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PERCEPTIONS OF OVERSTIMULATION

Master's Project

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Allowed for defense ……………………………………

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1. INTRODUCTION

Perceptions of overstimulation relies on the themes of overstimulation, the over-abundance of information, and the extent to which technology reigns over our lives either consciously or otherwise. In each facet of our digital lives, we are oversaturated with the constant cycle of news, social media, art, and culture. We are surrounded by the digital noise of our technological existence.

Principally, a drummer tells a story through his or her playing. As the drummer plays slower and quieter, the story is more lucid. As the drummer plays quicker and louder, the ambiguous mess of information floods the projector and speakers. The project is intended to work as a microcosm detailing our digitized lives and our attachment to, the necessity of, and the burden of the technology surrounding us.

The purpose of the project is to create an audiovisual performance using sensors that track data in real-time on a drummer. The movement sensors track a drummer's triaxial movements while the ECG sensor captures the electrical activity of the heart. The data captured affects the projections in terms of shape, color, and picture. For the audio, the data captured influences projections being represented visually but also manipulate delay, pitch, reverb, as well as imported VSTs. Bitalino R-IoT sensors, which track data movements over each 10-millisecond increment, are utilized for the project. The data is sent to a router that is connected to a computer where the software Max 8 receives and then parses the data to its respective outputs in order to manipulate the audiovisual ecosystem. The sensors were chosen due to their ease of movement, rugged structure, and cost efficiency. To realize this project, I have created a short film as proof of concept and as an art performance.

Perceptions of overstimulation is rooted in sensory overload amidst the changing technological landscape. The technological landscape has always been an ever-evolving, rapidly shifting, an unpredictable enigma, and one in which we are all immersed in some way. Recently, due to COVID-19, exponential and altering changes in lifestyle has tethered people even tighter to their digital identities. We work, shop, pay bills, bank, create, relax, get news, socialize, study, exercise, vote, set alarms, sleep, and the list goes on.

At the same time, the apparent ease and streamlined nature of our digital lifestyle and this unprecedented access to so much information also presents new complications, tribulations, and harms. “The paradox of an era of information glut emerges against the background of this new information landscape: at the very moment when we have the technology available to inform ourselves as never before, we are simultaneously and compellingly confronted with the impossibility of ever being fully informed” (Andrejevic 2013, p. 2). The more we know, the more we understand what we do not know, and the more we understand that we can never know everything. This paradox is not new, but our newfound ability to retrieve so much information at any given time with relative ease gives it a darker slant.

As we are continually lapped by this fluctuating wave of information, we are constantly confronted with the realization that access to information is not equal to intellectual, artistic, or humanistic growth. We must grapple with these concepts on a daily basis, and this internal battle takes its toll. Even before the boom of the Internet age and information-overloaded world that contextualizes our modern backdrop, artists were concerned with the notion of overstimulation: “Trauma is used here in the general sense of overstimulation, whether due to actual massive flooding from the external world or stemming from the person's own hypersensitivity to stimulation. As is well known, a complementary relationship exists between external overstimulation and inner sensitivity” (Rose 1987, p. ix). To process this overstimulation, we must manage, prioritize, and deploy that overflow of data within the framework of our digital selves. The project aims to highlight how we contextualize these feelings of loneliness, exhaustion, emptiness, and discomfort due the overwhelming sea of information enveloping us.

2. SENSORS, HARDWARE, & SOFTWARE

Computer-human interaction is sewn into the fabric of our everyday lives. We are forced to confront this in mundane tasks, artistic endeavors, and social interactions. We rely so heavily on technology, and in many ways, it relies on us. Sensors are everywhere around us; in cities we walk on streets monitored by cameras; cars are equipped with anti-collision sensors; motion-activated doors are the norm in shopping malls; we carry pedometers with us embedded into our mobile phones. All that we do is sensed, recorded, processed, and stored.

The sensors, hardware, and software used to undertake this project are really no different than the technology we carry around in our pockets, but it's how we contextualize the resulting data that is important, not the raw data itself. The sensors are merely providing information; it's our relationship to that information that is being investigated and the threshold of where that information becomes superfluous or overwhelming.

2.1 Sensors

BITalino, a biomedical education, research, and prototyping company, has created streamlined compact sensors to transmit data efficiently over WiFi or Bluetooth. The BITalino R-IoT sensor is equipped with an accelerometer, gyroscope, and magnetometer, all of which are triaxial (three different axes: x, y, z). The HeartBIT by BITalino is a package equipped with an ECG (electrocardiography), and a PPG (photoplethysmography) sensor. The ECG sensor measures electrical heart activity that amalgamates a thorough representation of your heart rate and rhythm. These two devices are used in tandem as the HeartBIT sensor acquisitions and transmits data via Bluetooth whereas the R-IoTs acquisition and transmit data through WiFi. Additionally, the BITalino R-IoT's two analog ports can be wired for even further data capture. Other sensors include electroencephalography (electrical brain activity), electro-dermal activity (skin conductance), temperature activity, electrooculography (retina activity), and even electro-gastrography (gastric activity), amongst others.

BITalino has placed focus on transmitting and acquisitioning biophysical data for various DIY uses with their affordable sensors that are easy to use out of the box. The system is simple enough to use as plug-and-play but can be adapted and modified into many different configurations according to your needs:

> By default, the system comes as a single board, with its onboard sensors pre-connected to analog and digital ports on the control block. Nonetheless, the control, power, and communication blocks, as well as the firmware are completely general purpose, enabling people to use only the digital back-end of the BITalino with their own custom sensor and actuator designs. Furthermore, each individual block can be physically detached from the main board, allowing people to use it in many different ways; in essence, this architecture enables three configurations:
>
> - Board: BITalino is used with no modifications, enabling people to simply experiment with the onboard sensors for prototyping activities or real time observation of multiple physiological phenomena (Figure 1);
> - Plugged: plugs are added to the BITalino and the individual sensor blocks are separated from the BITalino main board, leaving only the control, power, communication and auxiliary connectivity blocks, and enabling people to interchangeably use different sensor combinations (Figure 2(a));
> - Freestyle: all the individual blocks are detached from the BITalino main board, enabling people to combine them in any way that best suits their project ideas and applications (Figure 2(b)). (Da Silva *et al.* 2014, p.247)

The company describes themselves as "redefining biomedical education, research and prototyping, by making otherwise inaccessible tools available to everyone" (Company About Us. 2021). You can download free software and instantly see the results streamed over WiFi or Bluetooth. These sensors often come at a hefty price tag and applications with biophysical data have historically been circumscribed to the medical industry rather than widely used for artistic, DIY, and home applications. "Affordable instrumentation has been a fundamental problem in the field of physiological computing for many years, and while the state-of-the-art is rich in attempts to provide sensors and systems, no single work found to date has provided a comprehensive and reliable solution. (…) [T]he BITalino [is] a low-cost all-in-one hardware framework that has a basic set of multimodal sensors, enabling anyone to easily integrate biosignal acquisition in their projects and applications" (Da Silva *et al.* 2014, p. 252). Their affordability and reliability were the driving factors in deciding to use these sensors for the performance.

