

# Appendix A: Assessments

## 1. Theory of Mind Assessments

The following questions are selected from Wellman & Liu [20]. It is used as a pre-assessment in this experiment to assess knowledge access, content false belief, and explicit false belief.

### 1.1 Knowledge Access

Present children with an image of a plastic box with a drawer containing a small toy dog inside the closed drawer. “Here’s a drawer. What do you think is inside the drawer?” (The child can give any answer he or she likes or indicate that he or she does not know).



Next, the drawer is opened and the child is shown the content of the drawer. “Let’s see ... it’s really a dog inside!”



Close the drawer: “Okay, what is in the drawer?”



Then, a girl is produced: “Polly has never seen inside this drawer. Now here comes Polly.



So, does Polly know what is in the drawer? (the target question)



“Did Polly see inside this drawer?” (the memory question).



To be correct, the child must answer the target question “no” and the memory control question “no”. In Wellman and Liu, 73% of 3-5 year olds answered this correctly [20].

## 1.2 Content False Belief

The child sees a clearly identifiable Band-Aid box with a toy pig inside the closed Band-Aid box. “Here’s a Band-Aid box. What do you think is inside the Band-Aid box?”



Next, the Band-Aid box is opened: "Let's see ... it's really a pig inside!"



The Band-Aid box is closed: "Okay, what is in the Band-Aid box?"



Then a boy is produced: "Peter has never ever seen inside this Band-Aid box."



Now here comes Peter. So, what does Peter think is in the box? Band-Aids or a pig (the target question)



“Did Peter see inside this box? (the memory question).”



To be correct the child must answer the target question “Band-Aids” and answer the memory question “no.” In Wellman and Liu, 59% of children answered this correctly [20].

### 1.3 Explicit False Belief

Children see boy and a picture with a backpack and a closet drawn on it. “Here’s Scott. Scott wants to find his mittens.



His mittens might be in his backpack or they might be in the closet. Really, Scott’s mittens are in his backpack. But Scott thinks his mittens are in the closet.



So where will Scott look for his mittens? In his backpack or in the closet?” (the target question)



“Where are Scott’s mittens really? In his backpack or in the closet?” (the reality question).



To be correct the child must answer the target question “closet” and answer the reality question “backpack.” In Wellman and Liu, 57% of children answered this correctly [20].

## 2. Understanding Target AI Concepts

### (10 Total Probe Questions)

This set of questions was administered after each associated activity to assess children's understanding of key AI concepts.

