around our participants in phase one using different adapted playstyles to work around video game interaction barriers
Figure 7.1.: Scene from our YouTube video design fiction archetype showing how shoulder movement could translate to in-game action in Minecraft.
and similar findings by Vatavu and Ungurean [11]. This tendency towards device adaptation is an asset, and should therefore be highlighted and designed into accessible gaming wearables. When creating entirely new video game interaction devices is not feasible (some users may not want to invest in new devices or have the financial means to do so), designers and researchers should also consider how to make adaptations to existing devices to allow for more flexibility in use and to support adapted playstyles. By adapting already existing projects, it will increase the ability of customized projects which are tailored to individual needs. Researchers might be able to contribute to the development of customized projects by developing individualized research processes.

Flexibility in how a wearable is used also allows users to relocate interaction to the areas of the body they feel the most comfortable using. Traditional video game interaction focuses interaction on the hands and fingers. However, our participants showed a preference to be able to relocate interaction away from these areas of the body. Accessible gaming wearables must allow for this expression of preference. This was further highlighted during the participatory design fiction sessions. Though from the first phase of the study, the hand and wrist were the most commonly suggested locations for a gaming wearable by our participants, in the participatory design fiction sessions, it was clear that spreading interaction to many parts of the body and allowing the user to choose which part of the body to use the wearable were highly desired. For example, our participants suggested relocating interaction from the hand to the torso. Instead of moving and rotating their hand for interaction, they could instead lead in different directions and twist at the waist to interact. Figure 7.2 shows alternative
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Figure 7.2.: Alternative placements for wearable on the body as identified by our participants as represented in our Youtube video design fiction archetype.

7.3.0.4. Designing for Modularity

Designing gaming wearables to contribute to a collection of modular inputs is a valuable consideration. Consoles like the Nintendo Switch highly support modularity. The Xbox Adaptive controller has the design capabilities to support a variety of interactions, even if current interaction modalities focus on exclusively accessible switches, joysticks, and proximity sensors. Combining the design trend of gaming hardware with the findings around the benefits of modularity for users with disabilities, future accessible gaming wearable designs should contribute to a growing collection of mod-
Figure 7.3.: Scene from YouTube design fiction archetype showing how a gaming wearable could be used with the Xbox Adaptive controller.

Diverse interaction devices to provide users with diverse interaction options and find the device that works for them. Figure 7.3 shows how the Xbox adaptive controller could support using a gaming wearable instead of a traditional accessible switch which was developed from our participant’s feedback. Though we have seen many projects that showcase new technologies and controllers to support the community, we hope to see more explorations by researchers that develop accessories and add-ons to already available controllers.

During phase two participatory design fiction sessions, it was further highlighted how designing for modularity and designing for flexibility in use overlap. In addition to creating a wearable that could be easily swapped out with a traditional controller during game sessions, our participants also identified how a wearable could be moved
to different body parts for interaction. This creates flexibility in how it could be used, as identified above. It also adds to the modularity aspect by offering a collection of interaction methods for users to switch between as their interaction needs change throughout a gaming session. We employ other researchers to consider designing technologies that support modularity and are flexible enough to be used in multiple placements on the body.

7.4. Participatory Design Fiction Workshop and Tools

7.4.1. Using a Persona to Create Deeper Understanding of User Group

Though we initially wanted enough feedback about what users needed in an accessible gaming wearable from the first phase of the study, we found that not all of our participants were eager to share intimate details about their gaming experience or ignored their needs and wants in favour of considering other users with disabilities (e.g. considering blind or low vision users). To help our participants identify with and speak through a user representing a video game player with an upper limb motor disability, we included a persona-making activity in the participatory design fiction sessions. Additionally, this persona serves as the reviewer in our YouTube video design fiction archetype. The specific characteristics of the persona created in the participatory design fiction sessions are specified in section 6.3.1. Interestingly, in ad-
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dition to representing a user with upper limb motor disabilities, our participants also wanted the persona to represent someone who was non-binary. This aspect highlights the importance of considering intersectionality when designing for disability. This intersectionality may be represented by multiple disabilities or disability and other marginalized identities (like the non-binary identity, as defined by the persona). Given the study did not ask participants to go into detail about their identities outside of a disabled identity, this value towards intersectionality that our participants identified would likely not have arisen without the use of a persona.

In addition to highlighting the importance of intersectionality, the personas were also successful in helping our participants limit feedback to considering users with specifically upper limb motor disabilities. This resulted in more specific feedback we could apply to designing an accessible gaming wearable prototype for this user group. The persona also served as a conduit for our participants to provide more information about their experiences and preferences. This helped solve the initial barrier we experienced in the first phase of the study, where our participants were not always as eager to provide personal stories of lived experiences.

Personas are widely used in HCI research as a way for designers and researchers to understand the needs of specific user groups [101]. However, when used with marginalized groups like disabled users, there is some risk of enforcing harmful stereotypes [102–104]. This potential was not taken lightly, and to avoid any possibility of stereotypes being implemented, we allowed our participants (who all experience upper limb motor disabilities firsthand) to lead the conversation around the characteristics of the persona being created. This concern for accurate representation was
further carried into the design fiction archetype by having the actor featured in the video represent the upper limb motor disability and non-binary communities.

Considering all these aspects, we found a persona to be a valuable tool to help our participants streamline feedback to users with upper limb motor disabilities. This, in turn, resulted in more stories of lived experiences as told through the persona to help us better understand the user group and how to design accessible gaming wearables for them. However, efforts to avoid the persona representing stereotypes were taken, and this was helped by taking steps to find an actor for the design fiction archetype who was also representative of the intersectional experience of having an upper limb motor disability and being a part of the non-binary community.

7.4.2. Design Fiction Archetype

Design fiction is a well-known design tool to inform designers and researchers of how the implications that new technologies would have in the future if they were adopted [18]. This implication is represented through a diegetic prototype or archetype [18]. The goal of this archetype is to believably represent future technology through a medium where it would naturally fit if it existed today. In HCI research, there are many examples of the use of design fiction archetypes to represent future concepts. These include archetypes as posters [77], storyboards [20, 78], and physical prototypes [76, 78, 87, 105]. Though widely used, we observed the variety of media used to represent design fiction archetypes is somewhat limited. There have been ventures outside of posters, storyboards, and physical prototypes, such as work booklets used to explore social eating practices [106] and body maps used to explore queer expres-
sion through wearable technology [22]. Here we present the use of a YouTube video as a new media to represent design fiction archetypes in HCI research.

For our application of design fiction, a natural fit for our design archetype was a tech review-style YouTube video. This archetype also served as a natural fit for our dialogic/performance analysis application. Through using the narrative inquiry methodology, our data focused on collecting stories of lived experiences as they relate to gaming and wearable interaction. Through dialogic/performance analysis, these narratives were transformed into scripts. With one additional step, those scripts were transformed into a script for the YouTube video archetype, combined with the persona to create the YouTuber character and film. This provided us with the ability to specifically highlight positive and negative experiential aspects of a disabled user using a gaming wearable, as identified by our participants. The use of representing the archetype through a tech review YouTube video was additionally able to relay this experiential perspective in a way that other mediums of archetypes, like a poster or low-fidelity prototype, could not. Using a video format, we see a gamer representative of a person with an upper limb motor disability using a gaming wearable and hear the stories of our participants’ experiences through this user. This aspect of visual and auditory narrative delivery engages the viewer in this fictional world where accessible gaming wearables exist and shows us what that experience would look like.
7.5. Reflecting on Reflexive Thematic Analysis and Dialogic/Performance Analysis

We used this study as an opportunity to explore different data analysis methods. We find it valuable to reflect on each analysis method and how we applied them to each study phase. We first explored the commonly used method of reflexive thematic analysis in the first phase and then explored the narrative inquiry method of dialogic/performance analysis. This latter method is novel in its application to participatory design fiction HCI research. So we found it valuable to highlight how each method differs and the values they bring to the analysis process.

7.5.1. Reflexive Thematic Analysis Process

The first phase of the study utilized reflexive thematic analysis following the writing of Braun and Clarke [17]. This qualitative method of data analysis is widely used across many research disciplines. Braun and Clarke write that their method of thematic analysis is often misused, which motivated their 2019 paper clarifying the method and its applications [17]. This was the primary writing about reflexive thematic analysis that we followed to analyze the first phase of the study.

The fundamental value of thematic analysis is in the themes that the data is described through. These themes represent “interpretive stories about the data, produced at the intersection of the researcher’s theoretical assumptions, their analytic resources and skill, and the data themselves” [17]. This analysis method considers both the researcher’s perspective as well as the content of the data and the par-
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ticipants’ perspectives. This is a valuable approach as it utilizes the researcher’s subjectivity to enhance the data rather than viewing it as a threat to objectivity [17]. However, a noted downside of this analysis method was retaining the context of what participants said and how they said it. Reflexive thematic analysis concerns aspects of shared meaning between participants’ opinions and experiences and represents those as themes and codes. Reducing an entire expression of lived experience down to a theme or code and focusing on how these themes and codes relate to each other can lose some of the nuance present in the individual quotes from participants.

Lastly, reflecting on the specific application of thematic analysis on interview data, we were able to procure a large amount of data. However, it remained difficult to retain data from participants who were more difficult to elicit responses from. This also speaks to the effectiveness of the interview method of data collection– often some participants are more eager and willing to share perspectives from lived experiences than others. This is a barrier we attempted to alleviate by using personas in the second phase of the study, as discussed previously.

