

Final Design Report

The Learning Box - An Intellectually Stimulating Binary Classification Task for Adults with Intellectual Disabilities

Prepared for:

Nicole Humphrey

Misericordia Home (Chicago, IL)

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Executive Summary

Problem

Due to a lack of engaging educational activities for adults with intellectual disabilities, residents of the Misericordia Home have trouble sustaining their attention, feeling motivated to learn, and progressing through their programs. Our client, Nicole Humphrey, asked us to design an age-appropriate educational device that motivates, engages, and sustains the focus of her students.

Purpose and Requirements

The objective of this design is to educate and motivate the residents to learn. The design should stimulate the residents, be able to be individualized, work with the learning manipulatives present, and keep the learning manipulatives isolated.

Methodology

Besides observing residents engaging with their activities, we also interviewed Ms. Humphrey and showcased multiple iterations of our design to better synergize with her classroom. We also received consulting for our design from a speech language pathologist that teaches children with autism.

Design

Our design is a device with two podiums surrounded by transparent plexiglass to offer students a choice of answers. An access portal in the back of the Mystery Box provides both a way to adjust the sound settings of the sound-producing button that reinforces correct choices, but also a place to stow a prize for a series of correct answers. Inside of the prism, there is a sound chip connected to a wire with a button at the end of the wire that stretches to the back of the box. This button plays various songs when pressed, which offers immediate stimulation and gratification. Surrounding the two white platforms on the top of the box, there is transparent plexiglass to ensure that the residents do not touch the objects placed on each platform. The front of the rectangle has a removable picture to ensure that residents are visually pleased by the design of the box.

Introduction

The nature of intellectual disabilities leads to challenges in educational settings. Due to the nature of intellectual disabilities, people experience challenges with sustained motivation, retention of information, and effective intellectual stimulation. According to our client, current solutions are not age-appropriate and they do not sustain the attention of our users. Our solution utilizes a short-term and long-term reward system to motivate users to engage with educational activities. The activity itself is a classification game in which the users must correctly identify the object based on the instructor's prompt. For example, the teacher might ask them to correctly identify an apple, given a set of two options, one being the apple. If they answer correctly, the users are rewarded with a snippet of a song they enjoy, which is the short-term incentive for them to engage with the activity. After a certain number of correct answers, the instructor gives the users a toy they enjoy, which acts as a long-term incentive for the users to engage with the activity. This activity takes the form of a rectangle that has two platforms on the top where the two objects are placed respectively, enclosed by plexiglass so the users can point to the correct option. This design ensures that the users will be engaged with the activity and motivated to continue the activity. As the users continue to engage with the activity, they will learn to distinguish similar objects from one another such as an apple versus an orange. The goal of this product is to motivate residents to learn and engage with educational activities and to sustain their focus.

Users and Requirements

Residents of the Misericordia Home

The users of the device include three adult males with intellectual disabilities, which lead to challenges in their ability to engage with educational activities. One of the residents has difficulty staying upright, and lays down on a mat for a substantial portion of the lesson. Another resident is very active and uses physical activities to stimulate himself. The last resident is affectionate and enjoys receiving attention from others. Each resident has difficulty focusing on lessons and would benefit from a stimulating educational tool.

Instructor at the Misericordia Home

She works closely with the residents and provides them with educational lessons. She described the challenges she experiences with the residents in regards to their learning which include sustaining their attention, effectively stimulating them, and motivating them to learn. Her ideal product would address these issues to make her lessons more engaging for the residents.

Major Requirements:

Effective stimulation

The residents stimulate themselves using their toys, so the product needs to have a component of stimulation that motivates them to engage with the activity.

Sustained attention

The residents currently struggle to sustain their attention to the activities, so the product needs to incorporate a system where residents can achieve a state of flow.

Education

The product needs to educate the residents and give them skills that they can utilize in the real world.

Cleanliness

Must be easy to clean to ensure that the residents will not be contaminated by touching the box.

Age-appropriate

Must respect the dignity of the instructor and the residents; should not be seen as a toy.

Safety

No hazardous materials or small parts since the residents tend to chew on objects.

The rest of the report will discuss the design concept and rationale for the requirements, future developments for the product, and the conclusions made from the project.

Design Concept and Rationale

The Mystery Box is a learning platform that features two podiums surrounded by transparent plexiglass to offer students a choice of answers. An access portal in the back of the Mystery Box provides both a way to adjust the sound settings of the sound-producing button that reinforces correct choices, but also a place to stow a prize for a series of correct answers. Inside of the prism, there is a sound chip connected to a wire with a button at the end of the wire that stretches to the back of the box. This button plays various songs when pressed, which offers immediate stimulation and gratification. Surrounding the two white platforms on the top of the box, there is transparent plexiglass to ensure that the residents do not touch the objects placed on each platform. The front of the rectangle has a removable picture to ensure that residents are visually pleased by the design of the box.

The following sections describe the components of the device — sound chip, podiums, rectangle with hole, changeable design, plexiglass — as well as the rationale behind each component.

Sound chips



Figure 1: The Learning Box with two buttons connected to sound chips

Specifications and use

One sound chip with ten different songs of 3-6 seconds and another sound chip with chimes and dings that play after a correct response to the question. The song snippet and chimes provide immediate rewards tailored to each resident, as Ms. Humphrey can change the song with two clicks of the back button to provide each resident with their preferred sounds.

