INTERACTIVE STORYBOOK FOR LEARNING PRONUNCIATION

PROPOSAL REPORT

Chaotic Control

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Semester 1, 2021

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CONCEPT / INTENDED EXPERIENCE

We will look to create an interactive story book, the story will serve as an engaging and playful way for people, specifically children, to practise their pronunciation of words and look to identify where difficulties are arising with pronunciation. The story will be told through physical objects which need to be placed in the story world. Silhouettes of the different story characters and elements which match the objects will be presented on the backdrop of the given scene from the story. Users will put the correlating objects over the silhouettes and be required to pronounce each word as they do so. This interaction can be seen in Figure 1 with the user placing a sheep over the silhouette and then pronouncing the word as prompted by the system. The system will provide feedback to the user about how accurate their pronunciation was, playing back the users pronunciation against the correct pronunciation. If the user is able to pronounce the words correctly, the system will read the next section of the story out to the users as a reward. This process will be repeated throughout each story with different backgrounds requiring different objects providing a unique experience every interaction.
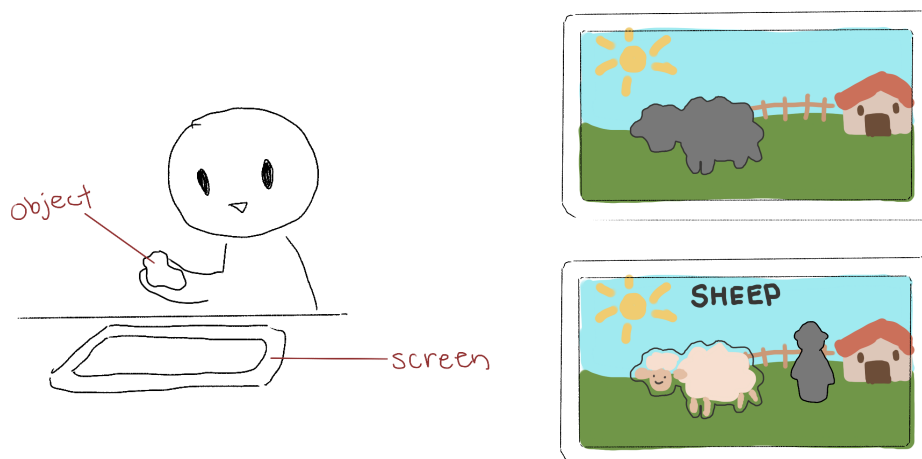

Figure 1: Concept Use

We understand that speech therapy is often a draining and mundane exercise which research shows is not engaging in the home setting - especially for younger target audiences. In a bid to tackle these pain points we want our users to:

- Feel more engaged in their speech therapy
- Feel more encouraged to practise speech therapy at home.
- Show progression and points of difficulty to therapists and parents
- Make speech therapy a much more pleasant and fun experience

We are looking to spark users' curiosity and interest to work on and improve their speech through a more exciting and rewarding system. Speech therapy methods which could also be used without a speech pathologist present hope to make the experience much more joyful and less stressful, as it can be taken at a users own pace providing positive reinforcement through telling stories.

The tactile objects will combine audio and visual prompts, focusing the users on the interaction as it provides feedback in an engaging way which appeals to the younger target audience. Our research shows that current solutions for speech pathologists do not integrate future technology possibilities, being either purely digital solutions using a touch screen or physical tools that don't provide feedback when used outside of a therapy appointment (Vaezipour et al., 2020). We believe that the hands on curiosity of children will benefit greatly from the implementation of future technologies allowing them to playfully learn the skills needed for accurate pronunciation.

CONTEXT / DOMAIN

We will aim to design this primarily for at home use, providing feedback to be applied in a clinical setting. The device will be integrated along with the user's speech pathologist. We will be mostly focusing on preschool to early primary school children who are having difficulties with pronunciation. Children are less likely to look at the big picture benefits provided by doing their speech therapy exercises compared to adults. Adults are able see the long term benefits of therapy whereas kids often struggle unless there are incentives and there is adequate engagement provided to them. The system will integrate with speech pathology clinicians, providing them with feedback on where users are having difficulties with their pronunciation so the therapists can tailor therapy sessions accordingly.

Learning will never be instantaneous for us humans, we will always require practise and training to perform tasks correctly and efficiently. The learning process can be a mundane task, so we are intending to implement a physical solution for users to interact with that makes skills learning more playful. The aim of the project will be to specifically make speech therapy training exercises much more approachable and enjoyable. It will look to engage children to practise their pronunciation and identify where they are having difficulties. The system will provide feedback regarding user difficulties, not only to the users during the interaction, but also back to speech pathologists who are then able to provide tailored exercises for each individual user to improve their therapy process. The form of the concept looks to specifically engage children by focusing on their curiosity and providing positive reinforcement by rewarding them with a story

when they are successful in completing their exercises. Our overall aim is to make their mundane learning process more engaging through future technologies.