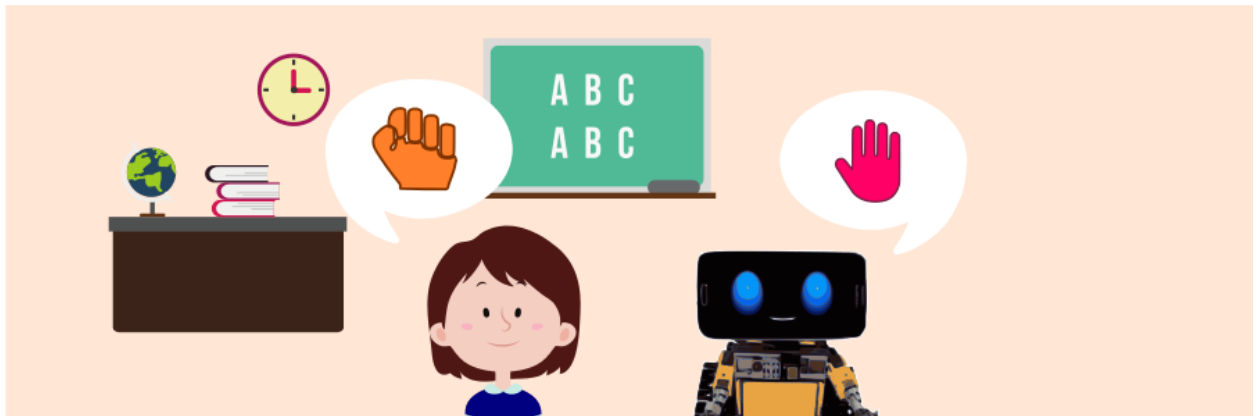
### 2.1 Rule-Based Systems Assessment

#### (5 Questions)

1. Control: Which of these is rock? Rock, paper, or scissors?

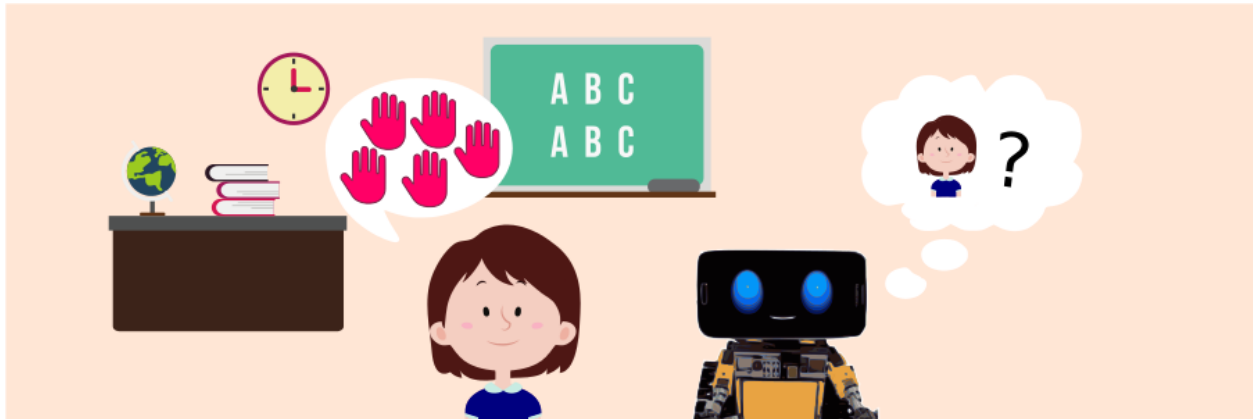


2. We teach the robot the normal rules. Then, Sally plays rock and the robot plays paper, who does the robot think has won? Sally or the robot?

