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Studio: Learning & Education  
Word Count: 2307

## Written Report: Low-fi Prototyping & Pilot Usability Testing

### **Introduction**

#### **Mission Statement**

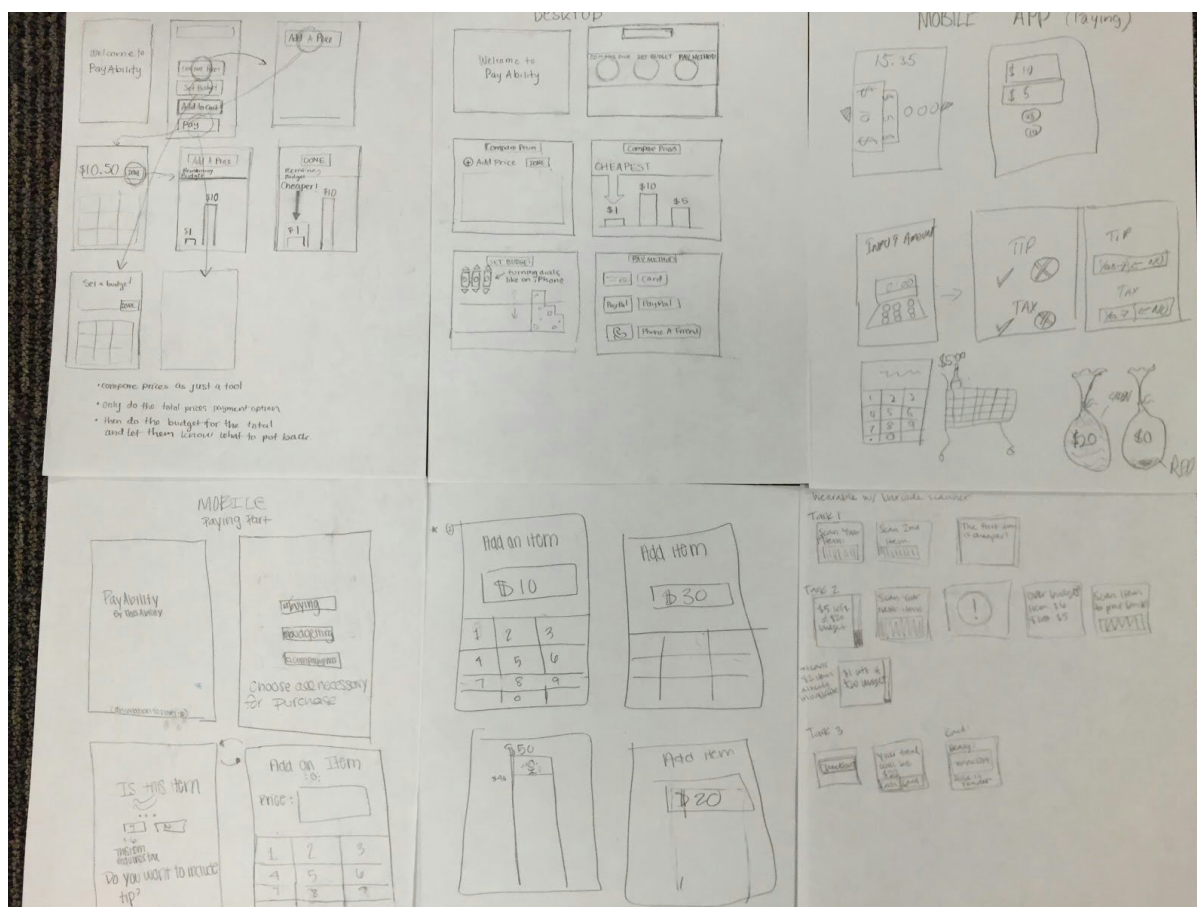
To empower people with math learning disabilities to compare prices, stay within budget and pay with exact change.

#### **Problem Overview**

Studies have shown that about 1% of the population are diagnosed with nonverbal learning disorder [see Reference 2], and 4-5% of the population have dyscalculia, a developmental disorder rendering them unable to do any basic math, such as simple addition and subtraction, or even choosing which of two numbers is the larger [see Reference 1]. This percentage does not account for those with acalculia, which has the same symptoms as dyscalculia but results from brain damage. Those with dyscalculia, acalculia, nonverbal learning disorder, and similar disorders are unable to understand prices and pay for things while shopping.

#### **Solution Overview**

To make paying easier and less stressful, the PayAbility app helps users compare prices, stay within budget, and pay with exact change.