Rationale

This aspect of the design provides residents with stimulation to meet the needs of their sensory profile. Based on user-observations, residents have trouble focusing and maintaining their

attention during Ms. Humphrey's lessons, which indicated that their sensory profile was not being met during lessons. Our client indicated that residents enjoy music and artists such as Beyonce, which we included in the sound chip for tailored stimulation and attention maintenance.

Podiums and plexiglass

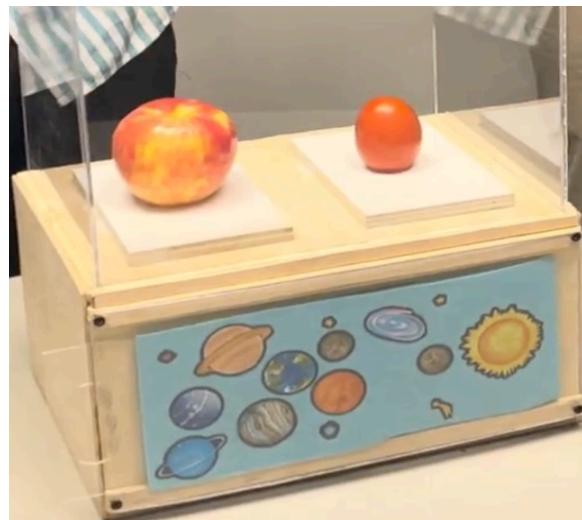


Figure 2: The Learning Box showcasing two objects on each white podium

Specifications and use

The wooden box features two wooden podiums attached to the box. These two wooden platforms are painted white, which contrasts the color of the box itself. The wooden platforms are 7 x 10 inches, allowing objects of moderate size to be placed on each podium. The box also features three pieces of plexiglass each of 12 x 14 inches adhesively connected to one another, and placed in divots on the top piece of the wooden box.

Rationale

The contrasting color of the two wooden podiums allow objects to be distinctly viewed as separate entities from the box and from one another. Since the residents need to nonverbally indicate the answer, the podiums have distance from one another so the instructor can clearly see that the residents correctly responded. The residents associate the objects with their purpose, so if they see an object such as an apple they might have the impulse to reach and take a bite of the apple. The plexiglass prevents them from reaching and biting the apple, and helps them associate the objects with the learning activity as opposed to their day to day purpose. By including the transparent plexiglass, the residents will eventually associate the objects behind the plexiglass with learning.

Box with hole

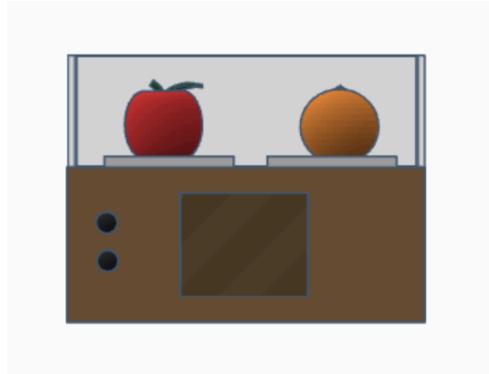


Figure 3: Graphics of the back of box with a hole

Specifications and use

The hole in the back of the box allows multiple objects of moderate size to be stored inside. Client stores residents' learning manipulatives inside of the box, which would be given to the residents at the end of the lesson as a reward.

Rationale

The residents enjoy stimulating themselves with their learning manipulatives, which tends to distract them from their activities based on user-observations. As an incentive for residents to engage with the activity and sustain their attention throughout the duration of the lesson, Ms. Humphrey would place their learning manipulatives inside of the box and reward them with the objects at the end of the lesson. This provides a long-term incentive for the residents to learn and engage with the activity, which reinforces their motivation to engage in the lesson.

Interchangeable design



Figure 4: Group member changing the design of the box

Specifications and use

Plexiglass with velcro adhesive attached to it and holes for grip allows for changeable design on the front of the box. The front panel made of plexiglass allows for ease when sliding the new design into the slot.

Rationale

Each resident has a different sensory profile; the purpose of the interchangeable design is to appeal to the residents and spark their interest in the box itself. Based on user-observations the residents were interested in objects with dynamic patterns and colors. Ms. Humphrey also indicated that she would like the device to be age-appropriate. This design choice allows Ms. Humphrey to make the box age-appropriate when necessary but also provide visual stimulation to residents during lessons.

Future Development

To develop the product further, we would recommend conducting research to better understand reward-based learning for long-term cognitive development. We discuss potential strategies to progress the product below:

Longitudinal Research Study

To better understand the reward-based learning for progress in adults with intellectual disabilities, we would recommend conducting further user-testing with a large sample size. The study should include different forms of short-term and long-term rewards to determine the most effective rewards for optimal stimulation and attention-maintenance. For example, one group of users could receive short-term rewards in the form of olfactory stimulation—the smell of something pleasant after a correct answer. To determine the effectiveness, each group would be subjected to different forms of short-term rewards and tested on their progress after a certain period of time. This study would take a long time to effectively measure the progress of each randomly sampled group. To prevent uncertainty in the results, each short-term reward would have a different concept associated with it, difficulty remaining constant between each lesson. This study would give direction for further development of the box by determining the most effective forms of stimulation for optimal learning.