7.5.2. Dialogic/Performance Analysis Process

The second phase of the study utilized the narrative inquiry method of dialogic/ performance analysis. This method is rarely used in HCI research, and this study explores a novel application of this method of narrative inquiry for participatory design fiction-based HCI research. Here we reflect on the overall process of using this narrative inquiry method and the overall benefits it presents for participatory design fiction research.
Riessman identified the primary application for dialogic/performance analysis is for data that involves a conversation between individuals, and through conversation, narratives of lived experiences will naturally arise [23]. We found this to be represented in our application of dialogic/performance analysis, as not all questions or topics covered in the participatory design workshops specifically asked participants to provide a story from their life however participants still volunteered short narratives to express their opinion or provide an example of their experience. Narrative inquiry also includes the researcher conducting the session with participants as a participant [23, 24, 88]. Therefore, even in instances where only one participant attended the participatory design session the conversational aspect which dialogic/performance analysis depends upon still occurred between the researcher as a participant and the attending participant. We conducted one participatory design workshop with three participants, and one with one participant and in both instances, ample narratives were relayed by participants. Another key aspect of dialogic/performance analysis is combining the focus on content from thematic analysis with the focus on how narratives are told from structural analysis [23]. Therefore, through dialogic/performance analysis the context of what was said by participants and how it was said is kept intact more than with using thematic analysis or structural analysis alone. This context of how narratives were expressed was particularly applicable in our case of creating a design fiction archetype (a review YouTube video) based on participant narratives as we were able to pull specific words/phrases said by participants as well as how these were expressed and reflect them in the YouTube video.

Smith-Chandler and Swart [107] identify that narrative-based methodologies are
particularly important for disability research. They identify that through narrative inquiry many perspectives from people with lived experience with disability can be explored and “challenge static beliefs etched in impairment stereotypes.” [107]. Furthermore, they highlight that through stories of lived experiences “alternative voices of disability can be heard from the unique perspectives of the individuals themselves.” [107]. Our conversation-based participatory design research reflected the importance of having alternative voices, not only to raise differing lived experiences and opinions but also to reflect commonalities through common lived experiences or common barriers. On multiple occasions, participants with different disabilities found commonalities in their experiences with barriers or opinions on the usability of an accessible gaming wearable. The lived experiences of disability can feel alienating, however through such conversations as the ones explored in this study commonalities in disability experience were able to be explored between individuals who experienced different disabilities. This aspect of finding commonalities and reflecting similar experiences allowed participants to express further narratives and build on each other’s narratives.

In a similar subject, Vyas et al. [81] used narrative inquiry to delve into the lived experiences of individuals in under-resourced communities. In this research, they found that the narrative nature of the data allowed participants to open up about very personal lived experiences [81]. We likewise found that hearing narratives of lived experiences from other participants allowed participants to open up more about their own experiences. In addition to this, utilizing the design fiction activity of creating a persona (used to inform our character for the YouTube video archetype) also allowed
participants to express more of their own experiences and beliefs through this persona. Therefore, the added aspect of design fiction and persona building contributes to the expression of narratives in participatory design research and narrative inquiry.

7.5.3. Differences in Processes

The primary difference we observed between the two data analysis methods was the level of context kept intact. Reflexive thematic analysis, like narrative thematic analysis, is focused solely on the content of what participants say. During the process of reflexive thematic analysis sentences or expressions from participants are whittled down to one or two words that encompass the meaning of what was said in a code. In organizing these individual codes into larger themes and subthemes it was difficult to keep the context of how each participant voiced each code. This resulted in some repetitions of codes in different themes and subthemes. With dialogic/performance analysis, the context of how participants voice their lived experiences is kept intact more so than reflexive thematic analysis. Furthermore, the narratives analyzed with dialogic/performance analysis were still able to be reduced to establish the narratives in relation to the framework (in our study the framework of fit vs misfit and dependence vs vulnerability) while still retaining the context that participants established while voicing their narratives.

Lastly, it is worth discussing the conversational aspect of the research conducted through the two phases of the study and how this relates to the data analysis process. In dialogic/performance analysis the researcher is explicitly included additionally as a participant in the research. This aspect is useful both in encouraging narratives
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to arise through conversation and is also valuable in instances where the researcher may have their own lived experiences to share. This was the case in our research where the lead researcher conducting the participatory design fiction sessions self-identifies as neurodivergent and has their own experiences with difficulty using traditional controllers. Reflexive analysis only considers the input from participants, and so the conversational aspect that makes research on lived experiences so rich is largely lost. Different voices of lived experiences are valuable in disability research [107] and contribute to the richness of data, and through dialogic/performance analysis those different voices can be more equally valued.

To summarize, both reflexive thematic analysis and dialogic/performance analysis each have their own more useful applications and different results. In our experience of using reflexive thematic analysis on interview data, we were able to retain a large quantity of data from a relatively small participant pool and provide an overview of the different needs and experiences of the participants. In our application of dialogic/performance analysis to participatory design fiction sessions, we were able to retrieve a more detailed look at the lived experiences of participants relayed through narratives. The goal for the first phase of interviews was to generate a base-level understanding of the user group of players with upper limb motor disabilities, while the goal of the second phase was to retrieve actionable feedback on how accessible gaming wearables could be used in video games. Both data analysis method applied to their respective phases was able to provide the needed information.
7.6. Limitations and Future Work

We presented our research on the topic of accessible gaming wearables for players with upper limb motor disabilities and identify the limitations of our research and opportunities for future work.

We acknowledge that participants recruited for this study are exclusively representative of Western, educated, industrialized, rich, and democratic (WEIRD) societies. Additionally, this study was limited in the spectrum of disability characteristics. Upper limb motor disabilities are extensively diverse, and there are a multitude not represented by participants in this study. While we seek to provide knowledge on lived experience to support future designs of accessible gaming controllers, we recognize that it would be impossible with this small user group to generalize findings to design large-scale projects. We also note the importance of including researchers in these projects that have upper limb motor disabilities in the research. We hope others will run similar studies with different communities to gain even stronger insights to understand the lived experiences of gamers with upper limb motor disabilities.

Future work on accessible gaming wearables should similarly explore different types of disabilities beyond just upper limb motor disabilities. There are diverse disabilities represented in the disabled gamer community, and similar studies to explore how gaming wearables should be designed for these groups should be explored. Our research presented an idea for an accessible gaming wearable and represented its use through a design fiction archetype. The logical next step for our research is to create a working prototype of an accessible gaming wearable and evaluate it at the low-fidelity and mid-fidelity levels. Furthermore, data from the study shows that both
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wearables with input interactivity, as well as output interactivity, show the potential to be meaningful assets to the user base of gamers with upper limb motor disabilities. This study focuses on accessible gaming wearables for input interaction, but opportunities are present for similar exploration into accessible gaming wearables for output interaction.

Future work on dialogic/performance analysis should explore other examples of how this analysis method can be applied to other types of participatory design fiction research. Our research presented a natural fit for dialogic/performance analysis as our chosen design fiction archetype was a script and accompanying video for a tech review YouTube video. Design fiction archetypes can represent a diverse number of artifacts, and exploration into how dialogic/performance analysis can support other types of design fiction archetypes is valuable. Future applications of dialogic/performance analysis with disability research should also strive to create a framework specifically for disability research in HCI that can be used with narrative inquiry through dialogic/performance analysis.
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Conclusion

This study aimed to explore the design space of accessible gaming wearables for players with upper limb motor disabilities. Through eleven semi-structured interviews and two participatory design fiction sessions we explored the lived experiences of gamers with upper limb motor disabilities, the barriers they experience, their strategies for overcoming barriers, and their feedback on proposed and existing gaming wearables. Additionally, we reflect on the use of reflexive thematic analysis and dialogic/performance analysis on the qualitative data collected through the study. In this chapter, we revisit the research questions and conclude our findings on each study goal.

8.1. Research Questions

Over the two phases of the study, we explored the research questions: RQ1. What design guidelines for an accessible gaming wearable can be formulated that capture the needs of players with upper limb motor disabilities? RQ2. How can the use
of a design fiction archetype be used to represent the future of accessible gaming wearables? **RQ3.** How can personas as a research activity be used to develop deeper understanding of our user group of individuals with upper limb motor disabilities to inform future designs of accessible gaming wearables?

In the first phase of the study, we interviewed eleven disabled video game players to explore their experience playing video games and any barriers they face in doing so, as well as their experience using wearable technology. We furthered this exploration in the second phase of the study where, through participatory design fiction sessions, participants were asked to give feedback on a proposed accessible gaming wearable and how it could practically be used in playing video games. These explorations provided the basis of information to propose design guidelines to address RQ1. We proposed the design guidelines designing for interactivity, designing for flexibility in use, designing for large muscle movement, and designing for modularity. Though these conclusions are not novel in accessible design research, they add value to the research on gaming wearables as contemporary research proposes design guidelines such as designing for interactivity, sociality, and performance/costuming [25]. We identify here the difference between conclusions made about how to design gaming wearables for the average user, and our research on how to design gaming wearables for users with upper limb motor disabilities.

We furthermore used input from the phase two participatory design fiction session to build a design fiction archetype which represented how an accessible gaming wearable could be used in practice. The design fiction archetype used was a tech review YouTube video. This medium provided a natural opportunity to highlight the positive
Chapter 8. Conclusion

and negative aspects of using a gaming wearable in practical gameplay as identified by study participants. Points outlined in the archetype were directly inspired by the results of the dialogic/performance analysis used on participatory design fiction session data. Furthermore, the medium of a YouTube video as a design fiction archetype was able to better represent the use of an accessible gaming wearable better than the more commonly used mediums of posters or storyboards. The combination of visual and auditory narrative deliver engages the viewer in the fictional world represented and shows us what the real-life experience of using an accessible gaming wearable would look like.

We found some participants in the first phase of the study to be less eager to provide stories of lived experiences to identify their needs and experiences alleviating interaction barriers, so personas were used in the second phase as a conduit to generate a deeper understanding of the user group. This addressed RQ3. Through using a persona-building activity in the participatory design fiction sessions we were able to create the character for the design fiction archetype. This character represented the intersectional aspects of being part of both the disability and non-binary communities. This aspect of intersectionality when considering accessibility was valued by participants. Additionally, care was taken to avoid perpetuating harmful stereotypes as is a risk with personas [102–104], and all aspects of the persona were directly informed by participants.