### Figure 1: Concept Sketches

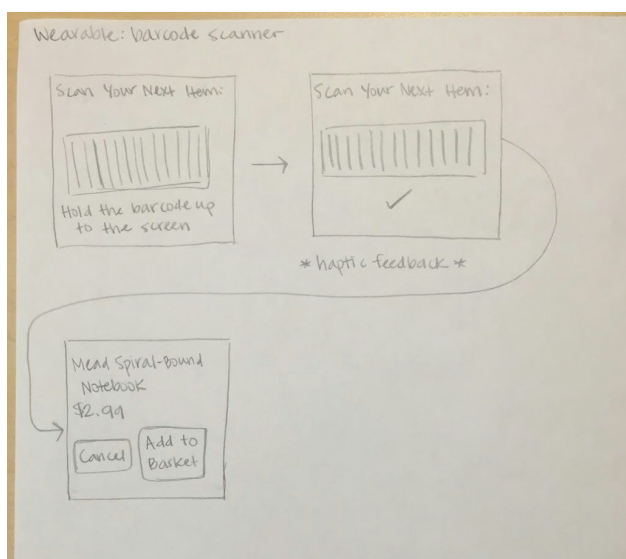


Figure 2: Wearable Sketch Task Storyboard (1 of 2 top sketches)

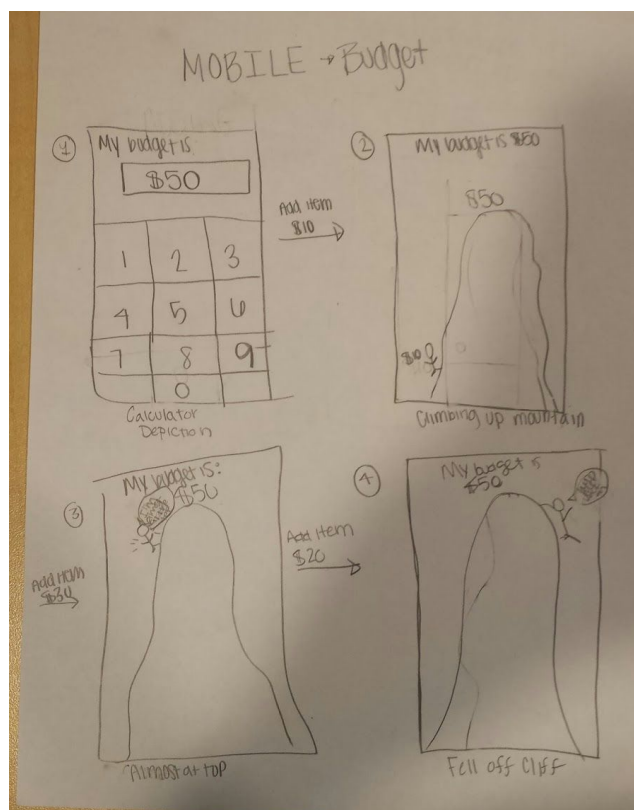


Figure 3: Mobile Sketch Task Storyboard (2 of 2 top sketches)

## Selected Interface Design

We ultimately chose to create a mobile interface design. The following pages present the storyboard for each of the 3 main tasks, followed by a discussion regarding our design decisions.

### Task 1: Comparing prices

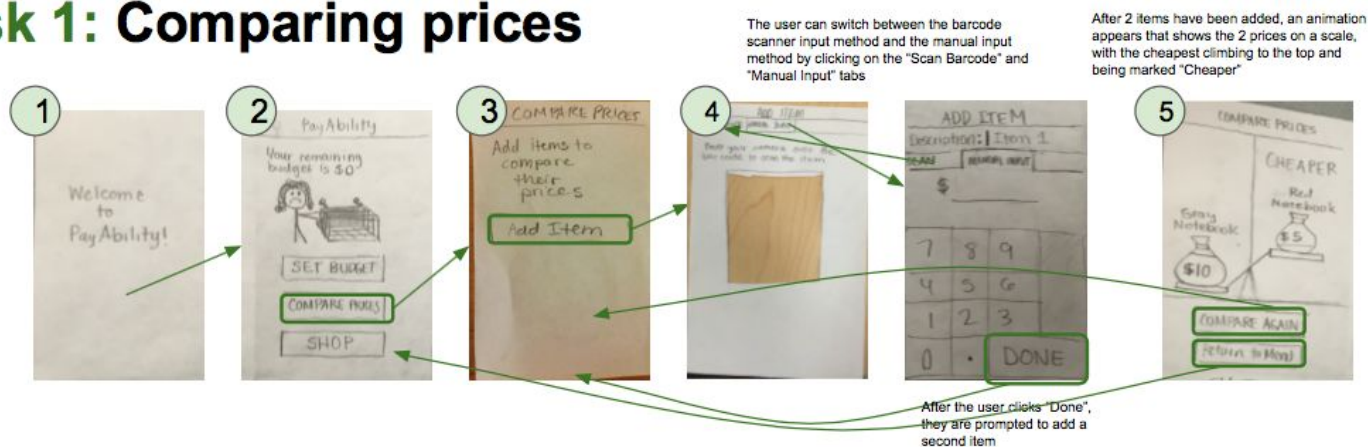


Figure 4: Task 1 (Comparing prices)

#### Key task flow:

1. Open app and see welcome screen, which disappears after 2 seconds
2. Select "Compare Prices" Option from menu
3. Select the "Add Item" button
4. Add an item price using either the barcode scanner (default) or the manual input method; can switch between the 2 input methods with tabs at the top of the screen; after successfully scanning a barcode or clicking the "Done" button in manual input, return to step 3 to add a second item price
5. After the user has added the second item price, the user sees an animation indicating the cheaper of the 2 prices; user can click on "Compare Again" to start a new 2-price comparison at step 3, or click on "Return to Menu" to return to step 2