Current Product Flaws

The box currently only has 10 snippets of songs downloaded onto the sound chip, which may cause residents to lose interest in the song after a certain number of lessons. To combat this issue, the sound chip should connect to Ms. Humphrey's phone via bluetooth to play any song for any duration of time. The box itself only has 5 designs on the front panel which the residents may lose interest in as well, which can be fixed by adding more designs and swapping between them randomly based on the residents' preferences. Lastly, the box only features two podiums, which may be too simple for the residents, as they progress, the number of podiums and complexity of the questions should increase.

Ideas for Product Features and Advancement

To further the motivation of residents in the long-term, we would suggest incorporating a token economy where residents receive tokens that act as a measure of their progress throughout the lessons. These tokens could be traded for rewards such as new learning manipulatives or activities that the residents enjoy. Another addition could be to replace the front panel with a digital panel that has animated designs and could be used to evaluate the residents' accuracy in front of them. It would also allow dynamic visual stimulation as a reward for accurate performance.

Conclusion

The Learning Box meets Ms. Humphrey's requirements which fulfill the needs of the Misericordia residents. The box effectively stimulates and educates the residents with its short-term long-term reward system that stimulates residents for correct answers to intellectually stimulating prompts. The box cannot be chewed on and the plexiglass prevents residents from reaching and chewing on the learning objects, which meets Ms. Humphrey's safety requirement. The box is also durable and easy to clean, as each piece of the box is adhesively attached to one another. Wood is also easily cleaned with the cleaning tools that Ms. Humphrey has available at her disposal. In conclusion, the Learning Box will effectively educate, stimulate, and engage residents with the lessons in Ms. Humphrey's classroom.

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Appendix A: Project Definition

Project name: The Learning Box

Client: Nicole Humphrey, Misericordia Home – Chicago

Team members: Shayan Shabani, Andrew Smart, Jay Yegon, Daniel Guchua

Date: November 15, 2023

Version: Three

Mission Statement

Design an accessible educational tool that effectively teaches and motivates adults with intellectual disabilities by integrating short-term and long-term rewards.

Project Deliverables

- Final Prototype based on various iterations and feedback
- Final Report Draft
- Poster and Presentation for Design Expo

Constraints

- Budget of \$75 for prototype
- Final project has to be completed before the end of fall quarter (December 2nd)
- Needs to fit into Ms. Humphrey's lessons in a cohesive manner that complements her current objects

Users/Stakeholders

- Adults with intellectual disabilities (the main users) - These residents have disabilities ranging from mild to severe. These residents have a very difficult time learning and paying attention, for which a reward system is needed in order to maintain their attention and incentivise them to learn. Residents will frequently lose attention and focus on something else, such as a toy.

- Instructors (Ms. Humphrey) and volunteers for the people with disabilities (the people monitoring the users). Currently, from what we observed, Ms. Humphrey (and most likely other instructors) have a difficult time keeping the residents' attention while trying to teach them.
- Donors of Misericordia (the charity organizing construction of the system)

User Profile

Patrick is one of many vibrant Misericordia residents. His intellectual disability impacts his concentration greatly, creating a need for an educational tool that effectively engages his attention. Nonetheless, Patrick is a very lively individual with a penchant for movement. On an average day, one might witness Patrick engaging with a bouncy ball, which he can joyfully play with for hours at a time. His enthusiasm extends to music as well; he enjoys a wide variety of tunes ranging all the way from old classics like the Beatles to current pop-stars like Beyonce. This love for music stems from the natural liveliness of Patrick, and is a common trait among the residents. Commonly, upon walking into the classroom one can witness the smiles and dance moves of many of the residents as they listen to artists like Beyonce.

Patrick's engagement with his surroundings and his natural need for stimulation through physical activities is an attribute to his vibrant personality. However, in an educational setting this trait hinders Patrick as he struggles deeply with being able to concentrate on the material he is learning. Ms. Humphrey is Patrick's admirable instructor, and she often struggles to balance Patrick's natural need for an immense amount of auditory and physical stimulation during lessons. Although Patrick is just one example, many of the other Misericordia residents also struggle with engagement and concentration in lessons as they are naturally more prone to distraction and the need for immediate stimulation. Therefore, an educational tool that includes both short-term auditory and long-term stimulation rewards is essential as it would create a balance between the residents' need for stimulation and their educational goals.

User Scenario: It is a typical day at Misericordia, and Ms. Humphrey is walking around and checking on each of the residents. As she heads over to the space of each resident, Ms. Humphrey brings objects with her, such as an apple and a tomato, and asks residents to decipher the difference between the two. While she is asking the residents to choose which one is the

apple, she holds each object in each of her hands and awaits for the answer. Many of the times the residents will answer the first time, but afterwards lose attention and continue playing with their stimulation devices. Ms. Humphrey keeps on trying throughout the day and often gets the residents to answer, but it is evident that the residents, some more than others, become uninterested very easily. After multiple conversations with Ms. Humphrey, it is evident that there are only two wishes she has for her beloved residents: for there to be a smile on their face and for them to learn something new every day. Ms. Humphrey wishes that the residents know more



about the world around them.

