Jumbled Jungle Final Report

ECE1778 Creative Applications of Mobile Device

Annabel Wing-Yan Fan, Said Banos Cuevas, & Zhaodong Yan

15/04/2020

Word Count: 2370

Contents

Introduction

Spatial and temporal visual resolution is not yet fully developed in children (Ellemberg et al. 1999; Farzin, Rivera, and Whitney 2010, 2011). This would suggest that children may have a coarse visual experience, but children are able to navigate their visual environment in a way that seems contradictory to this limitation. Sweeny et al. (2015) demonstrated that children aged 4 – 5 years old use ensemble perception— the ability of the visual system to represent similar objects as a group instead of individually. The authors reported that children use this ability with less efficiency than adults. Thus, a research gap exists in determining how ensemble perception develops throughout the human lifespan. This includes knowledge of the factors that may lead to individual differences in this capability, and whether or not it can be trained or improved over time.

Jumbled Jungle aims to adapt the experimental paradigm from Sweeny et al. into a mobile game in order to reach a larger participant pool. We will collect user demographics (i.e. age) and game performance (i.e. the percentage of correct choices), which will allow for exploratory analyses to highlight key age-groups or user demographics to study further in a controlled laboratory environment. Using an attractive user interface and reward features we hope to provide a good user experience and encourage user retention. The following report highlights the features, visuals, software design and learning outcomes from work completed on the application during the ECE1778 Winter 2020 course.

Statement of Functionality & App Screenshots

Figure 1: Main Menu Screen.

Jumbled Jungle is a game that is designed to collect user inputs which reflects their ensemble perception ability. Researchers can then use the data to guide the development of new hypotheses. The main functional workflow of the mobile app consists of the gameplay stage and the results stage.

Figure 2: Game Screen. Users are presented with two groups of fruits on either side of the screen.

Gameplay

During the game, the user is presented with two groups of fruits on the left and right sides of the screen (Figure 2). Each group has eight fruits and the location of the fruits are always fixed. However, the sizes of the fruits are different, and the user is tasked with selecting the group with the larger average fruit size. In addition, the sizes of fruits are pseudo-randomly generated based on set parameters defined in Sweeny et al. (2015). To teach users how to play the game, we have included a tutorial component which uses animations to teach the game objectives and controls (see Figure 3).

Another functionality is the stamina counter, which is located in the bottom-right corner of the screen. When a user makes an incorrect choice on a round, their stamina counter will decrease by one. The game ends when the stamina counter reaches zero. This allows the game to be ended when the user has reached an approximation of their peak performance. Currently the game consists of four levels which contain five rounds each. If a user completes five rounds without their stamina counter reaching zero, the counter resets and the next level of the game will begin. As level goes up, the average sizes of the two groups of fruits will become increasingly similar, making it more difficult to determine which group has the larger average size. The visual elements in the background will also progressively change from day to night as the levels increase, providing the users with an intuitive impression of their progress (see Figure 4).

The game ends when the user loses all stamina counters or completes all levels of the game. They are then shown a result screen which displays the fruits (points) collected, percentage of correct choices, and total accumulated points (see Figure 5).