Lastly, we found it valuable to reflect on the processes of using reflexive thematic analysis and dialogic/performance analysis in the first and second phases of the study, respectively. We found it difficult to retain the context of what was said by partici-
pants in interviews when using reflexive thematic analysis, as this method is primarily concerned with what was said rather than how it was said. Secondly, participants sometimes relayed valuable points of lived experiences and it was difficult to whittle these points down to one or two word codes and subthemes. When using dialogic/performance analysis on the second phase of the study, we found it easier to retain the context of the stories told to us. These stories were also easier to keep intact as the analysis method considers the whole of the story. Additionally, we found a particular value of dialogic/performance analysis to be that the researcher is also included as a participant and this can be beneficial when the researcher has their own lived experience with the topic being explored. These different aspects are valuable when considering which qualitative analysis method to utilize, and additionally show the potential that dialogic/performance analysis has in applications to HCI research. This research presents an in-depth examination of the needs of video game players with upper limb motor disabilities as they apply to accessible gaming wearables. Our research advances research on gaming accessibility by providing insight into how new and novel technologies such as wearable technology can benefit users with disabilities. Our research findings can be applied to gaming interaction design in both research and industry applications to design wearable gaming interaction that is accessible and eliminates interaction barriers for players with upper limb motor disabilities.
Appendix A.

Interview Consent Form
Study Title

Understanding the Potential of Gaming Wearables for Players with Upper Limb Motor Disabilities

Name and Contact Information of Researchers:

Georgia Loewen, Carleton University, Human-Computer Interaction
Tel.: 204-396-4726
Email: georgialoewen@cmail.carleton.ca

Supervisor and Contact Information:

Dr. Audrey Girouard, Carleton University, School of Information Technology.
Email: AudreyGirouard@CUNET.CARLETON.CA

Carleton University Project Clearance

Clearance #: 117808
Study Clearance Date: July 2022
Consent form version date: 2

Project Sponsor and Funder (if any)

N/A

Invitation

You are invited to take part in a research project because you are English-speaking, 18 years of age, self-identify as having an upper limb motor disability, and have 1+ years of experience playing video games. The information in this form is intended to help you understand what we are asking of you so that you can decide whether you agree to participate in this study. Your participation in this study is voluntary, and a decision not to participate will not be used against you in any way. As you read this form, and decide whether to participate, please ask all the questions you might have, take whatever time you need, and consult with others as you wish.

What is the purpose of the study?

Video games are a popular hobby, and so video game interaction methods should be designed to be inclusive. Historically, the player base with disabilities has been overlooked and so more efforts should be exercised to understand this player bases’ needs. Wearable devices for gaming interaction are also an area of growing interest with some overlap in interaction methods with assistive technology. The aim of this study is to better understand how gaming wearable devices are being utilized by players with upper limb motor disabilities. Additionally, this study hopes to use input from the user base to provide guidance on how gaming wearable devices can be better designed to be inclusive.
What will I be asked to do?

If you agree to take part in the study, we will ask you to:

- Participate in a preliminary demographics survey to confirm eligibility
- Participate in a semi-structured individual interview conducted over Zoom, Google Meets, or over the phone
- Interview questions will focus on questions pertaining to your understanding of wearable devices and your experiences using them for video game, entertainment, or other hobby purposes, as well as questions focused on your experiences and preferences surrounding interacting with video games
- The semi-structured interview is expected to take 60 minutes, and will be audio recorded
- Audio recording of the interview is required. The audio recordings will be stored on password protected devices only accessible by the lead researcher and will later be permanently deleted on completion of transcription of the data.
- Video recording of the interview is optional. The video recordings will be stored on password protected devices only accessible by the lead researcher and will later be permanently deleted on completion of transcription of the data.
- Transcription of interviews will be done using the artificial intelligence audio transcription software Trint. Should you decide to opt out of the use of Trint software for audio transcription, transcription of recordings will be done manually by the lead researcher.
- Anonymized data collected from the interview may be used in future reports, teaching and for publication purposes which may include a summary of findings as well as direct quotes from the interviews along with associated coded titles. No quotes that contain identifiable information about you will be included.

Risks and Inconveniences

There are not anticipated physical, emotional, social, privacy, or legal risks associated with this study. All questions asked are intended to investigate participants’ experience interacting with video games, and using gaming or entertainment/hobby wearables. The nature of these questions makes it unlikely that inadvertent disclosure of responses would place a participant at risk for criminal or civil liability, or damage their financial, employment or reputation. Additionally, it is not expected that any question asked in the survey would put participants’ identity at risk, and all data and responses will be anonymized to further protect participant identities.

Possible Benefits

Benefits of this study are expected to be contributions to the growing knowledge of information on gaming wearables and how to incorporate and design around the input of users with upper limb motor disabilities. Direct benefits to participants will include learning more about gaming wearables, and potentially being introduced to new and useful video game interaction methods.
Compensation/Incentives

Participants will be compensated with a $25 (CAD) e-gift card of their choosing, with the default choice being Amazon. This compensation is dependent on your completion of the study demographics survey and confirmed eligibility in the study according to the inclusion criteria. Compensation will be delivered to participants via the email they used to express interest in the research study, and they will be delivered after the semi-structured interview has concluded. If a participant decides to withdraw from the study, compensation will still be provided to them.

No waiver of your rights

By signing this form, you are not waiving any rights or releasing the researchers from any liability.

Withdrawing from the study

If you withdraw your consent during the course of the study, all information collected from you before your withdrawal will be discarded.

After the study, you may request that your data be removed from the study and deleted by notice given to the lead investigator (Georgia Loewen) before September 30, 2022.

Confidentiality

We will remove all identifying information from the study data as soon as possible, which will be after data has been collected.

We will treat your personal information as confidential, although absolute privacy cannot be guaranteed. No information that discloses your identity will be released or published without your specific consent. Research records may be accessed by the Carleton University Research Ethics Board in order to ensure continuing ethics compliance.

All data will be kept confidential, unless release is required by law (e.g. child abuse, harm to self or others).

The results of this study may be published or presented at an academic conference or meeting, but the data will be presented so that it will not be possible to identify any participants unless you give your express consent.

We will remove all identifying information from the study data as soon as possible, which will be after data has been collected. You will be assigned a code so that your identity will not be directly associated with the data you have provided (e.g. P01, P02, P03). All data, including coded information, will be will be kept in a password-protected file on a secure computer.

All audio recordings will be recorded on a password protected mobile phone. Data from the interviews will be then transcribed and all original audio and video files will be deleted. Transcribed data, interview notes and consent forms will be stored of Citrix ShareFile hosted by Carleton University secure servers. A master list with identifiable participant information will be stored on a usb thumb drive in a secure location under lock on campus.

For transcription, audio recordings of the interviews will be uploaded to Trint for transcription using pseudonyms to ensure all information remains anonymous. This will be stored on Trint’s servers during
transcription which uses AWS data centers in the US (Oregon, North California, North Virginia, Ohio.) Once interviews are transcribed and collected by the research team, Trint will be contacted to permanently delete all data. Trint is also fully certified to ISO 27001, PCI DSS compliant, and verified by SAM, UK Crown Commercial Service and Cyber Essentials. Further information regarding Trint’s data security such as data transfer and storage using HTTPS and encryption using AES 256 can be seen in their security information at trint.com/security. Should you decide to opt out of the use of Trint software for audio transcription, transcription of recordings will be done manually by the lead researcher.

We will password protect any research data that we store or transfer.

**Data Retention**
Your de-identified data will be retained for a period of 3 years and then securely destroyed.

**New information during the study**
In the event that any changes could affect your decision to continue participating in this study, you will be promptly informed.

**Ethics review**
This project was reviewed and cleared by the Carleton University Research Ethics Board B. If you have any ethical concerns with the study, please contact Carleton University Research Ethics Board by email at ethics@carleton.ca.

**Statement of consent – print and sign name**
I voluntarily agree to participate in this study. ___Yes ___No
I agree to be audio recorded ___Yes ___No
I agree to be video recorded (optional for study) ___Yes ___No
I agree to have recordings of my interview be uploaded to Trint (optional for study) ___Yes ___No
I agree to be contacted for follow up research ___Yes ___No

__________________________
Signature of participant (or parent/guardian) Date

**Research team member who interacted with the participant**
I have explained the study to the participant and answered any and all of their questions. The participant appeared to understand and agree. I provided a copy of the consent form to the participant for their reference.
__________________________  ____________________
Signature of researcher     Date
Appendix B.

Interview Script

B.1. Gaming

1. What current input methods do you use when playing video games? (e.g. keyboard, console controller)

2. Do you experience any barriers when playing video games with your input method of choice? If yes, please describe them.

3. If yes, how do you solve these barriers?

B.2. Wearables

4. What kind of devices do you think of when you hear the term “wearable technology” or “wearable devices”?

5. Do you use any wearable devices for other entertainment, hobby, or everyday life activities?
Appendix B. Interview Script

a) If YES

i. Can you name or describe the wearable devices you use in these contexts?

ii. How did you find out about these devices?

iii. What aspects of the wearable device/s do you like or dislike?

iv. How often do you use these devices?

b) If NO

i. Are there any wearable devices you are interested in using for these contexts?

A. If YES - How did you find out about these devices?

B. If NO - Do you think that wearable devices would be useful for you in the context of entertainment/hobbies/everyday life activities?

6. Do you use any wearable devices for playing video games?

a) If YES

i. Can you name or describe the wearable device/s you use for playing video games?

ii. How did you find out about these devices?

iii. What aspects of the wearable device/s do you like or dislike?

iv. How often do you use them when playing video games?

b) If NO
Appendix B. Interview Script

i. Are you interested in using any wearable devices for playing video games? Can you name or describe them?