RELATED WORK

In a field as sensitive and complex as speech pathology, it was essential to gain a sound understanding of our domain space. This involved us understanding current speech pathology practices, potential future technological applications, patient sensitivities, and the validity of teletherapy within speech pathology. Finding evidence to support the validity of teletherapy was the first major step in ensuring our concept is a suitable form for our domain.

An ever-increasing population will require transformational strategies to deliver even the current levels of speech-language pathology (SLP) (Theodoros, 2012). There isn't just pressure on clinics to provide sufficient sessions for the growing population, but our growing population is also a time poor one. Work and family commitments have resulted in patients having difficulties in attending face-to-face (FTF) sessions. "Against this background of social change, the need for more time and cost effective service strategies is evident" (Theodoros, 2012). Speech therapy can also last for years depending on the level of impairment (Ahmed et al., 2018), which further compounds the stress on FTF SLP sessions. The treatment model in SLP is shifting away from sporadic treatment over multiple years to a more consistent treatment regime that incorporates a combination of both FTF and teletherapy sessions. "Speech disorders will not be fully remediated without intensive and long-term intervention" (McAllister & Ballard, 2018). It is evident that a treatment program which incorporates both FTF and teletherapy sessions is the optimal way to treat the modern day patient, which validates the need for our concept in SLP.

Teletherapy is clearly a valuable component to a patient's therapy, but how can we keep remote sessions consistent without the presence of a speech pathologist? "Children need to be constantly motivated to perform exercises that are often monotonous and repetitive" (Ahmed et al., 2018). Our concept aims at incentivising continuous usage by providing engaging and challenging gameplay, rewards, and multiple difficulty levels. When asked about their preferences regarding existing SLP mobile games, users reported specifically liking gameplay that incorporated "reward systems (e.g. points), games that were challenging and the option of multiple levels of difficulty" (Ahmed et al., 2018). Users expressed an interest in fast paced challenging gameplay. "More complex and fast-paced games than typically preferred by SLPs may be better at engaging and motivating children" (Ahmed et al., 2018). This finding should be taken with caution as fast paced gameplay may deviate from the end goal of providing speech therapy as users may lose focus on their therapy. Gameplay must focus on creating as many speech production opportunities without compromising gameplay. To avoid user frustration it is important to use leading automatic speech analysis (ASA) and recognition tools to ensure accurate speech recognition (Ahmed et al., 2018).

In order to provide sufficient remote therapy, ASA tools must have an accuracy above 80% when compared to human judgment. SLP tools utilise ASA to recognise users' speech

and compare that to correct pronunciation of selected words. The market is saturated with ASA tools and selecting the correct one will dictate overall user satisfaction with their therapy. "False acceptance and rejection rates need to be low to avoid frustration for the user, and error detection accuracy and feedback capabilities need to be high" (McKechnie et al., 2018). The Hidden Markov Model (HMM) has been widely studied and proven in recognising both correct and incorrect speech; therefore it will be the foundation of our concept. Although existing solutions stimulated users, it is evident that there's room for improvement in the space.

Before designing an application around speech pathology, it is essential to understand the advantages and disadvantages of existing solutions. Current applications have a lack of interactive and engaging elements - which is detrimental to creating self managed therapy (Vaezipour et al., 2020). All observed existing applications require users to use their voice to affect gameplay in unique ways. In a review of seventy existing solutions, only three of the top ten rated apps claimed to be designed and developed based on evidence-based therapy techniques (Vaezipour et al., 2020). Lackluster implementation of existing therapy techniques creates the possibility that treatment may be counterproductive for a patient's recovery and indicates a compromised design process. Speech pathologists are calling out for a product designed via a co-design process which involves all key stakeholders, including patients, speech pathologists and caregivers. "From the early stages, apps should be designed and developed by a multidisciplinary team of experts, including speech pathologists, human-computer interaction experts, user experience designers, and app developers" (Vaezipour et al., 2020). This statement shows strong support for an application similar to ours. By utilising a sound co-design process which involves all stakeholders, our concept will likely avoid the pitfalls of existing solutions.

Market leading applications, such as 'Naming Therapy' (Vaezipour et al., 202), utilise a vast array of tools to minimise the risk of users feeling frustrated and dejected with their therapy. 'Naming Therapy' provides an array of hints for the user when they're trying to pronounce a particular word. These hints range from revealing the first letter of the word, all the way to giving an example on how to pronounce the word (TactusTherapy, 2019). These hints allow the application to provide support to the patient regardless of their impediment. It would be wise to review how these features could be utilised in our concept.