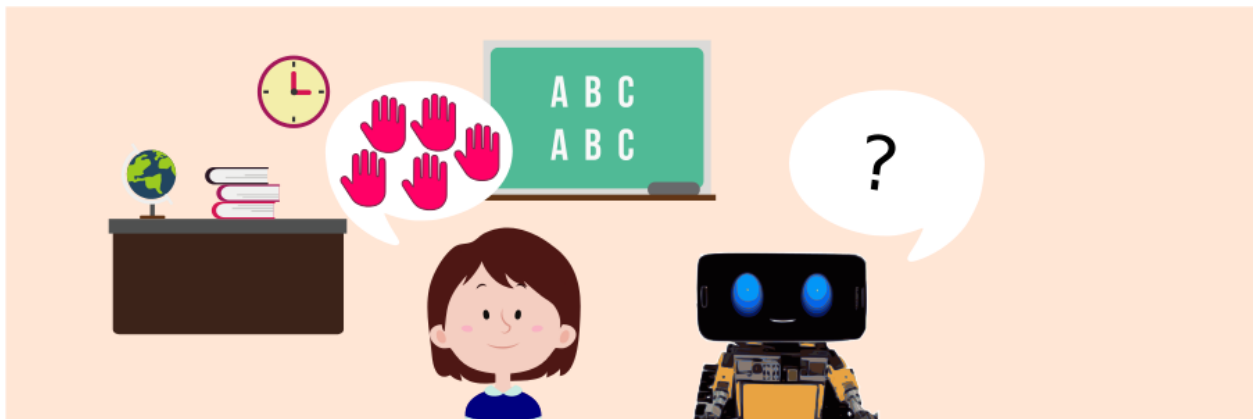




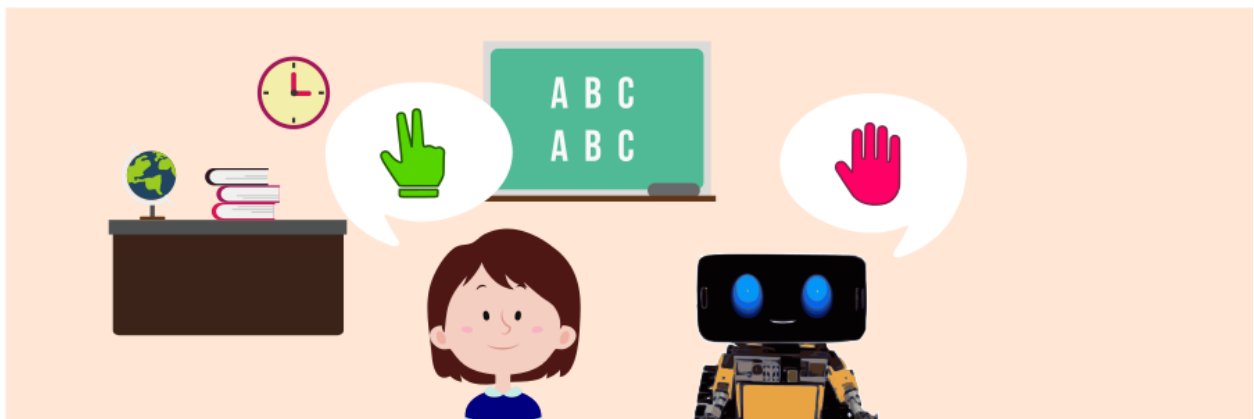
3. Sally plays paper five times. What does the robot think she will play next? Rock, paper, or scissors?



4. The robot thinks that Sally will play paper next. What will the robot play so that it can beat Sally? Rock, paper, or scissors?



5. We changed the rules so that they are all opposite rules (paper beats scissors). Sally plays scissors and the robot plays paper. Who does the robot think has won? Sally or the robot?