## Task 2: Setting a budget

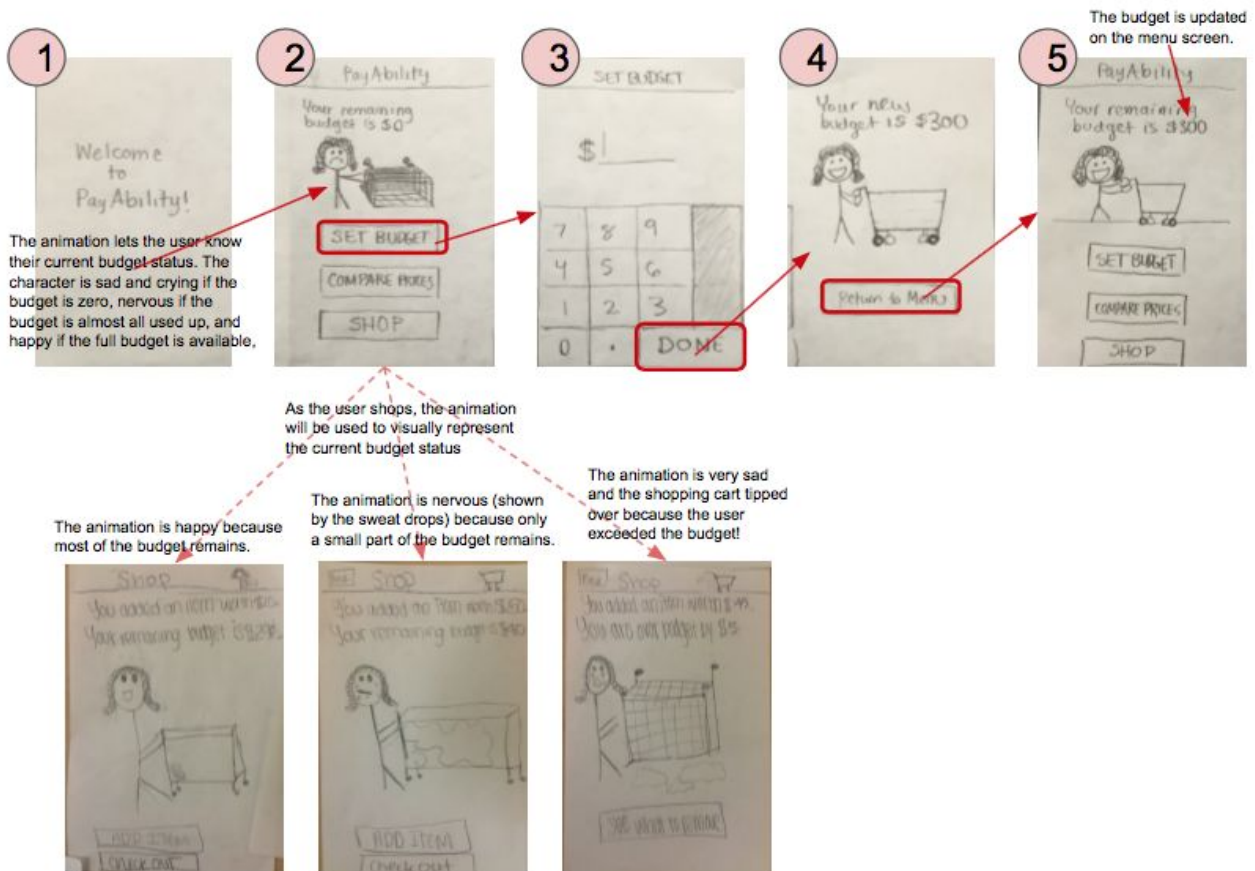


Figure 5: Task 2 (Setting a budget)

### Key task flow:

1. Open app and see welcome screen, which disappears after 2 seconds
2. Select "Set Budget" Option from menu
3. Input budget amount using number buttons and select "Done"
4. Touch the "Return to Menu" button
5. Return to menu screen and see the updated budget and corresponding animation



