The Return of a Voice:

Implementing Smart Technology to Provide an Outlet that Aids in Communication for Non-Verbal Children with Autism

By: Timothy Arquitt, Jr.

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Abstract

The Current state of communication based software designed to aid those with non-verbal autism is extremely limited or overly complex. The purpose of this research is to look into the world of communication based software aids that provide accessibility options for those with non-verbal autism. This paper looks to assess what is currently availability draw conclusions regarding gaps within the research and technology in order to derive a solution in the form of a mobile phone application that can serve to fill in the aforementioned gaps. The major focus of this study is to pinpoint exactly what elements of design work best regarding UI, UX, and aesthetics along with which elements do not. The goal is to then synthesize and amalgamate these elements into a visual solution that can serve the designated demographic in the best way possible. This thesis study looks at several different cases regarding accessibility based technology and draws many of its conclusions from the success rate of these projects in order to find what is believed to be the best solution in the form of a multi-platform mobile phone application that is both easy to use and widely distributed.
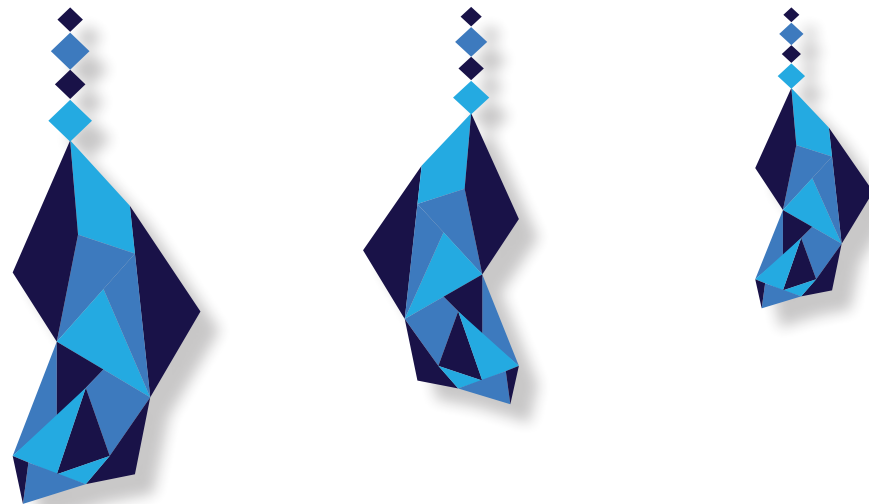
Preface

A PERSONAL MATTER

I want to preface this Thesis document with a personal story that can give some context as to why this subject matter is so near and dear to my heart. I have a cousin whom I grew up with who was diagnosed with autism. This relative and I have always been extremely close and considered ourselves more like brothers than cousins. Due to his autism however he often times found himself unable to share his emotions as he wished and this often times left him feeling isolated when he was younger. This isolation often led to him not being able to engage in family activities he wished to, due to his social anxieties and trouble communicating. While over time and with the help of counselors and family members he found himself able to socialize and engage it still proved a challenge. However when it came to another cousin of mine who was diagnosed years later and was non-verbal. This individual was often times isolated at family functions and was unable to engage with his loved ones. He did however engage with electronic devices and animated characters very easily something I had noticed the previous family member did as well. It was due to this observation that I began my research into the development of creating an application that can serve to engage these individuals socially in a way that is comfortable to them essentially providing them with a voice.
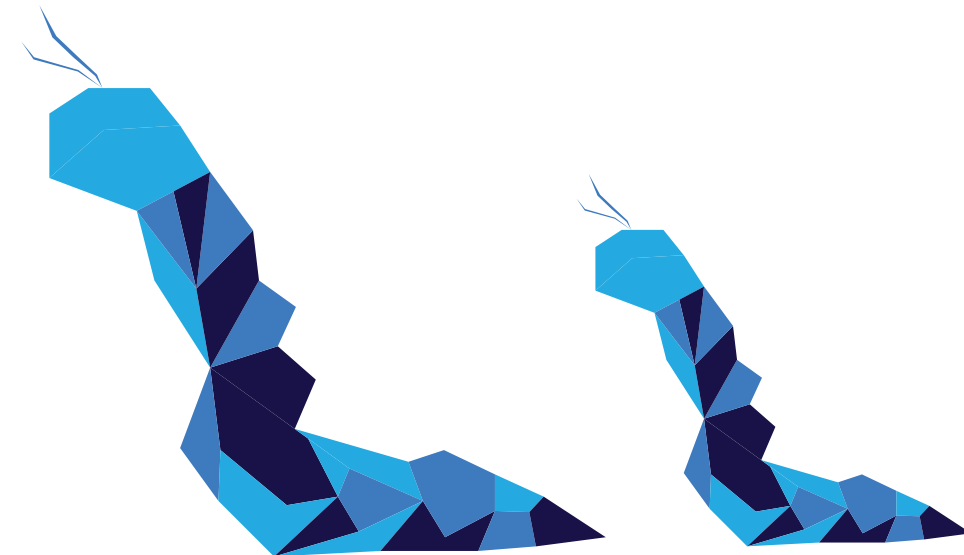
Chapter One

INTRODUCTION

PROBLEM

Non-verbal children ages three to five with autism struggle to express their emotions in an effective manner which can lead to limited social interaction and eventual possible isolation.

PURPOSE

This research project will focus on the impact of having an inability to communicate one's emotional state of mind can have on non-verbal young people with autism and how this problem can be solved in the modern era using smart technology and application design. Many young people, particularly those with neurodivergences are non-verbal or unable to put into words their thoughts and feelings. The lack of communication could in turn cause a sense of isolation for the struggling individual as well as a host of issues for their caretakers. The importance of being able to verbalize one's thoughts is a key and for most of us this act is taken for granted. Throughout history these voiceless individuals have often been pushed by the wayside or seen as non-integral part of society however in recent decades actions have been taken to foster a sense of community for this group of people and provide them with a sense of purpose. However, many struggles still arise regarding these issues and often decisions are made on behalf of the afflicted individuals without regard to what they want or feel. A broad solution to the above proposed problem can be found using a common item that is easily accessible in most areas, the smart phone. The goal is to create a phone application that makes use of a simple UI (User Interface) that presents the users with illustrated options for various emotional states. The user can touch an image that matches how they feel, and the device can play an audible sound describing their emotions. The application will also implement a learning system which includes interactive games and quizzes that help educate the user and further expand their emotional understanding. This system could act as a basis for a much larger scale tool which could help researchers better understand both the inner workings of the user's mind as well as be expanded upon in the future as technology based around neurological connectivity continues to grow. The basic principle for this project can be summed up in five words "The Return of a Voice".

RESEARCH QUESTIONS

- What is the importance of communication and self expression amongst the target audience?

- Do the stakeholders have a desire to communicate their inner thought and emotions with their caretakers and the wider world?

- What are some of the benefits that the stakeholders may receive when provided with the proper equipment for communication?

- Does the current market provide the stakeholders with the tools they need or is there a deficit within this area of accessibility based technologies?

- How easy are the current technological solutions to this problem if any exist and what can be improved upon moving forward

GAPS IN RESEARCH & DEVELOPMENT

Areas in which gaps can be seen within the research is the realm of education. This is about the education of those who interact with the affected individuals as well as those who have been diagnosed with autism spectrum disorder. Education in this context refers not to academics but rather an enlightenment and better understanding of the struggles and issues individuals with ASD face. Most of the research again focuses on the accommodation and the aid of non-verbal autistic individuals and while this aid can help the individual to progress there is a clear lack of understanding being presented to them regarding their syndrome. The same can be said for the education of those who interact with these individuals daily. The importance of real time technology that can update caretakers and educate them on the proper steps to take is severely lacking if not altogether ignored.

APPLICABILITY AND ACCESSIBILITY

The other gap in the research is how technology is being used within the daily lives of those within the demographic. Currently the research which is being produced involving technology and communication is not consumer friendly and mostly serves as a research tool focused on labratory based testing as opposed to being implemented in the everyday life through the use of a simple and user friendly application. The discussion involving wearable technologies is present within the current research particularly by Esma M. Benssassi who refers to them as Wearable Assistive Technologies or WAT for short. However within this study the user is using of technologies that are not practical or easily acessible for the average consumer in a real world scenario. The types of wearable technology that are present within the study are eaither on a largescale that is not mobile or it is too expensive for the common consumer to obtain.

There is a opening for the development of devices and applications that implement inexpensive technology that the demographic can make us of on a daily basis. The technology implemented should be both educational as well as widely accessible and affordable. The combination the previously noted elements in conjunction with the desired visual aesthetics of the specified demographic could serve as a positive addition to accessibility-focused technologies especially in a field that is lacking such. The gaps within the research could serve to provide a better way of life for non-verbal autistic individuals as well as grant a greater insight into their minds and help promote the study and development of new areas regarding this disorder. The field of research regarding technology created to study and assist those with autism particularly non-verbal individuals is vast and ever growing. The research is continually pushing forward at a ever growing pace and evolving as technology as a whole evolves. There is also a growing push for inclusion and acceptance within this field of research which is overall beneficial and provides a safe environment conducive to growth.

Chapter Two

RESEARCH

RATIONALE & BACKGROUND

Autism is a neurological disorder also known as ASD which affects many individuals. These individuals often struggle with social interaction and the understanding of non-verbal cues as well as the identification of one's emotional state based on elements such as facial expressions and body language. This disconnect of social understanding is believed to be linked to possible gene mutation within the brain as noted by researcher Meng-Chuan Lai "Autism is now thought of as a set of neurodevelopmental conditions, some of which can be attributed to distinct aetiological factors, such as Mendelian single-gene mutations. However, most are probably the result of complex interactions between genetic and non-genetic risk factors." (Lai). Many of these individuals also suffer from being non-verbal which can oftentimes make communicating their own emotional state to their loved ones very challenging (Hinzen).

Currently strides are being made within the realm of technology to help provide aid to these individuals particularly those who are non-verbal by creating applications that assist in the learning of social cues as well as AI assisted systems that track the non-verbal cues of those with autism to help better understand what emotions they are trying to convey (HOQUE). As early as the 2000s researchers have been taking steps to create technology to aid individuals with autism and by 2011, they have gone so far as to propose the use of virtual reality to create a controlled environment. This virtual environment would emulate the real world to help promote engagement and foster social learning (Parsons). Others have proposed the use of video-based technologies as well as in-depth and interactive computer software, all of which aim to aid those affected by providing them with an outlet for both communication as well as education (Sherer).

The field of technological aid regarding autism is extremely vast and covers a wide variety of issues. This review serves to examine and synthesize much of the research being done in this realm in order to identify core concepts as well as identify areas which require a more focused and integrated approach that may be lacking in some aspects. It will also look to focus on technologies and research that aid in the development and assistance of those individuals with autism that are also non-verbal. This is done to illuminate what is being concentrated on within this emphasis area and find possible gaps within the research and reasoning.

STAKEHOLDERS

The stakeholders for the research include both verbal and non-verbal people with autism ranging from ages three to five. This particular grouping was chosen in order to assess and aid those within a formative stage in development. While the major emphasis will be placed on those in adolescents focuses on that specific demographic, the application of the research is applicable to anyone within the autism spectrum.

The research will serve to provide the stakeholders with a general boost in quality of life. The goal is to open the doors of communication to those who struggle with verbalizing their thoughts and in doing so providing them with a voice that they otherwise would not have. This implementation of research will allow for a greater understanding of the inner mind of this demographic and possibly open the door to a wider range of communication allowing for a deeper emotional connection between the stakeholders and others which in turn can help break down pre-existing barriers and aid in a reduction in isolation on the behalf of the stakeholders.

NON-VERBAL
Non-verbal individuals with autism are the major focus for stakeholders as the application's function will be to help these individuals communicate more easily. These individuals lack the ability to properly express their emotional state in a verbal manner which can make it difficult to communicate with loved ones and care takers. This particular group will more than likely gain the most value out of this type of research and design.

VERBAL
Autistic individuals who are verbal still often times struggle with communication and properly verbalizing how they feel. This secondary group of stakeholders will also see a great benefit from the development and advancement of this form of technology especial when it is made widely available and in a format that is both appealing and conducive to operation.

RESEARCH METHODS

The major research methods being applied for this project include but are not limited to the elito method, ergonomic method, and experience sampling method through the use of case studies. These types of research will help in the compilation of needed information on the subject matter to build a thesis that is rooted in scientific data and psychological studies. These methods will also serve to expand upon the technological side of the study implementing knowledge based around hands on experience with different types of technology regarding the stakeholders based on the gathered research found within the respective case studies. The use of research that has implemented hands-on testing and firsthand testimonials from loved ones of those within the demographic as well as verbal members of the autism spectrum will also be implemented in order to gain a better understanding of what is both appealing and has been successful in the past. All of this will however be gathered from prior researchers within peer reviewed academic studies. The end goal is to gain the best understanding of the demographic as possible and provide them with a tool that will help them to better express and understand their emotions on a broad scale.

LITERATURE REVIEW SUMMARY

Technological advancements within this field of research span a wide variety of mediums and have evolved over time as technology has also evolved. During the early 2000s an emphasis was placed on the use of video technology and the implementation of visual learning (Sherer). Findings within this study showed that videos did serve to better facilitate the educational process for those with neurodivergence especially when the individual was more apt to be a visual learner. These studies focused on the different approaches to teaching as well, particularly learning through the lens of oneself versus the lens of others (Sherer).

The technological advancements of the 2010s helped to foster forms of research that allowed researchers to make use of a more interactive environment through the implementation of computer applications, and virtual reality (VR). The creation of virtual environments that could be interacted with and explored by the user allowed researchers to create a safe and controlled environment that both allowed for the study of the subject within a more natural learning environment as well as providing the individual a way in which to understand and practice social cues without the fear of the unknown variables that are present within a real world setting (Parsons). It also to be noted that within this particular realm of research many found that those with autism benefited from the technologies and where not distracted by the fidelity of the visuals within the simulation "Given the known cognitive, sensory and perceptual differences and difficulties experienced by many people on the autism spectrum it could be that the realistic nature of 3-D scenes is less important because they may not be perceived in the same way as by typically developing children."(Parsons).

The presence of smart devices within the 21st century continual grows and many researchers have turned their attention toward the use of wearable smart devices. The idea is that the technology is portable and can been worn to keep track of the users non-verbal cues such as their eye movement in order to gain better insight into their though process. These forms of portable devices also look at the speech patterns of specified individuals in order to help the user identify key landmarks in understanding particular emotional responses within conversation. The focus on analyzing non-verbal cues of others is partnered the wearable smart device to present the user with what social interactions may be expected or required of the individual (Benssassi). The wearable devices also serve to provide a form of feedback that is easy for the user to understand and displayed in a way that is inconspicuous if necessary (Benssassi).

RESEARCH CONSENSUS

The consensus among researchers is that implementing and designing technology to facilitate and better the lives of autistic individuals, particularly those that are non-verbal in order to provide them with a better life, is key. Autism Syndrome Disorder is challenging and even more so to non-verbal individuals, who lack the ability to verbalize their inner thoughts and feelings. Providing these individuals with an outlet to express themselves and share their world is not only beneficial to them but also a net positive for everyone including those who continue to study the disorder in the hopes of better understanding it and possibly find a way in which to prevent its development.

KEY FINDINGS

Isolation has been found to be an element that manifests itself in the lives of these individuals. For those who do not suffer from ASD isolation and in particular self-isolation can be a very real problem this is even more so for individuals with autism who lack the ability to recognize social cues and oftentimes do not know how to approach a social interaction. This is taken even further in regard to autistic individuals who are non-verbal (Parsons). These individuals not only struggle with the inability to recognize social cues and engage in typical social interactions that those who are neurotypical take for granted but they also are faced with the added layer of not being able to verbalize and vocalize their thoughts and feelings. This intense disconnect from others can lead to complete isolation if the individuals do not have some form of assistance (Lai). This is where the importance of technology comes into play allowing for the affected demographic to engage with others and in turn grant them a sense of autonomy.