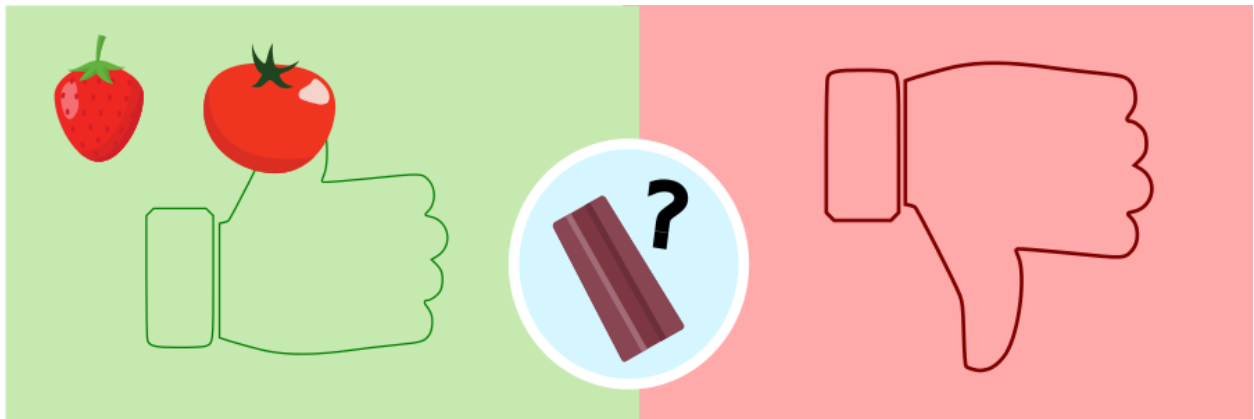
## 2.2 Supervised Machine Learning

### (4 Questions)

1. Control: Which one of these foods is bad for your teeth? Strawberry, ice cream, or corn?



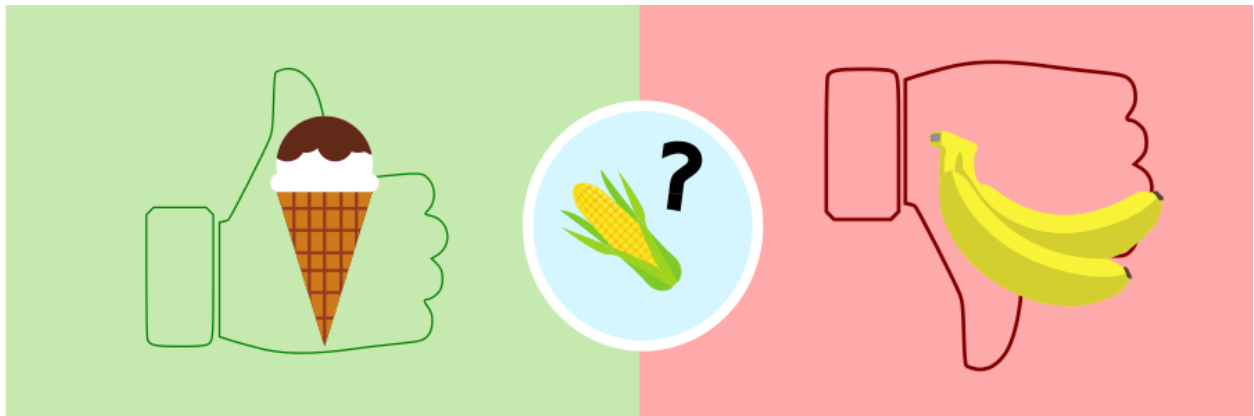
2. You start the robot and put strawberries and tomatoes into the good group. Which group will the robot think chocolate goes in? The good group or the bad group?



3. What food does the robot think is most like a tomato? Strawberry, banana, or milk?



4. You put ice cream in the good category and bananas in the bad category. What category will the robot put corn in? The good category or the bad category?