## Task 3: Shopping & paying with exact change

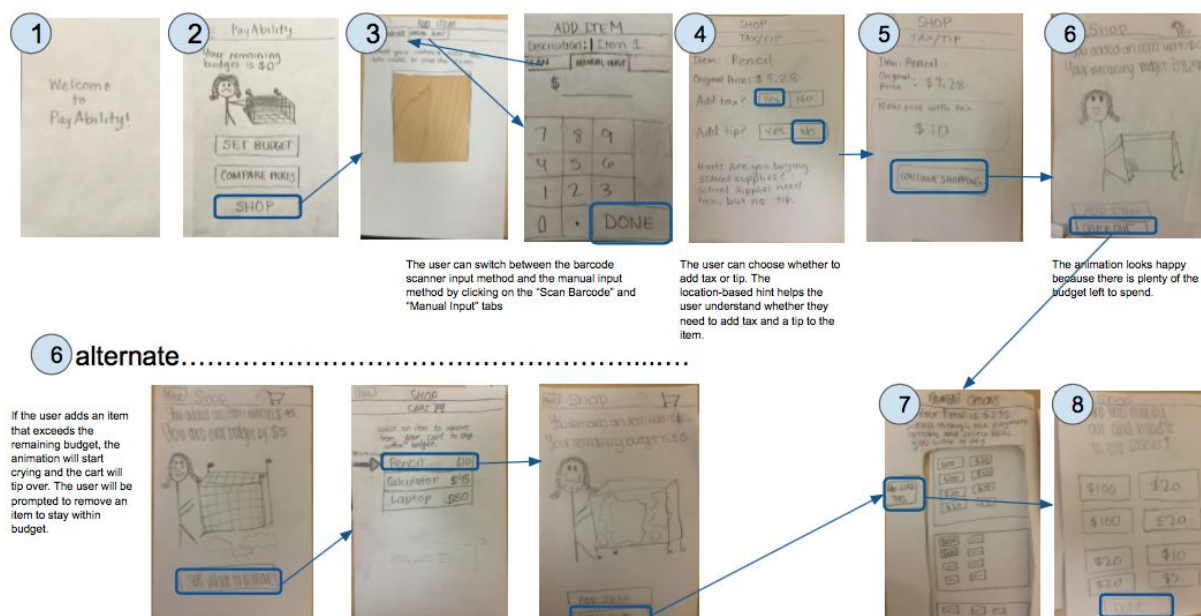


Figure 6: Task 3 (Shopping and paying with exact change)

### Key task flow:

1. Open app and see welcome screen, which disappears after 2 seconds
2. Select "Shop" Option from menu
3. Add an item price using either the barcode scanner (default) or the manual input method; can switch between the 2 input methods with tabs at the top of the screen;
4. After successfully scanning a barcode or clicking the "Done" button in manual input, select "Yes" or "No" in response to "Add tax?" prompt and to "Add tip?" prompt.
5. See the new price for the item, taking into account tax and/or tip depending on the selections made in step 4; click "Continue Shopping" to advance
6. Select "Add Item" to add another item and jump back to step 3, or select "Checkout" to jump to step 7 and begin the paying process  
(alternate....) - if the user adds an item that exceeds the budget, a new animation appears in which the person is crying and the cart is tipped over; select "See what to

remove" to continue; the next screen shows a list of items currently in the cart, with a suggestion for which items can be removed to stay within the budget; select recommended item to proceed to another screen showing an animation in which the cart is no longer tipped over and the person is no longer crying; select "Add Item" to return to step 3, or select "Checkout" to jump to step 7 and begin the paying process

7. Scroll through various money combination options, and select the "Pay like this" button to choose the combination of bills and coins to pay with
8. Follow the on screen prompt and pull out the bills and coins that match the picture that is displayed on the screen; hand over the money to the cashier; select "Done" when done paying to return to the menu screen (step 2)

We ultimately chose the mobile interface over the wearable for many important reasons. Firstly, while mobile is just as portable as a wearable device, phones have much bigger screens, and the larger surface area is necessary for all the details we need to show, such as a screen displaying different bills and coins with which to pay. Additionally, mobile is cheaper and more accessible than wearables, so more people with the learning disabilities previously discussed would have access to the app.

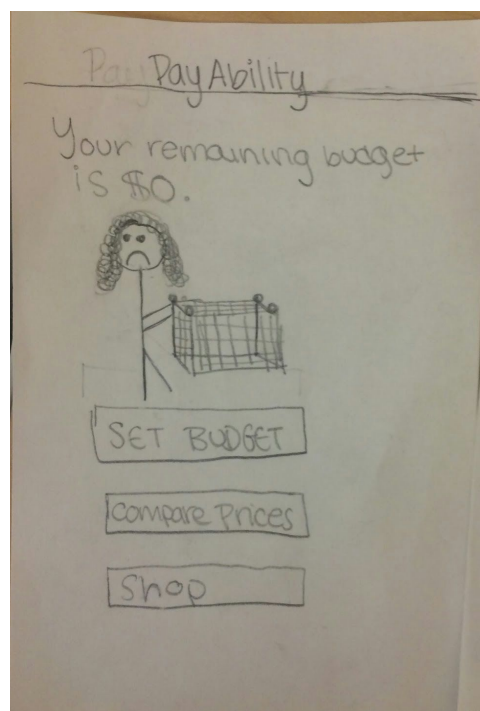
Moreover, there were certain visual aspects from our mobile storyboard that we preferred over the other interface designs, like a girl climbing a mountain and dangling over the edge to represent reaching or spending more than a set budget. However, we decided to pursue other visual representations more relevant to the product space, like a shopping cart, that would still get the point across.

This is not to say, however, that there were no aspects of the wearable interface design that we liked; the barcode scanner was one of our top implementations to input a new item into the app, so we decided to use the scanner in at least one of our iterations for our mobile UI.