The BITalino R-IoT also seemed the most attractive option for the physical sensors attached to the drummer due to their flexibility, ease of use, and reliability in a compact and rugged design. With just one sensor, you can achieve nine data points 'out of the box' plus the option of incorporating the two extra analog ports. The protocol followed is OSC, which coincides with the software used.

Biophysical data was fundamental for this performance due to the nature of the human-computer interaction element in connection with the themes of information overload and overstimulation. Further, the project requires the biophysical and movement data acquisition be stable and constant while also being rugged enough to handle sharp movements of a drummer; hence, utilizing BITalino meets this need by allowing for easy data acquisition over Bluetooth or WiFi via a router. Additionally, the size and robustness of the BITalino R-IoT allows flexibility as to where to place the sensors on the drummer’s arms. This performance utilizes the two R-IoTs and the ECG, excluding the PPG sensor, as the fingertip placement would be very inhibiting for the drummer to wear during the performance. For the ECG sensor, utilizing the Einthoven triangle technique was deemed most effective. Placing electrodes on the drummer’s fingers or palms was out of the question and the Einthoven triangle allows for better results, as the sensors are not obstructing.

The triaxial movement data of the R-IoT’s accelerometer and gyroscope tracks yaw, pitch, and roll. Built into the R-IoT is also a triaxial magnetometer that measures magnetic vectors in proximity to the instrument. The magnetometer monitors a magnetic field three dimensionally, much like a compass. For this project, however, only the accelerometer is used to track data from each hand of the drummer. Initially, the plan was to also use an electroencephalography sensor (EEG) to measure brain activity to use for data manipulation in the performance. This EEG sensor could have been easily soldered to one of the analog ports of the R-IoT. To track the EEG data, a BITalino EEG headband would be placed on the drummer. However, due to high amplification gain of the EEG and its sensitivity to magnetic vectors and sound, the data would be corrupted by interference caused by the lighting, projectors, and most of all the audio element of the performance. Therefore, certain sensors weren’t used due to this potential for corruption of data.

The data acquisition signal flow is as follows:
R-IoT 1 – Left arm ACC (x_1, y_1, z_1)
R-IoT 2 – Right arm ACC (x_2, y_2, z_2)
HeartBIT – ECG (a_1)

Although this data is constantly being monitored, inputting and outputting into the router, computer, and programs can be quite slow. The data is sent and parsed in 10-millisecond increments. From an audiovisual standpoint, 10-millisecond increments is slow. In film, one subframe consists of 0.5 milliseconds, which is noticeable to the human eye. In audio, latency past three milliseconds can be disorienting. This proves to be the one downside to the BITalino workflow through Max 8. Although the data acquisition is stable, the increment delay and latency that could be caused by the system might prove problematic. However, for the drummer to adjust to and embrace these technical abnormalities actually feeds into the themes of the project.

2.2 Hardware

The hardware involved in this audiovisual performance (other than the sensors) is minimal. One computer takes up the entirety of the backend of the performance, as the two projectors and an RME soundcard with two 8-input preamps hooked up through ADAT act more as an output of the performance itself. The computer handles everything from data visualization, monitoring, analyzing, manipulation of audio and video, to digital inputting and outputting. The RME soundcard and projectors receive the outputting information only after the computer interprets the data.

2.2.1 Performance

For the audio section, the hardware used is the drum kit, the RME FireFace soundcard with two RME Octamic preamps connected through ADAT, and nine microphones with stands and cables. Each microphone routes into the system and splits to its respective module, where Max handles all the audio recording. For the visual section, the necessary hardware is the two matching projectors and screen. To output the videos to the projectors, the computer utilizes a thunderbolt-to-HDMI adapter and HDMI respectively. The computer can be split into three separate monitors, ensuring one monitor is the front projection, one monitor is the back projection, and the last monitor is the computer running the program.

Because the program is very CPU heavy, the maximum resolution of the projections is only 360p to ensure a somewhat ‘smooth’ playing of the projections. Even with the low resolution, the videos still glitch, speed up, and slow down, because the computer’s resources are completely consumed, much as our mental and emotional resources are consumed by overinformation. Despite these limitations, the lo-fi pixelated resolution and glitches of the videos benefit the aesthetic and can be overall embraced.

2.2.2 Filming

For the filming of the performance, the audio is recorded from the performance itself. The filming requires two matching cameras, one tripod, and one rig. The performance is shot on two Panasonic GH5s in 4K. Due to the brilliant luminance of the projectors, no extra lights are needed to execute the shooting of the performance.

2.3 Software

Two software programs are used to monitor, visualize, record, and playback the incoming biophysical and movement signals. OpenSignals (r)evolution allows for visualization of the data in real time with data attainment and visualization of multiple devices and multiple different signals at once. It was developed specifically for BITalino users and is also designed to work 'out of the box' with the BITalino hardware. Wekinator, a free and open-source machine learning program, allows for the instrumentation. This program also operates OSC and is vital in creating a gesture-controlled interactive system. For the actual performance itself, Wekinator is not used; however, it has been instrumental in being able to quickly playback previously recorded data during development and testing. Namely, this software was used when scaling data for modules and building the system. These two software programs work in tandem to monitor, record, and visualize the data into Max 8.

The movement and biophysical data is finally transmitted to Max 8 software, a visual programming language by Cycling '74, for data manipulation of the sound and visual properties of the performance. There, movement and heart data is parsed and made legible for the respective audio and visual ecosystems of the program. The visual programming environment will respond in real time as the data flows into the system.

The overall audiovisual program built within Max is a multifaceted ecosystem made up of many modules, each designed for a specific task. The first relevant module routes data flow into the audio and visual modules. Here, the data must be scaled in order to be comprehensible and decipherable for the audiovisual program to ensure efficient data acquisition and interpretation before the data flows into each respective audio and visual module. Without scaling, the data cannot fit within or be understood by the respective modules, much as we must process, decode, contextualize, and compartmentalize information to make sense of the data we are constantly receiving.

2.4 Interactive systems and environment

The visual ecosystem starts with an ADAC (analog-digital-analog converter), meaning the audio, in addition to both sensors, controls aspects of the visuals. The ADAC is routed to an audio-visualization module that responds to loudness to transmit signal data into a video matrix. This signal data video matrix interacts and overlaps with the contemporaneous projections. It also goes through visual filters to manipulate color, noise, and flare via mathematical equations and parameters, all with simultaneous data modulation from the sensors. Concurrent to the audio influencing visual aspects of the performance, there is also a module to import your own video files. The visual matrix also encompasses a spatial noise filter as well as a module that introduces probability lines of cells of a matrix and whether they extend to another cell. The movement and biophysical data in the sensors control the varying parameters of these filters. The resulting video images are then outputted to each respective projector for the performance.

The audio ecosystem begins with the same ADAC, and then each channel is split and sent to a different module. Some channels are inputted into a module consisting of a comb filter that also has delay capabilities. Other channels are routed into a stereo reverb module with the scaled ECG data controlling the spatial components of the reverb. Some channels are routed to pitch and phase modulation modules. As with the importing of your own video files, there is also a module to import your own sound files for use with the ECG data and two R-IoT sensors. Once the audio has flown through each module it finally enters the last module, which is a gain control and the back end of the ADAC to output the audio. The audio is also recorded inside the system and saved as a .wav file to the chosen location on your computer for later use.