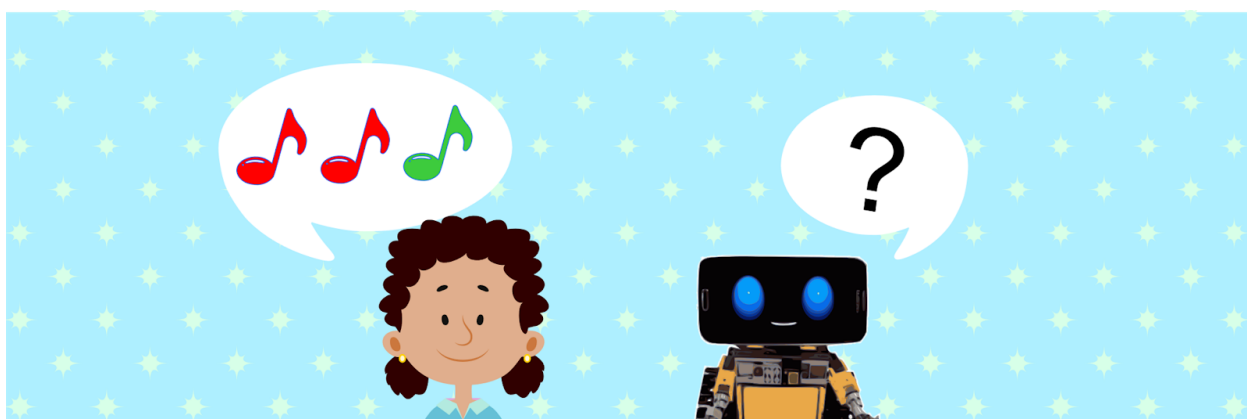
## 2.3 Generative AI Assessment

### (4 Questions)

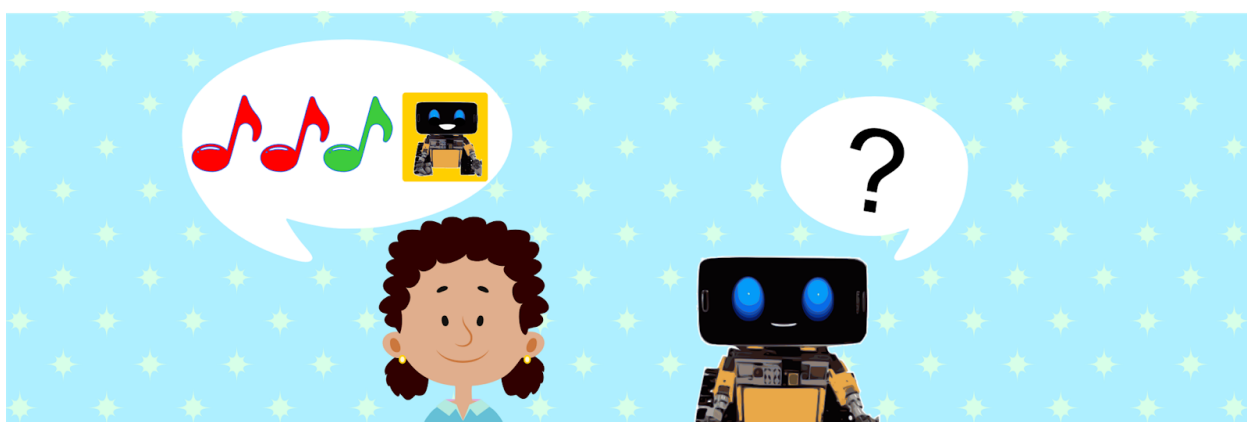
1. Control: Which one of these notes will make the robot's eyes go orange? Purple note, orange note, or green note?



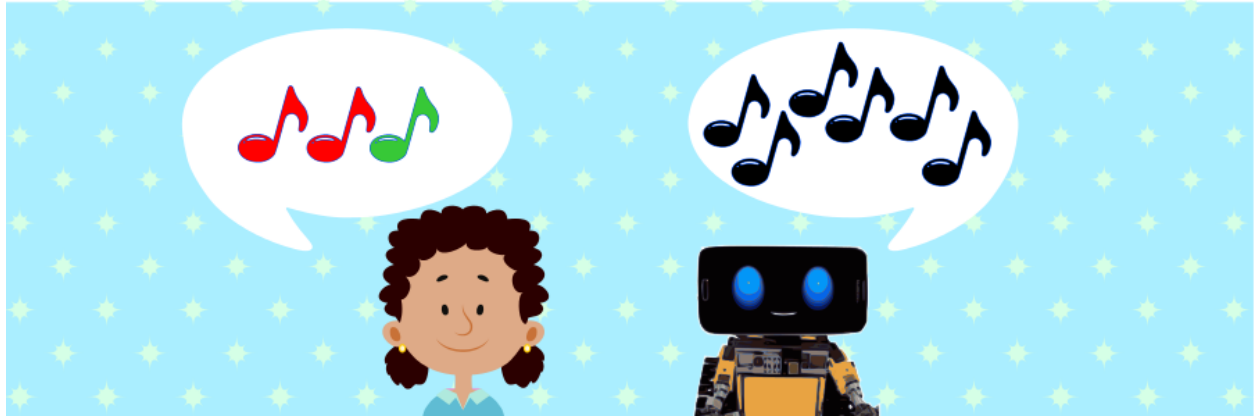
2. Priya asks the robot to play back with the bars in the middle. Does the robot play the same song or a different song?