Autonomy being one of the major elements within the field of research continues to promote the belief that customization and the treatment of each person as an individual when designing technology for their use is of the utmost importance (Lopez-Herrejon). People with autism are no different than neurotypical individuals in regard to diversity and a need for individuality both on in regard to their mental state as well as their personality (Picard), "Those who have worked with a lot of people on the autism spectrum know the following adage: 'If you've met one person with autism, then you've met one person with autism'. In this day when the computational power of the first lunar mission fits into a trouser pocket, when wireless technology is pervasive and when kids upload home videos for the entertainment of people around the planet, there is no reason to restrict research to the old paradigm of laboratory observations that use snapshot measurement technology and average the findings across a group." (Picard)

DIVERSITY AND INTEGRITY

The importance of inclusion and diversity is one of the major points of consensus noted throughout all the research and that autism is a spectrum for a reason (Parsons). No two individuals are the same and should be treated as their own person (Picard). Including these unique individuals in the research process both serving in an advisory role as well as participating in study serves to benefit the field overall giving greater insight into the workings of the minds

of those affected (Parsons). By allowing these individuals to participate in the narrative of research and the presenting of the findings it also grants researchers a deeper understanding into how people with autism spectrum disorder retain and process information further propelling the research in favorable manners (Cascio).

The integrity of the individual and the importance of their consent is the most important element in which most of the researchers have found consensus within this field. Each individual who volunteers both in an advisory role or to serve as a member of the subjects being studied should be regarded with the utmost respect and consent should be present at all times (Lei).
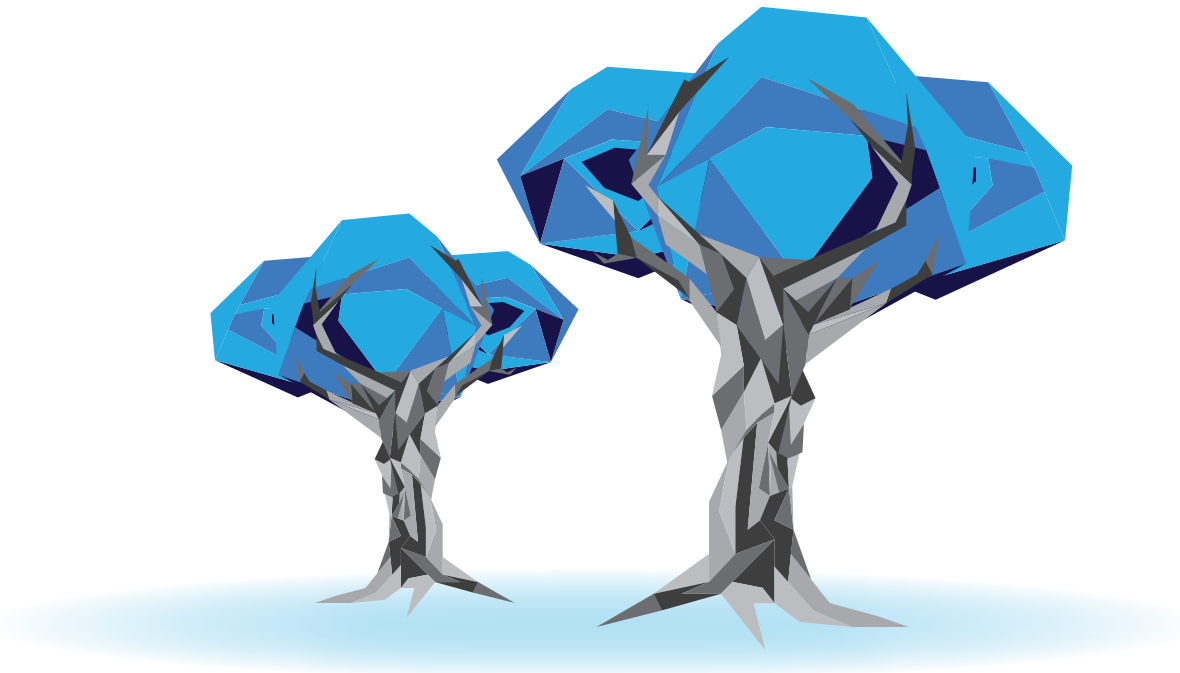
LITERATURE REVIEW

ABSTRACT

This review serves to analyze and synthesize research regarding technology and nonverbal autism. The use of such technologies and how they are implemented will be explored in depth providing insight into what is currently available. This review also serves to explore the ethics of such technologies and the proper way to implement them. The attitudes toward the use of technology regarding non-verbal autism is also considered and the consensus on what is deemed appropriate within the field. Inclusion is a major theme within ethics and the opinions of autistic individuals are considered regarding these matters. This paper will also sever to review and identify gaps within the area of research and whether there are areas of study which need to be explored further.

INTRODUCTION

Autism is a neurological disorder also known as ASD which affects a large number of individuals. These individuals often struggle with social interaction and the understanding of non-verbal cues as well as the identification of one's emotional state based on elements such as facial expressions and body language. This disconnect of social understanding is believed to be linked to possible gene mutation within the brain as noted by researcher Meng-Chuan Lai "Autism is now thought of as a set of neurodevelopmental conditions, some of which can be attributed to distinct aetiological factors, such as Mendelian single-gene mutations. However, most are probably the result of complex interactions between genetic and non-genetic risk factors." (Lai). Many of these individuals also suffer from being non-verbal which can oftentimes make communicating their own emotional state to their loved ones very challenging (Hinzen).

Currently strides are being made within the realm of technology to help pro-vide aid to these individuals particularly those who are non-verbal by creating applications that assist in the learning of social cues as well as AI assisted sys-tems that track the non-verbal cues of those with autism to help better understand what emotions they are trying to convey (HOQUE). As early as the 2000s researchers have been taking steps to create technology to aid individuals with autism and by 2011, they have gone so far as to propose the use of virtual reality to create a controlled environment. This virtual environment would emulate the real world to help promote engagement and foster social learning (Parsons). Others have proposed the use of video-based technologies as well as in-depth and interactive computer software all of which aim to aid those affected by providing them with an outlet for both communication as well as education (Sherer).

The field of technological aid in regard to autism is extremely vast and covers a wide variety of issues. This review serves to examine and synthesize much of the research being done in this realm in order to identify core concepts as well as identify areas which require a more focused and integrated approach that may be lacking in some aspects. It will also look to focus on particular technologies and research that aid in the development and assistance of those individuals with autism that are also non-verbal. This is done in order to illuminate what is being concentrated on within this emphasis area and find possible gaps within the research and reasoning.

AUTISM SPECTRUM DISORDER (ASD)

Autism Spectrum Disorder or ASD is a neurological disorder that affects a growing number of young people. The disorder is often noted for causing the individual to lack a basic understanding of social cues and an inability to naturally read body language. The affected individuals also suffer from mental overstimulation which can in turn lead to negative outcomes for both those with autism as well as their loved ones. It is believed that the disorder is the result of mutation within certain genes that causes a disconnect within the brain (Lai). Most individuals with the disorder are noted for taking everything in conversation at face value and having a very literal understanding of the world around them. It is important to note that the disorder is a spectrum, and each individual is affected differently (Lai). Some who have ASD are known as "High Functioning" and while they may face the same challenges and symptoms that others have, they are able to adapt and live fairly normal lives (Lai). For the purposes of this paper we will be looking at individuals who are on the other end of the spectrum, particularly those who suffer from being non-verbal. Non-verbal individuals lack the ability to vocalize their inner

thoughts in a traditional manner which can keep them from adequately communicating their emotional state which could lead to possible isolation (Hinzen).

TYPES OF TECHNOLOGY

Technological advancements within this field of research span a wide variety of mediums and have evolved over time as technology has also evolved. During the early 2000s an emphasis was placed on the use of video technology and the implementation of visual learning (Sherer).Findings within this study showed that videos did serve to better facilitate the educational process for those with neurodivergence especially when the particular individual was more apt to be a visual learner. These studies focused on the different approaches to teaching as well, particularly learning through the lens of oneself versus the lens of others (Sherer).

The technological advancements of the 2010s helped to foster forms of research that allowed for researchers to make use of a more interactive environment through the implementation of computer applications, and virtual reality (VR). The creation of virtual environments that could be interacted with and explored by the user allowed researchers to create a safe and controlled environment that both allowed for the study of the subject within a more natural learning environment as well as providing the individual a way in which to understand and practice social cues without the fear of the unknown variables that are present within a real world setting (Parsons). It also to be noted that within this particular realm of research many found that those with autism benefited from the technologies and where not distracted by the fidelity of the visuals within the simulation "Given the known cognitive, sensory and perceptual differences and difficulties experienced by many people on the autism spectrum it could be that the realistic nature of 3-D scenes is less important because they may not be perceived in the same way as by typically developing children."(Parsons).

A major area in which advancements have been made is that of eye tracking technology and the ability to control devices with one's gaze. This form of technology is designed to examine the movements of the individual's eyes and interpret that data to the computer as movement enabling individuals to control a mouse cursor or other form of navigational tool by simply looking (Karlsson). This technology was initially used to aid younger individuals who suffer from cerebral palsy but has led to advances in the field that has become applicable in the aid of those with non-verbal autism (Fujiwara). The ability to track eye movement helps provide insight into the inner workings of these individuals' minds and allows for researchers to facilitate a form of communication with these individuals as they did with those with cerebral palsy(Karlsson). The results of research within this field have led to net positive and found that it is beneficial in providing these individuals with a way in which to communicate with their loved ones, "In addition to goal achievement, communication, quality of life and participation outcomes, we sought parents' perceptions of their child's response to eye-gaze control technology and of their experiences of the process of device implementation. As expected, the families reported that their children very quickly mastered the initial simple games and families were asking for more games and early learning software. The newly released Windows Control from Tobii Dynavox 24 and the Microsoft 25 initiative, Eye control which enables eye-gaze control in a Windows 10 environment, hold promise for supporting exploration and playfulness by facilitating access to mainstream early learning activities, previously only accessible for children who were able to operate a mouse or use a touch screen." (Karlsson).

Technology is also found to be implemented not only to facilitate those with autism and educate them on social interaction but also to educate those around them as well as provide them with a means to communicate and socialize. Artificial intelligence has played a major role in the development of applications that aid the noted demographic, some of which make use of sensors and algorithms to measure physical data in regard to non-verbal cues. These forms of tech have allowed for non-verbal individuals to communicate their inner thoughts in ways they could not previously articulate (Cabibihan). This engagement and interaction-based technology has also expanded into the realm of robotics allowing for younger individuals to practice and engage with an object that is representative of another person. The use of these machines allows for a safe way to engage and practice one's skills (Baraka). The use of applications such as those previously mentioned also serves to aid the

individual in coping with their disorder and the as they continue to interact and engage many of their symptoms can be alleviated, "Because ASD is not a neurodegenerative disorder, many of the core symptoms can improve as the individuals learn to cope with their environments under the right conditions." (Cabibihan)

With the ever-increasing presence of smart devices within the 21st century many researchers have turned their attention toward the use of wearable technology. The concept behind this is that technology that is portable and can be worn to track certain non-verbal signals such as heart rate and eye movement could help communicate when an individual with autism is becoming overstimulated and the proper actions can be taken. These forms of wearable technologies also serve to recognize speech patterns and create profiles off of them to serve as educational tools in order to better equip these individuals with a deeper understanding of social interaction. This focus on reading the non-verbal cues of others is used in conjunction with the wearable technology in order to display what possible social interactions may be expected on behalf of the individual (Benssassi). These wearables also serve to provide a form of feedback that is both easy to understand and presented in a manner that is discrete if necessary (Benssassi). It is also noted that an that a balance has to be struct in regards to how the technology is presented and how the feedback maybe received otherwise overstimulation could have a negative outcome, "Existing WAT feedback modalities consist of a text message (for example, "anger"),11 cartoon icon representing an emotional state,12 color or color animation pattern (for example, bright red indicates anger), voice speaking out an emotion, or subtle beep or monolithic sound.15 These aim to attract the attention of autistic people to ensure they receive the message, but overattraction might have a negative impact in social situations."(Benssassi).

The customization of these forms of technology also serves to cater to a wider demographic and allows researchers to provide a more catered experience, "We start by identifying and characterizing the different forms of customization that have been supported. We further analyze the computer technologies employed to provide the identified customization, the sensorial

dimensions considered, the level of aid required for adequate use of the computer-based systems, the consideration of the common co-occurring condition of intellectual disability, the user's developmental domains (e.g. social competencies), the deployment context (e.g. house or clinic), the empirical evidence supporting each approach (e.g. forms of experimental designs employed), and the publication outlets."(Lopez-Herrejon). The ability to adjust the technology to fit specific needs allows users on different points on the spectrum to benefit from the available tools. This customization allows for more input from the end user and provides a wider pool of individuals for researchers to learn from (Lopez-Herrejon).

ETHICS
Technology is advancing at a rapid rate and has been implemented into many fields of study; however, this raises questions about the ethics of using such technologies in regard to the affected individuals. Much of the technology previously mentioned makes use of data that is being gathered and oftentimes compiled into profiles for each user. The ethical question then comes into play "Is profiling and cataloging data on users particularly regarding their neurodivergence ethical?" This is an area in which many researchers tread lightly due to both the subject matter as well as the requirements for research. Many have found that if the participants and users of the applications and technology are consenting then there is no moral or ethical qualm. However, this area begins to get fuzzy when younger or non-verbal individuals are brought into play. These individuals cannot oftentimes express their verbal consent to the use of such data (Lei).

The other major issue that is noted within the field in regard to ethics comes in the form of diversity and inclusion. Many researchers find it important to gauge their study over a wide variety of individuals from differing backgrounds; they are only oftentimes studied as subjects and not included within the research as cooperative contributors (Parsons). Some have found that it is important to engage with the volunteers and provide them with multiple options and reinforce the concept of consent in order to create a more conducive and inclusive atmosphere, "Technology design does not exist in a vacuum, it is part of a broader context which includes human contact and

learning. Inherent in every design decision are a number of ethical, social, and cultural assumptions which need to be explicitly considered" (Parsons). This type of research has led both to better test results as well as an overall boost in confidence on behalf of the participants which in turn promotes their socialization skills (Parsons).

Parents with children who have autism have expressed within case studies a need for privacy while using assistive technology. Technology needs to have safeguards to protect these individuals so that both their privacy is maintained as well as a guaranteed sense of security when engaging with such technologies. (Just) It is for these reasons from an ethical point of view that wearable technology that tracks data on the user may not be the best solution for this particularly demographic. "In many cases, carers identified actions by their children for which the carers wanted more knowledge or control. Throughout, we asked carers to confirm that the challenges were specific to their children with ASD. This was confirmed by the carers, and while the concerns bear some resemblance to cases with children without ASD, carers noted clear differences, e.g., C7: "I think the vulnerability, they just don't see danger, they can't sense danger. They can't see the big picture, because they tunnel-vision, it's black and white, no grey areas." This should not be surprising and is reflective of the wide spectrum within ASD. The difference, in most cases, comes in terms of the challenges of protecting the child and influencing their behaviour," (Just)

Researchers lean toward the viewpoint that when studying autism they should include the affected individuals as part of the research party, not only as voluntary subjects (Parsons). This idea of inclusion has raised ethical questions within the field of whether or not research about autism should be approached without the inclusion of individuals with autism working alongside the researchers to produce the studies. In this same vein the ethics of language and terminology has arisen in regards to the identity of those with autism. Those with autism prefer to use language that places the disorder before the individual an example of which would be "autistic person" versus the preferred terminology that scientific researchers use which places the disorder after the individual as to not make it seems that the disorder is their identity an exam-

ple of this would be "Person with Autism" (Lei). This use of language directly correlates itself with the concepts of research involving the opinions of the affected party and whether it is ethical to study these individuals without their inclusion within the narrative being derived from the research. The consensus among researchers is that these individuals should be prioritized, and their opinions should be respected, "The consensus across stakeholder groups is that the autistic individual's opinion should always be respected and prioritized, and language should strive to accurately convey individual's unique strengths and weaknesses by adopting a person-centered approach." (Lei)

The ethics of inclusion are also to be noted particularly when developing technology. Many researchers believe that inclusion of individuals with autism when designing the programs can provide a better understanding into what appeals to the demographic as well as what may be the most beneficial (Parsons). The ideology behind this is that the affected individuals would know what works best for them however it is taken into consideration that each individual is unique and a blanket form of technology isn't applicable,

Along with inclusion, a major concern within the field of research is the ability to empower the individuals and making sure that the research and technology being implemented leaves the user feeling positive (Parsons). Many of these individuals, when presented with the ability to choose between multiple options and given the power to decide for themselves felt an overwhelming sense of pride and an overall boost to their confidence level (Cascio). This is key when designing and implementing these technologies while it is important to facilitate a better life on the physical level the mental state of the user always needs to be taken into account, "Sometimes empowering participants to make choices can be vital to research design, when the design is about such choices."(Cascio). This concept of positivity and empowerment also helps to foster a sense of control within the individual and helps them to use the technology as an aid without becoming overly dependent and in giving this level of control to the user it also helps foster the customization needed for each individual as mentioned above. Decision making helps avoid the use of blanket solutions and allows for a personalized experience (Cascio).