Figure 5: Matthew engaging with a lesson with Ms. Humphrey

Design Overview:

The Mystery Box is a learning platform that features two podiums surrounded by transparent plexiglass to offer students a choice of answers. An access portal provides both a way to reach a sound-producing button to reinforce correct choices, but also a place to stow a prize for a series of correct answers. The basis of the Mystery Box is a rectangular prism. Directly on the top of the prism, there are two white podiums that are an inch apart from each other. Around the perimeter of the top, there are indentations that are $\frac{1}{8}$ of an inch deep into the top wood piece. These indentations hold plexi-glass on three sides, which act as a protective case to the objects

on each podium. The back of the rectangular prism consists of an opening where the long-term reward incentives will go inside the box. Additionally, on the back of the box there are two buttons, each one connecting to a small speaker that will play different short-term reward auditory stimulation. The button on top will correlate to a segment of a song, while the button on the bottom will correlate to a soft sound like a bell for a correct answer. On the front of our box, we have two horizontal spacers (one on top and one on bottom) that are about $\frac{1}{8}$ of an inch out. On top of these spacers, there is a plexi-glass sheet that protects the design that will be inserted into the free area that the spacers created. The designs will be pieces of paper, the width and length of the spacer area, and can be taken and replaced easily depending on the resident.

Requirements and As-Built Specifications

The product shall work with existing classroom learning manipulatives

Prototype specifications:

Ms. Humphrey can comfortably place the device on her tables during activities. The 10 x 14 x 19.5 inch design allows her to comfortably place the device on her tables. The two 7 x 4 inch podiums allow Ms. Humphrey to place any object in her classroom that she would normally hold in the palms of her hands.

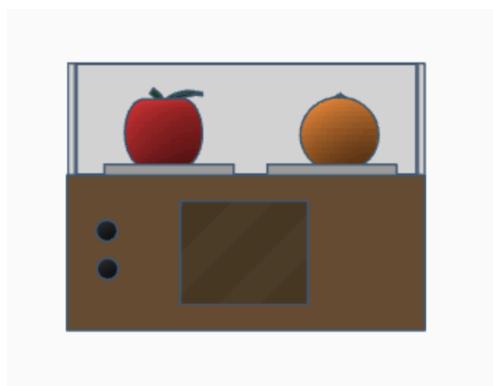


Figure 6: The size of the device and platforms suit her classroom requirements

The product shall provide a way for residents to indicate an answer to a question from Ms. Humphrey's through pointing or gazing at objects.

Prototype specifications:

The transparent plexiglass allows residents to clearly see both options. They communicate with Ms. Humphrey by pointing at the answer or looking at the object they believe to be correct; Ms. Humphrey understands their non-verbal cues.

The product shall keep objects on platform out of reach of residents

Prototype specifications:

The 14 x 12 inch plexiglass attached to the top of the device will prevent residents from reaching over the box and grabbing the objects. Two pieces of 14 x 12 inch plexiglass surround the left and right sides of the device to prevent residents from reaching around to grab the objects.

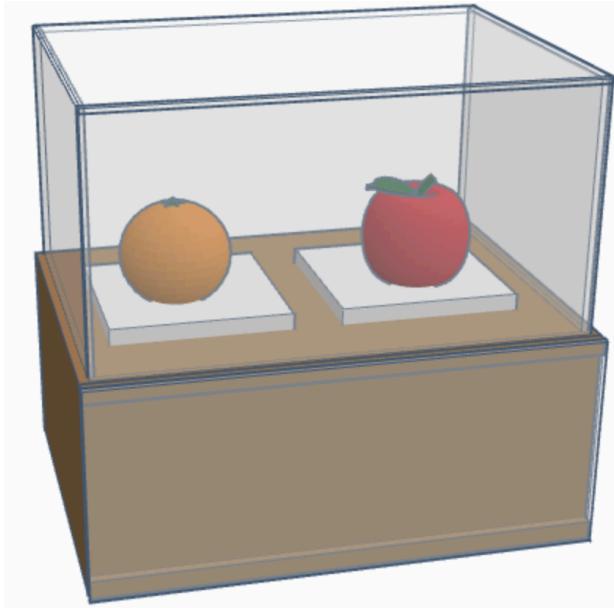


Figure 7: The plexiglass surrounds the box

The product shall allow Ms. Humphrey to reinforce learning through an immediate reward tailored to each resident

Prototype specifications:

Sound chip with 10 different songs of 3 seconds after correct response. Song snippet provides immediate reward tailored to each resident, as Ms. Humphrey can change the song with 2 clicks of the back button to provide each resident with their preferred sounds.

The product shall allow Ms. Humphrey's to reinforce repeated correct responses

Prototype specifications:

Access portal in the back of the device with 10 x 14 x 7.5 inches of space allows Ms. Humphrey to store residents' toys as a reward at the end of the lesson, or as a reward for a certain number of correct answers.