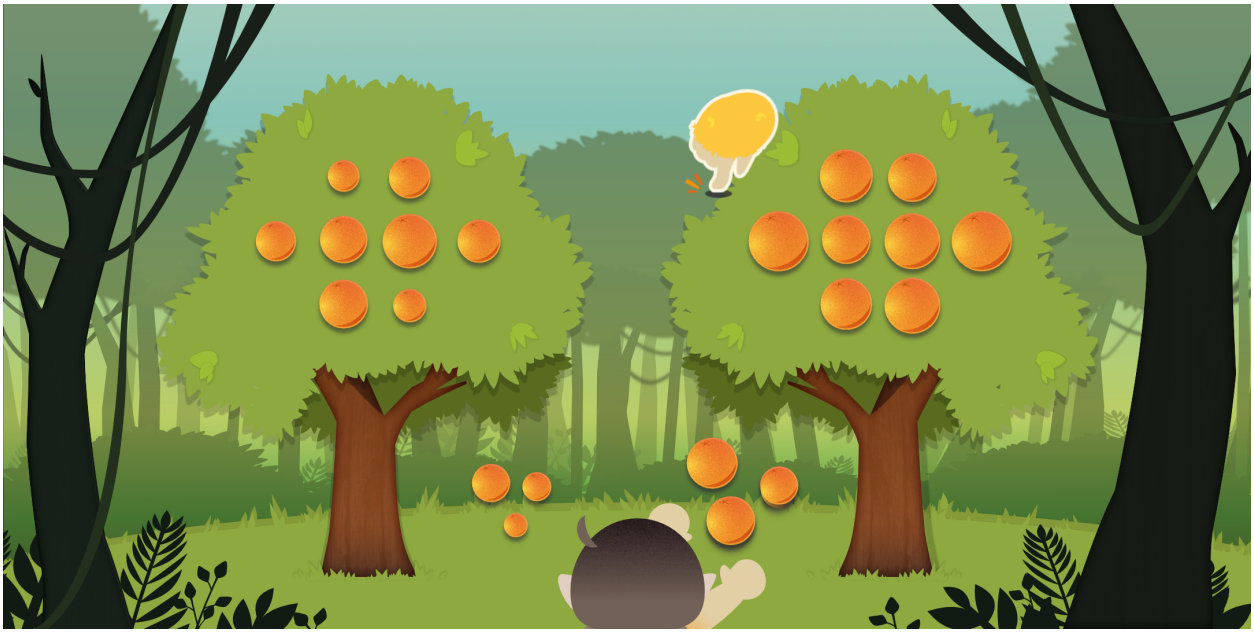

Figure 3: Tutorial Screen. In the tutorial animations are used to show the user the game objectives and controls.

Figure 4: Level Up Background Changes. As the game level increases the time of day progresses in the background images.

Figure 5: Results Screen. Displays points rewarded in this game session, percentage of correct choices, and total accumulated points.

Data

The user performance screen shows daily, monthly, and yearly user performance in addition to a comparison chart between user performance and the average app user's performance (see Figure 6). Detailed, anonymized data of user demographics, device, and game performance information can be exported as a .csv file so any user or researcher can have access to it.

Rewards and Game Settings

To reward the user for playing the game, they can use their accumulated points to unlock new fruits and characters. We currently have six types of fruits: grapefruit (default), mango, fig, orange, banana, and grape, and two characters: squirrel monkey (default), and sloth (see Figure 7). Finally, all additional features are configured in the settings screen, where the user can control the music and sound effects, replay the tutorial, and learn more about the app and its creators (see Figure 8).

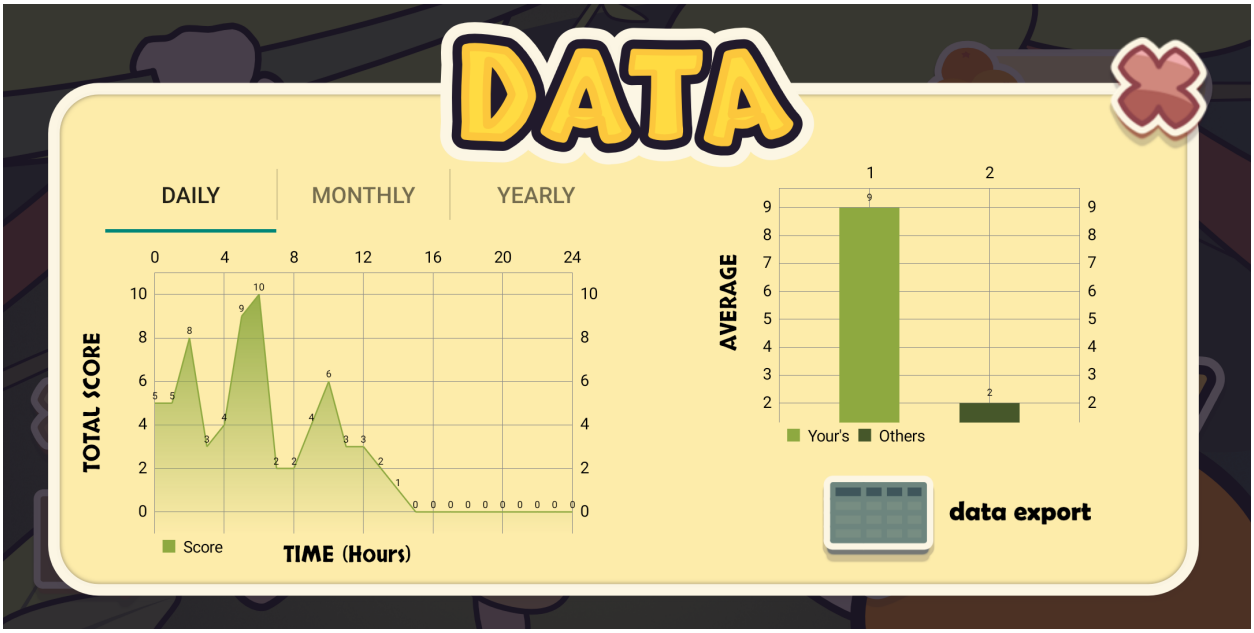

Figure 6: User Performance Screen. Shows user daily, monthly, and yearly performance as well as a comparision with the average user performance. Data exportation is also supported.