The audio and visual modules are then combined through the use of one computer (MacBook Pro 2015 i7), a router for the R-IoTs, a Bluetooth USB dongle for the HeartBIT, a thunderbolt-to-HDMI adapter for the first projector, and an HDMI cable for the second projector. This allows for all data acquisition and implementation as well as the output of audio and video to the respective sources, all from one computer.

Although using one computer is easily portable and minimal, audiovisual rendering and recording, in addition to the data acquisition and implementation, is extremely taxing on the CPU. With all of the data accumulated over the two R-IoTs and the ECG, the overinformation to the system is substantial. Again, the functionality of the system mimics the reality of over-information in our everyday lives.

The movement data of the R-IoTs and the heart data of the ECG both simultaneously affect the audio and visuals by moderating in real-time certain modules within the webbed coded system within the software Max 8. The modules of the coded system include the ADAC, projector outputs, buffer for the audio and video playlists, data acquisition and contextualization, as well as various filters for audio and visual components of the project.

2.4.1 AV schematic

The software AV schematic can be broken down into two separate patches: 1) data acquisition and 2) audiovisual manipulation. These two patches are open concurrently and working together. The attached figures show the internal program of Max 8 from data acquisition (figures 2.1 and 2.2) to the coded audiovisual program (figures 2.3 and 2.4).