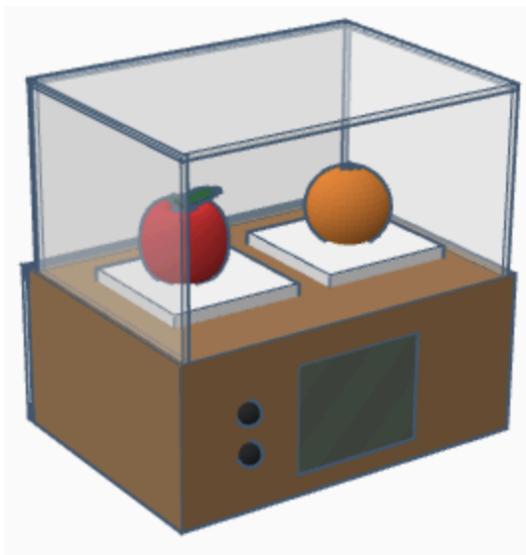


Figure 8: Compartment in the back of the box

The product shall be age-appropriate to the residents in all aspects of functioning

Prototype specifications:

Transparent plexiglass in the front allows Ms. Humphrey to change the design to an age-appropriate picture. The box itself painted with neutral colors ensures an unassuming appearance.

The product shall be easy for Ms. Humphrey to clean

Prototype specifications:

The plexiglass protecting the objects and the individualized design is easy to clean with a wipe.

If residents choose to answer by pointing, Ms. Humphrey can easily clean the plexiglass between residents.

The product shall be visually appealing to each resident

Prototype specifications:

There will be a total of five designs that are tailored depending on the residents' sensory profile.

These designs can be easily exchanged among residents, as there is an area $\frac{1}{8}$ inches out in front of the box that is protected by plexiglass. In this area, the design can easily be inserted in or out.

Appendix B: User Observation Notes

Introduction:

The purpose of this study is to determine the intellectual stimulation needs of adults with intellectual disabilities. We aim to create an educational object that fits the needs of the residents with intellectual disabilities based on the data we collect. Adults with intellectual experience disparities in healthcare as well as mitigation strategies for their symptoms; the majority of stimulating objects for people with intellectual disabilities are geared towards children. Because of this, the client's residents chew on demeaning objects like dog toys. The client wants a safe to chew, discrete, educational object to reduce the likelihood of the residents stimulating themselves with demeaning objects. By interviewing and observing the residents, we hope to learn their object preferences, any bothersome symptoms they may have, the safety considerations we need to take into account, the most effective options for intellectual stimulation, methods to prevent overstimulation, and the client's current strategies for helping the residents. Understanding these variables will give us the ability to create a tailored product that safely stimulates the residents.

Methodology:

- Goal: to understand the residents' needs and effective methods to stimulate them intellectually.
- Ideas:
 - Create different puzzles (matching colors, counting, drawing/coloring, 2x2 Rubik's cube, connect-the-dots, etc) observe the residents' reactions (survey with yes or no questions, verbal questions, emotion-identification, etc) to the puzzles to determine the most effective method of intellectual stimulation.
 - Bring a variety of objects for the residents to stimulate themselves with (include a survey or ask directly about their opinions of the object, could use "time played with" as a measure of effectiveness).
 - Interview the residents and ask them questions about the methods they use to stimulate themselves.
- Materials:
 - Computer
 - Paper and pencils (for survey and/or coloring/activities)
 - Potential objects
 - Toys
 - Coloring tools
 - Object meshes of various materials/textures (rubber, memory foam, etc)

Results:

We will have results to share once we visit the residents on 10/09/2023. As of now, we've spoken to the client, Ms. Humphrey.

Our interview with Ms. Humphrey provided us with valuable information.

Here is a list of her points during the interview:

- Many sensory needs, want to chew, explore, 56 years old but still have sensory needs
- Product needs durability, won't rip off and go down throat
- Dog toys used; some people can bite through, others use dog keys, cannot bite through
- Client wants more age appropriate, durable, intellectually stimulating objects
- Residents rub their heads and have other ticks; do it so much they pull hair out
- Can satiate for short period of time and they move on to something else, or they will continue and bite it harder - or may fight over toys
- Baby shaker - often too small so she gets bigger shakers; need materials that won't break
- Manipulative that is educational and stimulating; ensure that it's safe to put in mouth (prioritize educational component)
- Residents hate spiky balls with little plastic spines
- If the object is colorful they will play with it
- The more noise the better most of the time, otherwise they will be making noises
- From teaching standpoint; loves intellectual stimulation but a lot of residents prefer fidget cubes and other stimulating objects without an educational component
- Goal of client: object doesn't break fast and residents will want to interact with it every day
- Baby toys and manipulatives don't last that long, residents often slam them on floor
- Residents like repetitive noises
- Residents love music; don't necessarily like to make the music
- To calm down residents, play with soft items and give them back massagers; turn off lights and play meditation sounds or their favorite song
- To prevent overstimulation, maybe pick one thing, like a texture item or sound item, one sensory type because often can be too much
- To clean objects, our client washes the object in soap and water and has a chemical (yellow product), bleach after residents chew on it or when thrown on ground

Discussion:

Based on our conversation with our client, we aim to design a safe-to-chew educational object that residents will consistently be interested in. She indicated that she feels uncomfortable when outsiders look inside the residential area to see adults chewing on objects; she wants a discrete product. She also indicated that the residents experience overstimulation due to sensory overload which leads to self-harming behaviors such as hair-pulling. To prevent this, we need to heavily target one sense and only mildly target other senses. Lastly, we need to create a product that is easy to clean with the resources that our client has available. These findings are deeply flawed due to a number of factors. Firstly, Ms. Humphrey is not a scientist and everything she witnessed had a biased, non-scientific lens on it. Since she recalled everything from memory, there could have been confabulations in her points. She also looks at the residents from the perspective of their caretaker, which likely affects the way she perceives and processes their

behaviors; she may have misinterpreted some of the behaviors she saw, which would lead us down the wrong path. In order to solidify our understanding of our goals and approach, we should conduct an experiment/interview with the residents directly, using a rigorous scientific method to document our findings.