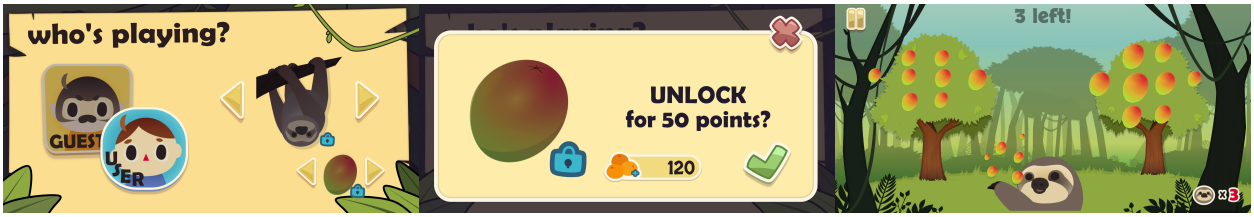

Figure 7: In-game Rewards. Rewards such as new characters and fruits can be unlocked by spending points.

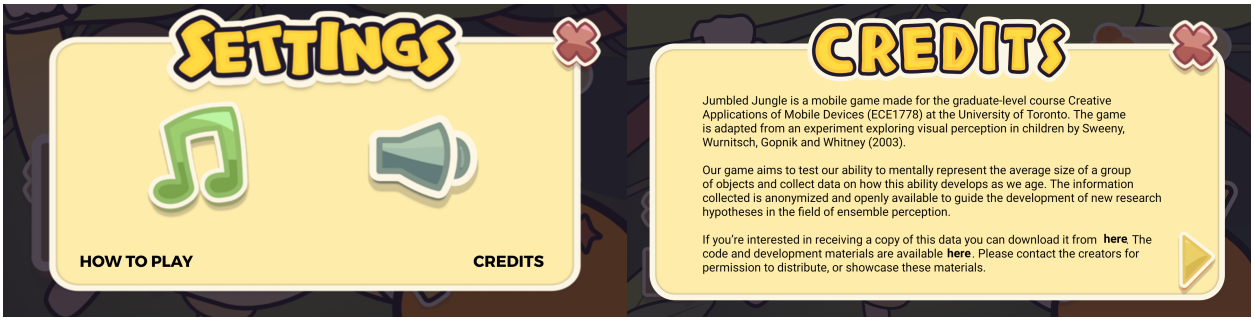

Figure 8: Setting and Credits Screen. Users can control game settings and learn more about the app in the settings and credits screens.