RESPONSE TO FEEDBACK

Our concept has undergone major revisions based on the feedback we received during the pitch. Originally, our concept consisted of a competitive two player pronunciation game, which was facilitated by a transparent screen and microphones, in which the users were shown mouth positions to make various sounds, and would be scored based on their microphone input. We received feedback that our audience may have been too broad and our form of interaction was not physical or playful enough.

We chose to drop second language learners as an audience, instead focusing solely on speech pathology. These two target audiences often have different needs and areas of focus, likely resulting in our concept being too generalised. Much of the feedback we received to our initial concept was focused on interactions and issues relating to speech therapy, such as bad habits with pressuring teeth when speaking, the speed of word pronunciation, and mouth or tongue based controllers for pronunciation; as such, we felt this would be the more interesting of the two domains to focus on going forward. Part of the reason why we had included second language learners initially was due to fears regarding the ability to test users, but we were assured during the pitch feedback that there were options available to us, including UQ's own speech pathology clinic.

With this change in audience, we decided to make a number of significant changes to our concept and its interaction. We received feedback during the pitch that our reliance on the screen was not physical enough and that our interaction lacked playfulness as it was a rather formulaic process of pronouncing a sound, then getting a point. To address the lack of physical interaction, we decided to include a more tactile element with the physical objects. We also added the story element as a reward to make the experience more playful and motivating for younger children. Another piece of feedback we received regarded the importance of hearing someone else make the sound, as such, our current concept will now play back the user's recording and a correct pronunciation recording when they get the answer wrong - allowing them to identify their error. We also made sure that our revised concept took up less space, as we were encouraged to avoid installations due to them not fitting well into the 'future mundane' of people's everyday lives.

TEAM INTRODUCTION

OSCAR DUNSTAN

During earlier years of schooling I had the opportunity to design and build physical products for clients. I believe the skills I obtained in the workshop will benefit myself and the team during this semester. This workshop experience mainly revolved around timberworks, I hope during this semester I will build upon this skill by learning how to incorporate our tangible device and technical application together. A key goal for my semester is to build upon my key weakness of programming, this has been an area I have neglected during my studies. I'm excited to enter this design process with such a strong design team. I believe my design heavy background will complement the rest of the team's skills well.

AIDEN TAYLOR

Hello! I am Aiden, I will look to implement my strong communication skills to keep the group on the same page consistently throughout the development of this project. I recently have been

very eager to further develop my programming skills as I have taken up software development outside of my university studies and enrolled in heavily coding focused subjects for my final semester. While I have had very little experience creating physical prototypes I'm decently handy and should be able to assist the group in constructing our physical artifacts for the system. My weaknesses lie in my inexperience with integrating these artifacts with computing solutions as I have only ever created purely digital solutions. This means I have no experience with microcontrollers, soldering, sensor implementation or any similar technologies. As a group of designers I believe we are all fairly confident with the design of different prototypes but will have to work together on the implementation of these physical computing solutions. This is expected obviously and is where I hope to develop my skills and work with the group to learn these new skills for implementation in any future projects.

JULIAN SUNDE

My main strengths lie in my organisation, aesthetic sense, and attention to detail. I hope to use these strengths to deliver a quality prototype through organised scheduling with my team. While I am not a confident coder, my main weakness is definitely my inexperience in creating physical prototypes. I will likely require assistance and guidance from either my teammates or the tutors when constructing our prototypes. In this course I'm aiming to improve upon the skills which I lack, while also creating a fun and unique prototype, unlike any which I've created in previous courses. I hope to submit each project section in a timely manner, either the day before or early morning of submission; I will also ensure that our submission is of a high quality.

THEODORE TEO

I'm currently studying for a Bachelor of Information Technology, majoring in User Experience Design. My main strengths lie in my versatility in terms of design - I'm good at visual design, user experience design and have experience in game design. I also have a passion and desire to learn new and different things outside of my field. When discussing ideas, I consider how grounded and feasible the idea will be in the real world and how we can execute it, and I'm good at considering and weighing different pros and cons of our decisions and bringing up concerns if needed. Unfortunately, I don't have much experience with coding and building, and will likely need team effort with building to accomplish building the prototype.

My main aims of the course are to learn how to build a genuine prototype using the skills and inductions I've learned about in this course - the probability of that makes me excited to progress with the course. I'd also like to learn more social and professional communication skills to improve with working with other designers, since we all likely have different design ideas that might clash with each other. I will help out with any visual design aspects and generate ideas for the team. I've also taken down meeting notes for the team to refer to so they can stay on track, and I will continue to do so. My approach with tackling this project is mainly to focus on generating ideas, visual design and building the prototype itself.