Another ethical issue that can be noted by many is the overdependence on technology in regard to individuals with autism. Some researchers believe it is important to strike a balance between real world application and technology (Lei). The concerns that arise when becoming dependent on technical applications as an aid rather than a learning tool include the possibilities of self-isolation as well as a codependency that may hinder the learning process rather than foster it. Most researchers agree that it is important to strike a balance that is beneficial to all parties involved and that serves to promote a better way of life for the affected individual (Lei).

ATTITUDES TOWARD THE USE OF TECHNOLOGY

The overall attitude toward the use of technology as a general aid or learning tool for those with autism is strikingly positive. In a study done on elementary teachers a vast majority of the educators were in favor of the use of computerized technology to help create an atmosphere conducive to learning for the affected individuals (Sulaimani), "The respondents also held positive views regarding the use of technology to impact student learning. Different categories emerged from instructors' responses. Two instructors spoke of the role technology can play in providing students with alternative tools to express themselves and answer questions by simply using pictures or clicking and pointing techniques to answer questions." (Sulaimani)

Within the realm of scientific research and application development the attitude toward technological aid is also overwhelmingly positive. This is noted not only within the field of accessibility based software but also in regard to researchers studying these individuals. The technological advancements of eye tracking software and AI based programs that can measure data involving non-verbal cues provides such detailed information particularly regarding younger non-verbal individuals that the results speak for themselves which intern frames these technologies in a positive light (Cabibihan). An important element that must be considered when designing an application for non-verbal autistic aid is the role of the parent and the attitudes that they may have toward the use of phone and tablet applications within the household and whether it is seen as a positive form of communication aid and education. According to case studies and intieriews conducted involving parents

of children with ASD it was found that attitudes toward the use of iPad applications is positive and most find it to be beneficial. "The attitudes toward technology in general and iPad applications specifically were favorable among both parents and professionals" (Clark) This positive attitude can be also be noted within the children themselves the use of the iPad as the preferred platform was of notoriety and it was found that most children with ASD had a basic understanding of the functionality of the iPad as well as increased engagement. "Parental reports of child iPad use showed that almost half of the children (46%) had begun using an iPad 12 to 18 months ago, while 30% had begun using an iPad in the past 6 months. Only a small percentage of children in the sample (3%) had never used an iPad. iPad use was high for children with ASD, with the mean frequency of use reported as a total of 4.6 days (SD = 1.74) out of the previous 5 days."(Clark) This preference for the iPad has been further expanded upon for the target user within the United States in a separate study showing that it serves to be more accessible for younger users due to its large size and ease of use. "The rise of toddler-friendly touch screen technology, as embodied in the iPad, has begun to influence educational approaches to autism [37]. Evidence suggests that children with ASD can access iPad and other touchscreen technologies [38], [39], and have been observed to be more engaged and verbal during their use." (Fletcher)

Overall attitudes toward the implementation of technologies are considered positive and seen as beneficial for everyone involved. Most individuals find that use of this technology in the education space is an overall net positive and should be explored and implemented further to help facilitate the learning and overall success of individuals with ASD (Benssassi). Within the field of using the technology as an aid within daily activities many also agree it is a net positive if the individuals do not become over dependent on the technology and continue to learn and grow as an individual making progress within their lives.

APPLICATION OF TECHNOLOGY REGARDING YOUNGER INDIVIDUALS

Much of the research being performed within the field of accessibility and technological implementation regarding Autism has been performed over a wide range of individuals from multiple walks of life. However, a particular

subset of individuals targeted stands out and that is younger children ranging in age from two years to Elementary school age. This particular subset of individuals faces a whole different host of problems in regard to being able to communicate their thoughts and emotions (Parsons).

These younger individuals are in a very key phase of life when developmental processes of the brain are in full effect. This stage of life is particularly ideal to introduce new technologies to aid in the expression of emotions due to their ability to learn quickly as well as the lifelong effects it will have on them in regards to acquiring skills (Lai). This age range is also key in the detection and prevention portion of research which can allow for scientists to detect irregularities within development and address them for possible course correction (Lai). Technologies such as those mentioned above regarding the sensing of non-verbal cues have been implemented when studying this demographic due to the restrictions of speech at this developmental age. This new form of technology is able to correlate and draw conclusions based on context clues and provide feedback that is beneficial in understanding the thought process and attitudes of the children in question (Cabibihan).

When examining the visual fixation and preference of children with autism many attributes of their behavior can be noted that intern provide a significant increase in specific fixation on particular design aspects. Younger individuals with autism prefer less social and organic imagery and prefer designs that are representative of machinery or have a rigidity to them that is less reflective of nature. Repetition is another key attribute that is to be noted within the preferred aesthetic of the target demographic particularly that of repeating patterns and geometric shapes. (Gong) "Compared to other diagnostic groups, they also prefer to attend to highly repetitive images, such as repeating geometric shapes rather than social images (3,16,17). Pierce et al. (17) examined simultaneously the eye gaze of subjects on videos of children doing yoga and found that children with ASD paid more attention to geometric pictures. Kou et al. (21) presented geometric figures of repetitive motion and videos of dancing children or adults to subjects at the same time and found that children with ASD preferred to look at geometric figures with repetitive motion compared to typically developmental (TD) children rather than

looking at humans presented." (Gong)

Other considerations to be taken into account when designing applications for autistic individuals particularly children include an emphasis on vocal reinforcement and the use of familiar phrases that can be repeated when engaged with. This type of design process was implemented in a series of case studies conducted by a group of researchers based out of the UK and they found that these audible elements are beneficial to the users' overall experience but should be used strategically. The study also found that while applications can contain music, it is advised that music be a mutable option as to avoid overstimulation and provide a conducive environment that is beneficial to the user on a case by case basis. (Fletcher) "The advisors recommended autism-specific rewards such as familiar phrases ("good looking!"), spinning shapes and vehicles. They were keen that verbal prompts and sound effects should be used throughout the game (e.g. character saying "Look at me!") but considered that music should be mute-able." (Fletcher)

When implementing such technologies at a young age, researchers have found it important to tread carefully due to the sensitive and receptive nature of the individuals. It is in this stage of life that one can easily develop lifelong dependency on such devices, and this is seen as the darker side of its implementation. The goal of the researchers is to better understand these individuals and aid them in their self-expression however in doing so they want to avoid creating habits that may not be beneficial on a long-term scale (Parsons). As long as a balance is struck it is believed that the implementation of such technologies is a net positive for both researchers and the individuals who deal with neurodivergence particularly on the autistic spectrum. The major challenge faced when studying and implementing these technologies on younger individuals is their lack of communication and the need for custom tailored options on a person-to-person basis. Each individual faces different challenges when on the spectrum and those challenges must be compiled into a profile in order to help better cater to this individual's needs (Porayska-pomsta). This again brings up the ethical questions faced by many of the researchers on whether or not these individuals can consent to data collection; however, this is somewhat alleviated when studying younger

individuals due to consent falling on the shoulders of their legal guardian (Parsons). However there has been a push to receive some form of non-verbal consent on behalf of the child in order to better facilitate their growing need for validation and for the purposes of inclusion which in turn has been found to boost their overall confidence (Cascio).

The use of these technologies on younger individuals with autism has been shown to produce positive results and many researchers agree that the implementation of this form of aid will facilitate a better future both on an individual basis as well as overall (deLeyer-Tiarks). The use of technology with younger individuals has been proven to be an easier feat than with older patients due to the receptive nature of younger children. Also the importance of alleviating and facilitating younger individuals to provide them with a better future is paramount due to the large number of issues that arise with autism during childhood as noted by researcher Johanna M. deLeyer-Tiarks, "Children and adolescents on the autism spectrum experience challenges across both social and communication contexts including joint attention, understanding, and use of pragmatic language, imitation, and social reciprocity (Shukla-Mehta et al., 2010). This includes social interaction and communication weaknesses, along with restricted and repetitive behaviors (American Psychiatric Association, 2013)." (deLeyer-Tiarks)

The mentioned target demographic has been known to engage with media more efficiently when it is presented literally through a visual means with the associated wording displayed along side it. It is to be noted that when designing for these individuals it is important not to create distracting imagery or place images within the background but rather have them floating on a basic color this provides a more conducive learning environment and cuts down on over stimulation. (Pavlov) Another key element to make note of is the use of customization within UI design for those with ASD and the vital role it plays in assisting these individuals "Personalization is a key element for the successful user experience for people with ASD, because they have very different personal preferences and needs [17]. The research described in this paper investigates the inclusion of people with ASD in participatory design of user interfaces. It notes that people with ASD can benefit from this

as it enables them to directly ensure that the interface is personalized to their individual needs. It has the advantage that intermediaries do not serve as proxies for end users, but end users themselves have direct input in the design process. (Pavlov)

IMPORTANCE OF TECHNOLOGY AND COMMUNICATION

The importance of developing technologies to aid non-verbal individuals with ASD has become a major area of consensus for researchers. Many have found that the affected individuals have a deeper thought process and an inner world that has been overlooked in the past (Hills). Many of these individuals have deep understanding of specific concepts regarding faith and spirituality which they wish to communicate to others but are hindered in doing so due to their inability to verbalize their thoughts. The process in which they take in information and translate it is believed to be very different from verbal individuals however the desire to communicate it still remains (Hills). The use of technology in facilitating this communication opens up a whole new world to those with ASD as well as aids in the progression of research in regard to facilitating them Researcher Karenne Hills noted in their study on non-verbal autism and spirituality, "This study aimed to explore spiritual experiences of people with nonverbal autism from their own perspective. As such, the first significant finding of this research was that it was indeed possible to conduct meaningful, inclusive research with people who do not communicate in conventional ways." (Hills). They also state in their work that technological advancements both low tech and high tech have helped facilitate this form of meaningful conversation and that the importance of doing so was of supreme importance, "Recent technological advances have seen the development of various techniques and devices designed to support people who are nonverbal to communicate meaningfully. These devices are typically tailored to the needs of the individual and range from "low tech" (e.g.,letterboards), to sophisticated speech generating software." (Hills)

Communication is a key part of development in children and helps to shape the individual both cognitively and in regard to their personality (Hinzen). Researchers agree that the importance of providing non-verbal individuals with a way in which to communicate is paramount to their development and aids in their social growth as well as their ability to understand the world

around them, "Language not merely configures the space of communication and social interaction from birth, but it is also inherently linked to categorization and learning. From the first months onwards, words play a critical role in what aspects of stimuli babies attend to and what categories they form."(Hinzen). With the implementation of the technologies mentioned above it is believed that non-verbal individuals with autism may find a way to expand their horizons and educators will be better equipped to foster their academic abilities in a manner that is conducive to learning. These technologies grant these individuals a voice which fosters their ability to lead a much fuller life engaging in the world around them on a whole new level (Cabibihan).

CONSENSUS

The consensus among researchers is that implementing and designing technology to facilitate and better the lives of autistic individuals, particularly those that are non-verbal in order to provide them with a better life, is key. Autism Syndrome Disorder is challenging and even more so to non-verbal individuals, who lack the ability to verbalize their inner thoughts and feelings. Providing these individuals with an outlet to express themselves and share their world is not only beneficial to them but also a net positive for everyone including those who continue to study the disorder in the hopes of better understanding it and possibly find a way in which to prevent its development.

Isolation has been found to be an element that manifests itself in the lives of these individuals. For those who do not suffer from ASD isolation and in particular self-isolation can be a very real problem this is even more so for individuals with autism who lack the ability to recognize social cues and oftentimes do not know how to approach a social interaction. This is taken even further in regard to autistic individuals who are non-verbal (Parsons). These individuals not only struggle with the inability to recognize social cues and engage in typical social interactions that those who are neurotypical take for granted but they also are faced with the added layer of not being able to verbalize and vocalize their thoughts and feelings. This intense disconnect from others can lead to complete isolation if the individuals do not have some form of assistance (Lai). This is where the importance of technology comes

into play allowing for the affected demographic to engage with others and in turn grant them a sense of autonomy.

Autonomy is key, providing non-verbal individuals with Autism Syndrome Disorder a way in which to interact with the world around them without the aid of another person's help is one of the major reasons for technological advancements within this field. Empowerment of non-verbal autistic individuals is not only beneficial to them giving them a new lease on life and allowing them to live a richer and fuller life, but it also opens many doors within the field of research regarding ASD and as mentioned above how it can lead to discoveries in the field of prevention.

Autonomy being one of the major elements within the field of research continues to promote the belief that customization and the treatment of each person as an individual when designing technology for their use is of the utmost importance (Lopez-Herrejon). People with autism are no different than neurotypical individuals in regard to diversity and a need for individuality both on in regard to their mental state as well as their personality (Picard), "Those who have worked with a lot of people on the autism spectrum know the following adage: 'If you've met one person with autism, then you've met one person with autism'. In this day when the computational power of the first lunar mission fits into a trouser pocket, when wireless technology is pervasive and when kids upload home videos for the entertainment of people around the planet, there is no reason to restrict research to the old paradigm of laboratory observations that use snapshot measurement technology and average the findings across a group." (Picard)

Overall technology is seen in a positive light amongst researchers within the field and plays an important role in the lives of autistic individuals. The importance of creating educational material as well as facilitating the learning of these individuals has become one of the most important and key roles within research. This is done with the goal that these individuals can live a productive life and feel as though they are included within a larger society.

The importance of inclusion and diversity is one of the major points of

consensus noted throughout all the research and that autism is a spectrum for a reason (Parsons). No two individuals are the same and should be treated as their own person (Picard). Including these unique individuals in the research process both serving in an advisory role as well as participating in study serves to benefit the field overall giving greater insight into the workings of the minds of those affected (Parsons). By allowing these individuals to participate in the narrative of research and the presenting of the findings it also grants researchers a deeper understanding into how people with autism spectrum disorder retain and process informatio further propelling the research in favorable manners (Cascio).

The integrity of the individual and the importance of their consent is the most important element in which most of the researchers have found consensus within this field. Each individual who volunteers both in an advisory role or to serve as a member of the subjects being studied should be regarded with the utmost respect and consent should be present at all times. These individuals' thoughts and contributions to the field should be regarded as some of the most important elements and the individuals should never feel alienated or belittled. This mutual respect not only serves to create an environment that is welcoming and promotes the wellbeing of these individuals, but it also serves to provide the researchers with the best results possible (Lei).

GAPS IN KNOWLEDGE

The major areas within the research that contain possible gaps include firsthand interviews and accounts regarding the technology being applied outside of a laboratory setting. The emphasis on aid versus education and facilitation is another key area of lacking information. The major area however in which a gap in research can be noted is within the field of consumer-based technology that is applicable for everyday use as opposed to an academic or scientific setting.
Most of the research within this field focuses on in-lab studies of individuals within a controlled environment. There is very little research done in the field regarding hands on daily use of these technologies and user input regarding firsthand experiences when applying the technology to real world scenarios. This lack of real-world input is interesting as it leaves an opening for

exploration of a more hands-on approach that will provide results that better reflect how the end user will be making use of such technologies. A study that examines the daily lives of these individuals and how they implement this technology into their routines could be extremely beneficial at advancing the field and allowing for a larger pool of data to be made available for research and study. Most of the research within the field is psychological in nature with little regard to design and what elements are appealing to individuals with Autism and whether or not there are certain visual cues that act as through lines connecting many of these individuals together.

Another area in which gaps can be seen within the research is the realm of education. This is about the education of individuals who interact with the affected individuals as well as those who have been diagnosed with autism spectrum disorder. Education in this context refers not to academics but rather an enlightenment and better understanding of the struggles and issues individuals with ASD face. Most of the research again focuses on the accommodation and the aid of non-verbal autistic individuals and while this aid can help the individual to progress there is a clear lack of understanding being presented to them regarding their syndrome. The same can be said for the education of those who interact with these individuals daily.
The importance of real time technology that can update caretakers and educate them on the proper steps to take is severely lacking if not altogether ignored.