## **Prototype**

Our low-fi prototype consists primarily of pencil drawings and sketches on rectangular sheets of paper that measure approximately 6 inches diagonally (about the same size as an iPhone 6 Plus).

The primary means of interaction with the application is touch. Each screen contains various buttons that the user can touch in order to make selections, move from one screen to the next, and complete tasks. For example, on the menu screen, as you can see below, users can touch any of 3 on-screen buttons - "Set Budget," "Compare Prices," and "Shop" - depending on the task they wish to accomplish.

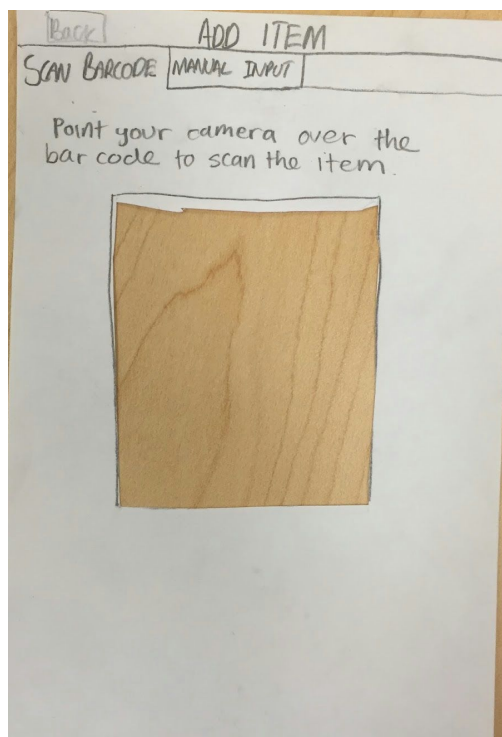


Menu Screen

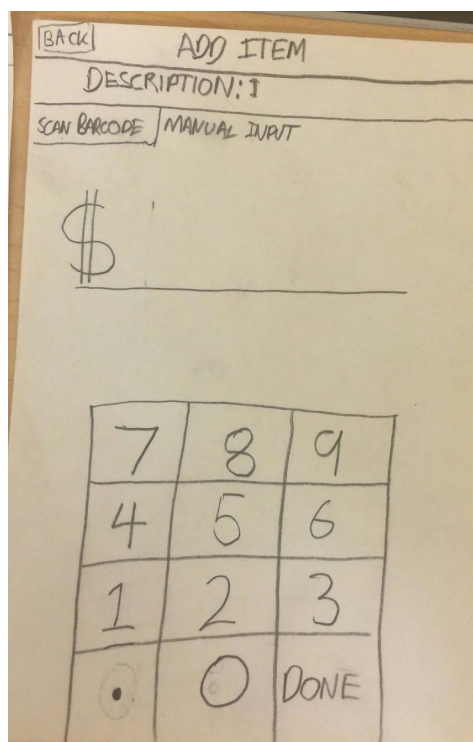
Any time the user needs to input an item price, there are two possible input methods that can be used: barcode scanner and manual input. The barcode scanner allows the user to scan the barcode of an item using the phone's camera. We simulated the barcode scanner in our prototype by cutting a square hole in the middle of the paper so that users could use the sheet of paper like a camera. Our prototype also includes audio feedback in the form of the "human computer" (Jorge) making a "Beep!" sound to let users know when they have successfully scanned the barcode of an item.

We also provided an alternative manual input mode for instances in which an item only includes a price tag and does not include a barcode. For the manual input, as you can see below, we simulated the key layout of a calculator or phone dialing pad to make it easy and intuitive for the user to input an amount by touching the number keys on the screen.