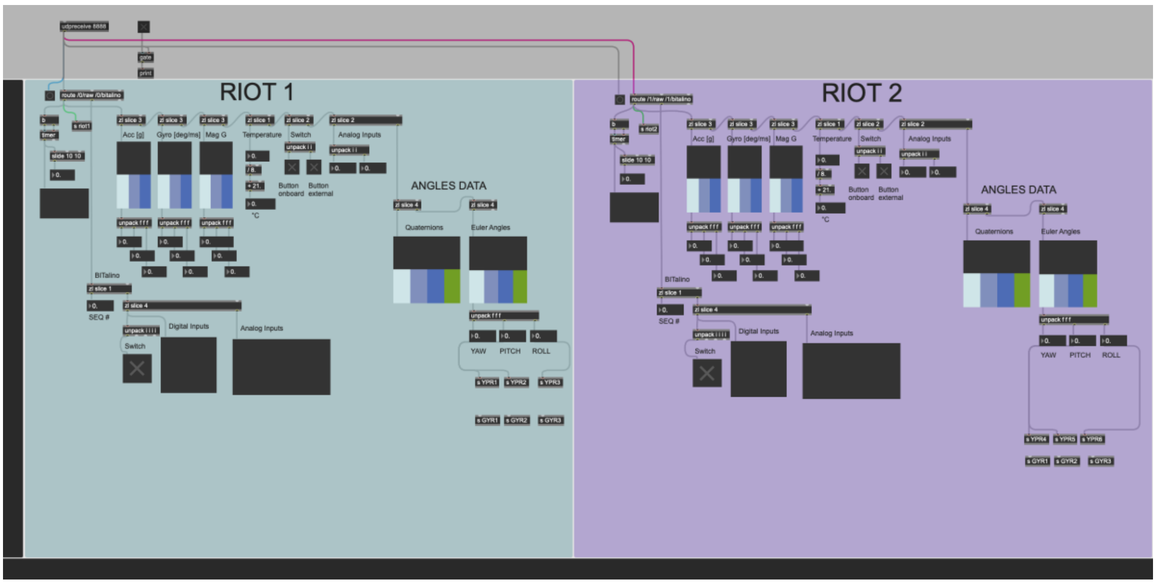

Figure 2.1: Data acquisition of BITalino R-IoTs in Max 8

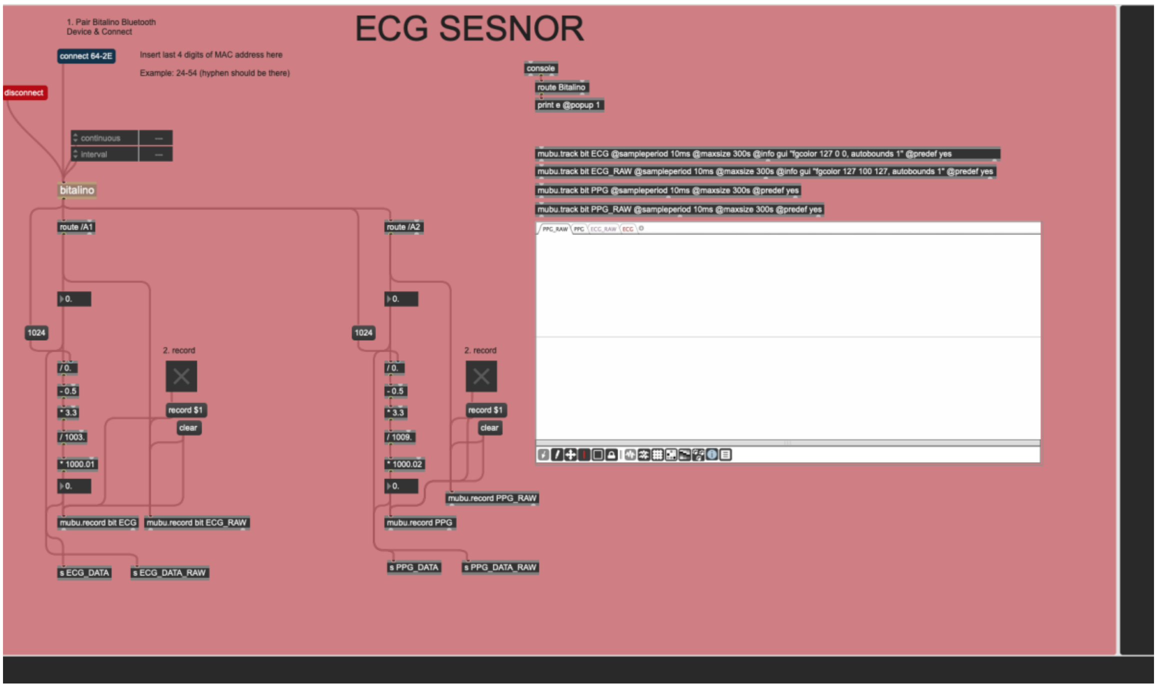

Figure 2.2: Data acquisition from BITalino HeartBIT ECG in Max 8

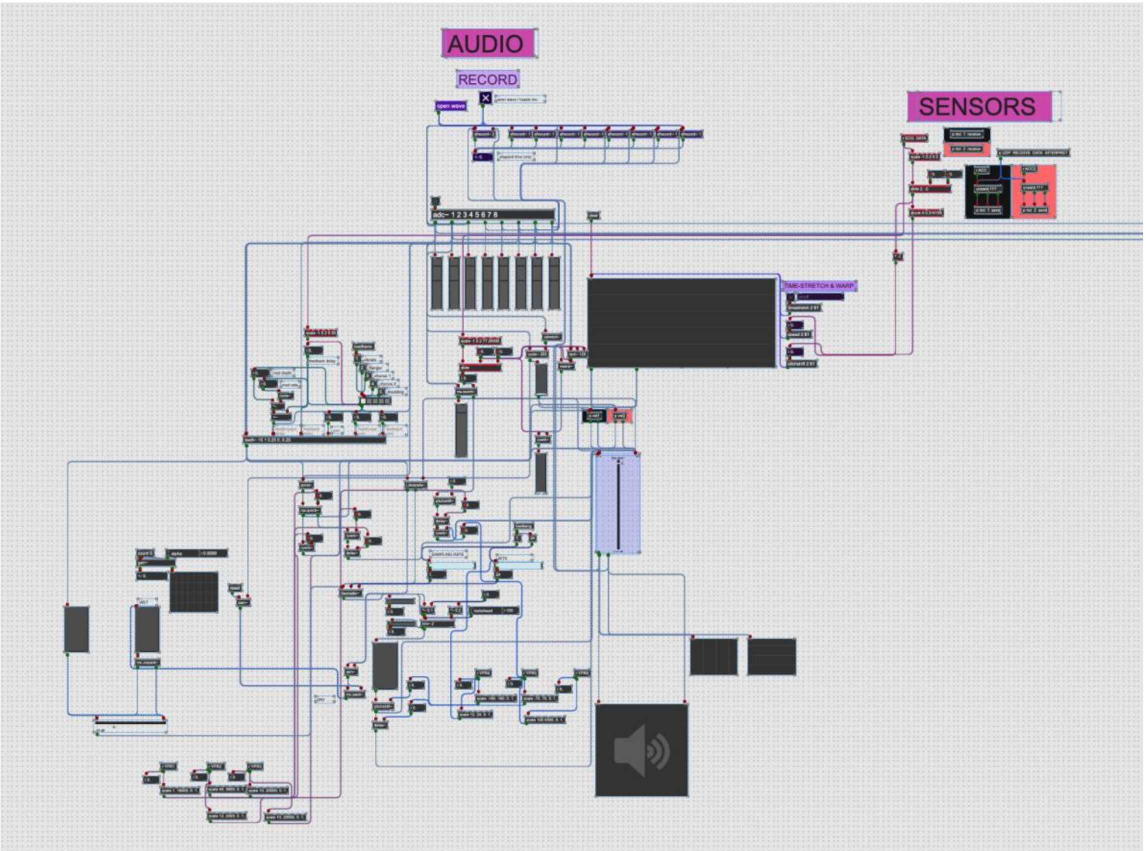

Figure 2.3: Audio and sensor modules in Max 8

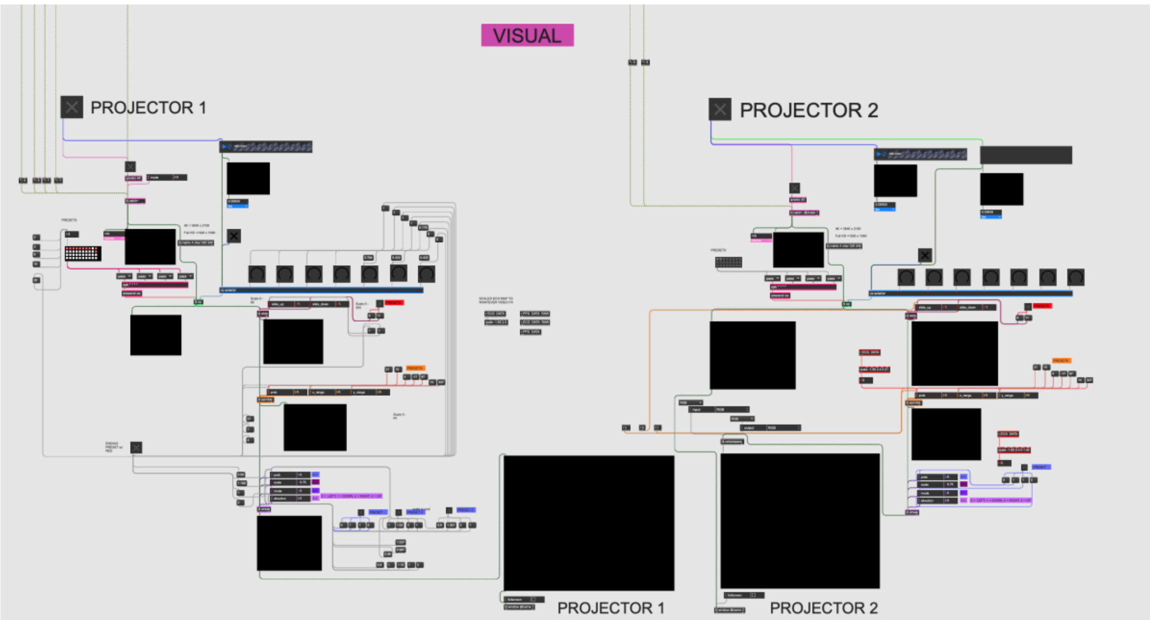

Figure 2.4: Visual modules in Max 8

2.4.2 Software and hardware interaction

Through the use of two BITalino R-IoTs, an ECG, and the system, the amount of data that can interact with the audiovisual aspects of the program are endless, creating a vast ecosystem that is lush for data employment. Each system and module can be cross-wired with the next. Each object can be manipulated and scaled. Choosing where to input data is the most difficult task since this data is so easily transmittable and usable. For my project, the choice of where to input the data to the various modules most closely resembles the aesthetic the creative team wanted; however, the potential for tailoring, modifying, and/or re-envisioning is limitless.

The most salient part of the data interaction with the program is never achieving the same results twice. Given that *Perceptions of overstimulation* stands on themes of information overload, I wanted the system environment to parallel this sensation of overload. This interactive biophysical human-hardware-software ecosystem is a vital premise to meditate on our relationship with information overload and the technology that governs our lives.

3. THE PROJECT

3.1 Purpose and themes

Stimuli are in bloom all around us.

Socially and societally, humans are interwoven into a technological landscape inundated with this stimuli. This aspect bears an interdependence between our technology, the resulting data, and us. The programmed system corresponds to this data overload in our everyday lives and reflects the interdependency and chaos throughout the various ecosystems as they respond to the movement, heart, and audio data. The purpose of the project is to contemplate the extent to which technology and information tether us to our reality but also seem to push us farther into the surreal.

Although access to information has never been more pervasive, the same is also true of saturation of information: overinformation. An overload of information, much like sensory overload, can cause delusion, overwhelming unease, and diminished ability to function in our daily lives.

> Information and cognitive overload lead to a loss of control over much of our professional and personal lives. This creates undo stress and unimportant distractions which may adversely affect our work and lives and contribute to professional dissatisfaction and burn out. A thoughtful understanding of this problem, and implementing effective approaches and strategies can help to regain control of many, if not most, responsibilities, work, and other activities. We are exposed to too much unimportant information that leads to cognitive overload. We are depleting our brain power with babble, drivel, foolishness, gibberish, and balderdash. The expectation that we will participate and respond to copious unimportant sources of information is unreasonable and impracticable. We must become experts at managing our time, expectations, and the influx of information that we seek out, and in turn, seeks us out. If we recognize and understand this new intrinsic element of the modern era, we can adapt, make behavioral changes, regain control, and improve our professional roles, personal and professional lives, and our overall well-being. (Byyny 2016, p. 7)

This project demonstrates one approach to controlling, manipulating, and compartmentalizing this ‘influx of information’ in a practical and concrete way that is aesthetically stimulating while still alluding to and even mimicking the chaotic nature of overinformation.