Overall Design

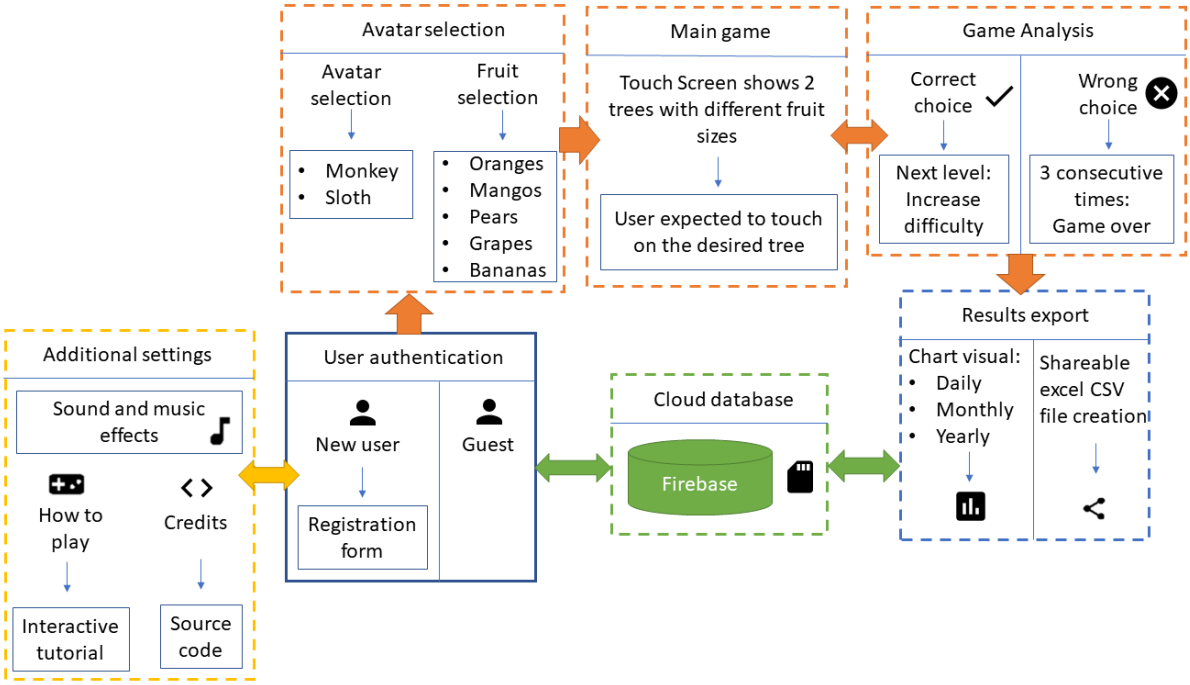

Figure 9: Black Diagram of Jumbled Jungle App Structure

User Authentication

Users can register an account, log in to existing accounts or enter the game as a guest (no information recorded). During registration, we will collect users' demographic data including: name, age, gender, handedness, whether glasses are needed, and if the user has any neurological disorders or learning disabilities.

Additional Settings

The user has the option to enable/disable the background music and sound effects. Also, the opportunity to watch an interactive tutorial to learn how to play the game. Finally, they can get the more information about the development of the game through the credits page.

Cloud Database

Our Google firebase database will create a new document for each of the users to store the demographics data.

Avatar Selection

A monkey and grapefruit will be selected as the default avatars, however the user can select between different avatars as well as a variety of fruits to make the game more fun, motivating and exciting. Some of them will be locked, and the only way to unlock them is to gain points and score high when playing the game.

Main Game

In the main game, our experimental algorithm will determine the fruit sizes at each level. The sizes of individual fruits are randomly generated, and the difference of mean sizes will decrease as level goes up in order to increase difficulty of the game.

Game Analysis

The user chooses which tree has larger fruits on average (using unconsciously their ensemble perception). Their selection in each trial will be recorded in our database for later research use. The other way to reach the end of the game is to complete all levels without losing all stamina counters. Once the game ends, the results screen displays the user's percentage of correct choices, the reward points for the last game and total accumulated reward points for that user.

Result's Export

The user's performance, measured as percentage of correct choices, are displayed in line and bar charts. Performance is plotted on a daily, monthly or yearly basis, as well as a comparison between the user's performance and that of the average user.

Reflection

What we learned and what we would do differently next time

Focus on the fun, earlier!

At the start of the project we had focused on faithfully recreating the experimental paradigm by Sweeny et al., but we realized that the game-like elements of our application were its strengths and what made our project unique. Working on those elements also gave us a lot of creative agency and generated interesting discussions between the contributors on the best ways to implement them. If we could start over, we would choose to focus on these aspects of the project earlier.

Everything has a trade-off

It was difficult to find a good balance between the time and effort invested in the project and the quality of the final application. We underestimated the amount of time needed to build each of the features we have included in our application and in the future, we would opt to make something simple, but robust enough to be considered a minimum viable product.

Planning for the worst-case scenarios

Working in an interdisciplinary team on the app, presentations and reports was a great learning opportunity. We learned the importance of considering the different needs and expectations of a mixed specialization audience and integrated the feedback from our peers and the teaching team to iteratively improve on our presentations.

Contribution of Each Group Member

Annabel Wing-Yan Fan, Specialist

Using my expertise in the field of vision and perceptual cognition I guided the conception of the mobile game by reviewing the relevant literature and taking into consideration the group's interests and learning goals. Jumbled Jungle was based on a pre-existing experimental paradigm which I summarized and presented to the programmers to ensure that the game algorithms and their implementation were experimentally sound. I researched mobile games to understand the current trends in mobile games and user interface (UI) choices designed for younger audiences. Additionally, I designed and generated a majority of the UI and graphical elements used in the application. Finally, I took the lead in project management, organizing meetings, and facilitating the timely completion of deliverables.

Said Banos Cuevas, Programmer

Brainstorm boundaries and features from a programming standpoint, where technical device constraints were considered in order to make the mobile game a realistic project given the specific due dates, expectations for the presentations and experience level from all the members of the team. On the other hand, areas that I developed were the plot results screen, where line and bar type data charts were shown based on the score obtained by the user on a daily, monthly and yearly basis, besides an average results against all other users. The generation of an csv (excel) file with all the data collected automatically (demographics, scores, device information, etc.) with the option to share it via email or social media. Also, the splash screen video, credits screen, tutorial guide to show interactively how to play the game, sounds and music effects, animation effects at the beginning, intermediate and final levels, translations and rotations of visual objects that are particularly important during the development of a game to give the user the best gaming experience.