A. If YES - How did you find out about these devices?

B. If NO- Do you think that wearable devices would be useful to your gaming experience?

7. Imagine a wearable device that you could use for playing video games

a) Where would it be located?

b) How do you imagine yourself interacting with it?

c) What kind of game contexts/game actions would it be used in?

d) What would it look like?

e) How would it fit in with your current gaming setup?

f) In addition to interaction, would this wearable highlight other aspects such as social aspects or costume/performance aspects?
Appendix C.

Participatory Design Fiction

Consent Form
Informed Consent form for Study Participants

<table>
<thead>
<tr>
<th>Study Title</th>
<th>Understanding the Potential of Gaming Wearables for Players with Upper Limb Motor Disabilities</th>
</tr>
</thead>
</table>
| Name and Contact Information of Researchers: | Georgia Loewen, Carleton University, Human-Computer Interaction  
Tel.: 204-396-4726  
Email: georgialoewen@cmail.carleton.ca  
Supervisor and Contact Information:  
Dr. Audrey Girouard, Carleton University, School of Information Technology.  
Email: AudreyGirouard@CUNET.CARLETON.CA |
| Carleton University Project Clearance | Clearance #: 117808  
Study Clearance Date: July 2022  
Consent form version date: 2 |
| Project Sponsor and Funder (if any) | N/A |

Invitation

You are invited to take part in a research project because you are English-speaking, 18 years of age, self-identify as having an upper limb motor disability with characteristics including fatigue in the hands/fingers, lowered finger response time, and difficulty with fine motor movements of the hands/fingers, and have 1+ years of experience playing video games. The information in this form is intended to help you understand what we are asking of you so that you can decide whether you agree to participate in this study. Your participation in this study is voluntary, and a decision not to participate will not be used against you in any way. As you read this form, and decide whether to participate, please ask all the questions you might have, take whatever time you need, and consult with others as you wish.

What is the purpose of the study?

Video games are a popular hobby, and so video game interaction methods should be designed to be inclusive. Historically, the player base with disabilities has been overlooked and so more efforts should be exercised to understand this player bases’ needs. Wearable devices for gaming interaction are also an area of growing interest with some overlap in interaction methods with assistive technology. The aim of this study is to conduct a remote co-design session to discuss user scenarios and benefits/drawbacks of an accessible gaming wearable.
What will I be asked to do?

If you agree to take part in the study, we will ask you to:

- Participate in a preliminary demographics survey to confirm eligibility
- Participate in a remote co-design workshop to discuss use case scenarios, benefits/drawbacks, and overall usability of an accessible gaming wearable device for video game interaction
- Data collected from the co-design workshop will be used by the lead researcher to inform the creation of a product review-style Youtube video.
- The co-design session is expected to take 2 hours and will be audio and video recorded.
- Audio recording of the interview is required. The audio recordings will be stored on password protected devices only accessible by the lead researcher and will later be permanently deleted on completion of transcription of the data.
- Video recording of the interview is optional. The video recordings will be stored on password protected devices only accessible by the lead researcher and will later be permanently deleted on completion of transcription of the data.
- If a participant prefers not to be audio recorded they are asked to turn their video off in the video conference call
- Transcription of interviews will be done using the artificial intelligence audio transcription software Trint. Should you decide to opt out of the use of Trint software for audio transcription, transcription of recordings will be done manually by the lead researcher.
- Anonymized data collected from the interview may be used in future reports, teaching and for publication purposes which may include a summary of findings as well as direct quotes from the interviews along with associated coded titles. No quotes that contain identifiable information about you will be included.

Risks and Inconveniences

There are not anticipated physical, emotional, social, privacy, or legal risks associated with this study. Usability testing tasks are not anticipated to be physically taxing or cause physical harm, however in the event that using the prototype results in extreme discomfort or potential injury you are asked to stop using the prototype and inform the lead researcher. All interview questions asked are intended to evaluate the design quality of the gaming wearable prototype. The nature of these questions makes it unlikely that inadvertent disclosure of responses would place a participant at risk for criminal or civil liability, or damage their financial, employment or reputation. Additionally, it is not expected that any question asked would put participants’ identity at risk, and all data and responses will be anonymized to further protect participant identities.

Possible Benefits

Benefits of this study are expected to be contributions to the growing knowledge of information on gaming wearables and how to incorporate and design around the input of users with upper limb motor disabilities. Direct benefits to participants will include learning more about gaming wearables, and potentially being introduced to new and useful video game interaction methods.
Compensation/Incentives

Participants will be compensated with a $20 (CAD) e-gift card of their choosing, with the default choice being Amazon. This compensation is dependent on your completion of the study demographics survey and confirmed eligibility in the study according to the inclusion criteria. Compensation will be delivered to participants via the email they used to express interest in the research study, and they will be delivered after the co-design workshop has concluded. If a participant decides to withdraw from the study, compensation will still be provided to them.

No waiver of your rights

By signing this form, you are not waiving any rights or releasing the researchers from any liability.

Withdrawing from the study

If you withdraw your consent during the course of the study, all information collected from you before your withdrawal will be discarded.

After the study, you may request that your data be removed from the study and deleted by notice given to the lead investigator (Georgia Loewen) before August 1, 2023.

Confidentiality

We will remove all identifying information from the study data as soon as possible, which will be after data has been collected.

We will treat your personal information as confidential, although absolute privacy cannot be guaranteed. No information that discloses your identity will be released or published without your specific consent. Research records may be accessed by the Carleton University Research Ethics Board in order to ensure continuing ethics compliance.

All data will be kept confidential, unless release is required by law (e.g. child abuse, harm to self or others).

The results of this study may be published or presented at an academic conference or meeting, but the data will be presented so that it will not be possible to identify any participants unless you give your express consent.

We will remove all identifying information from the study data as soon as possible, which will be after data has been collected. You will be assigned a code so that your identity will not be directly associated with the data you have provided (e.g. P01, P02, P03). All data, including coded information, will be will be kept in a password-protected file on a secure computer.

All audio recordings will be recorded on a password protected mobile phone. Data from the interviews will be then transcribed and all original audio and video files will be deleted. Transcribed data, interview notes and consent forms will be stored of Citrix ShareFile hosted by Carleton University secure servers. A master list with identifiable participant information will be stored on a usb thumb drive in a secure location under lock on campus.

For transcription, audio recordings of the interviews will be uploaded to Trint for transcription using pseudonyms to ensure all information remains anonymous. This will be stored on Trint’s servers during
transcription which uses AWS data centers in the US (Oregon, North California, North Virginia, Ohio.) Once interviews are transcribed and collected by the research team, Trint will be contacted to permanently delete all data. Trint is also fully certified to ISO 27001, PCI DSS compliant, and verified by SAM, UK Crown Commercial Service and Cyber Essentials. Further information regarding Trint’s data security such as data transfer and storage using HTTPS and encryption using AES 256 can be seen in their security information at trint.com/security. Should you decide to opt out of the use of Trint software for audio transcription, transcription of recordings will be done manually by the lead researcher.

We will password protect any research data that we store or transfer.

**Data Retention**

Your de-identified data will be retained for a period of 3 years and then securely destroyed.

**New information during the study**

In the event that any changes could affect your decision to continue participating in this study, you will be promptly informed.

**Ethics review**

This project was reviewed and cleared by the Carleton University Research Ethics Board B. If you have any ethical concerns with the study, please contact Carleton University Research Ethics Board by email at ethics@carleton.ca.

**Statement of consent – print and sign name**

| I voluntarily agree to participate in this study. | ___Yes ___No |
| I agree to be audio recorded | ___Yes ___No |
| I agree to be video recorded (optional for study) | ___Yes ___No |
| I agree to have recordings of my interview be uploaded to Trint (optional for study) | ___Yes ___No |
| I agree to be contacted for follow up research | ___Yes ___No |

__________________________
Signature of participant (or parent/guardian) ____________________________
Date

**Research team member who interacted with the participant**

I have explained the study to the participant and answered any and all of their questions. The participant appeared to understand and agree. I provided a copy of the consent form to the participant for their reference.
Appendix D.

Narrative Inquiry Scripts

D.1. Session One

(Discussing how they got into playing video games)

Georgia: Where did your enjoyment of video games start from?

DP1: I was raised on Pokémon, I watched my brother play until I was able to play on my own. Without him I wouldn’t have played video games. Video games connect me with my family. I do feel like I would like to have more gaming options like keyboard and mouse, but my student apartment environment is so cramped, I only have space to play on my switch.

DP2: My dad used to play on the original Nintendo. I would watch him play and I wanted to play too. I used to play lots of games with many different interaction methods- keyboard and mouse, controllers, everything. I don’t play as much anymore,
mostly mobile and Switch Lite. The Switch is nice and portable though.

**Georgia:** We’ll look at a couple of gaming wearables that are on the market or are proposed in research. So first off, what do you guys think about devices like the Wiimote? How do you find the accessibility there?

**DP1:** I struggle with using such large movements in game interaction, I get tired out so quickly.

**DP2:** I know how you feel, I also struggle with the wiimote because of how steady I have to keep my upper limbs, not even the strap helps me with that really. Even though I experience frustration from using the Wiimote, it’s encouraging to know I’m not the only one. Someone else understands how these barriers make me feel excluded.

**Georgia:** What about a device like this gaming vest?

**DP1:** When I look at the vest, I wonder how easy it would be to put on, especially for anyone who struggles with dressing. It looks like it was really mostly made for able bodied men- the design of this vest feels exclusionary to non able-bodied men. Georgia: Here are some designs from HCI research- there’s the wrist worn device where you switch out a bunch of dongles for different controls, a cloak that you manipulate to create different interaction, and a head-worn device that you interact
Appendix D. Narrative Inquiry Scripts

with by touch.

**DP1:** I see the wrist wearable creating many barriers for use, for me even I struggle to put my key in the door. This seems so much harder than that even. If I had to use that level of fine motor movement with one hand while I’m playing a video game I would have a lot of trouble with that. It sounds like a nuisance, I prefer the cloak wearable.