The aesthetic of the performance is meant to conjure themes of sensory overload, exhaustion, and neurosis, juxtaposed with the mix of beauty and elation experienced from this very data in our everyday lives. We are simultaneously overwhelmed by too much information and complaining when we can’t find an answer quickly or we aren’t entertained and stimulated on demand. In this way, overstimulation cannot be fully understood without the inverse, and both have social consequences: “Understimulation and overstimulation respresent two contrasting disturbing influences, both of which may be considered typical psychosocial stressors of today’s environment” (Frankenhaeuser *et al.* 1971, p. 298). Whether it is through work, art, identity, or media, entertainment, or any other factor, our entrenchment in technology provides a vast fragility that can be daunting to some and beautiful to others. Some are overwhelmed whereas other see possibility.

In this way it’s not only the information itself; it’s how we use the information and how we engage consciously and unconsciously with the stimuli around us. Much like computers, humans parse data. If the information isn’t contextualized or is seemingly immaterial, we discard. Through repetition, we make neurological connections to ingrain information – this is memory, and it is built from stimuli. “Perhaps the best way to appreciate the importance of memory is to consider what it would be like to live without it, or rather them, as memory is not a single organ like the heart or liver, but an alliance of systems that work together, allowing us to learn from the past and predict the future” (Baddeley 1999, p. 1). As essential as stimuli are in this way, for our own survival, despite the access and amount, we must also must discard and disregard some of this information flow.

Finally, we must not mistake information for truth. Actor Denzel Washington, when asked about a tabloid rumor on the red carpet, rhetorically and meditatively touched on the societal implications and the use of so much information. “If you don’t read the newspaper, you’re uninformed. If you do read it [the newspaper] you’re misinformed. It’s a good question, what is the long-term affect of too much information? One of the affects is the need to be first, not even to be true anymore” (*Denzel Washington*… 2016). Information can be bought, sold, and wielded, and we must consider what responsibility we have in the information we take in and that which we put out.

For this reason the system is built to correspond to the vastness of not only the data that can be captured but the overload of possibilities when utilizing the complete system. The programmed system is unique in its myriad applications. A lighting designer, computer engineer, musician, performer, director, or dancer can customize the system to fit the needs and equipment of virtually any performance with BITalino sensors. Even without sensors, the audio visualization module can easily be used across live performances.

To execute this project, a drummer was the optimal choice, as the movement of a drummer is unlike any other musician. A drum performance perfectly encapsulates the disordered nature of over-information and overstimulation. First, drummers utilize all extremities, which aids in the acquisition of data due to the abundance of possibilities. Not to mention, the heart data of a drummer is incomparable to other musicians due to the physical nature of the instrument itself. Next, the drums can be described as a visceral instrument able to fluctuate from relaxed and methodical to outright chaotic. From an audio engineering perspective, this fluctuation means that drums are an extremely intricate instrument to record and extremely fascinating to manipulate. Third, for the performance and aesthetical perspective of the project, a drummer is extremely dynamic visually as well as in an auditory manor. Finally, the sensors are also suited for a drummer to wear with minimal interference.

The projections during the performance tell an abstract but intentional story – the story of segmentation versus dependence, the story of screens framing and contextualizing our lives. In *Essentials of Human Memory*, Baddeley asserts that memory is much like an architect: “The structure of materials does of course at some point constrain the architect and obviously has an important bearing on the creation of a building. Similarly, in principle, a number of aspects of human memory could be influenced by the physiological and biochemical findings” (1999, p. 4). We are constantly being shaped, built, and sculpted to the information and stimuli that is prevalent all around us. It is not a light switch to be shut on or off at our liking. Perhaps our only control is in how we frame this data. Whether we are looking out the window, at our phones, or at a projection, we are constantly outlining our perception through the flow of information around us.

Human-computer interaction is sewn into the fabric of who we are. Hence, the projection is an interaction and improvisational dance between technology and human; natural and unnatural. The subject of the performance is interacting with the environment but is also interacting internally with sensory reaction. When the drummer becomes tired or overwhelmed, his heart rate and his movement change, and this reflects in the environment. With the two movement sensors, the heart sensor, as well as the audio visualization module, the audience member feels the interconnectivity yet also notices the abundance, overload, and persistence of the stimuli all around us.

In a non-pandemic world, this performance would have been in front of guests and spectators and included interactive elements. However, the constraints of COVID-19 led us to shift tactics and ultimately embrace the filming of this performance. In Klingberg's book, *The Overflowing Brain: Information overload and the limits of working memory,* he says, "Attention is the portal through which the information flood reaches the brain. Directing your attention at something is analogous to selecting information, as you give priority to only a small part of all information available" (2000 p. 19). The ability to control every aspect of visuals allows the performance to more precisely direct this 'information flood', versus a live performance wherein the audience has a variety of views and perspectives. Further, creating a video was optimal for contextualizing the themes to the viewer, allowing for insights into the build and setup of the performance. This further contextualizing of the equipment and devices lends depth to the audience's understanding of the projections.

3.2 Team

Johannes Eriste is the drummer for the project and a bachelor's student at the Viljandi Culture Academy. He is a exceptional drummer who is creative and experimental, and was the first choice among respected drummers around Viljandi. Johannes also knows a bit about data acquisition and coding, and was therefore intrigued and curious to understand how the system worked.

Viljar Rosin is the technical manager and a master's student at the Viljandi Culture Academy. His role is to obtain and arrange the necessary equipment and run certain aspects of the technical side of the project. He was instrumental in testing and troubleshooting during the project. Viljar has knowledge in many different areas as a certified electrician, audio technician, and creative enthusiast, he is great in finding technical solutions to unique puzzles.

Jürgen Volmer, well-versed cinematographer and educator at the Viljandi Culture Academy. is tasked with the cinematography of the project. Through detailed storyboards and discussions, Jürgen interpreted the shotlist and worked with the team to capture visually stunning shots that beautifully encapsulate the theme and essence of the project.

Siim Reispass is both educator and student at the Viljandi Culture Academy, and has the role of lighting designer. Siim acted as a consultant for our lighting choices and was key in shaping the visual aesthetic through equipment choice and placement.

I'm *Michael Gugliotti*, audio engineer and master's student at the Viljandi Culture Academy. As the director and creator of *Perceptions of overstimulation*, I coded the system, shot the video for the projections, edited the performance video, edited the audio, executed the sound design, and mixed and mastered the performance audio. I spent countless nights experimenting with how to combine each specific module while keeping sight of the overarching themes.

It's worth noting that this creative process has all taken place in the time of COVID-19, through which we have all been simultaneously cut off from and inundated with information. Luckily, the team created a positive environment in spite of the many protocols we put in place. According to the advisories and rules from Tartu University, we adhered to the 2m social distancing measures, mask-wearing guidelines, and hand sanitation.