Appendix C: User Testing Results

Introduction

On Tuesday October 24th from 4:00 PM – 5:00 PM, every team member attended the mockup testing including Daniel, Jay, Shayan, and Andrew at the Misericordia Home. The testing occurred in our client's classroom for adults with intellectual disabilities. During testing, Ms. Humphrey was present and her classroom had three tables for us to organize our ideas into different categories. The goal of this mockup testing was to determine the product that we should focus on in our design process based on Ms. Humphrey's preferences and feedback.

Methodology

As previously mentioned, Ms. Humphrey was the only one present in the room during user-testing. We divided our ideas collectively into three separate categories: mathematics, reading, and a category for ideas that did not fall into the previously mentioned options. We had her go table-by-table, idea-by-idea where each designated team member would describe the mockup and its purpose and get her initial reaction to the idea before asking specific questions. This was in order to determine whether the idea would be of use to her classroom. We then asked questions regarding the specifics of each idea, including a varied combination of general and specific questions for each mockup:

General Questions

- What are your initial thoughts about this mockup?
- What's something we could improve about this mockup?
- Could you see this mockup being helpful in your classroom?
- Do you think the residents would like this idea?
- Do you have a way to measure the residents' progress and learning?

Specific Questions

- Would you prefer a Skinnerean system or a controlled system for the Binary Feedback Loop?
- Which of the designs do you think the residents would enjoy the most for the Binary Feedback Loop?
- Are balls a choking hazard for residents using the Quantity Sorting Game?
- Do you think these questions would be representable and explainable to the residents for the Progress Assessment?
- What materials and images would you like us to use for the Finger Tracing Board?
- Should we use different textures on both sides of the Finger Tracing Board?

After we asked our questions and showed her every mockup at each table, we organized our mockups group-by-group at four different tables to determine which mockups she liked the most from each group. This allows us to focus on building a single, high-quality prototype that will fit her needs.

Results

Summary of feedback for each mock-up

Mock-ups	Observations / Feedback
Binary Feedback Loop	<ul style="list-style-type: none"> - She said that the process of immediate reward and end-goal reward would be helpful in keeping their attention - She told us she liked that she could use this with the items that she already has - She said she liked the idea of giving them incentive in the form of toys - She said that she liked that this idea was out of the box and said that she has seen nothing like this before - She told us that the buttons should be really large and gave example (took picture of button beside hand) - She said that she preferred to have control of when the residents get their toys as opposed to a random system - She said that the outside of the box should be visually stimulating - Sound idea is good when the residents get the question correct - Top down selection - Learn once - Where should the button be? - Stark difference between the platform and the box.
Finger Tracing Board	<ul style="list-style-type: none"> - Ms. Humphrey seemed to really like our use of animals on the board. She said the residents love animals and this will keep them engaged. - She said finger tracing with textures is also engaging for residents. - She said she liked the cartoony image we put next to the words and said this will help residents with associating words with animals. - She said we should make multiple of these boards, each with different animals. - Ms. Humphrey said she liked our use of separate textures on front and back, saying she recommends this because it will keep residents engaged and help them better learn the words. - The textures Ms. Humphrey said she likes, which the residents enjoy the most, are bumpy, smooth materials like wood, and crinkles. - She said, "If you like the texture and enjoy tracing it, then they will too" - She said that the width of finger tracing cutouts are a great size for the residents.

Quantity Sorting Game (bags)	<ul style="list-style-type: none"> - She said she found the counting mechanism associated with this mock-up interesting - She remarked how it could help her with sorting her other sensory items in them - She agreed our design could use some durability aspects given how aggressive her residents could sometimes be - She said the residents would find it fun - When she had to choose one of our team's mock-ups, she said "This maybe I could make myself, but it would still be fun."
Number Board	<ul style="list-style-type: none"> - She said she loved our number board, mentioning how similar it could be to a letter board that she already had - She mentioned her residents could use some counting - She said the number '0' could be hard for her residents to comprehend and suggested we not include it in the board - She said placing shapes and images besides each number was thoughtful, as it could help her residents associate numbers with what they already know/love - food. - She said to make each cut-out to protrude a bit out of the board to help residents take it out of the board.
Progress Assessment For Residents	<ul style="list-style-type: none"> - She said that she doesn't have anything like this and hasn't been able to find anything like this. - Expressed difficulty in the current way of testing the residents' improvement and abilities. - She said that she would be able to communicate the questions on the quiz to the residents. - She agreed that a monthly or bi-weekly test would give her a better idea of their progress.

Discussion

Based on Ms. Humphreys' general feedback, she sought the unique aspect in each mock-up that could complement what she already had in store. She generally loved all of our team's ideas, as well as those from other teams, appreciating the time and effort that went into each mockup. We truly appreciated her feedback and hope that we can create a product that will benefit her and the residents. Based on the feedback we received during our group assessment, she mentioned that she wishes for us to focus on the binary feedback loop as our main project

and also to consider constructing something like the finger-tracing board and the monthly quiz because she believed that these three ideas are unique and would effectively engage the residents and facilitate their learning. Given this feedback, we believe that pursuing both the binary feedback loop and the finger tracing letter board would be the best approach to assist her. She expressed her hope that we could pursue these objects and finalize them because she believed that it would really help the residents learn. We decided to still keep the monthly assessment on the table, but to discuss the plan with the instructors before making a final decision.