This field of research is very focused on the psychology of Autism and its effects and rightfully so however this does leave an opening within the research regarding artistic influence and design. There's little to be found on the effects of certain visual cues and the response many of these individuals have to certain design style and artistic representations. This is a large gap in research that needs exploration. The possibility of visual stimulation and connection between these individuals' minds can be a key element in the success of designing technological applications that could aid them in their daily lives. A focus on the study of what is visually pleasing to those with Autism Syndrome Disorder versus those who are not affected could provide deeper insight into how the minds of these individuals work and what

neurological pathways are affected. This type of research could be implemented along with that of real-world hands-on exploration in order to provide designers with the best possible information on how to design the most pleasing user experience for this demographic and in turn make the technology easier to use and more widely accessible to a great number of people.

The final gap in the research to be noted is a focus on how technology is being implemented within the lives of these individuals. Most of what is currently being produced in this realm is not consumer friendly and rather serves a more research oriented and scientific approach as opposed to that of everyday application. The concept of wearable technologies is discussed within the research particularly by researcher Esma M. Benssassi who refers to them as Wearable Assistive Technologies or WAT for short. However even within this study the individual is making use of technologies that are quite practical for the average user on a daily basis. Most of the items that are used within the study are either large-scale equipment that is not easily transported or it is technology that is out of the price range of most consumers within this market.

There is a major opening for the development of both devices and applications that make use of unassuming inexpensive technology that can be implemented on a daily basis. This technology should implement educational protocols as well as being widely accessible and inexpensive. Combining the aforementioned elements in conjunction with the desired aesthetics of this demographic could serve as a beneficial addition to accessibility-based technologies particularly within a field that is lacking. These gaps within the research could serve to provide not only a better way of life for non-verbal individuals with Autism Syndrome Disorder but it can also grant a greater insight into their minds and help promote the research and discovery within new areas regarding this disorder if further explored.

CONCLUSION

The field of research regarding technologies designed to study and aid those with autism spectrum disorder and particularly Non-verbal individuals is vast and ever growing. There are many devices and software applications available

within the field and research continues to push forward at a rapid pace evolving as technology as a whole evolves. There is also an ever-growing push for inclusion and tolerance within the field of research and education which is proving to be beneficial on all fronts providing a safe environment conducive to growth.

Attitudes toward the use of technology to aid these individuals are overwhelmingly positive and many individuals continue to embrace new and creative ideas that help propel the field forward. The positivity within the field of education and the adoption of beneficial technologies is very promising for the future regarding aiding students with non-verbal ASD and allowing for a safe and welcoming environment conducive to their success.

There are, however, still many areas in which improvements can be made within this field of research particularly in the area of availability and aesthetics. There is a major lack of focus on developing consumer grade technologies that could be easily accessed at an affordable price. This area in particular would be most beneficial to explore in future research and could serve to provide an overall better life for many non-verbal people. Overall, technology plays a positive role within the world of non-verbal autism and continues to aid and facilitate those affected.

CASE STUDIES

When examining case studies in regard to this thesis several applications will be evaluted in order to provide a better understanding of what is currently on the market in regard to communication based technologies related to autism. The studies will also examine individuals from a wide variety of backgrounds including but not limited to a wide range of European countries as well Middle Eastern countries.

FUNCTIONALITY OF APPS FOR PEOPLE WITH AUTISM: COMPARISON BETWEEN EDUCATORS FROM FLORENCE AND GRANADA

The examination of "Functionality of Apps for People with Autism" provides an interesting insight into the world of technological application and its implementation into the educational system. The research for this study was conducted by a group of individuals based out of Europe particularly that of Spain from the University of Granada which includes Carmen del Pilar Gallardo-Montes, Antonio Rodríguez Fuentes, María Jesús Caurcel Cara, as well as an individual from The University of Florence, Davide Capperucci who is based out of Italy.

The goal of the project is to examine and evaluate the current availability of smartphone applications and their viability within the realm of education regarding individuals with autism. The study looks to find which applications prove to be the most useful as well as the easiest to access. The study also investigates the attitudes of educators toward said technology and whether they find it beneficial for students with ASD and if there are any negative outcomes regarding the use of smart technology that these educators have noted in regard to the classroom atmosphere and whether or not the technology is found disruptive to the other students.

The researchers approached several schools and found volunteers within the education system who work with or have individuals with ASD in their classroom. The then proceeded to draw up the corresponding data making

note of the teachers' opinions and ideals in regard to the use of technology. They also made sure to take into account the gender, and background of the educators included within the study in order to examine whether certain biases could be found regarding their varying attributes. The researchers then presented these individuals with a questionnaire that inquired about the use of smart phone applications and asked questions regarding whether smartphone applications were used for the aid of autistic individuals within the classroom, how often they were used, and whether the educator found the use of such technology beneficial. The types of applications which were used were also inquired about and which apps had the most appeal and provided the best services.

Major issues that the researchers faced when approaching this project and more specifically this topic as a whole was the lack of prior data in regard to the usage of applications within the educational system. There had yet to be a base line established when looking at the type of software being used and relevant research regarding it. However, working from the ground up and making use of the questionnaire format allowed them to break new ground within the area of study. "Studies on the usage and frequency of use of apps in formal and informal education with people having autism are, however, non-existent, as is the case with studies on other types of technological resources (Eye Tracking, Virtual Reality, Augmented Reality (AR), Mixed Reality, Robotics, Digital Communication Boards, etc.)." (Gallardo-Montes)

After conducting research and synthesizing the data gathered, the researchers found that the usage of applications in the classroom particularly in regards to autism vary wildly depending on the teachers location, and sex. Female teachers were found to be much more likely to embrace the use of phone applications compared to their male counterparts particularly within the elementary level of education. (Gallardo-Montes) "The variable "sex" produced significant differences (Table 7) in two items of Dimension 2, with a medium effect size (d > 0.50). The women from Florence used apps more than the men for the purpose of holding the attention of people with autism for longer (t(125) = −2.25, p = 0.037). The women from Granada used apps for developing the understanding of emotions more than men (t(157) = −2.13, p = 0.034)." (Gallardo-Montes) It is also to be noted that in regards to locations

the female teachers of Granada made use of applications more often than those of Florence. However, both locations felt that the use of applications in the classroom was beneficial and aided in the education of those with ASD. (Gallardo-Montes)

When examining this case in regard to the proposed thesis project it can be seen that the conclusions drawn help to perpetuate the creation and need of more applications that aid in the educational and communication process of those with ASD. The embrace of technology on behalf of the educators and ideology that these applications are beneficial only further serves to reinforce the point that these types of technology are needed. Also as discussed above the wide variance and lack of research within the field only further promotes the idea that this is an area in which needs further exploration which will lead into the following cased study which exams the usage of such applications and whether they are beneficial to students and which applications server their function the most adequately.

ATTRIBUTES OF COMMUNICATION AIDS AS DESCRIBED BY THOSE SUPPORTING CHILDREN AND YOUNG PEOPLE WITH AAC

This case study serves to examine the use of communication aids and their implementation as well as limitations in order to better understand what is available within the field of assistive and accessible technology. The study focuses particularly on the subject of technology that has been implemented in order to aid individuals with diagnosed medical conditions such as Autism and Cerebral Palsy when communicating. The study was conducted by Simon Judge, Janice Murray, Yvonne Lynch, Stuart Meredith, Liz Moulam, Nicola Randall, Helen Whittle, and Juliet Goldbart all of whom hail from Department of Health Professions, Manchester Metropolitan University in the United Kingdom.

The study focuses on the implementation of the aforementioned technologies and how their application is received when applied to real world individuals who fall into the constraints of the designated demographic. The researchers investigate the possibilities of AAC (augmentative and alternative

communication) and how those who assistant these individuals who make use of the varying communication tools feel about the technology as well their feelings on what makes a particular application or device more attractive or viable for use. "This paper describes how communication aids were considered using the words of participants involved in AAC recommendations and support." (Judge)

The researchers made use of two different methods when conducting research, one of which focused on the use of interviews with the different individuals within the sample study. The second method was that of focus groups made up of multiple individuals from the specified demographic. In both cases the individuals were exposed to the AAC technology and presented with an explanation of the devices and applications functionality by an AAC professional. The volunteers were then asked questions regarding the technology and the different aspects that each used and whether a specified vocabulary was more conducive to the communication process when implemented within the different methods. The volunteers were also asked about the visuals of the different forms of technology what was being presented. After the interview and focus groups were completed, the researchers then examined the types of vocabulary used by the volunteers and what type of terminology and attributes were brought up most often. The researchers then drew their conclusions and found that particular elements such as ease of use were considered and discussed more than others. (Judge) "A number of attributes reflected the acceptability and uptake of the communication aid in a physical or social environment, for example, ease of use of software was a key consideration in some cases due to the impact on family adoption, and extensive personalization of vocabularies was described by participants and linked to improving adoption." (Judge)

Major challenges the researchers face in regard to the project mostly involved location and the limited sampling they could obtain. The study is from a UK perspective involving only UK participants. This limited sample size in turn provides little to no data for the effects and desires of those in the wider world making it harder to draw conclusions that involve the entirety of the effected demographic. (Judge) This limitation also presented them with the issue of

accessibility and the attitudes toward a particular medium due to what is available in the UK versus the wider world at large. "This paper provides a UK-specific picture and it is likely these data may reflect specific contextual and cultural practices within the UK that may not transfer to other countries or cultures. Efforts were made to ensure sampling of participants across diagnosis, age and geography; however, it is still likely that this cohort is biased towards those more likely to engage with AAC and use powered communication aids."(Judge) This lack of a greater sample size also proves to serve as a gap within the research that needs to be filled however due to the similarities in culture and technology most this does provide the reader with a decent picture of the attitudes of most of the western world.

The above study serves beneficial to the proposed thesis due to the nature of the sample as well as the picture it provides of the stake holders caretakers and what they find to be beneficial when looking for technology that aids communication. This detailed analysis and study allows for a view into what aesthetic and UI decisions should and or can be made regarding ease of use versus aesthetics. It also serves to provide a better understanding of what terminology is preferred on behalf of the end user as well as what is considered the most important or key elements to a communication-based aid technology. Similarities within this studies approach at understanding can be seen repeated and expanded upon in the following study which not only looks at what has done previously but also explores pushing the boundaries of this particular field in new directions.

AUTISTIC INNOVATIVE ASSISTANT (AIA): AN ANDROID APPLICATION FOR ARABIC AUTISM CHILDREN

This study covers the development of the Innovative Assistant or (AIA), which is an android application currently being developed in the middle east. The research and development of the previously stated case study was conducted at the University of Jordan with the goal of creating an educational tool that is both easy to use as well as effective. The goal of the research team is to provide alternative forms of education for those individuals who have autism, particularly those within the age range of elementary school to middle school from an Arabic background.

The major motivation for the developers and researchers came about from observations regarding the current educational system that is in place regarding children with autism. The developers felt that the current system for aiding and educating the effected demographic was lacking and did not provide a proper way in which to track the child's progress. With the implementation of the AIA application the educator as well as the student would benefit from a more tailored experience that tracked the user's progress and helped them to improve within the realm of math, language, and social skills. (Sweidan) "Most autism centers in Arabic countries rely on manual techniques in teaching children the basics of language, math, and social skills. Actually, these techniques may be limited in measuring the child's progress in a systematic way considering different fields. To overcome these limitations, we developed Autistic Innovative Assistant (AIA) which is an Android smartphone app that is dedicated to teach Arabic autistic children the necessary linguistic and mathematical basics in addition to improving their social skills through creating an interactive learning environment." (Sweidan)

The study started by examining the current awareness of individuals with specific disorders such as autism and the current moves to help accommodate and aid these individuals in order to live a successful and happy life. The researchers note that centers have been created within their home country of Jordan to help educate these individuals, but they are currently doing so in a very traditional manner without the aid of computer-based technology. It is the current state of education and the rising number of cases regarding autism that has propelled the researchers forward in the creation of a smartphone application. (Sweidan)

The paper goes on to layout the designers' plan along with different attributes they wish to implement within the project and how they want to place a major focus on language-based education. The researchers then presented several graphs and charts illustrating how the application can be used and the flow of the user interface as well as several other features. Along with the basics of the UI they demonstrated how the overall applications work and the way in which it educates its end users through the use of specific language and color association. Another key area in which they focused development was on the education of social skills. The application contains an entire subsection on

facial expressions as well as hygiene and health. The importance of educating the demographic on basic life skills is fundamental and considered of the upmost importance within the applications repertoire of tools. (Sweidan) "Social or "Ejtemaay" category aims at improving the social behavior for the autistics through three subcategories whereas each of them is concerned with a specific social area. The subcategories are "Facial expressions", "Social behavior", and "Health and hygiene"." (Sweidan)

The major challenges the researchers and the designers faced included the graphic design itself. While the functionality of the app is completely present and serves its purpose providing educational material to the end user and aiding the effected demographic the visual aesthetic is lacking. Typography is difficult to read in areas particularly when presenting the English language. Finding a solution to this issue could be easy in time and with the collaboration with the design community they could achieve an aesthetic that is both effective as well as visually pleasing.

It should be noted that the researchers came to the conclusion after the development of the application that there is not a blanket answer when it comes to the time and education needed regarding children with autism. They did find that the application improved the performance of specific individuals and that younger children were able to gain a grasp on how to use the technology quicker. (Sweidan) "Based on our own notes and supervisors reports which were collected during the test period, we have noticed that a child's improvement degree may be affected by a number of factors. Firstly, between the three age ranges covered in the test group, we have found that the children in level 1 have shown the highest improvement degree followed by level 2 then level 3 children. Actually, this result was not a surprise to us because it is very common to see children in early ages master different computer and smartphones apps and learn to use all types of high technology devices professionally and even faster than adults." The researchers also stated that each child was an individual and while the application aided in their education the way in which it should be applied and how much time is needed has to be considered on a case-by-case basis. (Sweidan)

DOMAIN RESEARCH
VISUAL ANALYSIS

EMOPLAY

EmoPlay is an iconographic based application that serves to aid in the education and communication of younger individuals with autism particularly those within elementary school. The application makes use of several types of icons and images that display varying emotions all based around facial recognition and social cues. It also allows the user to practice making different faces through the use of the camera to better understand and apply the learned mannerism of certain emotional states.

The aesthetic choices of the application as can be seen in fig.1a show the use of an illustrated style that is similar in nature to that of popular children's books. This particular style seems to resonate with educators, and it is considered one of few applications that have a high-quality standard. (Gallardo-Montes) This use of a style that is already familiar could also be seen as beneficial on behalf of the students due to the comfort that can be triggered by familiarity. It can also be noted that the UI is presented in a large format in order to accommodate younger children as well as those with physical restrictions. The use of large colorful images and universally recognized imagery of the human face serve to provide a smooth and easy to understand format that allows a student to simply pick up and engage.

On a cultural level the application could easily translate for most users within the western world. The images make use of basic human emotional states that are easy to identify through the use of facial recognition. These particular emotions as seen in Fig.1a. are fairly universally recognized within the western world and play off of the common archetypes of emotion expression. Using the emotion of happiness for an example it presents the user with key landmarks that are synonymous with the emotion within western cultures such as raised eyebrows and a smiling mouth.

The applications as a whole is very well thought out and provide a very simple and engaging user experience. This ease of use combined with interesting and unique visuals acts to draw the user in and provide an easy and fun learning experience. The app, however, does not only make use of symbolism and

animated figures but also presents the user with real world examples of the emotion that is being displayed and practiced as can be seen in fig.1b. This combination of methods allows the user to transition from a stylized example of an emotional state to how it might be applied in the real world. The application then makes use of the ipad's built in camera to allow the user to emulate the facial expressions and then provides encouragement.

Fig.1a. Fundacion Orange, *EmoPlay*, 2017

The consumption of the specified application is very interesting as it is exclusive to the use of tablets or ipads. While the inclusion of both IOS and Android operating systems is integral to the applications success I do believe that the like of smart phone support is a gaping omission. However, the way in which the user engages via tablet is a very smooth process and the application itself is completely free of charge making it an appealing choice for educators and caretakers alike.