3.3 The future of physiological computing in audiovisual contexts

The use of biophysical sensors in audiovisual performance is merely at its beginning. The movement and heart sensors, at inexpensive price points, are effective, reliable, and easy to use. The sensors have limitless applications and can manipulate any facet of a performance including lighting, audio, and video. To facilitate this data manipulation and incorporation, Max 8 is the perfect canvas on which to create such a program because it allows for complete autonomy over the entire audiovisual performance in a clean and visual programming language. One can physically see the information flow and its relevance and impact within each audio and visual module.

Going forward, I see potential for presenting more performances with the sensors and the program I've built. Namely, putting the sensors on a dancer and tailoring the program for a performance wherein the dancer interacts with and controls the audio and projection through movement. Another interesting future experiment I plan to perform is using the ECG sensor in video editing and manipulation, proving the sensors also have application in post-production as well.

With the affordable access to the technology (both sensors and software) and widespread application for the data, it can be integrated seamlessly into any desired artistic medium. The flexibility lies completely within what you want to do with the data and for that reason, the capabilities for future performance, and practical use and integration are limitless within our growing and ever-changing socio-technological landscape.

4. RESULTS

4.1 Audio

The audio of the performance was recorded by the last program module and sent directly to a computer as .wav files. Each microphone was recorded before it entered the audiovisual system, in order to capture the clean sound. In addition, the stereo Max 8 audio of those same drums as they move through the system was recorded to capture the manipulated sound. Recording from Max 8 was straightforward as the ADAC was already incorporated into Max 8, so no additional Digital Audio Workstation was required. A Sennheiser ambisonic microphone was also used to record the drum set, and was decoded for a binaural listening format. The ambisonic microphone provided an atypical perspective of the drum kit and added a disorienting effect because the cymbals can be perceived behind the listener while listening on headphones.

The RME Fireface UFX and one RME Octamic II (ADAT) were used to record the eight channels of drums. A separate Zoom H6 with an SD card was used for the ambisonic microphone. Before each take, we started with a slate to sync all the audio. The microphones were placed to achieve minimal phase and be sonically interesting while still being non-distracting to the visual element. See the table below for an overview of the audio equipment (Table 4.1).

Table 4.1: Overview of audio equipment

Equipment and purpose	**Rationale**	**Adjustments**
RME Fireface UFX; interface	Powerful enough to handle the resources needed for this performance without burdening the computer.	n/a

RME Octamic II (x2); preamplifiers	Transparent and clean sound.	n/a
AKG D12VR cardioid dynamic microphone; kick drum	To capture the boominess of the kick.	n/a
Sennheiser 441super-cardioid dynamic microphone; snare drum top	Well suited to capture a more isolated snare sound.	n/a
AKG 414 condenser microphone set to cardioid; snare drum bottom	Used with a -20db pad to ensure no clipping.	n/a
Neumann Km184s condenser microphone (x2); underheads	Ideal for video as they can be nicely hidden; to provide clarity to the overall drum kit.	n/a
Neumann TLM103 condenser microphone (x2); ORTF room	To capture a stereo image of the drums about three meters from the drum kit.	n/a
AKG C414 condenser microphone set to cardioid; mono room	To capture the sound without the noise of the projectors. In a perfect world, projectors would make no noise.	n/a
Sennheiser Ambeo ambisonic microphone; trash mic	To provide a binaural image of the drum kit.	n/a
Max 8 software; audio ADAC with audio modules	This is the architecture of the performance audio.	n/a
Logic Pro X software; Digital Audio Workstation	Sound design of performance video, decoding of ambisonic microphone, mixing and mastering of the audio.	n/a

In conclusion, the recording, mixing, and mastering of the audio for this project was executed as planned without any technical difficulties. Despite the 'dead' acoustics of the room, the drum kit sound was captured as intended. The interface, preamps, and microphones all proved well-suited for recording this performance.

For the audio mix, the track constantly builds, with more of the stereo Max 8 audio mixed in for the final crescendo. Because the mix has binaural elements within the titles and performance, the challenge was making the audio translate for those who might not be wearing headphones or those who are listening in mono. The audio is also normalized for streaming platforms as the mix is exactly at -14 LUFS. (See figure 4.1 below.)

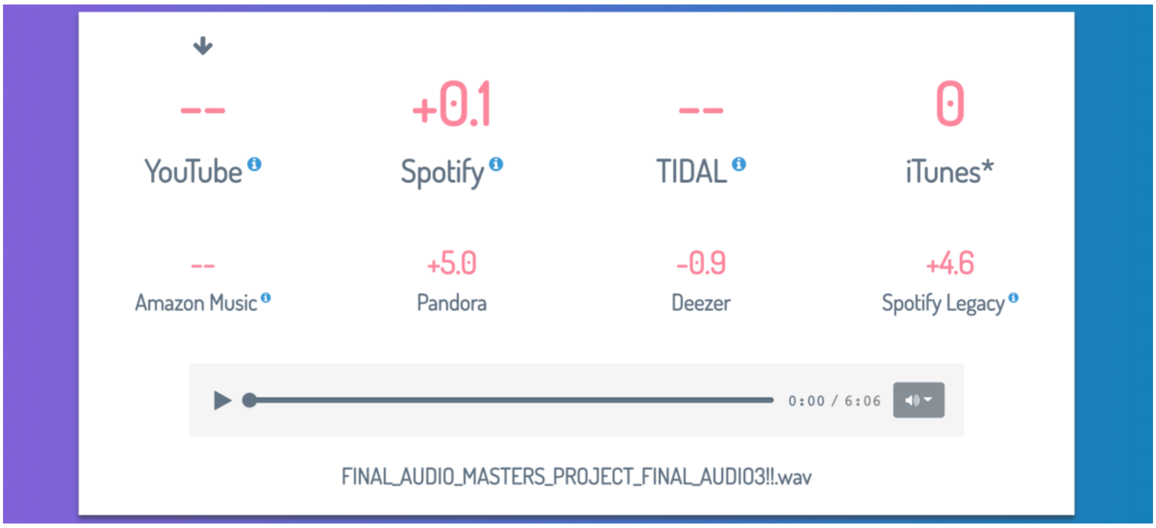

Figure 4.1: Loudness Penalty Analyzer results (*Results*, 2021)

It was imperative to the performance that the drums be disorienting, constantly modulating in pitch, shape, texture, space, and echo. The goal was to create an audio-rich environment for the listener's voluntary perception but also to create an unsettling and overloaded environment that interacts with the listener involuntarily. This multi-layered audio aids in contextualizing the themes of overstimulation within the performance. The viewer should at once want to look and not know where to look, and in this way they are also participating in the dialogue of the performance. "Information overload is compounded by the accompanying participation overload, which consumes time, attention, and brain power. It creates a poverty of attention (Byyny 2016, p. 3). This 'poverty of attention' is the intention of the audio; despite the lush audio environment, the viewer should be perplexed. The audio achieves this effect with nuanced surround mixing techniques and a chaotically dense sound design.

4.2 Visual

The equipment was assembled and tested two days before the shooting of the performance in order to explore the potential visual aesthetics in the space. The first task was making a stand that would hold the screen, as it was too small to hang from any lighting truss. The projectors, although heavy, were easy to manage and set up once positioned.

The lighting for the project was planned to be minimalistic to focus on the audiovisual aspects of the performance and not to detract from the projections and manipulation of projections. However, at setup, it became clear that the projectors provided enough luminance to light up the whole room, and it was determined that no additional lighting was needed. See the table below for an overview of the video equipment used (Table 4.2).