**DP2:** For the head worn device, I struggle to lift my arms above my head so interacting with a head worn device would be difficult. Maybe if I could just knock it instead of grasping it, that would be better. If maybe the device settings were variable I could maybe use it. It could create a barrier or knock one down.

**Georgia:** So with that all said, here is the proposed design for a gaming wearable that I formulated based on feedback from the previous portion of the study. It operates as a body worn device that uses large spatial movement to translate movement, and muscle activation of large muscle groups to provide interaction. What are some of your initial thoughts on this device? How would you picture yourself using it?

**DP1:** This interaction makes me think of Wii game interaction, which might bring up an issue for me as that interaction is difficult for me. But this device has the potential to alleviate barriers if it was designed to help me steady my cursor for me so I don’t have to worry about how precise I’m being.
Appendix D. Narrative Inquiry Scripts

**DP2:** Holding my hand out to use as a pointer also wouldn’t work for me, but I could see this wearable being used if I had my hand on my lap. Then I would just need to bend at my wrist to move forward, that would be a lot easier for me.

**Georgia:** Aside from on the hand where this device is shown, could you see it being used anywhere else on the body?

**DP2:** I could see this device being used on the chest as well, where you could move your torso to use it. Or even if it was worn on the leg, there’s ways to make it adaptable to a wide range of abilities.

**Georgia:** How natural do you think these movements would be in gaming?

**DP1:** I think VR becoming more popular makes introducing new movements into gaming interaction easier and more accepted.

**DP2:** I don’t use VR for other reasons, but I think it’s interesting. Especially a device like this, I wonder how it could account for force feedback, and how that would affect my gaming experience.

**DP1:** I see value in a device that can create immersion outside of a VR device. This way I don’t have to wear a full headset. I want to be able to experience gaming
immersion through VR, but VR is inaccessible to me. A device that can bridge the gap in immersion outside of VR can give me a higher level of gaming immersion.

**DP2:** I could use these sensors on my torso and lean forward to control the character, or left or right to move. That would help me and it could help others. I can place it on a different limb that works best for me. This creates a similar full body experience that’s in VR but it’s more accessible to me.

**Georgia:** I think it’s valuable to bridge that immersion gap because VR can be inaccessible to lots of people, and this would allow more people to have that immersive experience.

**Georgia:** Focusing on the muscle activation portion of the design, what do you guys think of that aspect? How natural would that feel in a gaming environment?

**DP1:** I would be interested in how muscle contraction interaction worked, but I also feel it wouldn’t work as a main game interaction. It might require too much attention from me to flex a specific muscle, it would be too distracting if it was a main game interaction. Maybe as a side interaction it could work, but not a main one.

**DP2:** I’m sitting here trying to flex various muscles to see how easy it is. I think it would be better to tie the muscle contractions to different motions that would make
sense in the game- like lifting a heel to jump. More natural movements over feeling like you need to contract certain muscles. Using more natural movements like that, that result in muscle contractions instead of isolated muscle contractions makes the interaction easier.

**Georgia:** Does anyone have any final thoughts on game interaction like this? With physical movement and muscle activation?

**DP2:** A device that you could use on any part of the body that best works for you would be really cool. You can customize the controls too, so if you were using your upper body, the controls could be described to the user as a series of motions

**DP1:** Having this wearable support modularity could also help accessibility. Everyone has different physical exertion levels, so if this wearable could support that by easily being switched out with other devices would make it more accessible. Like if I got really tired from the physical activity, I could switch it out with a regular controller.

**Georgia:** On that note, would you picture yourself using this device primarily on its own? Or would you use it with other gaming devices as well?

**DP1:** I would have to learn how to use this device sitting down- my first instinct would be to use this wearable standing up, but that would contribute to my experi-
enced fatigue. That might just be my internal bias, but I would need to learn how to use it sitting down.

**Georgia**: Do you see any strong benefits or drawbacks that this device would create?

**DP1**: The additional cost of a device like this could make it inaccessible to some. Unless it came with the console, but most devices these days need to be bought separately.

**DP2**: Though fatigue would be a drawback, I also see the benefit of getting tired because now I’m using muscles that aren’t otherwise used in gaming, and aren’t as easily fatigued

**DP1**: I see this device taking more physical and cognitive effort to use—especially in how to set it up for use and taking it down. I like to eat or do other things while gaming, and this device wouldn’t allow me to do that. I feel like I need to dedicate time to using it, instead of just picking up and dropping a game at my leisure like usual.

**DP1**: On another note, I value being able to aesthetically customize my tech— I got my keyboard so I can use different light colours, and I put stickers I like on my controller. So being able to have some aesthetic customization makes me feel like I
Appendix D. Narrative Inquiry Scripts

can express myself, and makes me more inclined to use a device.

DP2: I do notice how a lot of mobility aids or other accessible accessories can look so clinical- even in the adaptive controller video the buttons looked really industrial. This makes them feel less personal and expressive to me.

Georgia: What kind of games do you see yourself playing with this device? It involves a lot of physical movement, so would you value playing exergames with it?

DP1: I wouldn’t want a device I can only use for exergaming, cause I don’t resonate with those games. Limitations in gaming options the device is compatible with impacts my eagerness to use the device

DP2: Sometimes when a game isn’t designed for the type of interaction your using it can feel less enjoyable- like a PC game ported to console. It doesn’t feel like the same experience that it was designed for. Those types of incompatibilities in how the game was designed to be interacted with and the method you’re using to interact negatively impact the gaming experience.

D.2. Session Two

Georgia: Where did your enjoyment of video games start from?

DP3: I used to play Pong, and then I played PlayStation and really tried to keep
up with current games. I really enjoyed the sports games, but I am not able to play them like I used to now, I want to be able to play the games I used to and keep up with current games, but now I mostly play Wii because it is simple and easier for me to play.

**Georgia**: We’ll look at a couple of gaming wearables that are on the market or are proposed in research. So first off, what do you guys think about devices like the Wiimote? How do you find the accessibility there?

**DP3**: The design of the Wiimote is simple and great for me to use. Simple isn’t bad- it has less buttons to keep track of and is more tolerant of double clicking.

**DP3**: The wearable vest shows more possibility of sharing the responsibility away from what is normally required of one or two hands and distributes it around other parts of the body.

**Georgia**: Now, I don’t think this particular vest has any sort of input aspect to it. I think it’s mostly output. Do you see, like in your own experiences, like the benefit accessibility wise of having sort of like an output feedback as well?

**DP3**: The more simple interfaces are better for me, even better if they can share the workload with other parts of my body less affected by Parkinson’s. A normal controller has so many keys, I need a more simple design. I feel frustrated with the
very complex controllers that have 20 or 30 keys, I don’t know what to do with all of those controls.

**Georgia:** what do you think of a device that uses muscle activation for interaction like the bionic arm?

**DP3:** I feel like that one is not just for gaming. I see value in assistive devices that could benefit me beyond gaming, that would help in other activities as well.

**DP3:** It makes me think of a device I read about that was a hand prosthetic for Parkinson’s. It would stop the shaking of your hands. Devices like that, that learn my disability characteristics and can counterbalance them are valuable to me.

**Georgia:** In terms of gaming, what aspects would you want to see accessible improvement on?

**DP3:** I want to play video games as well as I used to, and I know I would play much better if controllers were not so complex and required so much concentration. I feel hindered by the design of controllers, I know I could play video games so much better if I didn’t have to multitask or have so many things to focus on with controllers

**Georgia:** Here are some designs from HCI research- there’s the wrist worn device where you switch out a bunch of dongles for different controls, a cloak that you
manipulate to create different interaction, and a head-worn device that you interact with by touch.

**DP3:** These futuristic solutions don’t contribute to my life, I need to see practical solutions to help my day to day management. I have difficulty with many activities, even driving I have difficulty using the pedal, break, and staying within the road lines. I need practical solutions to these problems, not futuristic ones.

**Georgia:** So these types of more involved interaction you’re not as interested in?

**DP3:** The way I see it, the wearables from the research papers frustrate me because I don’t see how they can help me, they look like they would just make interaction harder for me. The other wearables from the industry examples appear to be more geared towards alleviating frustration. I need to see devices that will eliminate interaction frustration, not add to my frustration.

**DP3:** The other thing is, the wearables from research papers seem to be directed more towards individual gaming. I’m looking for more ways to share the gaming experience. Sharing the gaming experience with others makes it more enjoyable for me. Individualistic solutions that isolate my gaming experience aren’t enjoyable for me.

**Georgia:** Can you think of examples of gaming interaction that gives you that
Appendix D. Narrative Inquiry Scripts

shared experience?

DP3: Rock band is a fun game for me because the controls are simple, and the game is about playing with others- not winning or losing. Sharing the load makes gaming more fun for me. I enjoy video games that share controls with others. I feel included.

Georgia: I like the idea of involving others to balance out the gaming experience with others.

DP3: It's something I prefer in gaming, I don’t know if that’s the typical direction that video games are going in, or if the focus is more on an individual experience.

Georgia: In terms of the type of YouTube character you would want to see, what are different aspects that you’re sort of looking for? What are this person’s likes or dislikes, any sort of personality traits that they have, what type of games they play, what kind of devices do they like to game on. And then most importantly, their experience with video game accessibility. And we asked these just to sort of like what kind of these aspects would you like to see in a person or what aspects would make you trust that person’s opinion that they’re giving you?

DP3: I feel more inclined to watch someone my own age, I feel like they’ll use words I understand and are more relatable. I feel discouraged from watching videos
that use jargon or language I don’t understand.

**Georgia:** So very clear, concise delivery of information?

**DP3:** Simple controls, and simple explanations of tech are better suited to my needs, I don’t want to feel like I have more questions than answers. At this point I just want to keep pace with others, I don’t need to advance my skills or win I just want to play.

**Georgia:** Do you have any preferences in terms of length of videos?

**DP3:** I feel more inclined to watch videos that are shorter, that only deliver the specific information I’m interested in, not videos that go off on tangents I’m not interested in.