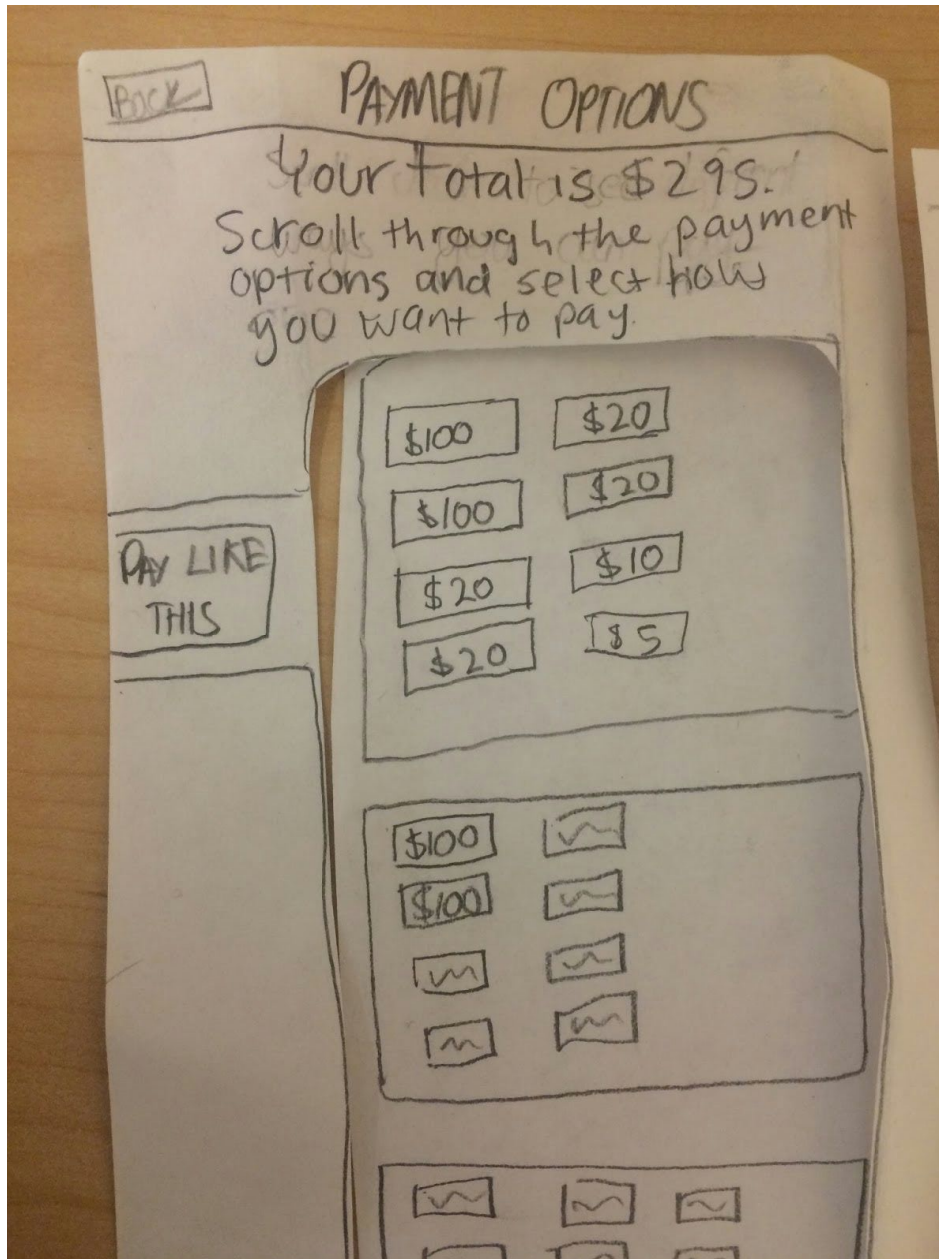


Barcode Scanner



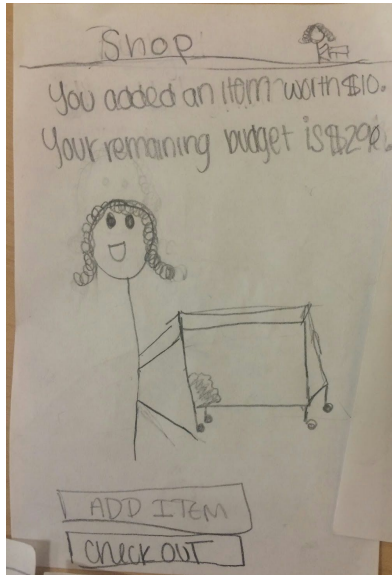
Manual Input

In addition to buttons that can be selected via touch, such as those in the manual input screen, our interface incorporates scrolling menus that the user can interact with using vertical swipes. For example, in the screen for selecting the desired money combination to pay, shown below, the user can swipe vertically to scroll through all of the money combination options available. In our prototype we simulated the scrolling functionality by cutting out a rectangular hole on the paper and placing a really long sheet of paper beneath it, which could be pulled up and down by the “human computer” as the user swiped on the screen.

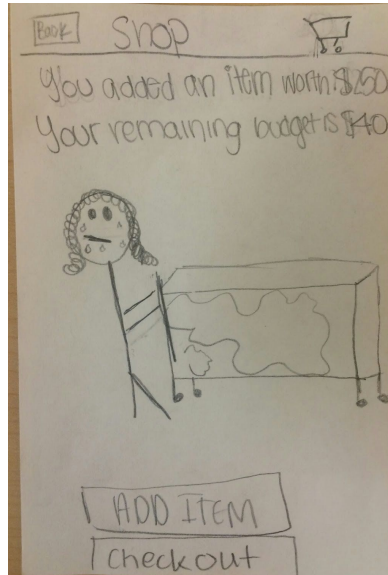


Money Combination Screen (with swipe-to-scroll interface)