Fig.1b. Fundacion Orange, *EmoPlay*, 2017

The visual solution serves to aid in the research of this thesis project by providing a successful example of smart technology and iconography. It gives insight into what visual cues and UI elements work best in regard to the target demographic as well as what is preferred by the educators working within this field. The applications use of a specific visual style also serves to show an understanding of visual engagement which serves as a beneficial source of inspiration when approaching the design phase of the proposed thesis project. Overall it is a great example of how to approach a visual solution in regard to both aesthetics and UI when designing for an audience that is either the affected by ASD or is educating someone affected.

GRID PLAYER

Grid player is an application developed by Smart Box, a UK based company who develops technology that aids individuals who face issues regarding communication as well as technology that provides accessibility on several fronts. Grid player is one of their main applications developed to aid individuals with autism as well as other debilitating disorders in the process of communication. The application makes use of a grid style layout that presents different options and phrases that the affected individual can select from in order to better express themselves or communicate the needs and desires more efficiently as seen in Fig.1a.

The target demographic for this product includes those on the autism spectrum as well as individuals affected by diseases and disorders such as cerebral palsy. The application grants the users who may have limited mobility or an inability to vocalize their own thoughts and emotions properly a simplistic and easy to use outlet for communication. With the highly customizable interface that is able to be adjusted and changed in order to suit the specific needs of an individual in regard to the challenges they face on a daily basis.

Due to the need for a larger workspace for the application and a desire to make it easy and accessible the grid player is available for use on Apple's family of iPad tablets. There is currently no version available on the google play store and while this does limit the availability of the application to some individuals the fact that it is a commercial consumer grade application that can be accessed without the need of specialized equipment is a step in the correct direction for accessible technology. The availability of the application is one of the key factors that is being examined in regard to this thesis as well as a point of interest in regard to their being a gap in the available platforms which in turn could serve the proposed project by allowing for it to fill that gap and making accessible technology that is even more widely available on several more platforms. However, it should be noted that when discussing availability and the ease of use on a larger cultural scale "Grid Player" does serve to provide a very wide encompassing set of tools and is available in multiple languages as stated on their website a few of note include Arabic,

Portuguese, and Spanish as well as a wide range of European based languages such as Dutch, Italian, Swedish to name a few. This expansion into several different languages allows for the application to be accessible to a broader range of individuals as opposed to technology that is simply based in English.

"Removed to comply with copyright"

Fig.1a. Sensory Software International, *Grid Player,* 2016

Grid Player makes use of an interesting set of iconographies as well making use of different symbols that could easily be interpreted by individuals from a wide array of backgrounds as well as serving to be beneficial and accessible to those who struggle with literacy in the available languages. As seen in Fig. 1b.

"Removed to comply with copyright"

Fig.1b. Sensory Software International, *Grid Player,* 2016

The different options available present a wide gamut of tools that use semi-universal symbolism that can be easily understood such as the image of a straw or the ice cube. It is this implementation of icons that are easily recognized along with a fluid and orderly layout that proves to be successful for the application and part of the reason why "Grid Player" has been so widely accepted and implemented as an aid for the specified demographic. Ease of use and ease of understanding are the two major key elements that helped to propel the visual solution forward and allow for the application to become a standard tool within the field of communication and accessibility combine this with the availability of the product and the fact that it is easy to set up and begin using on almost any iPad and it becomes evident why the application has been so successful.

Grid Player serves as a perfect example of how to produce a high-quality application and what features should be taken into account when developing

a similar concept or product. The aesthetics serve to prove that a simple and easy to read grid pattern is the best option when approaching these forms of technology as well as the combination of iconography and symbolism that is easy to interpret and serves as a supplement to those who struggle with literacy. It is these elements that lead to this application serving as a beneficial point of study in regard to the proposed thesis as well as an area in which can continue to be expanded upon particularly in regard to availability on multiple platforms.

AUTISTIC INNOVATIVE ASSISTANT (AIA)

The Autistic Innovative Assistant or AIA for short is an educational application design by a team located at the University of Jordan. The goal of the application is to serve as an educational tool and aid that provides children with autism easier experience when learning language, math, and social skills. The application makes use of a simplified user interface made up of images and bright colors that is easy to navigate for the target demographic as seen in Fig. 1a.

The specified demographic for the application is school aged children, particularly those who are Arabic. The application places a focus on several elements that are culturally relevant to the demographic and serves not only to teach them language skills, but Arabic language skills in particular teaching them the basis of that particular alphabet and combing the words with visual interpretations in order to better communicate there meaning to the end user. The application is being put to use withing specific school/facilities that specialize in the education of children with autism. (Sweidan)

The relationship between image and form as previously mentioned plays a role in the success of the application due to the fact that many of the individuals using this application are learning to read for the first time or are expanding upon their reading skills. The need for a visual aid that can be easily translated to the associated is paramount to the application's success and can be seen demonstrated in Fig. 1b. "This app is mainly concerned with improving the children linguistic skills, it teaches both Arabic and English letters and num-

bers. The app starts by teaching the child how to pronounce letters along with showing pictures of words start with each of the alphabet letters." (Sweidan)

It should also be noted that the application makes use of good amount of visual iconography that serves to communicate the intended message as well and while some of these icons may be only relevant to the specified culture

Fig.1a. Sweidan, Saadeh Z., Autistic Innovative Assistant , 2022

many of them are universally recognized particularly those that involve objects that children often interact with such as toys. The researcher also makes heavy use of autism awareness iconography and based most of the application

Fig.1a. Sweidan, Saadeh Z., Autistic Innovative Assistant , 2022

around the puzzle piece motif. This not only helps to provide the greater public with an understanding of what the application is used for but also helps to bring in a sense of inclusivity and awareness to the effect individuals. The puzzle symbolism also serves to play into the fact that the application not only serves to aid but educate and requires the user to take part in several types of quizzes that track

their learning progress in order to better inform their teachers and educators on what areas they may need more attention so that they can achieve their current goals. The application makes use of this data collection and displays it within a section known as the "supervisor mode" which breaks down the child's progress and provides their educator with a detailed analysis of what their strengths and weaknesses are. (Sweidan) "AIA tries to give the supervisor a recommendation report that is issued based on the child's performance" (Sweidan)

In regard to the current proposed thesis this particular visual artifact serves as both an interesting starting point for how to approach app development in regards to individuals with autism as well as providing key areas in which there is a gap in the research and development.(Sweidan) It is due to the applications current success rate and implementation within society and how it has proven to be beneficial to the stakeholders that it serves as a good example of what types of elements and features should be considered when developing within this particular field. However, within the realm of aesthetics and graphic design the application leaves a lot to be desired. While accessibility should be the first and foremost aspect of the application, aesthetics should not be completely ignored. It is within this particular gap that further progress can be made to create educational aids and applications that are both accessible as well as appealing aesthetically. The end goal should be to marry both attributes together and create the best possible solution.

DESIGN GUIDELINES

Research regarding the usability of applications and the aspects of accessibility have lead to the creation of the following guidelines in regard to the development and testing of the application. The provided list is sourced from other projects that have made use of these methods and is an amalgamation of their research findings. During the development process of the proposed application these guidelines will be taken into account in order to provide a basis on which to develop the proper user interface as well as the key elements that may be most beneficial to the end user.

List of Application Design Guidelines for Autistic Children

01. Simplicity
02. Reusability and engagement
03. Large Text and Iconography
04. Customization of settings
05. Minimal Distractions
06. Vocalization and pronunciation settings
07. Use of visual imagery versus text
08. All descriptors must be literal no complex or metaphorical language
09. Multifaceted assets visual, audio, interaction.
10. Clear and efficient navigational system

CONCLUSION

The visual analysis along side the case study provide an image of the current state of what applications and software are available for use within the field of communication in regard to autism. The research also serves to show the gaps within the market and the need for a simple to use application that requires little to no setup. This is where the proposed application comes into play. The design of the application that is the focal point of this thesis will serve to deliver an product that fills in the aforementioned gaps and serve as a simple yet effective solution to the proposed problem in chapter one.

Chapter Three

Design Process

PROCESS

In order to provide an outlet for effective communication for the specified demographic of three to five year old autistic children, I had to take into account several key concepts. These concepts which I would later implement included education of the user as well as their caretaker, and engagement of the user. When researching engagement within applications similar to that I proposed replayablitiy of the application was crucial to implement as well as a reward system that acts as a tool to encourage continual growth and progress.

When looking at the research regarding applications within this field variability and aesthetics played major roles in development and success. As stated in the previous chapter the focus on creating visuals that are both colorful and visually engaging while not being over stimulating are key to the visual style of the application and serve to be one of the main points of interest for both the developer and the target audience.

BRAINSTORMING

I began my creative process by making use of mind maps and visual research. Before I ever putting pen to paper to begin sketching I brainstormed several concepts and ideas of how both the functionality and the aesthetics of the applications may work. I then turned my attention toward ascetics and created mood boards to get a general idea of the feel I wanted for both the applications characters and the UI.
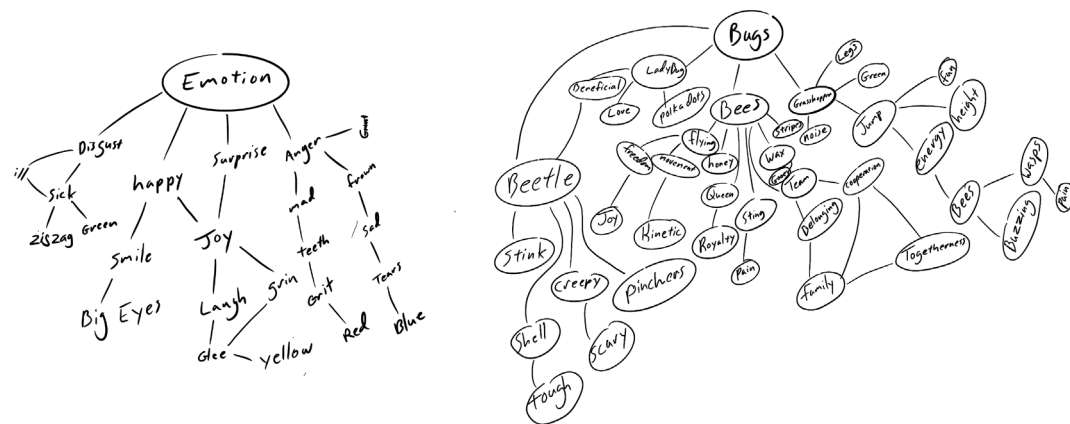
After much research I began moving into the sketching stage for the cast of characters that would act as guides for the user when they engaged with the software. Initially I investigated the use of different types of beings such as bugs, people, and possibly animals but after consulting with my research I settled on using different types of shapes to represent the different characters. This was due in part to notes made during the research process which stated this particular demographic respond better to nonsocial objects than that of organic human like figures. (Gong)
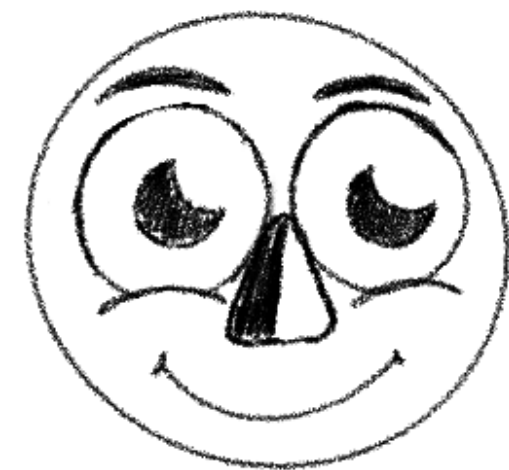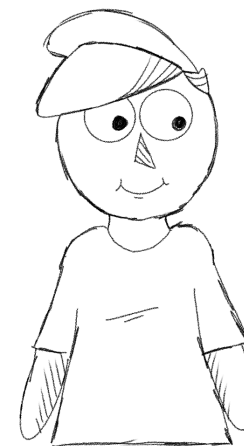
MOOD BOARD

FLOW CHART

The mood board and flow chart acted as the basis on which to build the applications UI as well as its overall aesthetic. The moodboard provided inspiration for all aspects from color choices, to character design, as well as UI design. The flow chart then acted as a guide for how the UI interface could work and mapped out the inital fuctions of each portion of the application as well as their path and how the interconnect with each other.

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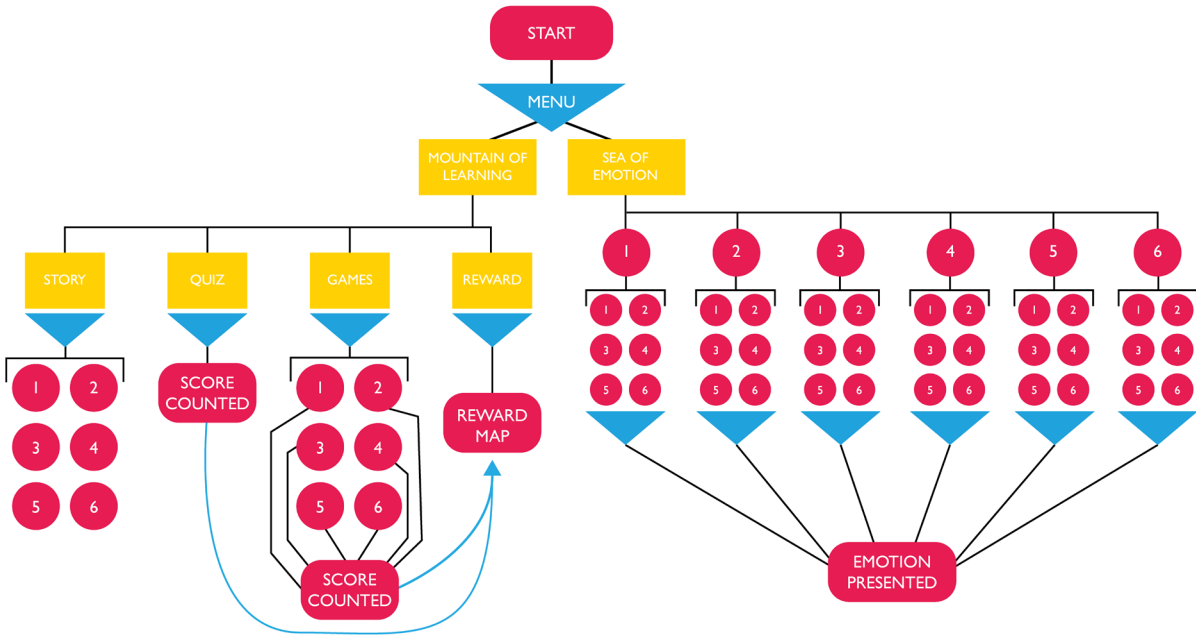
CAST OF CHARACTERS

The characters took several different forms and shapes. Originally they began life as a group of bugs that acted as avatars for the different emotions that where to be conveyed. These bugs then began to shift and the concept of avatar customization came into play making use of human characters. Finally the characters evolved into a cast of shapes each with unique personalities and features each of whom can convey the full gambit of emotions however each one of them have two particular emotions they typically lean toward and this is reflected in the applications stories and games.

With the concept for the cast decided on I turned my attention to sketching out these characters and having them present themselves in the six different emotional states. These initial sketches acted as my guide to further expand on each individual character later providing them with unique character traits and personalities.