**DP3:** I want to watch videos that just cover the information I need to know. Don’t throw all the information at me at once, I just want small concise packets of information.

**DP3:** I watch individual videos that just cover the specific skill I want to learn for a video game, instead of one long video that covers everything.

**Georgia:** Any sort of interaction you think you would want to watch this Youtube
character talk about?

DP3: I like having an opportunity to learn more skills, like adding another button to the Wiimote. I think about what I could do with that. I like the simplicity of the Wiimote controls because they fit my capabilities. I could see the design being built on too, to include just a bit more controls.

Georgia: What about this person’s connection to accessibility? What could that be that would make you feel like you trust this person?

DP3: I want to see more inclusion of Parkinson’s in controller design, even a controller option that is designed specifically for Parkinson’s users. There are many Canadians with Parkinson’s that I think feel similarly and I could see many people wanting to feel included in controller design.

DP3: In order to design an accessible controller you need to understand the lived experience with Parkinson’s- it needs to be specific. For me, using controllers, even the Wiimote, can be frustrating because different movements could trigger your hands and have you do something that you don’t want to do.

DP3: I want to hear somebody who’s talking about Parkinson’s who either has experience with it or know someone who has. You can’t know what you’re talking about with Parkinson’s unless you’ve experienced it or know somebody who has.
Appendix D. Narrative Inquiry Scripts

**Georgia**: Can you provide an example of a specific experience that you think would be hard for others to anticipate?

**DP3**: To set up for this interview I had to think a lot in advance. I made sure my phone was charged so I don’t have to hold it and have it shake, I set up my earbuds so I don’t have to hold a microphone. It’s hard for people who don’t have Parkinson’s to anticipate what I all have to think about in advance.

**DP3**: I want to hear someone who knows the lived experience to talk about it- that person I would listen to for as long as they wanted to talk.

**Georgia**: Yeah, I think you’ve really sort of hit the nail on the head there that, you know, living with a disability, it’s not just about like the direct experience of playing the game. It can be leading up to that. It can be putting the devices on yourself or taking them off and like, that’s all part of it, too.

**DP3**: I need to do more preparation when using devices and I need to test them out- and that’s not the direction the market is going. It’s getting more complex and that’s affecting my ability to play along. I also need a device that will challenge me and exercise my hands- it’s not just for fun it’s a necessity.

**Georgia**: with the Wii they’re Nintendo’s main selling point with that was this idea of like exergaming. Do you have any like sort of thoughts on that as a, as a, as
Appendix D. Narrative Inquiry Scripts

a market or as a game genre?

**DP3:** I play boxing on the Wii out of necessity because it’s the only thing on the market that fits my needs and ability. But I’ve resigned myself to the fact that I can’t play many other video games. I feel like a lag on others who play with me because they have better skill sets than I do. I feel isolated in the gaming world.

**DP3:** I play video games out of necessity. I would like to be brought back into feeling enjoyment and less frustration with video games.

**Georgia:** Moving to a different topic, here is the proposed design for a gaming wearable that I formulated based on feedback from the previous portion of the study. It operates as a body worn device that uses large spatial movement to translate movement, and muscle activation of large muscle groups to provide interaction. What are some of your initial thoughts on this device? How would you picture yourself using it?

**DP3:** In my case with Parkinson’s, it’s attacked mainly my right side. I need to learn how to adapt to my disability, and right now that is learning how to use my left side for most things- I’m right hand dominant

**DP3:** for this device, it needs to be designed to not trigger my tremors. They need to lie flat on a support, or even grasping something, otherwise they will shake.
Appendix D. Narrative Inquiry Scripts

**DP3**: There is a lot of pain associated with movement too- like writing in a card for me is very painful so I type instead and just short messages. That is also something to consider.

**DP3**: So the material the glove portion would be made out of would have to be both strong and rigid but also soft to help relax the hands.

**DP3**: It would also need to be highly configurable to tone it down or turn it up a notch to fit what my hands are doing. Because as excitement builds in a game my hands will shake more and it would need to account for that.

**Georgia**: Some participants also talked about looking sort of like at the core muscles through like movements from side to side or torsion. Would that be like a better sort of location for these like muscle sort of trackers?

**DP3**: So it comes back to configurability. People with Parkinson’s it’s all about rigidity. There are similarities that we all experience like attacking muscle control, hand and finger control.

**Georgia**: Do you see any strong benefits or drawbacks that this device would create?
DP3: A new controller design would allow me to game again, and allow me more opportunities to exercise areas that aren’t currently exercised through gaming.

DP3: I would also see value in a device I could use outside of just gaming that would help in other day to day life activities as well.

Georgia: Can you think of any drawbacks?

DP3: Complexity is a killer for me, I need a device that keeps interaction simple. I only have so much energy to spend on an activity, whatever exercise activity I decide to do it needs to be the right thing for me.

Georgia: Is there any risk of interaction being too simple?

DP3: If I swim I need a floatie, if I bike I crash to stop, there’s no such thing as too simple.

Georgia: How would the cost of a device affect its accessibility to you?

DP3: There is very little funding support that I get, for physiotherapy, for voice therapy, for any kind of gaming therapy. If I knew a device could give me an improvement I would spend the extra money on it.
Appendix D. Narrative Inquiry Scripts

**Georgia:** Do you have any final thoughts on the benefits or drawbacks of a device like this?

**DP3:** I’m not even not on the playing stage, I’m not even in the concert hall. I feel like a drag on others, but I want to be involved and play. I’m looking for a device that will help me improve.

**DP3:** I know I’m not gonna be picked to be on the team, but I want to make it so they don’t want me to play at all. I’m not looking to hit a home run, I just want to play.
Appendix E.

Dialogic/Performance Analysis

Data Visualization Quote Table
## Quotes to accompany Fit vs Misfit Dependence vs Vulnerability data visualization