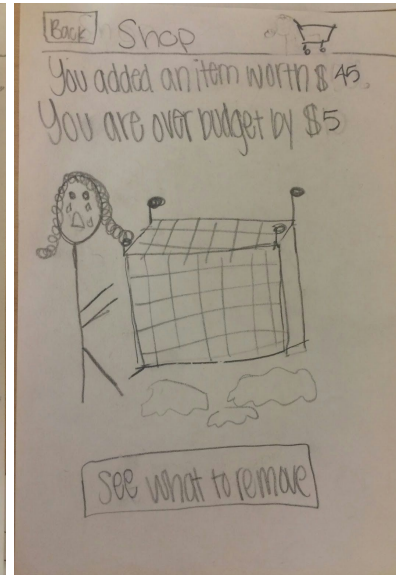
We also included engaging visual elements in the prototype, in the form of cartoon animations. As the user is shopping using the app, we display a cartoon drawing of a person pushing a shopping cart. The cartoon's emotional expression indicates how much money in the budget is still available to spend. If there is still a lot of money available, the cartoon character is happy. If the user is getting close to the limit, the cartoon character is nervous, with sweat going down her face. If the user has \$0 left, or has exceeded the budget, the cartoon character starts crying and the cart tips over, as you can see below.



Happy Animation



Nervous Animation



Sad Animation

All of the screens in our prototype can be viewed below.



## Method

We recruited three different people to test our prototype: an adult with Nonverbal Learning Disorder (Participant 1), a parent of an adult with a learning disability who also works with children with learning disabilities (Participant 2), and a student familiar with dyscalculia from an academic standpoint (Participant 3). Participants 1 and 2 were recruited through an email to the



Power2Act mailing list, and Participant 3 lives in the same house as one of our team members. None of our participants were compensated for their role in the testing. Participants 1 and 2 ran through our prototype test in the basement of the Linguistics building seated in front of a coffee table. Participant 3 ran through the testing in the Storey lounge. In each case, we simulated the setting of an office supply store, such as Staples, by placing a couple of notebooks, a calculator, and a laptop with barcodes on a table, as well as a new pencil with a price tag.

The three tasks we tested were: (1) comparing prices, (2) setting a budget, and (3) shopping and paying with exact change.

For the first two rounds of testing, Nicole took notes, Jorge was the computer, Musila took pictures, and Lynne filmed the participants. For the third round, Jorge was the computer, Musila took notes, and Lynne took pictures while filming. For each participant, we read them the script, and then observed them attempt to use the prototype.

Throughout each trial, we measured the number and severity of errors and emotional response to each task in the app. We also quantitatively measured the amount of time each participant took to complete each task and the time overall spent interacting with the prototype.

## **Results**

During the testing of our prototype we found negatives and positives in both the general flow of the tasks and also specific aspects of each screens design and layout. In general we found the app to be straightforward and easy to navigate. Participants understood how to carry out the tasks we provided thanks in part to the animations and help texts on the screens. The participants did have issues with some specific design decisions that we made. These included a different screen for showing tax and tip when adding items manually and with a barcode scanner, the method of changing from manual input to barcode scanning and the way we represented money when it was time for the participants to pay for their items.

The app prototype was designed to have the participant use either a barcode scanner to get the product information about the items they were buying or manually input this information. Unfortunately our users did not understand the method we had created to switch between this two modes. The method was meant to mimic the tabs on a browser but the text was too small for the users to make the connection.

In our design when a participant put in prices manually they were given a screen which showed the calculation of the price included in tax but when they scanned the barcode this screen was left out. This meant that they could not practice the mathematical skills they lacked and it was suggested that we should make the two different processes more uniform.

When the users had successfully added all the items they wanted to buy and had stayed within their budget they moved onto the screen that represented the different combinations of currency



they could pay with visually. The representation of the money left the users confused as to how to select which combination of notes and coins they would pay with.

The complete table of the problems that the users experienced and their accompanying severity ranking is below.

#### Participant 1

Problem	Severity Rating
didn't know how to choose between the 2 price input methods (barcode scanner vs. manual input)	4 - failed task 3
took a while to select a money combination to pay with exact change	3 - major usability problem

#### Participant 2

Problem	Severity Rating
didn't know how to choose between the 2 price input methods (barcode scanner vs. manual input)	4 - failed task 3
took a while to select a money combination to pay with exact change	3 - major usability problem

#### Participant 3

Problem	Severity Rating
took a while to switch between the 2 price input methods (barcode scanner vs. manual input)	3 - major usability problem
confused as to why there was no tax and tip screen after scanning the barcode of an item	2 - minor usability problem
took a while to select a money combination to pay with exact change	3 - major usability problem

The final form of results we compiled was the time taken to complete each task and this data is attached in appendix C. The first participant had the longest completion times for the first two tasks we assigned. Given her nonverbal learning disorder this was to be expected. The other two users did not have the same difficulties with numbers they all had faster times for the first two task. The final task which was to shop and pay with exact change had the longest times

across the 3 users and this stemmed from the confusion about the final screen and the representation of money. It was interesting to note that our third participant had the longest time for the third task. This could be attributed to the fact that he had less exposure to dyscalculia than the other two users and therefore did not understand the functionality of the screen show payment combinations.