CHARACTER PROFILE

STARBEE

GENDER: Male

COLOR: Yellow

FAVORITE GAME: Face Match

MAIN EMOTIONS: Happiness and Surprise

SKETCHES

FEAR

SADNESS

HAPPY

ANGRY
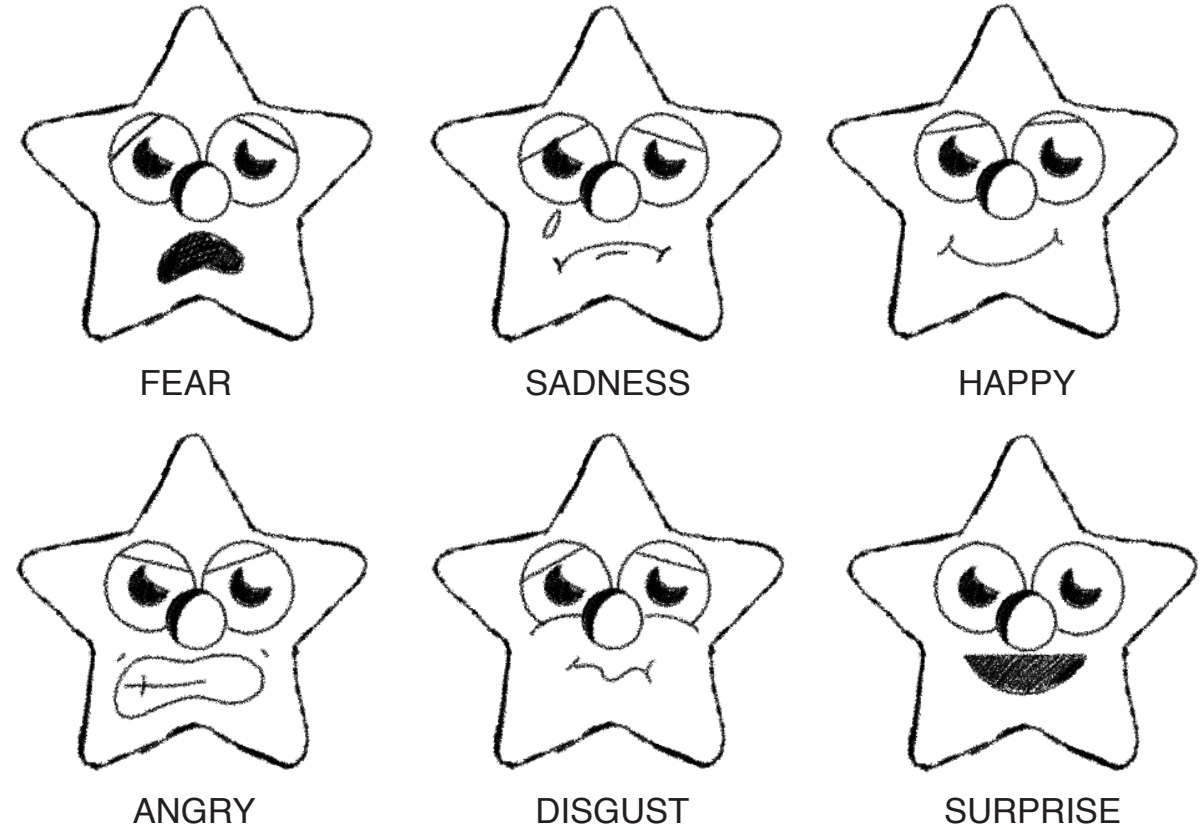
DISGUST

SURPRISE

CHARACTER PROFILE

BLOOP

GENDER: Male

COLOR: Blue

FAVORITE GAME: Coloring

MAIN EMOTIONS: Sadness and fear

SKETCHES
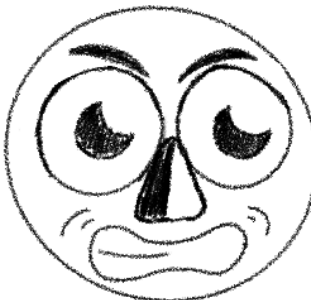
FEAR

SADNESS
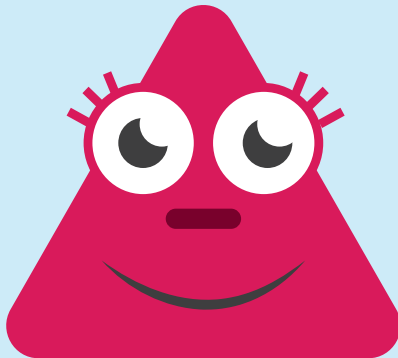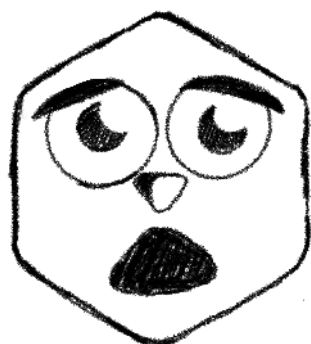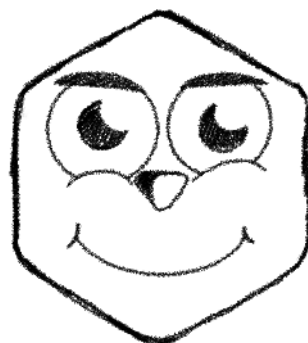
HAPPY

ANGRY

DISGUST

SURPRISE

CHARACTER PROFILE

TIBA

GENDER: Female

COLOR: Pink

FAVORITE GAME: This or that

MAIN EMOTIONS: Surprise and Disgust

SKETCHES
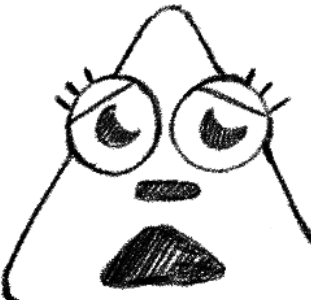
FEAR

SADNESS

HAPPY
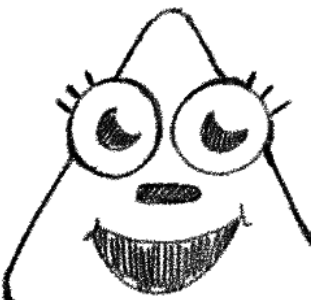
ANGRY

DISGUST

SURPRISE

CHARACTER PROFILE

LITTLE TOMMY

GENDER: Male

COLOR: Green

FAVORITE GAME: Match Game

MAIN EMOTIONS: Happiness and Fear

SKETCHES
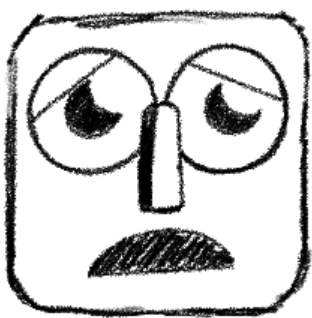
FEAR

SADNESS

HAPPY

ANGRY

DISGUST

SURPRISE

CHARACTER PROFILE

LEANNE
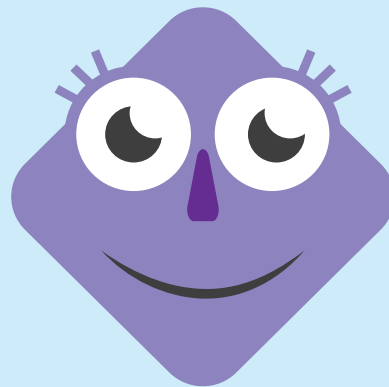
GENDER: Female

COLOR: Purple

FAVORITE GAME: Draw the Line

MAIN EMOTIONS: Anger and Surprise

SKETCHES
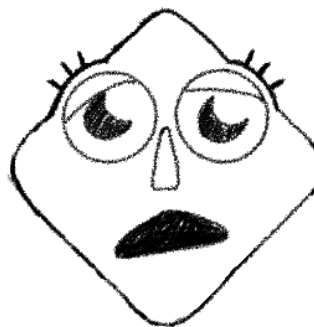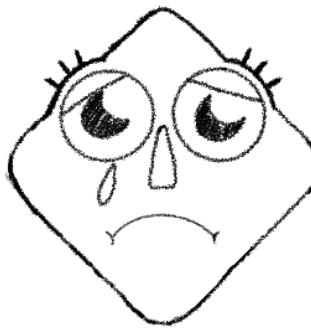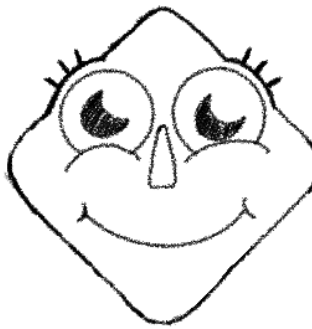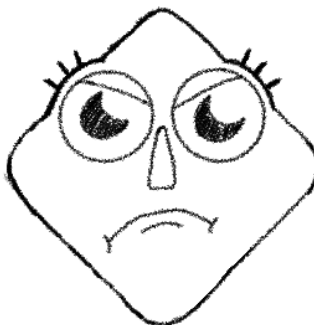
FEAR

SADNESS
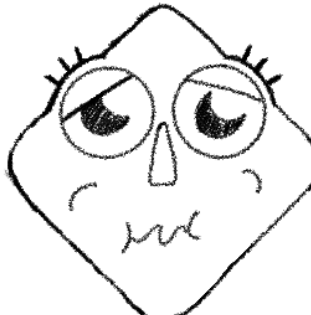
HAPPY
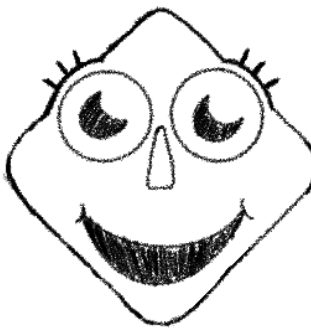
ANGRY

DISGUST

SURPRISE

CHARACTER PROFILE

BROCK

GENDER: Female

COLOR: Purple

FAVORITE GAME: Draw the Line

MAIN EMOTIONS: Anger and Disgust

SKETCHES

FEAR

SADNESS

HAPPY
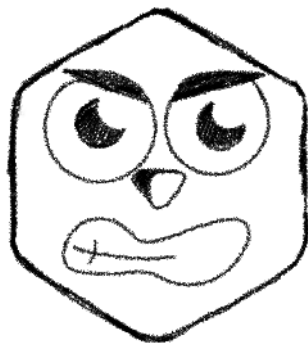
ANGRY

DISGUST

SURPRISE

UI DESIGN

Once the cast had been settled on I turned my attention to the development of the UI. I started with a basic sketches that gave a vague idea of the direction I wanted to take the project. Once that was complete I began expanding on those sketches to better visualize the process and begin nailing down how I wanted the overall UI to appear. I chose to design strictly for the iPad format and resolution making it the primary platform for the application but keeping in mind the possibilities of expanding on to other platforms such as smart phones.
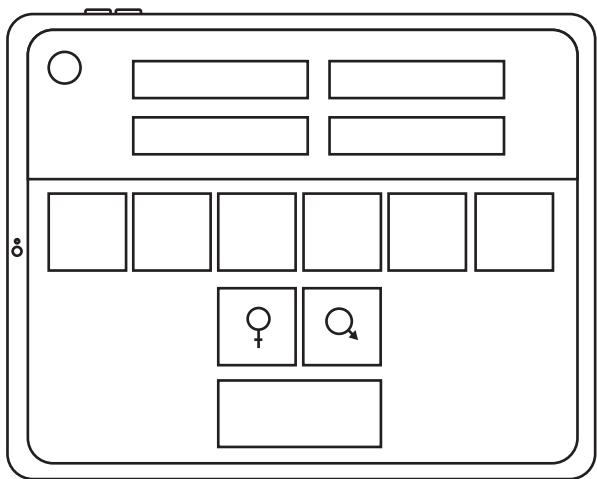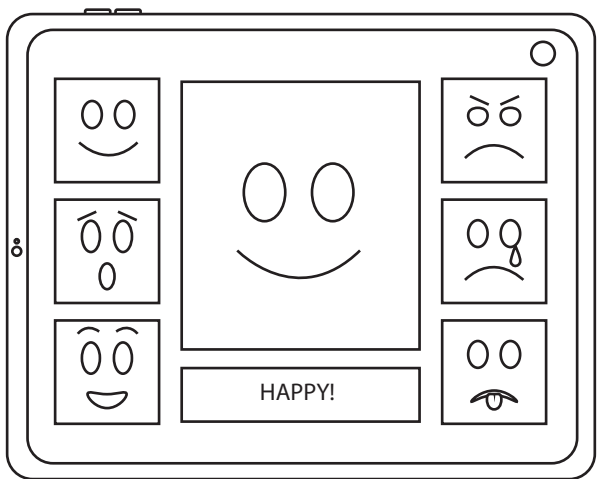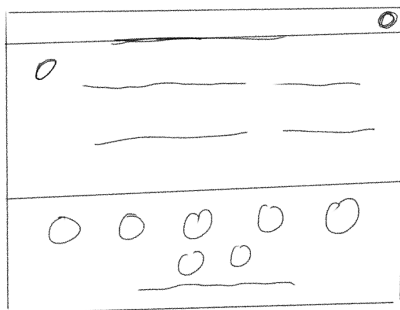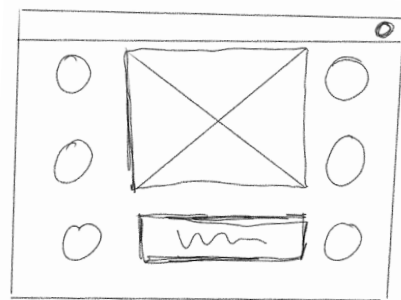
WIREFRAME

With the initial sketches completed I began work on the wireframe for the software and focused on the flow and interactivity of how the user interface also providing a general road map for the functionality of the application as a whole. This initial wireframe only displayed the most rudimentary of functions and served as basis to build off. After taking some time to review and further

research similar applications, I then expanded this wireframe out demonstrating the multiple pathways that the app contains including demonstrations of the animated story time feature as well as interactive games. As pictured there are many branching pathways that lead to several options for the user to engage with and each of these acts as a guide to for how the application will function in its final state.
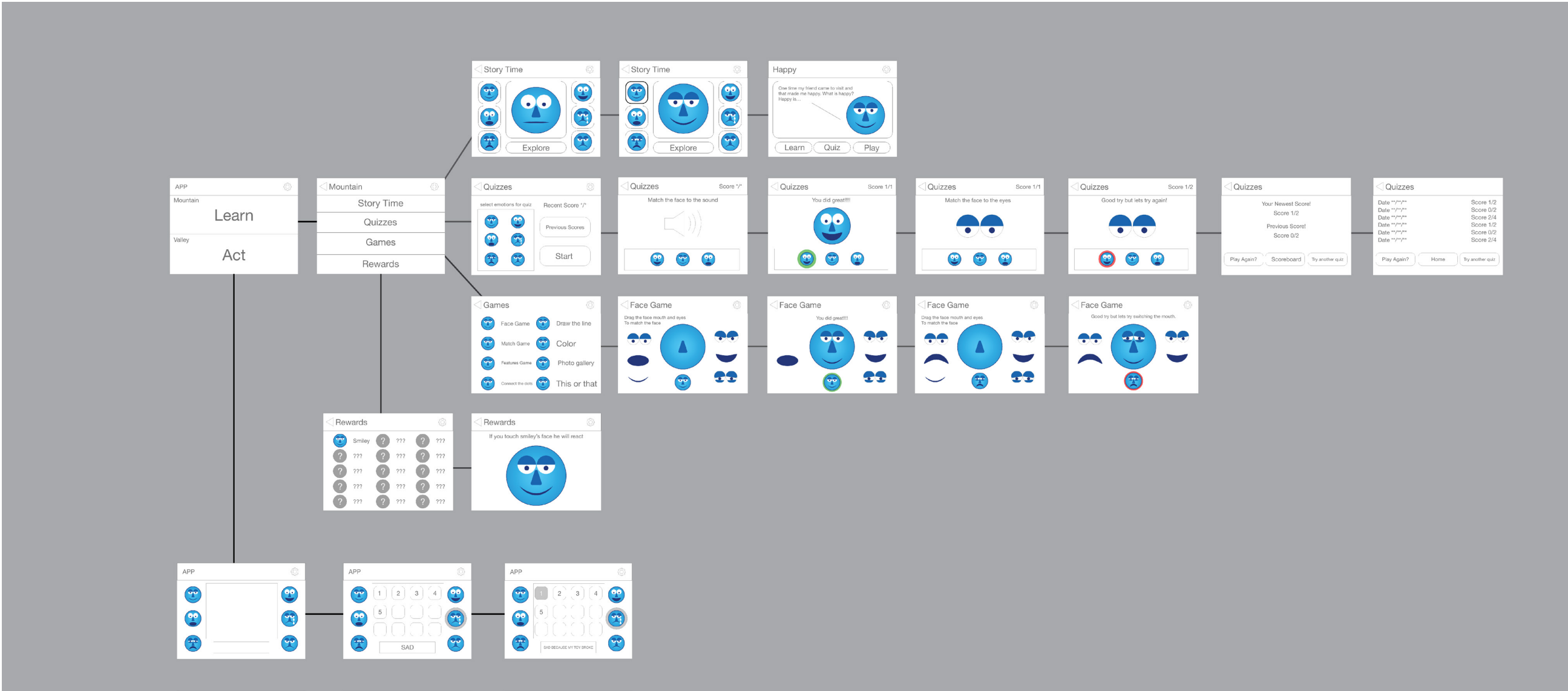
ICONOGRAPHY

With the characters complete and the UI mapped out I turned my attention to the development of the different icons and UI interface buttons. I based the general aesthetic off of the characters designs and began implementing story elements such as calling the games and learning section of the application "The Mountain of Learning" For the portion of the application that acts as a talk box and provides and outlet for communication I chose the name "Sea of Emotions" which is representative the fluctuating state in which ones emotions can reside.