Table 4.2: Overview of video equipment

Equipment and purpose	**Rationale**	**Adjustments**
Texas Instruments Barco (x2); projectors Positioned the projectors in front of and behind the projection screen, on stacked green apple boxes.	These are reliable and professional projectors; front and back projectors were used in order to capture both sides of the performance as well as the superimposed projections.	The focal length of the projection lens wasn’t optimal due to the limited space in the video studio and the size of the projection screen; therefore, the projections couldn’t be the same distance from the screen.
Screen (for back & front projection) Due to no trusses where the drummer is positioned, used a long wooden pole and zip-ties attached to heavy lighting stands to make a DIY screen mount.	This screen displayed both the front and back screen projections.	The screen size wasn’t optimal and so in some of the video frames, you can actually see what was used to make the screen stands to mount the screen. A bigger screen would be better suited to this performance.

Max 8 software; video engine Used to manipulate and output projections.	This software provides complete autonomy over video manipulation within the same program as the audio and biophysical elements.	In future performances, a better computer graphics card would have allowed for more resources to be delegated to video. Further, refine the video engine to add more features to allow for even more video manipulation.

With a larger space, the planned lighting would have been used. There were two different approaches to the lighting plan. The first approach involved creating a time-code by slowly fading a spotlight to a cold blue or vivid red or pink over a desired period of time. This time-code would be synced with a midi-trigger to start it; once the time code is complete, the spotlight would remain the desired color for ten seconds and then cut to a blackout. Ultimately this plan determined to be too limiting creatively by setting an arbitrary time limit for an improvisational performance. The second approach was to place a static spotlight over the drummer where the lighting wouldn't interfere with the projections. This approach would have been used had the projectors not provided enough light.

The visual components of the performance, although not implemented as planned, achieved the desired effect even with the spatial limitations. Another concern that arose due to the size of the space was that the whirring of the projectors would affect the audio. Ultimately, even with the spatial limitations encountered and improvisations that were necessary, the space and setup were maximized. In the future, a bigger space and screen would allow the same projectors to be used and give a cleaner and more symmetric visual aesthetic.

4.3 Filming and video editing

Filming took place on 9 April 2021. Of the two cameras used, one was primarily tripod-mounted while the other was primarily operated by the cinematographer. Having two cameras enabled quick and easy interchange between shots within the same take. The goal was to have as much footage as possible to allow for flexible editing to reinforce the themes of the project. Therefore, many takes were required with many different colors. The tripod shots were there to act as the safety shots but also offered a way to quickly and seamlessly interchange between the same take from a different perspective and flash back and forth accordingly. The shot list, starting with wide shots and working up to close-ups, outlined different aesthetics for each take. Once the main shots were finished, various B-roll shots as well as different angles, profiles, and experimental shots were taken.

For the video, it was paramount to keep the viewer's focus on the performer as the subject of the performance. A variety of close shots gives the viewer a more intimate look at what is happening to the performer and not necessarily on the screens in the background. The viewer sees the performer's direct relationship with the technology; how it can't be escaped, how it is always there, and how we are its subject and lifeblood as much as it is ours.

To further reinforce these themes, the editing software used to edit the video and create basic animations and titles was Adobe Premiere Pro. Since the footage was shot in 4k, proxies were made to help the memory power of the computer. During the editing process, jump cutting between the two cameras provided more visually dynamic transitions and manual glitching effects without the use of preset transition effects. The edit leads the audience to watch the subject interact with the system, such that the focus is the musician's improvisational interaction with the audiovisual ecosystem.

The table below gives an overview of the filming equipment used for both the performance and the projected video (Table 4.3).

Table 4.3: Overview of filming equipment

Equipment and Purpose	**Rationale**	**Adjustments**
Pansonic GH5 (x2); cameras with tripod and handheld rig Used to film the performance.	These cameras are portable, have long-lasting battery life, and have 4k shooting capabilities.	n/a

Cannon Sigma (x2); 18-35mm lenses Used in the filming of the performance.	These are industry standard lenses suitable for all occasions and have wide-angle capabilities.	An anamorphic lens would offer the stretched image and light bokeh more in line with the project's aesthetic.
Adobe Premiere Pro; editing software For video editing, animation, and titles.	An industry standard editing software that allows for all aspects of video editing and animation.	When the video was exported from Premiere, the colors became less saturated. The cause hasn't been identified but could be due to Premiere.
Cannon EOS 50D; camera Used to film footage for the projections.	The lo-fi and noisy aesthetic of this inexpensive camera lent an additional layer of information to the projections, in line with the themes of the project.	While this equipment was well-suited aesthetically, it's not a film camera, rather a photography camera. The project would benefit from the features a film camera provides, such as stabilization and color science.
Helios 44-2; 58mm lens Used on the camera to film footage for the projections.	The dense glass of this lens lends a retro, grainy look to the image; the lens also provides light bokeh despite not being anamorphic.	This lens requires an adaptor because it's an old Soviet lens not suitable for modern cameras. Adaptors vary in quality and create a higher margin of error.

Overall, the video shoot and edit were successful in capturing the aesthetic of the project. The basic animations, frantic cuts, and glitches reinforce the overarching themes in tandem with the sound design. In the future, a more specialized setup would allow for even more visual possibilities.

4.4 Data acquisition

Although the sensors took longer to arrive than anticipated due to COVID-related shipping delays, they were effective in their ease, reliability, and application. They worked ‘out of the box’ as promised with the OpenSignals software. The table below gives an overview of the equipment used in data acquisition (Table 4.4).

Table 4.4: Overview of data acquisition equipment

Equipment and Purpose	**Rationale**	**Adjustments**
BITalino R-IoT (x2); triaxial movement sensor To capture the drummer’s hand movements.	These sensors have a long battery life and could be easily affixed to the drummer’s hands without inhibiting movement.	n/a
BITalino HeartBIT ECG; heart sensor To capture the electrical activity in the drummer’s heart.	This sensor has a long battery life and could be easily affixed to the drummer’s body by means of a clip, with the attached electrodes placed on the drummer’s neck without inhibiting movement.	A challenge was finding a seamless way to acquisition the ECG data into Max 8, because the heart data is acquisitioned via Bluetooth (vs. WiFi) and the data wasn’t syphoning directly from the router. The solution was through a patch made specifically for BITalino users (Borghesi *et al.* 2021).
TP-Link MR3020; WiFi router Created a network for the sensors.	The router is compact and easy to use and set up.	n/a

Macbook Pro 2015; laptop computer Captured and routed the sensor data into the program.	This computer had all the necessary programs for data acquisition and implementation.	The computer was bogged down by all the processes and sometimes glitched, although the data acquisition was stable. A newer computer with more RAM would allow for even more stable and steady acquisition.
OpenSignals; data capturing software that works directly with BITalino sensors Used for straightforward data acquisition, visualization, and recording purposes.	This software works with the sensors out-of-the-box, as promised.	This software is extremely heavy. The computer needed restarted multiple times because it froze OpenSignals and Max 8 were run concurrently. A newer computer would solve this issue.
Max 8; visual programming software Used for all programming purposes related to data acquisition, visualization, and recording purposes.	This software is well-suited for audiovisual performance uses because it allows for control of all aspects of a performance. It's also quite light on CPU load and can render and record in real-time.	n/a

The sensors and the software have infinite capabilities and applications while also being intuitive, compact, and reliable. While the technology, equipment, and setup seemed initially complex, once the system was in place, it proved intuitive to use.