<table>
<thead>
<tr>
<th>Participant</th>
<th>Plot Point</th>
<th>Fit vs Misfit</th>
<th>Dependence vs Vulnerability</th>
<th>Fit(+) Misfit(-)</th>
<th>Dependence (+) Vulnerability (-)</th>
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</thead>
<tbody>
<tr>
<td>DP1</td>
<td>1</td>
<td>I would like to have more gaming options like keyboard and mouse, but my student apartment environment is so cramped, I was raised on Pokémon, I watched my brother play until I was able to play on my own. Without him I wouldn’t have played video games.</td>
<td>-1</td>
<td>5</td>
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<tr>
<td>DP1</td>
<td>2</td>
<td>When I look at the vest, I wonder how easy it would be to put on, especially for anyone who struggles with The design of this vest feels exclusionary to non able-bodied men</td>
<td>-3</td>
<td>-3</td>
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<tr>
<td>DP1</td>
<td>3</td>
<td>When I look at this wearable I really have to question the accessibility especially for attaching the controls. I sometimes struggle putting my key in the door, if I had to use that level of fine motor movement with one hand while I'm playing a video game I would have</td>
<td>I see the wrist wearable creating many barriers for use, for me even I struggle to put my key in the door. This seems so much harder than that even.</td>
<td>-5</td>
<td>-5</td>
</tr>
<tr>
<td>DP1</td>
<td>4</td>
<td>This interaction makes me think of Wii game interaction, which might bring up an issue for me as that interaction is difficult for me. If the game could</td>
<td>Similar devices like the Wiimote can cause barriers for me, but this device has the potential to alleviate those barriers if it was designed to help me</td>
<td>-1</td>
<td>1</td>
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137
<table>
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<tr>
<th>Participant</th>
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</thead>
<tbody>
<tr>
<td>DP1</td>
<td>5</td>
<td>I see value in a device that can create immersion outside of a VR device. This way I don't have to wear a full headset, but I still have a device that can bridge</td>
<td>I want to be able to experience gaming immersion through VR, but it is inaccessible to me. A device that can bridge the gap in immersion outside of VR can give</td>
<td>5</td>
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<tr>
<td>DP1</td>
<td>6</td>
<td>I would be interested in how muscle contraction interaction worked, but I also feel it wouldn't work as a main game interaction. I think it might be distracting - I would get wrapped up in trying to flex</td>
<td>This interaction might require too much attention from me to flex a specific muscle, it would be too distracting if it was a main game interaction, maybe as a side</td>
<td>-1</td>
<td>-1</td>
</tr>
<tr>
<td>DP1</td>
<td>7</td>
<td>Having this wearable support modularity could help accessibility. Like if I got really tired from the physical</td>
<td>Everyone has different physical exertion levels, so if this wearable could support that by easily</td>
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<td>DP1</td>
<td>8</td>
<td>My first instinct would be to use this wearable standing up, but that would contribute to my experienced fatigue. That might just</td>
<td>I would have to learn how to use this device sitting down—my instinct would be to use it standing up but that would cause a lot of fatigue.</td>
<td>-2</td>
<td>-1</td>
</tr>
<tr>
<td>DP1</td>
<td>9</td>
<td>The additional cost of a device like this could make it inaccessible to some. Unless it came with the console, but most</td>
<td></td>
<td>0</td>
<td>-4</td>
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<tr>
<td>DP1</td>
<td>10</td>
<td>I like to eat or do other things while gaming, and this device wouldn't allow me to do that. I feel like I need to dedicate time to using it,</td>
<td>this device would take more physical and cognitive effort to use—especially in how to set it up for use and taking it down</td>
<td>-2</td>
<td>-4</td>
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<td>DP1</td>
<td>11</td>
<td>Being able to have some aesthetic customizatio n makes me feel like I can express myself, and makes me</td>
<td>0</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>DP1</td>
<td>12</td>
<td>I wouldn't want a device I can only use for exergaming, cause I don't resonate with those games. If I was limited in my limitations in gaming options the device is compatible with impacts my eagerness to use the device</td>
<td>-1</td>
<td>-2</td>
<td></td>
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<tr>
<td>DP1</td>
<td>13</td>
<td>P01: I think VR becoming more popular makes introducing new movements into gaming interaction easier and more accepted. P02: I don't use VR for other reasons, but I think it's interesting. Especially a device like this, I wonder how it could</td>
<td>4</td>
<td>0</td>
<td></td>
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<tr>
<td>DP1</td>
<td>14</td>
<td>I struggle to lift my arms above my head so interacting with a head worn device would be difficult. Maybe if I could just</td>
<td>-4</td>
<td>1</td>
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<td>DP1</td>
<td>15</td>
<td>P02: I struggle with using such large movements in game interaction, I get tired out so quickly. P01: I know how you feel, I also struggle with the Wiimote because of how steady I have to</td>
<td>P02: Even though I experience frustration from using the Wiimote, it's encouraging to know I'm not the only one. Someone else understands how these barriers make me</td>
<td>-4</td>
<td>3</td>
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<tr>
<td>DP2</td>
<td>15</td>
<td>P02: I struggle with using such large movements in game interaction, I get tired out so quickly. P01: I know how you feel, I also struggle with the Wiimote because of how steady I have to</td>
<td>P02: Even though I experience frustration from using the Wiimote, it's encouraging to know I'm not the only one. Someone else understands how these barriers make me</td>
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<tr>
<td>DP2</td>
<td>14</td>
<td>I struggle to lift my arms above my head so interacting with a head worn device would be difficult. Maybe if I could just</td>
<td>If the device settings were variable I could maybe use it, if it allowed me to knock it instead of grasp it.</td>
<td>-4</td>
<td>1</td>
</tr>
<tr>
<td>DP2</td>
<td>13</td>
<td>P01: I think VR becoming more popular makes introducing new movements into gaming interaction easier and more accepted. P02: I don't use VR for other reasons, but I think it's interesting. Especially a device like this, I wonder how it could</td>
<td>4</td>
<td>0</td>
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<tr>
<td>DP2</td>
<td>16</td>
<td>I used to play lots of games with many different interaction methods- keyboard and mouse, controllers, everything. I don't play as much anymore, mostly</td>
<td>My dad used to play on the original Nintendo. I would watch him play and I wanted to play too.</td>
<td>-2</td>
<td>5</td>
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<tr>
<td>DP2</td>
<td>17</td>
<td>Holding my hand out to use as a pointer also wouldn't work for me, but I could see this wearable being used if I had my hand on my lap. Then I would just...</td>
<td>This devices has the potential to alleviate barriers for me, or create them</td>
<td>2</td>
<td>1</td>
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<tr>
<td>DP2</td>
<td>18</td>
<td>I could see this device being used on the chest as well, where you could move your torso to use it. Or even if it was worn on the leg,</td>
<td>This design could be used in different ways, and could be made adaptable and usable to people with a wide range of</td>
<td>4</td>
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<td>DP2</td>
<td>19</td>
<td>I could use these sensors on my torso and lean forward to control the character, or left or right to move. That would help me and it could help others. I can place it on a different limb that works best for me. This creates a similar full body experience.</td>
<td>Speaker 2: Having the ability to use the sensors on different body parts that work better allows more people to use it and have an immersive experience. Georgia: I think it's valuable to bridge that immersion gap because VR can be inaccessible to lots of</td>
<td>5</td>
<td>5</td>
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<tr>
<td>DP2</td>
<td>20</td>
<td>I'm sitting here trying to flex various muscles to see how easy it is. I think it would be better to tie the muscle contractions to different motions that would make sense in the game- like lifting a heel</td>
<td>Using natural movements that result in muscle contractions instead of isolated muscle contractions makes the interaction easier, and those movements could relate to actions in game. Like</td>
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<td>Participant</td>
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<tr>
<td>DP2</td>
<td>21</td>
<td>A device that you could use on any part of the body that best works for you would be really cool. You can customize the controls too, so if Having the customizability of where you use the device and how its used would be valuable. And the controls can be described to the user in terms of</td>
<td>5</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>DP2</td>
<td>22</td>
<td>Though fatigue would be a drawback, I also see the benefit of getting tired because now I'm using muscles that aren't The wearable gives me the opportunity to use muscles that otherwise aren't used in gaming, and aren't fatigued as</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>DP2</td>
<td>23</td>
<td>A lot of mobility aids or other accessible accessories can look so clinical - even in the adaptive controller video the buttons looked really industrial.</td>
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<td>-4</td>
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<tr>
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<tr>
<td>DP2</td>
<td>24</td>
<td>Sometimes when a game isn't designed for the type of interaction your using it can feel less enjoyable-like a PC game ported to console. It doesn't feel like the same</td>
<td>Incompatibilities between how the game was designed to be interacted with, and the method you're interacting with makes it feel like you're not playing the</td>
<td>-4</td>
<td>-4</td>
</tr>
<tr>
<td>DP3</td>
<td>25</td>
<td>I want to be able to play the games I used to and keep up with current games, but now I mostly play Wii because it is simple and easier for me to play</td>
<td>I used to play Pong, and then I played PlayStation and really tried to keep up with current games. I really enjoyed the sports games, but I</td>
<td>1</td>
<td>-3</td>
</tr>
<tr>
<td>DP3</td>
<td>26</td>
<td>The design of the Wiimote is simple and great for me to use. Simple isn't bad- it has less buttons to keep track of and is more</td>
<td>4</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>DP3</td>
<td>27</td>
<td>The wearable vest shows more possibility of sharing the responsibility away from what is normally required of one or two</td>
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<tr>
<td>DP3</td>
<td>28</td>
<td>The more simple interfaces are better for me, even better if they can share the workload with other parts of my body less affected by Parkinson's.</td>
<td>I feel frustrated with the very complex controllers that have 20 or 30 keys, I don't know what to do with all of those controls</td>
<td>3</td>
<td>-4</td>
</tr>
<tr>
<td>DP3</td>
<td>29</td>
<td>Devices that learn my disability characteristics and can counterbalance them</td>
<td>I see value in assistive devices that could benefit me beyond gaming, that would help</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>DP3</td>
<td>30</td>
<td>Devices that learn my disability characteristics and can counterbalance them</td>
<td></td>
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</tr>
<tr>
<td>DP3</td>
<td>31</td>
<td>I feel hindered by the design of controllers, I know I could play video games so much better if I didn't have to</td>
<td>I want to play video games as well as I used to, and I know I would play much better if controllers were not so complex</td>
<td>-5</td>
<td>-5</td>
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<tr>
<td>Participant</td>
<td>Plot Point</td>
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<tr>
<td>DP3</td>
<td>32</td>
<td>I have difficulty with many activities, even driving I have difficulty using the pedal, break, and staying within the</td>
<td>Futuristic solutions don't contribute to my life, I need to see practical solutions to help my day to day management</td>
<td>-5</td>
<td>-4</td>
</tr>
<tr>
<td>DP3</td>
<td>33</td>
<td>(Wearables from research papers) frustrates me because I don't see how they can help me, they look like they would just make interaction harder for me.</td>
<td>I need to see devices that will eliminate interaction frustration, not add to my frustration.</td>
<td>-2</td>
<td>-4</td>
</tr>
<tr>
<td>DP3</td>
<td>34</td>
<td>Sharing the gaming experience with others makes it more enjoyable for me. Individualistic solutions that isolate</td>
<td></td>
<td>0</td>
<td>4</td>
</tr>
<tr>
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<tr>
<td>DP3</td>
<td>35</td>
<td>Rock band is a fun game for me because the controls are simple, and the game is about playing with others- not winning or losing.</td>
<td>I enjoy video games that share controls with others. I feel included, and it feels more fun when games aren't about winning or losing.</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>DP3</td>
<td>36</td>
<td>Gee: I like the idea of involving others to balance out the gaming experience with others. P10: It's something I prefer in gaming, I don't know if that's the typical</td>
<td></td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>DP3</td>
<td>37</td>
<td>I feel discouraged from watching videos that use jargon or language</td>
<td>I feel more inclined to watch someone my own age, I feel like they'll</td>
<td>-3</td>
<td>2</td>
</tr>
<tr>
<td>DP3</td>
<td>38</td>
<td>Simple controls, and simple explanations of tech are better suited to my needs, I don't want to feel like I</td>
<td>At this point I just want to keep pace with others, I don't need to advance my skills or win I just want to play</td>
<td>3</td>
<td>2</td>
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<tr>
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<tr>
<td>DP3</td>
<td>39</td>
<td>I feel more inclined to watch videos that are shorter, that only deliver the specific information I'm interested in, not videos</td>
<td></td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>DP3</td>
<td>40</td>
<td>I want to watch videos that just cover the information I need to know. Don't throw all the information at me at once, I just want small</td>
<td></td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>DP3</td>
<td>41</td>
<td>I watch individual videos that just cover the specific skill I want to learn for a video game, instead of one</td>
<td></td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>DP3</td>
<td>42</td>
<td>I like the simplicity of the Wiimote controls because they fit my capabilities. I could see the design being built</td>
<td>I like having an opportunity to learn more skills, like adding another button to the Wiimote. I think about</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>DP3</td>
<td>43</td>
<td>I want to see more inclusion of Parkinson's in controller design, even a controller option that</td>
<td>There are many Canadians with Parkinson's that I think feel similarly and I could see many</td>
<td>1</td>
<td>-1</td>
</tr>
<tr>
<td>DP3</td>
<td>44</td>
<td>Using controllers, even the Wiimote, can be frustrating because different movements could trigger</td>
<td>In order to design an accessible controller you need to understand the lived experience with Parkinson's-</td>
<td>-3</td>
<td>-3</td>
</tr>
<tr>
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<tr>
<td>DP3</td>
<td>45</td>
<td>You can't know what you're talking about with Parkinson's unless you've</td>
<td></td>
<td>0</td>
<td>-3</td>
</tr>
<tr>
<td>DP3</td>
<td>46</td>
<td>To set up for this interview I had to think a lot in advance. I made sure my phone was charged so I don't have to hold it</td>
<td>It's hard for people who don't have Parkinson's to anticipate what I all have to think about in advance</td>
<td>-1</td>
<td>-3</td>
</tr>
<tr>
<td>DP3</td>
<td>47</td>
<td>I want to hear someone who knows the lived experience to talk about it- that person I</td>
<td></td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>DP3</td>
<td>48</td>
<td>I need to do more preparation when using devices and I need to test them out- and that's not the direction the market is going. It's getting more</td>
<td>I need a device that will challenge me and exercise my hands- it's not just for fun it's a necessity</td>
<td>-3</td>
<td>3</td>
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<tr>
<th>Participant</th>
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<tbody>
<tr>
<td>DP3</td>
<td>49</td>
<td>I play boxing on the Wii out of necessity because it's the only thing on the market that fits my needs</td>
<td>2</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>DP3</td>
<td>50</td>
<td>I feel like a lag on others who play with me because they have better skill sets than I</td>
<td>0</td>
<td>-5</td>
<td></td>
</tr>
<tr>
<td>DP3</td>
<td>51</td>
<td>I play video games out of necessity. I would like to be brought back into feeling</td>
<td>0</td>
<td>-4</td>
<td></td>
</tr>
<tr>
<td>DP3</td>
<td>52</td>
<td>I need to learn how to adapt to my disability, and right now that is learning how to use my left side</td>
<td>0</td>
<td>-2</td>
<td></td>
</tr>
<tr>
<td>P3</td>
<td>53</td>
<td>The device needs to be designed to not trigger my tremors. They need to lie flat on a support, or even</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>DP3</td>
<td>54</td>
<td>There is a lot of pain associated with movement too- like writing in a card for me is very painful so I</td>
<td>-3</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>DP3</td>
<td>55</td>
<td>The material would have to be both strong and rigid but also soft to</td>
<td>2</td>
<td>0</td>
<td></td>
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<tr>
<td>Participant</td>
<td>Plot Point</td>
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<tr>
<td>DP3</td>
<td>56</td>
<td>The device would need to be configurable to tone it down or turn it up a notch to fit what my hands are doing. Because as</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DP3</td>
<td>57</td>
<td>There are similarities that we all experience like attacking muscle</td>
<td>0</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>DP3</td>
<td>58</td>
<td>A new controller design would allow me to game again, and allow me more opportunities to exercise areas that</td>
<td>0</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>DP3</td>
<td>59</td>
<td>I would see value in a device I could use outside of just gaming that would</td>
<td>0</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>DP3</td>
<td>60</td>
<td>complexity is a killer for my, I need a device that keeps interaction simple</td>
<td>0</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>DP3</td>
<td>61</td>
<td>I only have so much energy to spend on an activity, whatever exercise activity I</td>
<td>-4</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>DP3</td>
<td>62</td>
<td>If I swim I need a floatie, if I bike I crash to stop, there's no</td>
<td>-3</td>
<td>0</td>
<td></td>
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<tr>
<td>DP3</td>
<td>62</td>
<td>There is very little funding support that I get, for physiotherapy, for voice</td>
<td>If I knew a device could give me an improvement I would spend the extra money</td>
<td>-5</td>
<td>-4</td>
</tr>
<tr>
<td>DP3</td>
<td>63</td>
<td>I'm not even not on the playing stage, I'm not even in the concert hall. I feel like a drag on others, but I want to be involved and play. I'm</td>
<td></td>
<td>0</td>
<td>-5</td>
</tr>
<tr>
<td>DP3</td>
<td>64</td>
<td>I know I'm not gonna be picked to be on the team, but I want to make it so they don't want me to play at all.</td>
<td></td>
<td>0</td>
<td>-5</td>
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Appendix F.