The UI elements themselves are brightly colored and make use of plain backgrounds as not to be too distracting. The symbolism and typography are also very straightforward and provide the user with an easy to understand interface. The choice of colors reflects both the thematic elements of the applications as well as providing a distinction between the various sections of the software.

MOUNTAIN OF LEARNING

SEA OF EMOTIONS

STORY TIME

QUIZZES

GAMES

REWARDS
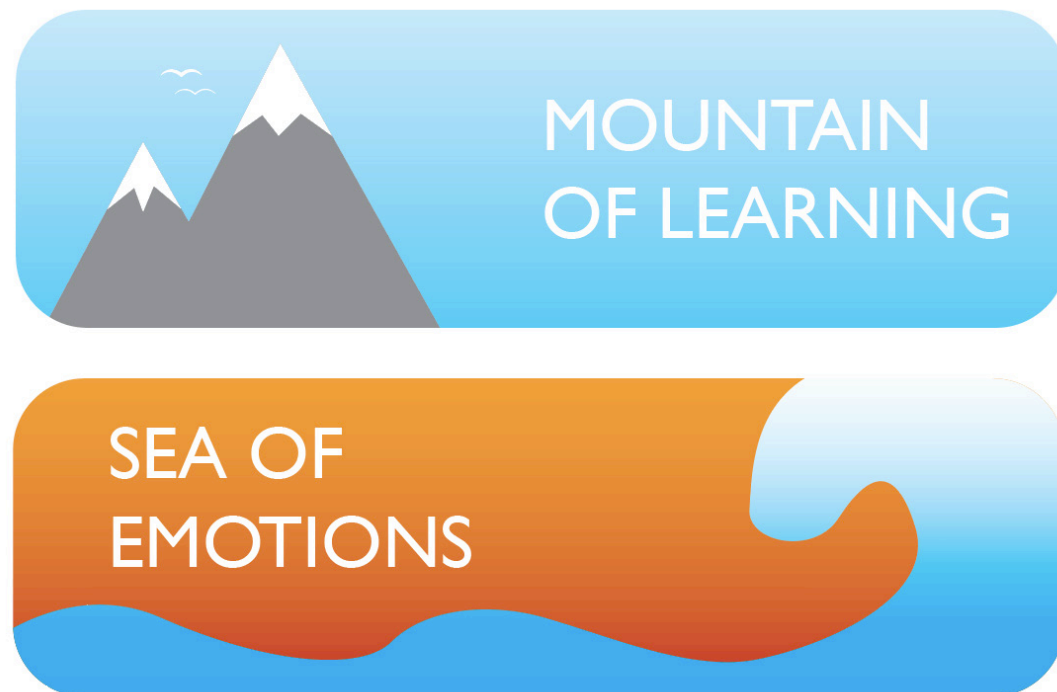
Chapter Four

Deliverables

ADVENTURES IN EMOTION

The final application has been broken down into two sections based on my research findings which show a need for both communication and education within the community of the demographic. It is also to be noted that within the research of application used based around children with autism the concept of replayablity and gamificaiton are extremely import and positive reinforcement is a key component in the education process for the demographic and is shown to encourage the individuals interest within the subject matter.

MOUNTAIN OF LEARNING

The Mountain of Learning serves as the major educational portion of the application and implements a series of different activities that include, animated stories, games, and quizzes as well as a reward section which provides the users' guardians with ideas for possible ways to reward the user for engaging with the application and scoring well on the quizzes. All of these elements work in conjunction together and allow the users scores and progress to be tracked over time and adapt by increasing the difficulty as the child learns. With continual progress the application adaptation allows for a catered experience that is strictly based off of the child's learning habits and patterns and provides a unique and focused educational environment.

STORY TIME

The story time portion of the application engages the user with fun and short animated adventures that help them better understand their emotions. The shorts display are cast of characters engaging in different activities that cause them to experience the key emotions noted within the research. The use of multiple facets of sensory input during the short story including sounds, and bright visuals help provide the user with the best possible learning experience as noted within the previous chapter.

Quizzes

The quizzes section serves as a way in which to gauge the users learning. Here different quizzes will be presented to the user and as their score increases over time so does the difficulty of the questions. The users guardian however will have the ability to manually adjust the quiz difficulty as well in order to provide the best customized experience.
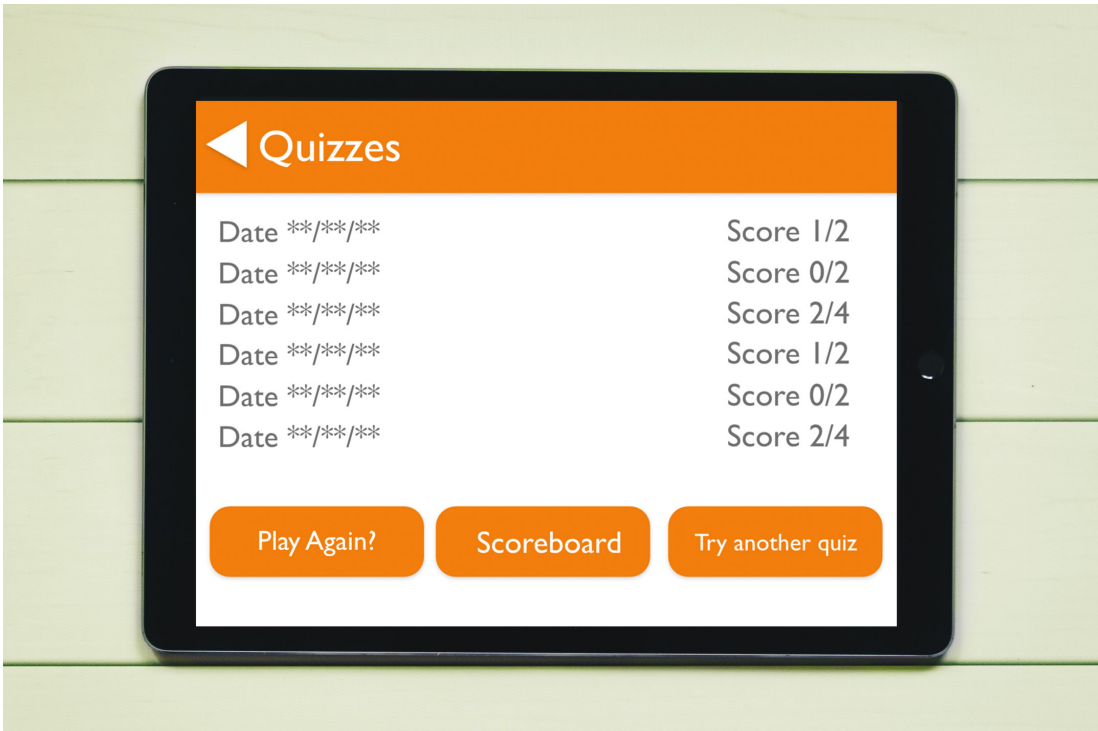
Games

The games area provides the user with a handful of fun and replayable games that help to promote their learning experience as well as provide them with a way in which to engage with the application that is presented in a less formal educational way and allowing for learning through gamification. The games will also track scores of the user and take into account the different aspects of emotional learning and engagement that the user is excelling at as well as the area which may need work. The game section also works in conjunction with the rewards category in order to provide positive reinforcement which has been shown in the above research as one of the more productive methods of encouragement behavioral engagement.
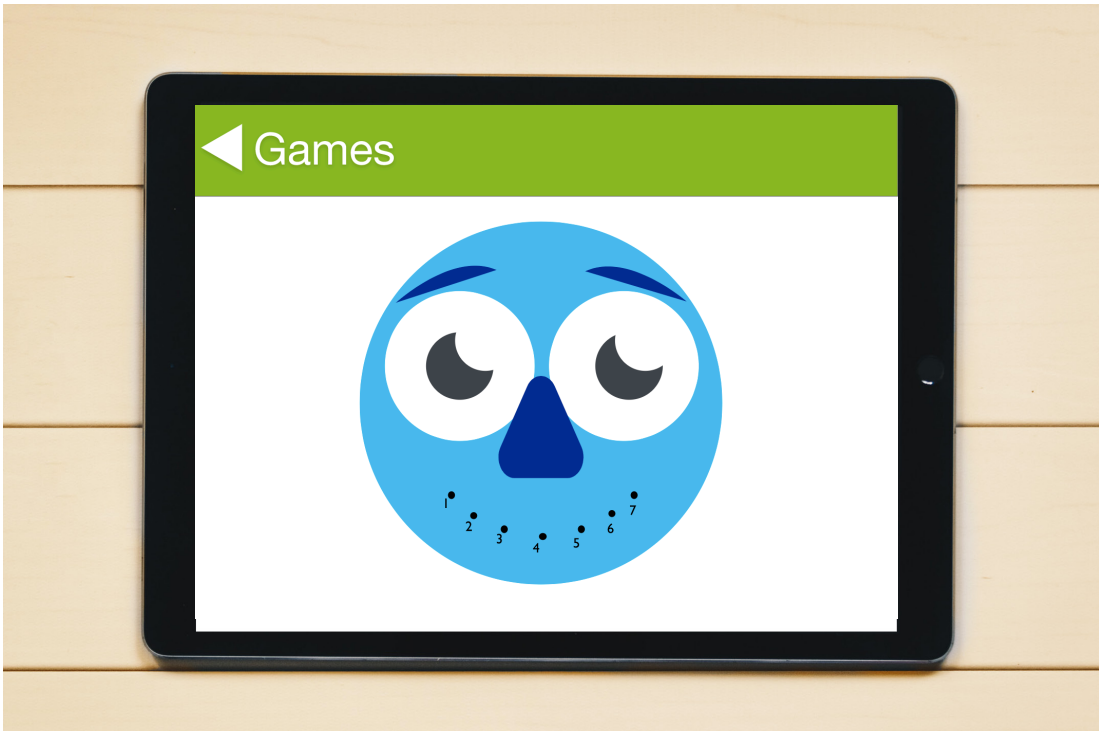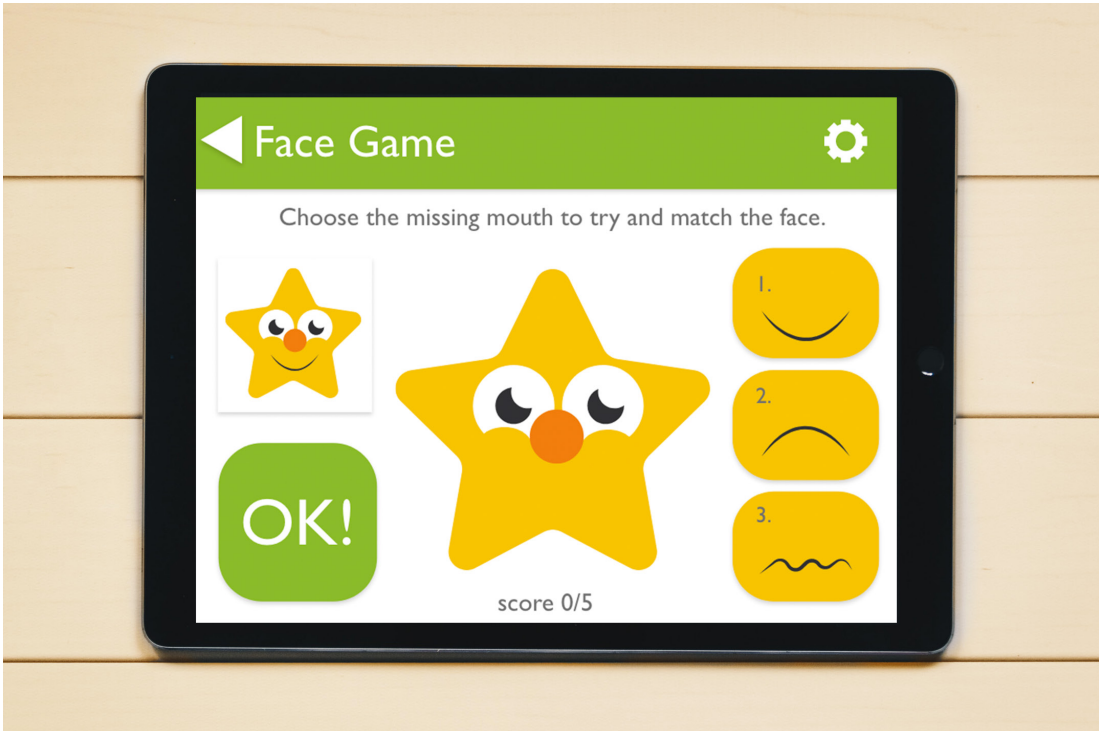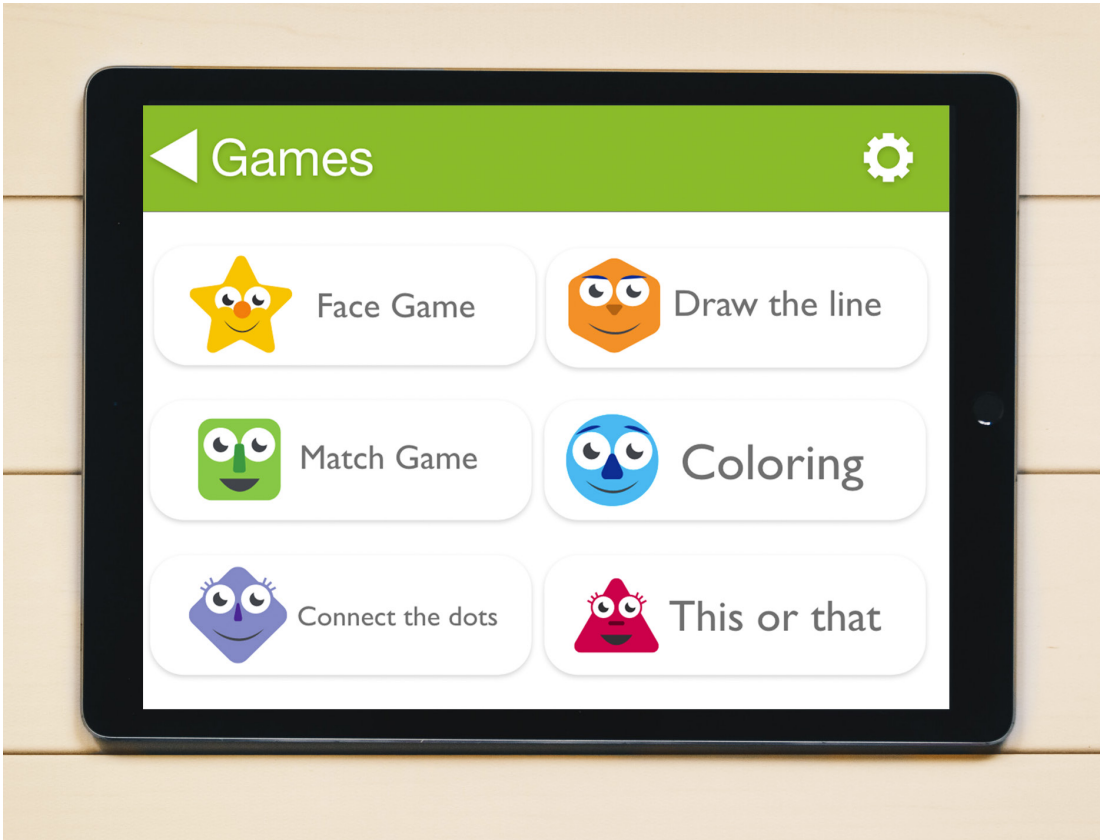
Rewards