Additionally, she gave us feedback on what the end goal for our binary feedback should look like, in which we gave her a couple options and asked her what she would like the outside of the box to look like. She said that it would be extremely helpful if the box was visually appealing, and we ended up settling on a nature design (with clouds, trees, and pictures of animals on the box) with a rainbow handle on the top. She also stated that the buttons need to be really big if we use buttons, which is something that we will definitely implement in our final project. She also really liked the song idea if the residents get the answer correct and wants us to create a system in which she would decide when the residents end up getting the toy out of the box. In conclusion, based on the feedback we received, since she said that we should focus more on the more complex ideas, like the feedback loop, and since she really enjoyed the finger tracing board we are going to try to pursue those for our final design. As of now, we are deciding to not pursue the other mock-ups such as the bag sorting game and the number board because she expressed that although these ideas could be good they are something that she already has or can make with the toys that she has. One thing that is keeping us from making a final decision is to keep that the residents were not present at the time of the study, meaning that we could not see how they interacted with the objects; therefore we would have to rely on Ms. Humphrey's observations to make our conclusions whenever she gets back to us.

Appendix D: Expert Feedback

Results

After our discussion with the prototyping specialist, we realized that we need to ask Ms. Humphrey a little bit more questions about the design being individualized. For instance, we are currently debating on whether to create the design for Jack specifically or to appeal to the most residents as possible, for which our platforms and box would be ideal for.

- We debated this today and tomorrow morning we are going to meet again and talk to the specialist about possibly making the design convertible, such that we could have the normal platforms (not angled) and platforms angled for Jack specifically. We have an idea for how to approach this, but before making any decisions we need to consult more with the consultant.

Design + Immediate Reward

- We decided that for our design we are going to either try to stick to a nature theme or possibly make it individualized for people, which the specialist said it would be simple to do. We could just make a little slit on the top of the box and insert different designs based on the resident that Ms. Humphrey is teaching.
- For the immediate reward aspect, we decided that we are not going to have buttons but rather simply allow Ms. Humphrey to click a button on her end which will play the second for a duration of 5 seconds. The residents can point to the answer rather than pressing the button, which could be distracting to them. We will use a EzSound Multiplay button, which will make it easy to download songs onto it as well as incorporate it into our design. This was recommended by the design specialist, and it will be simple to use as well as cheap.

Long-Term reward aspect

- Considering the feedback that we received from both Ms. Humphrey and Michelle, we are currently not too sure how to approach this aspect. The two options that we have are either remove the whole aspect of the long-term reward (eliminating the need for the box) OR create a sort of token system for which the residents can reach in, get a token, and trade that token for a toy. This would remove the possibility of the residents getting distracted by the toy in the box and would teach them valuable lessons as well as possibly the concept of money. We will talk to the specialist about this tomorrow and make a final decision.

Appendix E: Background Research

At the beginning of this project, we were given vague information about how the client, Nicole Humphrey, wishes the device to be built. We knew very broadly that she wanted the device to be applied to multiple senses, including the device being able to be chewed on. We also knew that the project had to stimulate mentally-challenged adults while also eliminating negative attention. We composed many questions through this initial description, some of which we researched on our own and some of which would have to be answered directly by Nicole. These questions would later be asked in the interview process, in which we gained eye-opening insight on Nicole's wants and needs for this device. The research that we performed focused on four main topics: 1) Overview of intellectual disabilities in adults, 2) Debilitating effects of intellectual disabilities, 3) Current options for intellectual stimulation, 4) Stimulation vs Over-stimulation. This background research gives us a better understanding of the overall situation that Nicole wishes to address. Below are the summary of our findings to these four questions.

Overview of intellectual disabilities in Adults

Intellectual disabilities come in many forms and severities, which creates a spectrum of symptoms among adults. Intellectual disabilities are critical to be familiar with, as around 200 million people worldwide have some sort of intellectual disability. The critical point to note, however, is that no intellectual disability comes in the same form. Each individual with an intellectual disability has unique limitations, severity levels, and needs. These limitations generally come in two forms - intellectual functioning and adaptive behavior. Intellectual functioning refers to the reasoning, planning, problem-solving, and processing information and adaptive behavior refers to the collection of social, conceptual, and practical skills people learn in order to function in daily lives. Some common intellectual disabilities are ADHD, autism, and cerebral palsy. People with these intellectual disabilities often have issues concentrating, processing information, speaking clearly, or understanding universal social cues and language. Although these are the most common symptoms, it is important to remember that these symptoms lie on a spectrum and come in many different severity levels. The importance of having a broad overview of intellectual disabilities in adults is to better understand this situation and be able to ask Ms. Nicole the most efficient questions. During the interview with Ms. Humphrey, we learned more about what types of intellectual disabilities the residents have. She stated that a lot of her students have an eating disorder classified by the name of Pica, in which people compulsively try to eat things that are not food (meaning that the students often chew on their toys). Additionally, she said many of the students are non-verbal. This specific information signifies that the residents need a durable, chewable, as well as stimulating object to play with.