Zhaodong Yan, Programmer

I constructed our database that stores user credentials and I wrote codes that can let users play as guests, register an account with their demographics data, review existing accounts, log in and log out. Another part I did is the main game phase, where I designed the algorithms to randomly generate fruit sizes and decrease the differences of mean sizes of the two groups of fruits as level increases. Besides, I built the data collection and analysis for the user-input data during the game. This allows the game to determine when to terminate or continue to the next level, and when to count the reward points earned by the user. Finally, I implemented the function that allowed the user to change the displayed fruit type and displayed character before the game starts.

All members of the group contributed to brainstorming features and outlining the scope of the application, integrating feedback from presentations and deliverables, and continually improving the application through user testing.

Specialist Context

What we developed

Jumbled Jungle is a mobile game designed to test a user's ability to extract group level information from a collection of individual items. The experimental paradigm and setting are based on a pre-existing study by Sweeny and colleagues (2015), but we have updated the visuals and added rewards to unlock to gamify the user experience. Additionally, we have designed the game to get progressively more difficult as the user's performance improves. These changes coupled with the nature of collecting data in an unsupervised environment are quite different from the standardized conditions under which psychophysical experiments are conducted, which could lead to noisy data. Given that the main priority of the app is to collect user demographics and performance from as many users as possible and for as long as possible, we felt that these changes were justifiable.

Why it's important to the field of ensemble perception

The developmental trajectory of ensemble perception is currently understudied. Sweeny et al. (2015) reported that ensemble perception in children aged $4-5$ is less efficient than in adulthood, however no studies have begun to map out this ability as children age to see when in their lifetime it becomes fully developed. Not only is it more difficult (and therefore costly) to recruit from child populations, systematically testing youth from ages 5 to 18 is not economically feasible for the average laboratory. As such, the data collected from our application can be used to strategically locate age groups or individual factors which may be important in the development of ensemble perception. These hypotheses can then be tested in a controlled environment. Finally, it is not known whether or not ensemble perception is an ability that can be trained or improved with practice. If we are successful in encouraging users to play the game regularly perhaps an exploratory analysis of the data will lead to a novel research area in training ensemble perception abilities.

Future Work

If we were to continue work on Jumbled Jungle we would like to: (1) make the game available for iOS, (2) add multi-language features, (3) further develop in-game rewards, and (4) implement online play and features for social media to allow users to compete and build a community presence. These features would allow the app to be more accessible and act as a further incentive for users to play and share the game.

Before the game could be used as a research tool we would need to implement privacy and data use policies and acquire approval from the research ethics board to use the app to collect data for research purposes. Ideally, there would be a feature to allow researchers to design their own experimental paradigms by altering parameters such as trial length, timed trials, stimuli size etc. It would also be useful to create a companion web app to allow researchers to quickly filter and visualize real-time data in order to guide research hypotheses.

Finally, we hope that our app can be used to promote scientific communication within the general public. Additional tutorials and informational modules could be added to the companion web app to teach lay users to explore the data they have contributed to.

Statement of Consent

All contributors to this project, Annabel Wing-Yan Fan, Said Banos Cuevas, and Zhaodong Yan agree to publically share the (1) video of the final presentation, (2) final report, and (3) source code completed as part of ECE1778 Winter 2020. We ask that any reproduction or distribution of this content or any of its parts be appropriately credited to the contributors.

References

Ellemberg, Dave, Terri L. Lewis, Chang Hong Liu, and Daphne Maurer. 1999. "Development of Spatial and Temporal Vision During Childhood." *Vision Research* 39 (14): 2325–33. https://doi.org/10.1016/S0042-6989(98)00280-6.

Farzin, Faraz, Susan M. Rivera, and David Whitney. 2010. "Spatial Resolution of Conscious Visual Perception in Infants." *Psychological Science* 21 (10): 1502–9. https://doi.org/10.1177/0956797610382787.

Farzin, F., S. M. Rivera, and D. Whitney. 2011. "Resolution of Spatial and Temporal Visual Attention in Infants with Fragile X Syndrome." *Brain* 134 (11): 3355–68. https://doi.org/10.1093/brain/awr249.

Sweeny, Timothy D., Nicole Wurnitsch, Alison Gopnik, and David Whitney. 2015. "Ensemble Perception of Size in 4-5-Year-Old Children." *Developmental Science* 18 (4): 556–68. https://doi.org/10.1111/desc.12239.