## **Discussion**

In general the low-fi prototype showed marked improvement from the experience prototype. We managed to achieve this growth was listening to the feedback given and trying to incorporate it into the very design of the low-fi prototype. One piece of feedback for example we received in the last stage was that the users found it difficult to discern when to add tax and when not to. The user framed this concern in terms of visiting a grocery store where fewer items were taxed as opposed to a clothing retailer where more items would be taxed. This gave us the idea to take into account the user's location and use this data to suggest what might have tax added and what wouldn't. Building off the idea of suggesting items based on locale, we thought it may be helpful to suggest items when a user goes over budget and needs to remove items. All this would be done based on previous purchase history. The suggestions are intended to give the users a faster experience with the app which may be critical in real life situations.

In our experience prototype we found that the users had a much easier time when they had some initial guidance and this led us to incorporating tutorial hints at key screens of the app. Another method we used to make navigation easier was playing to the target market's strengths. Visual learning is often a substitute for people who have dyscalculia and so we add animations to our UI in order to make the users experience more intuitive as well as more enjoyable. We found that these animations not only helped participants with nonverbal learning disorder but those who were only familiar with the disorder as well.

Moving forward there are some key ways we hope to improve. From the timed results it's clear to see that the final screen and the task of paying with exact change presented a real problem. We hope to redesign this aspect for our medium-fi prototype by providing better instructions and a clearer representation of the payment combinations. Aside from this crucial improvement we hope to narrow down on the specific aspects our users appreciated and create more uniformity in the flow of the screens especially the barcode scanner and manual input screens.

In testing the low-fi prototype we were careful not to put our users into situations that might cause anxiety, this included real shopping situations. In the coming weeks we hope that our design can help our targeted users feel confident in their ability to navigate these spaces and thus enable us to do even more in depth testing in real shopping situations.

## **Appendix A: Script**

We are working on an app called PayAbility that is designed to help people calculate exact prices while shopping. We will present you with a prototype of the app and give you different tasks to complete with the interface we've created. I want to stress that none of the tasks should make you feel uncomfortable, but if they do, you are welcome to stop at any time. We will not be able to answer questions during the tasks so if you have any please feel free to ask them now. Otherwise, we'll answer any other questions you have at the end.

### **Task #1 (Comparing Prices):**

Let's say you're in a store and want to compare the price of two notebooks, where one is \$5 and the other is \$10. Can you show me how you would do that using PayAbility?

### **Task #2 (Setting a Budget):**

Can you show me how you would set a budget of \$300 using this app?

### **Task #3 (Paying with Exact Change & Staying within Budget):**

Now that you've compared prices and consulted your budget, try to buy a pencil, a laptop, and a calculator using PayAbility. Pay with exact change.

## Appendix B: Consent Form

The ThisAbility application is being produced as part of the coursework for Computer Science course CS 147 at Stanford University. Participants in experimental evaluation of the application provide data that is used to evaluate and modify the interface of ThisAbility. Data will be collected by interview, observation and questionnaire.

Participation in this experiment is voluntary. Participants may withdraw themselves and their data at any time without fear of consequences. Concerns about the experiment may be discussed with the researchers (Nicole Crawford, Jorge Cueto, Lynne Sneed, and Musila Munuve) or with Professor James Landay, the instructor of CS 147:

James A. Landay  
CS Department  
Stanford University  
650-498-8215  
landay at cs.stanford.edu

Participant anonymity will be provided by the separate storage of names from data. Data will only be identified by participant number. No identifying information about the participants will be available to anyone except the student researchers and their supervisors/teaching staff.

I hereby acknowledge that I have been given an opportunity to ask questions about the nature of the experiment and my participation in it. I give my consent to have data collected on my behavior and opinions in relation to the ThisAbility experiment. I also give permission for images/video of me using the application to be used in presentations or publications as long as I am not personally identifiable in the images/video. I understand I may withdraw my permission at any time

Name \_\_\_\_\_

Participant Number \_\_\_\_\_

Date \_\_\_\_\_

Signature \_\_\_\_\_

Witness name \_\_\_\_\_

Witness signature \_\_\_\_\_

## **Appendix C: Task Times**

### **Participant 1:**

Task 1 Completion Time: 1 min 44 sec

Task 2 Completion Time: 28 sec

Task 3 Completion Time: 2 min 44 sec

Total Time: 4 min 46 sec

### **Participant 2:**

Task 1 Completion Time: 1 min 15 sec

Task 2 Completion Time: 18 sec

Task 3 Completion Time: 1 min 31 sec

Total Time: 3 min 04 sec

### **Participant 3:**

Task 1 Completion Time: 1 min 40 sec

Task 2 Completion Time: 23 sec

Task 3 Completion Time: 4 mins

Total Time: 6 min 03 sec



## References

- [1] Butterworth, B (2010). "Foundational numerical capacities and the origins of dyscalculia". Trends in Cognitive Sciences 14 (12): 534–541. doi:[10.1016/j.tics.2010.09.007](https://doi.org/10.1016/j.tics.2010.09.007). PMID [20971676](https://pubmed.ncbi.nlm.nih.gov/20971676/)
- [2] Thompson, S (2015). "Nonverbal Learning Disorders." LD Online: The Educators Guide to Learning Disabilities and ADHD. <http://www.ldonline.org/article/6114/>