VANESSA ACKERMANN

To the team I contribute with the strengths of having a bachelor's degree in Health Informatics I find this topic of health and rehabilitation within speech pathology very interesting. I can contribute with a wide range of medical knowledge and a deep user understanding of patients and clinicians. Further I have worked within a hospital setting for a number of years and conducted research within a clinical setting within the area. This being the use Immersive VR as pain distraction in pain related treatment for children at danish hospitals. From this experience I gained great communication skills with parents, clinicians and children, and a deeper understanding of how to work with children and what constraints, challenges and opportunities that exist within this space. My weakness is my lack of coding skills and limited time, and my small network here in Australia. I am very aware that my team members are more experienced in coding and I will try to learn from them and take their advice in this area. My aim of the course is producing a product that I would be proud to present to patients and clinicians, that clearly fulfills the needs of the user. Further I would like to improve my crafting skills and produce a high quality product with attention to detail. My approach to project deliveries will be to carefully plan a time schedule with the group that takes everyone's schedule into account, and contribute with my strong research and people skills.

DISCOVERY & CONSTRAINTS

In this early stage of the project we have still not fully decided on the concept. The concept we proposed is yet to be validated. This is due to the fact that we still haven't conducted the essential user research that will help us understand our target audience and stakeholders in the project. The stakeholders most in need of research are speech pathologists. We need to gain a deeper understanding of their area of work, we need to know if our concept would be in their interest to use, and we need to be aware of key problem areas they find that we can solve with our solution. Hopefully the user research will match our academic research and confirm that there is a need for a speech pathology tool for children that is both interactive and fun. It will be interesting to find out the specific areas of speech pathology that are problem areas to target, for example, difficulties in children pronouncing 'R' sounds. Another question to ask is which of these areas are of high importance, and yet feasible to solve with a digital interactive tool - as a concern would be building a tool which is interactive and fun but does not solve the intended problem. Another concern is making this a tool that children will enjoy using and one that they won't experience as just another boring exercise or task that adults have told them to do.

For a child, imagining and understanding the long-term benefits and effects of their training could be difficult. To manage this concern, we need to maintain their attention and provide feedback that challenges them and makes them want to keep practicing at home. For investigating this area, we will conduct observations and interviews of children undergoing speech pathology training. From observations we can gain an understanding of their behavior in a treatment setting, and their attention span. Interviews will let us understand their perspective,

motivations and challenges with speech pathology training. As children will be the primary user of our product, this research is important as we will obtain insights into their pains, gains and jobs, that will then lead us to design opportunities.

This tool will be used primarily by children and their speech pathologist, but since the goal would be for the child to use the tool at home, parents would also be heavily involved in the training and motivation of the child. Our concerns regarding the parents would be that they would not find the tool relevant and efficient enough to buy for their child's use at home. It is important that they understand the value of the tool, its benefits, and that it matches the needs of their child. To mitigate this challenge we will conduct interviews with parents. The interviews will focus on how their child plays, what they notice works for their child, and the issues they find important in regards to their child's speech pathology training. After collecting this data we should have gained more information on the kinds of tools that exist, how we can help promote learning with children, and what methods they recommend us working within. Next it would be interesting to visit one to two children in their home environment to observe what kind of space they would be working within, for example a playroom, a children room or a living room space. We want to observe their way of playing and what children of preschool age till early primary age enjoy playing with.

Our constraints for further discovery will be the amount of access we will be able to get to these individuals. We will access speech pathologists through the UQ speech pathology department, but we can't guarantee their availability and interest in our project. Through that, we can hopefully gain access to children and parents relevant to our project. Working with children, of course, introduces difficulties in communication, attention span, and time since we can only conduct research during the day with the presence of a parent, guardian or speech pathologist. Further constraints would regard working within a medical area; issues with privacy and confidentiality might be introduced, and we must understand that it may be a sensitive issue for parents and children struggling with a speech pathology issue. To alleviate these constraints, we can try to create a strong bond and establish good communication with the stakeholders. This should ensure their trust and interest in us and the ongoing process.

Another area of consideration is finding out what materials we will be working with, and what kind of format would be relevant to facilitate these learnings. We would like to explore alternatives to the currently intended format of an interactive screen by researching materials to find out if other formats would work for our concept. Our constraints in this area are that we have a limited awareness of materials and a limited budget to test out and use different solutions. In further development, it will be interesting to discover if there is potential to make a suite of tools that are each targeted towards specific issues in speech pathology training with children. Creating a suite would make the concept more long-lasting and create a wider span within the area. A constraint here will again be budget, time, and access to test participants.