The rewards map acts as a level up system that allows the user to travel across the lands of learning as they engage and learn with the application. The more the users score increases the more travel points they receive and when they reach a milestone they are presented with an award. The awards special suggestions to the parents or guardians of the user for fun activities. The aforementioned activities are completely customizable by the parents however their are several built in suggestions such as going to get ice-cream or getting more screen time with their favorite show or game.
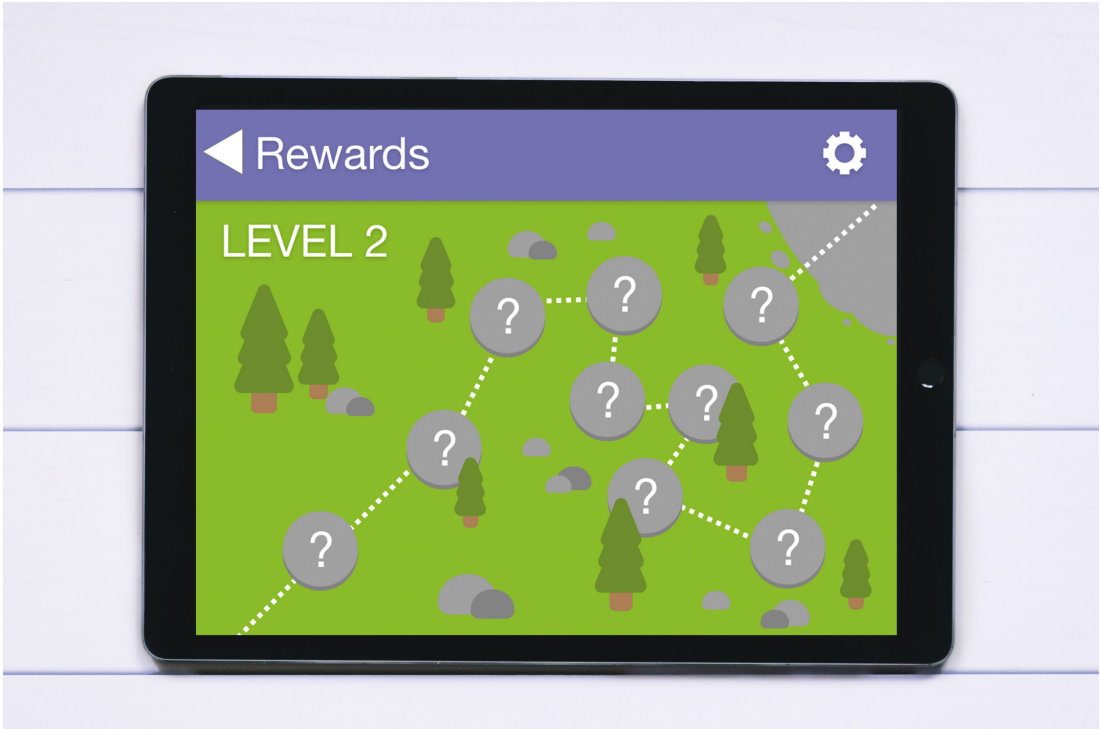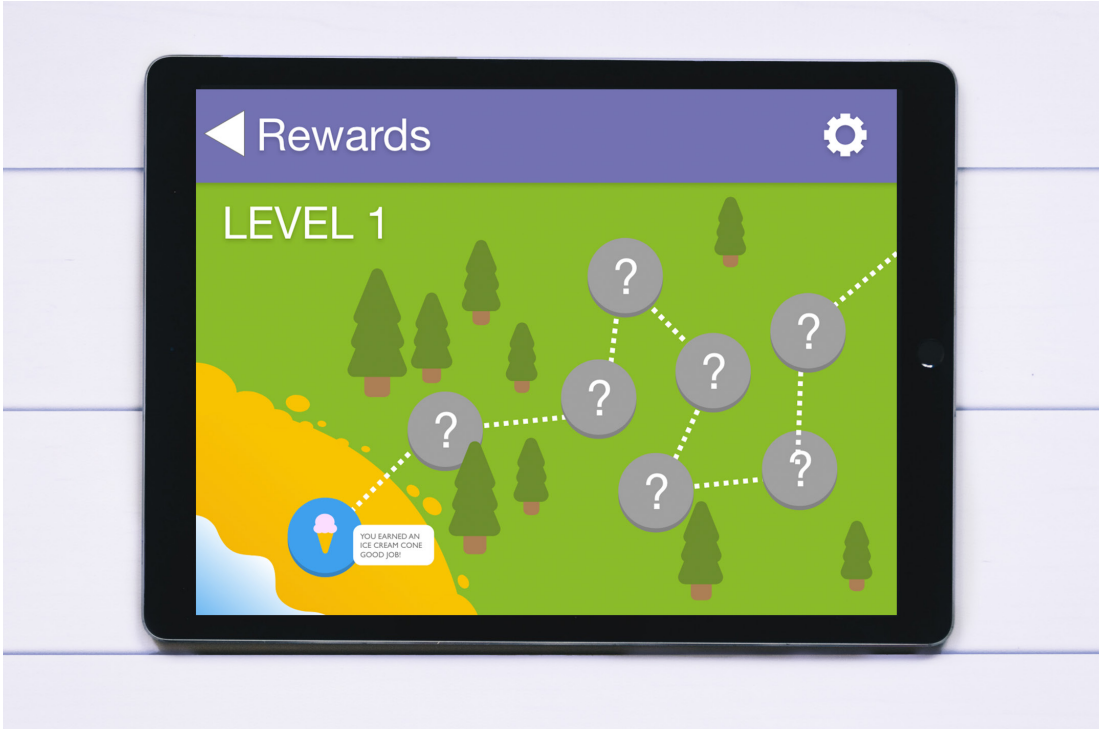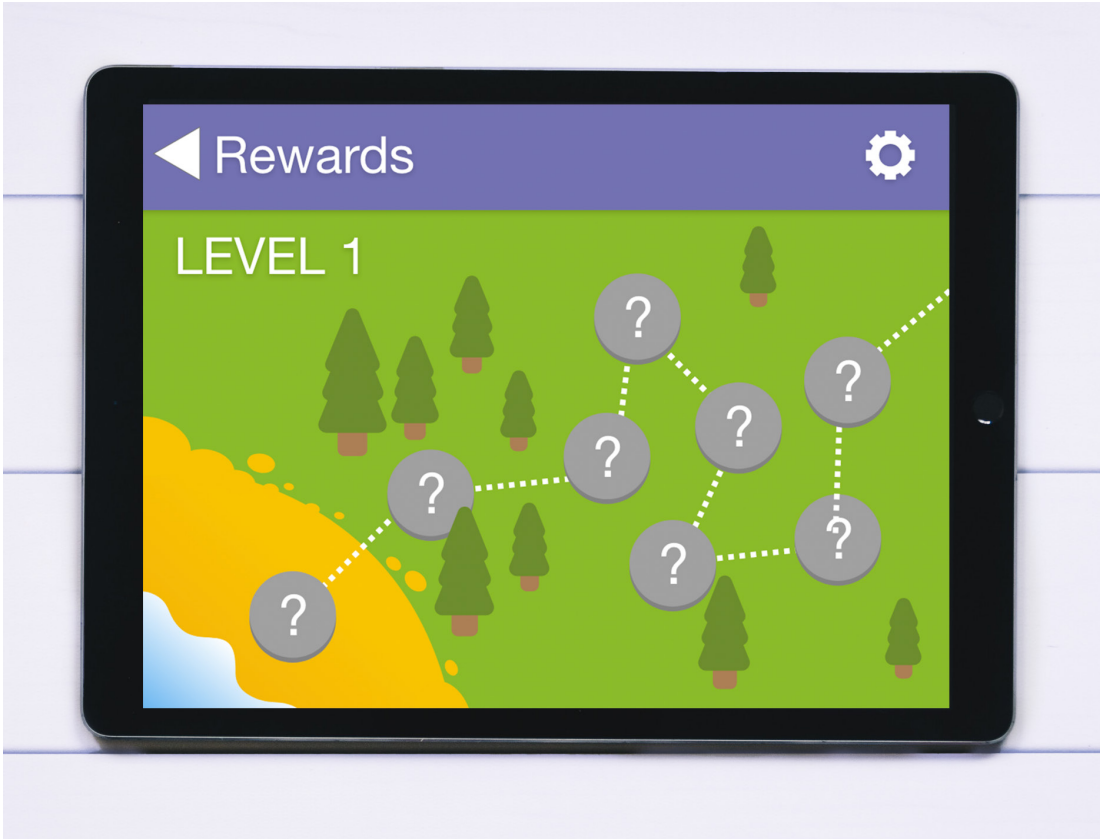
SEA OF EMOTIONS

The Sea of Emotion serves as a method for communication for the user and is implemented after the user has explored the mountain of learning. The symbols and UI elements are all based off of the components introduced within the Mountain of Learning and serve as an extension of that portion of the app with the purpose of real world application and use regarding the users emotional state. This portion of the application served as the birthplace for the entire product and is the culmination of all its parts. The UI for this portion of the application will be adaptable and will provide more emotional options for the user to make use of as they progress through the previous portion of the app. A parent or guardian can alternative add or remove an emotional elements they wish based on their judgment in order to provide the best possible experience that is customized for that specific user.
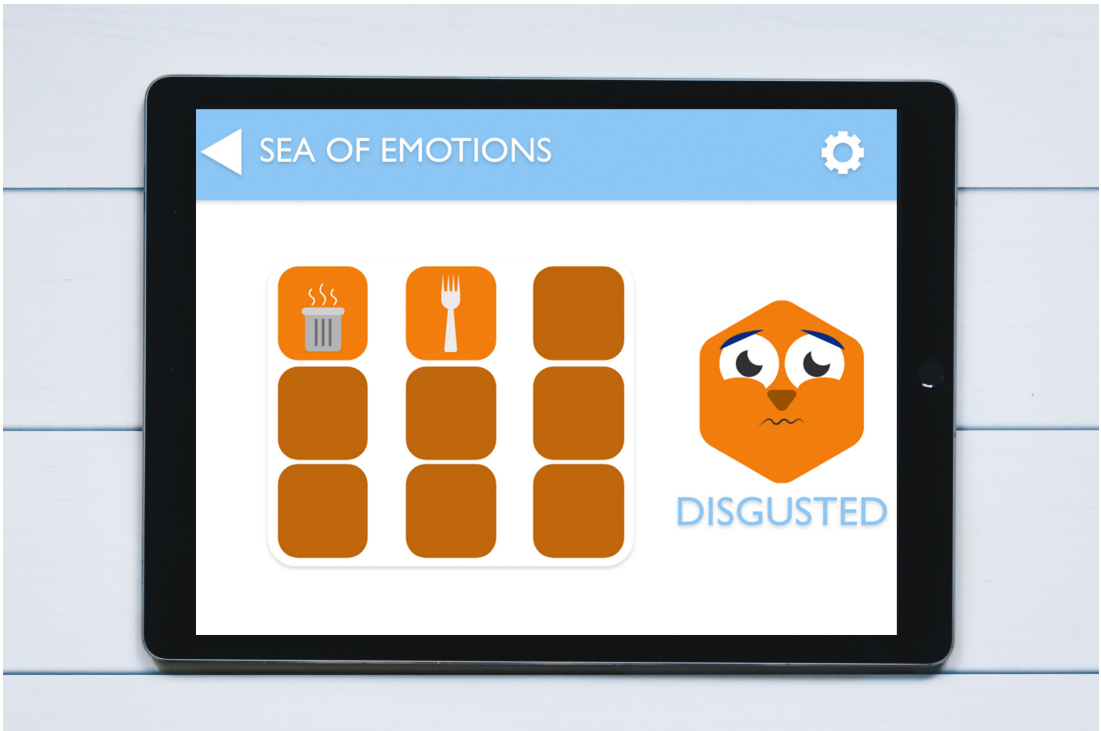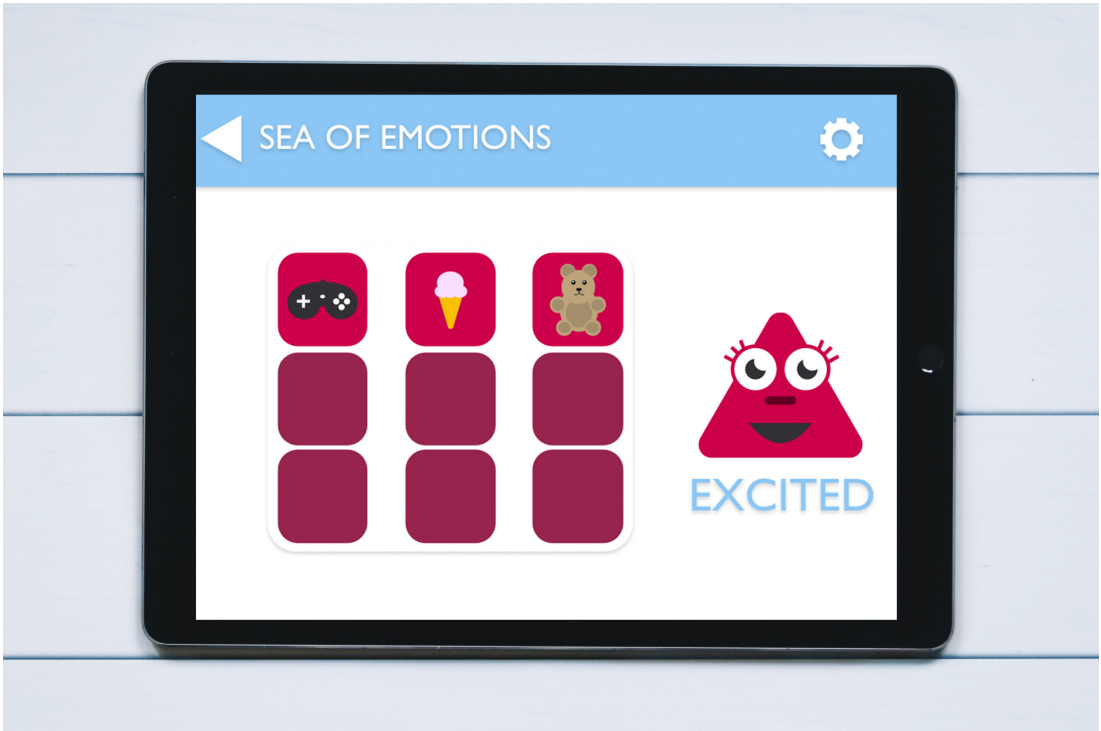
Chapter Five

Conclusion

CONCLUSION

In conclusion, the research has found that individuals with autism who are non-verbal do desire to communicate their emotional state and are capable in doing so when supplied with easy to use tools that aid in the process. These tools do however require some training and must be implemented in a way that is appealing to the demographic. This focus on education is rooted within the research itself and builds upon the concept that these individuals are capable of expanding and growing both mentally and academically as stated by Dr. John Cabibihan. Adventures in Emotion serves as that needed communication tool that allows the user to communicate with the wider world around them while also acting in tandem as an educational resource that allows them to better understand their own emotional state. The application makes use of colorful and fun visuals that have been shown to be appealing to the target demographic in combination with interactive experiences that serve to engage their minds and imagination in order to keep them coming back to further progress on their journey of emotional discovery.

The project that started out as a simple communication sound board quickly evolved over the course of this thesis and soon found itself branching into other areas related to the topic. It is this dynamic shift from basic tool to educational asset based on studies using real world scenarios that provides the proper user experience and serves as the answer to the initial problem.

The implementation of customization and flexibility that the application offers combined with its use of progress tracking and positive feedback provides for the perfect environment conducive to learning in regards to non-verbal autistic children within the age range of three to five years old. With continued development on this project in the future the application could be catered to a wide variety of age ranges and expand well into the user's teen years. However, these types of modifications and adaptability would require further in-depth research as well as user testing which was not possible or viable within the short window provided when developing this thesis. However, with time and resources, the application could evolve into something even larger than what

was initially envisioned provided the use and approval of user testing involving real-life subjects.

Adventures in Emotion accomplished what it set out to do and that is to create a proof of concept for an application based on thorough research and testing guidelines that could serve as a consumer-grade tool to aid in the education and communication of non-verbal autistic children. The concept for this application provided the blueprint for a piece of software that can enable a group of individuals who are often overlooked and did so while applying a visual style that is appealing and engaging to the demographic. All of these elements worked in conjunction to prepare for an application that will serve to usher in the return of a voice.

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