Debilitating effects of intellectual disabilities

People with intellectual disabilities tend to experience worse health and less access to health care compared to people without intellectual disabilities. According to a study, adults with intellectual and developmental disabilities were more likely to report being in poor health compared to adults

without disability. Due to this disparity, people with intellectual disabilities likely experience lower quality of life. Another research paper indicates that people with intellectual disabilities have a higher tendency to choke on objects and develop lung issues. This aligns with Nicole's statement so we need to take this into consideration when developing our final product. The paper also indicates that people with intellectual disabilities are susceptible to a range of other mental health issues such as depression and anxiety. To help mitigate these effects, we will need to create an intellectually stimulating object that reduces the symptoms the residents experience.

Current options for intellectual stimulation

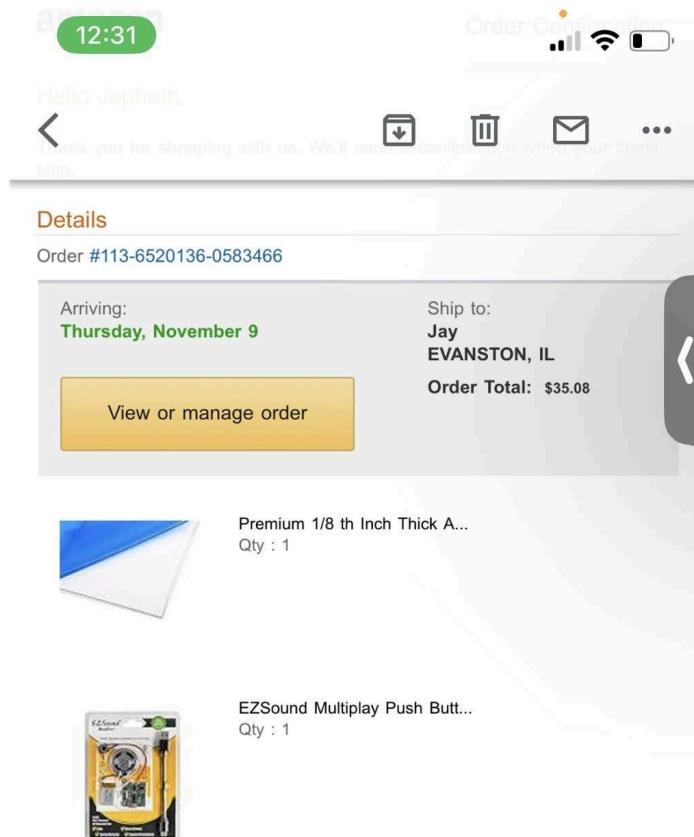
According to a study looking into sensory toys that can reduce vocal stereotypy, the research shows that vocal stereotypy, which is repetitive vocalizations, was reduced when using devices that produce auditory stimulation. Objects included in this experiment that did not produce a sound included puzzles, blocks, and books. Objects that activated auditory stimulation included electronic keyboards, books with buttons that make noise, and cassette players. In addition to reducing vocal stereotypy, participants in this study spent much more time in the area with the operative auditory toys, showing that they tended to choose auditory devices over those that did not produce noise. A study on the materials used in different sensory devices measured the effectiveness of an assortment of fabrics used in sensory balls including suede, wool, canvas, suede, and loose sequin. The levels of enjoyment of each of these were calculated and it was determined that the highest levels of stimulation and enjoyment came from loose sequin and similar materials, while the lowest levels of enjoyment came from canvas and similar materials. The level of initiation and activity response were also calculated and it was determined that materials with thin tactile characteristics (similar to loose sequin) consistently resulted in the highest level of initiation.

Stimulation and over-stimulation

Stimulation refers to providing sensory input or experiences, such as visual, tactile, gustatory, auditory, or olfactory activities, to individuals, especially those with developmental disabilities, to enhance their sensory perception, communication abilities, and overall quality of life. For developmentally disabled adults, sensory-focused activities offer opportunities to actively engage with their surroundings, interact with others, and potentially build relationships while developing new skills. These individuals often prioritize exploring sensations from their bodies and surroundings over comprehending complex concepts. The objective of sensory-focused activities is to allow low-functioning developmentally disabled adults to utilize their senses - sight, touch, smell, and hearing. This is especially important for Nicole, whose residents happen to be within the age bracket discussed. By creating effective sensory items to support her residents in exploring and interacting with their environment, we can tailor their sensory input to either excite or relax them based on individual responses. Our goal is to match the residents' sensory items with their capacity to process and manage sensory input effectively.

Overstimulation, on the other hand, happens when external stimuli become excessive, making it difficult for the brain to process and integrate them effectively. This phenomenon is particularly common among individuals with Asperger's syndrome, although the exact reasons behind it remain unclear. There are four primary forms of overstimulation: sensory, emotional, intellectual, and social. Sensory overstimulation is triggered by hypersensitive senses, emotional overstimulation involves intense and rapid emotional responses, intellectual overstimulation stems from the constant activity of the Aspie mind, and social overstimulation results from the complex and fast-paced nature of social interactions. While there is no medical treatment for OS, individuals can manage it by simplifying their lives, planning ahead, being proactive in requesting accommodations, staying healthy, and gradually building tolerance over time.

Appendix F: Bill of Materials



We hope to see you again soon.

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