PLAN OF WORK

	Milestones	**Member(s) responsible**
Week 5	• Produce a project report • Contact stakeholders • Initiate contact to UQ Speech Pathology • Collection of research • Sketches and concept mapping	• All • Oscar, Aiden • Julian • Oscar • Theodore, Vanessa
Week 6	Start collection of data - this includes interviews, observations • Observations and interviews of children • Interview speech pathologists • Interview and observation in home with Parent	• All • Vanessa, Aiden • Theodore, Julian • Oscar
Mid Sem Break	• Collection of insights and discovery of design opportunities from research • Initial low-fidelity prototype sketches	• Vanessa • Theodore, Julian
Week 7	Co-design process initiated • Sketches shown to stakeholders. Get feedback and remake sketches to fit needs of the user • Remake of low-fidelity prototype design	• All • Theodore, Julian
Week 8	Low-medium fidelity prototype generation • Generating the interactive story and creating assets • Creating the tactile objects so they interact with the storyboard • Implementing speech recognition and analysis	• All
Week 9	Prototype testing and refinement • Making prototype adjustments based on user testing results	• All
Week 10	• Appraisal report • Response to prototype feedback	• All
Week 11	• User testing • Refining the experience	• All

Week 12	Website generation: • Explainer video that helps in communicating the concept and desired experience • Video demonstrations of interaction with the final product • Description and illustration of the technical development of the project • Annotated imagery detailing the form and function of the projects	• All
Week 13	Final Exhibit	• All

Table A: Work Schedule

In starting this project, we have a clear and structured plan. We know that we need to conduct further consultation with industry experts, as shown in Table A our team has secured interviews with some speech pathologists in Week 6 which will look to affirm the concept's currently planned form. We will also conduct observations about how our target audience currently engages in speech therapy and how they play - looking for affordances our project will require. This will inform our prototype sketches and design, we will again consult industry experts to ensure that acceptance of the system is high before conducting our prototype generation.

For the following 4 weeks of the project we will take an iterative approach to prototyping in response to our user testing results. Maintaining user-centric design is core to the success of this project, finding target audience users to interact with the different prototypes will also be essential for our team. We will look to break the prototype down into individual interactions, so work can be evenly distributed amongst the team. The main features of the prototypes in the proposed form would be: generating the interactive story and creating assets, creating the tactile objects so they interact with the storyboard, and implementing speech recognition and analysis. We will collate a minimum requirements version of all these elements for the prototype submission in Week 9. As seen in Table A, we will focus on responding to this feedback and will then return to prototyping and testing with the newest iterations of our concept.

The group will collaboratively ensure that the project is cohesively operating by Week 11, as we will aim to have everything prepared for the final exhibit a week early. This will mean we can spend our week before the exhibit generating the promotional materials and required website without stressing about adding more features or functionality right up until the exhibit.

REFERENCES

Ahmed, B., Monroe, P., Hair, A., Tan, C. T., Gutierrez-Osuna, R., & Ballard, K. J. (2018). Speech-driven mobile games for speech therapy: User experiences and feasibility. International Journal of Speech-Language Pathology, 20(6), 644–658. https://doi.org/10.1080/17549507.2018.1513562

McAllister, T., & Ballard, K. J. (2018). Bringing advanced speech processing technology to the clinical management of speech disorders. International Journal of Speech-Language Pathology, 20(6), 581–582. https://doi.org/10.1080/17549507.2018.1510034

McKechnie, J., Ahmed, B., Gutierrez-Osuna, R., Monroe, P., McCabe, P., & Ballard, K. J. (2018). Automated speech analysis tools for children's speech production: A systematic literature review. International Journal of Speech-Language Pathology, 20(6), 583–598. https://doi.org/10.1080/17549507.2018.147799

TactusTherapy. (2019) Naming Therapy by Tactus Therapy - Speech Therapy App for Aphasia [Video file] YouTube: https://www.youtube.com/watch?v=PeK2cJUW0ts

Theodoros, D. (2012). A new era in speech-language pathology practice: Innovation and diversification*. *International Journal of Speech-Language Pathology*, *14*(3), 189–199. https://doi.org/10.3109/17549507.2011.639390

Vaezipour, A., Campbell, J., Theodoros, D., & Russell, T. (2020). Mobile Apps for Speech-Language Therapy in Adults With Communication Disorders: Review of Content and Quality. JMIR MHealth and UHealth, 8(10), e18858. https://doi.org/10.2196/18858