4.5 Venue

The performance needed a large space with room for two equidistant projectors and a screen. The venue changed due to availability and ease of equipment rigging, ultimately taking place in the Video Studio at the Viljandi Culture Academy. The table below gives an overview of the venue (Table 4.5).

Table 4.5: Overview of the venue

Venue	**Rationale**	**Adjustments**
Video Studio, Viljandi Culture Academy; green screen room The space was cleaned, re-arranged, and organized for the video shoot. Blackout floors and curtains were used for better projection.	This large studio was already equipped with projectors, cables, and adaptors, and allowed for flexible use of the overall space.	This space proved to be too small to capture both front and back screen projections. Due to this limitation, the wide shots in the video couldn't be as wide as intended. Further, the acoustics were 'dead', which made the drum sound less lively.

The Video Studio in Vilma House, although not perfect for the intended use, ultimately worked in executing the project. In the future, a bigger space with better acoustics and distance for projectors would be best.

4.6 Timeline

The timeline for the project was constantly changing due to availability of team members, the shipping of the sensors, and coordination of venue and video in lieu of a live performance with an audience, all factors related to COVID-19. See the table below for an overview of what changed and why (Table 4.6).

Table 4.6: Planned vs. adjusted timeline

Planned timeline	**Impact on the plan**	**Adjustments**
Sensors arrive in January.	Shipping was delayed and took over a month longer due to slowed transit.	Sensors arrived in March.

Visual tests all of February in the venue with the team.	COVID protocol made meeting with the team at the venue difficult if not impossible.	Sensors were tested at home with all visual tests taking place on 7 April, two days before the shooting.
Execute project on 15 March.	Execution was delayed due to the above factors.	Executed project 7-9 April.

The unpredictability of the pandemic and the oft-changing safety protocol were the most formidable challenges to the planning process. The reorganization of schedules aided in safety protocols and allowed for alternate testing. In the end, the team aimed for safety and efficiency above all, with most of the work going into the pre-production. Particularly when it came to setup, we aimed to mitigate time spent in the same room regardless of the space we kept between us. Ultimately the project took place over three days, and each day we stuck to the schedule. This altered timeline actually yielded results unique to the current moment and apropos to the themes of the project.

5. CONCLUSION

Perceptions of overstimulation amalgamated the current relationship between humans and technology and the impact of the information that inundates us. Through the use of biophysical sensors, this audiovisual performance explores the interconnectivity and interaction with computers, technology, and the stimuli that surround us. The profusion of movement, heart, and audio data flowing steadily through the system allow for endless play on aesthetics while also speaking to the principal themes of overstimulation and overinformation captured within the performance.

> We are in an age of information overload. The Internet, e-mails, apps, spam, tweets, social media, texting, Facebook, Instagram, memes, news feeds, online videos, updates, and myriad other forms of information have significantly increased the information directed at us, as well as those in which we request to participate. We have come to regard this overload of information, and brain drain, as the norm. We accept this inundation as communication, learning, practice, performance, social and professional interaction, and decision-making, without ever considering our well-being, productivity, and sanity. (Byyny 2016, p. 1)

Where do we go from here? Can we reap the benefits without the disadvantages or are we too far entrenched in our technological norms? Through the lens of our societal attachment to the technology we are flooded with, our interaction and integration in an information-overloaded world is seemingly inescapable.

Through the project, I noticed that I fall prey to all the same traps of stimuli and technology that permeate our everyday lives. I started questioning my own relationship with the devices that I rely so heavily on throughout my daily life for work, entertainment, research, and of course for this project. I was constantly both consuming and losing myself in the abyss of information. In this way, I realized, we are all the drummer in the performance, both consumed by and generating the stimuli around us. For all these reasons, the performance met the goals of exploring information-overload in musical, audiovisual, and biophysical contexts.

BIBLIOGRAPHY

Andrejevic, M. 2013. *Infoglut: How too much information is changing the way we think and know*. New York, NY: Routledge.

Baddeley, A. D. 1999. *Essentials of human memory*. East Sussex, UK: Psychology Press.

Borghesi, R. & Larralde, J. 2021. *Ircam-RnD / bitalino-max.* https://github.com/Ircam-RnD/bitalino-max

Byyny, R. L. Autumn 2016. *Information and cognitive overload*. Pharos Alpha Omega Alpha Honor Medical Society Journal, 79(4), pp. 2-7.

Company About Us. 2021. Plux. https://plux.info/content/9-about-us

Da Silva, H. P., Guerreiro, J., Lourenço, A., Fred, A. L., & Martins, R. January 2014. *BITalino: A novel hardware framework for physiological computing.* PhyCS, pp. 246-253.

Frankenhaeuser, M., Nordheden, B., Myrsten, A. L., & Post, B. 1971. *Psychophysiological reactions to understimulation and overstimulation*. Acta Psychologica, 35(4), pp. 298-308.

Klingberg, T. 2009. *The overflowing brain: Information overload and the limits of working memory*. New York, NY: Oxford University Press.

Results. 2021. Loudness Penalty Analyzer. https://www.loudnesspenalty.com/

Rose, G. J. 1987. *Trauma and mastery in life and art*. New Haven: Yale University Press.

Samuels, E. 14 December 2016. *Denzel Washington calls upon journalists to tell the truth.* Washington Post. https://www.washingtonpost.com/videoentertainment/denzel-washington-calls-upon-journalists-to-tell-truth/2016/12/13/b218db8e-c248-11e-92e8-c08f4f671da4_video.html?utm_term=.7b0a8751e6fa&outputType=default-article&deferJs=true

SUMMARY

Perceptions of overstimulation relies on the themes of overstimulation, the over-abundance of information, and the extent to which technology reigns over our lives either consciously or otherwise. In each facet of our digital lives, we are oversaturated with the constant cycle of news, social media, art, and culture. We are surrounded by the digital noise of our technological existence.

The project is intended to work as a microcosm detailing our digitized lives and our attachment to, the necessity of, and the burden of the technology surrounding us through an audiovisual performance using Bitalino R-IoT sensors that track movement and a BITalino HeartBIT sensor to track heart data in real-time on a drummer. The data is then sent to a router that is connected to a computer where the software Max 8 receives and then parses the data to its respective outputs in order to manipulate both audio and visual elements of the performance, and captured in a short film.

The use of biophysical and movement sensor data from a drummer are a means for investigating our relationship with technology and information as well as the future of biophysical data in artistic performance. With these sensors becoming more affordable, reliable, and intuitive, opportunities to use sensors and biophysical data in performance will only grow and open doors for performing artists and do-it-yourself enthusiasts, amongst others.

With only minute adversity, the technology [i.e. sensors, computer, projectors, soundcard, preamps, cables, dongles, adapters, etc.] performed and was successful in delivering for the performance to the viewer. In the future, the audiovisual program itself can be adapted and re-engineered, and the data acquisition can be made even more intensive.

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