YouTube Design Fiction Archetype

Script

Vi at her desk, recording video intro

Vi: Hey everyone, welcome back to my channel. For today’s video I’m going to review a really unique product I found, honestly completely by chance that advertises itself as a gaming wearable designed for accessibility. I was doomscrolling through tiktok as I do, honestly more often than I like to admit, and found a video about the Kickstarter program for this product called the ModuMuscle. I was kinda interested in it, especially since it specifically advertises itself as being designed for gamers with upper limb motor disabilities- that really resonated with me as someone who struggles with the fine motor movement associated with typical gaming interaction. So I contacted the creator of the ModuMuscle through Kickstarter, and I was able to get my hands on the ModuMuscle to review it.
Appendix F. YouTube Design Fiction Archetype Script

Speaking candidly

Vi: Let me just be clear though, I am not being compensated for this review and I will be speaking honestly about it. Too many times I’ve seen products that advertise accessibility that don’t measure up. So I do want to give my honest and true opinion about it. So with that, let’s jump right in!

View from above the desk laying out the product and accompanying tech

Vi: So this wearable was designed to be used with the Xbox Adaptive controller-which thankfully I already have. If I didn’t though, that would be like an additional $100 to spend on this setup so already that’s a negative point for cost of this whole thing. That aside, I do think it’s cool to create other ways to use the Xbox adaptive beyond just adaptive switches.

Demonstrating how to set up the device

Vi: The actual interaction part of this thing is in two parts. There’s this movement piece that kinda has a D-pad vibe to it with the different directional controls. And then there’s 3 sensors that are supposed to detect muscle movement that I guess you can decide where to attach those. For actually wearing this thing, it comes with a glove, a leg warmer, and this torso wrap that you can wear. They’re all made from this nice, comfortable stretchy material. And the D-pad like control just kinda clips onto them (demonstrates). That’s kinda nice that it gives you options if you want to wear it on your hand, your leg, or like your stomach- that fits a lot of preferences.
Vi: The dpad part has a USB type A on it, which goes into one of the two side ports on the Xbox adaptive, and each of the three sensors attaches to this box, I assume that houses the actual inner workings to make this thing, well work. And those connect to three of the 3.5mm mono jacks on the Xbox adaptive.

*View of Vi sitting in desk chair with device set up on her arm*

Vi: I’ve set up the device to work with my arm— with the movement interaction involved this device reminds me a lot of the Wiimote, so for my first time using it I’m gonna try and use it with a part of my body I’m more used to using in gaming. I did always struggle a bit when using the Wiimote and having to have my arm extended for long periods of time and feeling very fatigued, so I’m hoping I don’t have that issue with this device. So let’s try out this movement part of it first.

*Show Vi moving her arm up and down with corresponding action in video game*

Vi: Okay, so it’s nice that it works when I just need to rest my hand on my lap, or even my desk between movements so that does eliminate some fatigue concern I had. Though I do feel like fatigue is going to be an issue at some point, I feel like that’s not necessarily a bad thing? Like if I wore this on my leg or my torso then I would get to work out other parts of the body I don’t normally use in gaming.
Appendix F. YouTube Design Fiction Archetype Script

**Vi:** Let’s try out the muscle sensor part, I feel like this part is a bit more intimidating and maybe a little less natural. Like my initial reaction is how much like mental effort am I going to have to put towards moving individual muscles?

*Show Vi clenching fist, lifting ankle, and raising shoulder with corresponding action in video game*

**Vi:** I’ve set it up so it’s tracking movement in my forearm, my shoulder, and my ankle. I’ve configured it so clenching my hand is my item action like punching or hitting with my pickaxe, lifting my ankle off the ground is jump, and moving my shoulder is selecting different items in my hot bar. I do kinda like that you can choose which muscle groups you want to use in games and map them to different actions. There are suggestions in the manual for what muscle actions you can use, which I’m very glad about cause I am not that familiar with musculoskeletal movements. This is definitely something to get used to in game though, I’m really not used to using this many different parts of my body in a game.

*Back to speaking from her desk*

**Vi:** As far as things I like about this device, I really like that it is customizable to whatever part of the body you feel you have the most control of and I really like that it spreads interaction all over the body instead of just being confined to fine motor movement in the hands. That I think is a really big plus for this device. I
also feel like on some level it gives me a bit more immersion in game? That’s a really hot topic in gaming since VR, but for me and many other members of the disabled gaming community VR can be inaccessible, so this is a kinda cool way to bridge the gap in gaming immersion and involve more of the body in gaming like VR does.

Vi: I also like that it’s modular, and I feel like if I got tired using it on my arm I could switch it to a different part of the body and keep playing, or even switch to a regular controller. And with that I do really like that it adds more to the collection of Xbox Adaptive compatible devices.

Vi: There are some drawbacks I will say. The setup is kinda involved. Like going through the configuration process is a bit intense, and even just making sure the sensors are in the right place. I can tell the company tried to make it somewhat easy with having the dpad part connect pretty easily to the different wearable covers, but I feel like there’s more to be done to make it easier to set up and take off. I do also feel like looks wise, it’s a little boring. I would prefer to see a bit more aesthetic customizability, but maybe that will be something that comes in time. Lastly, there is the cost to consider. You need to have the Xbox adaptive controller in order to use it, and then there is an additional cost for the device itself which I think they are projecting to be around 100 to 150. I think if I knew for sure that this device was gonna improve my gaming and be accessible to me it would be worth it, but I feel like with a lot of advertised accessible devices it’s hard to know if they’re gonna work for you without trying them first or watching others with similar disabilities to you
use them. That is partly why I wanted to make this video for you guys.

**Vi:** So, to conclude I really do think this piece of tech is a step in the right direction. So often you see accessibility in game controllers kinda ending with the Xbox adaptive when really that should just be the start of it. So I do appreciate the effort to expand accessible options for gaming. That being said, as I said before there are some notable drawbacks that should really be improved. I would also encourage the company to reach out to other YouTubers in the disabled gaming community to make their own review videos of it, cause it’s important for the company and for any potential buyers to see different disabilities represented and to see how it can be used by each of us.

**Vi:** Thank you guys for watching my review of this gaming wearable, as always make sure to like and subscribe for more content like this.
Appendix G.

Youtube Design Fiction Archetype

Video Link

To watch our design fiction archetype, please visit: https://youtu.be/jgTqpFFz8fw.
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