3. Priya asks the robot to play back with the bars to the right. Does the robot play the same song or a different song?



4. Does the robot's song have to have the same notes as the input?

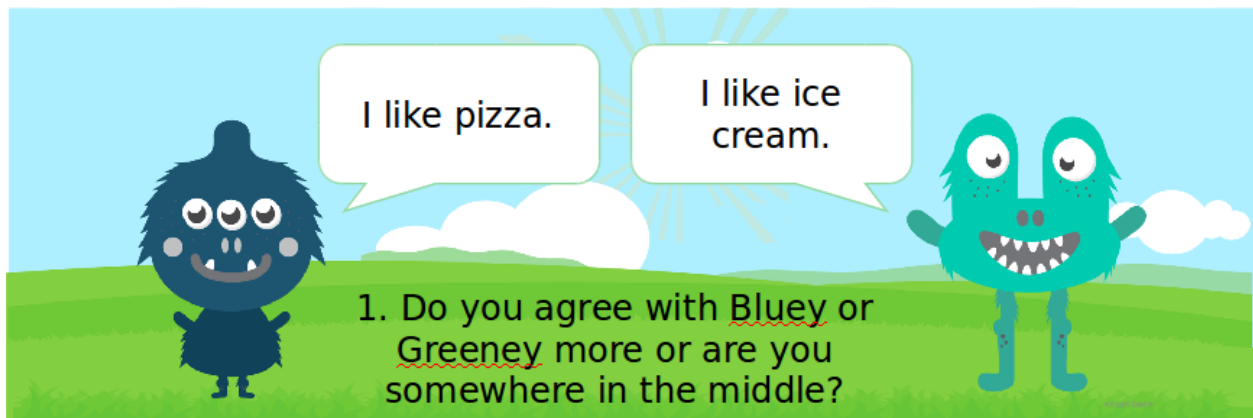


### 3. Perceptions of Robots Questionnaire

#### (5 Total Probe Questions)

Adapted from a prior study from the Personal Robots Group on children's perceptions of smart devices to assess young children's perception of AI robots [6]. These were used both as pre- and post-assessments. Two characters appear on the screen offering their differing (often opposite) opinions on the target question. The child is asked which character they agree with more, or if their opinion is somewhere in between the two.

Which view do you agree with more, or are you somewhere in the middle?



- A. Control: I love pizza / I love ice cream.
- B. Robots follow rules / robots do not follow rules.
- C. I am smarter than robots / robots are smarter than me.
- D. Robots are like toys / robots are like people.
- E. Robots cannot learn new things / robots can learn new things.
- F. Robots are like friends / robots are like adults.

# Appendix B: Detailed Evaluative Study Protocol

## 1 Session One: Pretests

*Hello there! My name is [RESEARCHER NAME] and I am an engineer, I build robots. **Who can tell me what a robot is?***

*For the next few weeks, we are going to play with a very special robot. This robot is one that you can build and teach to make it smarter. **Has anyone built or programmed a robot before?***

*(Hand out tablets.) First, I have some questions for you all. I have the questions here on your tablets. We are going to use the tablets to program the robots so let's get familiar with them.*

*First, we have a video to watch. We will watch the videos all together. Here's an example. (Play control question video). Now, you have to choose which answer you think is best by clicking one of the pictures at the bottom. So which one do you choose? (Make sure that all children choose the cow.) Great job, when you're ready for the next question, you click the yellow arrow. That's how all of the questions are. Now let's continue.*

Assessments (15-20 minutes): Theory of Mind Test, Perception of Robots questionnaire

## 2 Session Two: Introduction to PopBots

Learning Goals: have children program their own robot and become familiar with the interface

How to program your robot (15-20 minutes - it is OK if they don't get to the end)

*(Take out one robot.) These are the robots that we are going to build and program. You can see that they have eyes and a mouth. Do you think the robots can see? Can they speak? The robots don't have ears, so they cannot hear. If the robot cannot hear, then how do we talk to it? We use the tablet to talk to the robot.*

*Last time, we talked about whether robots are like toys or like people. **How is this robot kind of like a toy or like a person?***

*You each get your own robot and your own tablet to program the robot. The robot will talk to you and help you. If you need help you can press the question mark at the bottom.*

Children will go through a 5-part story that guide children through programming their robot. The story focuses on core parts of the PopBots: turning on the motors, playing an animation, using the motors, and changing colors. The

story is framed as open-ended challenges (e.g., teach your robot how to dance) where children will learn to use these blocks. Also help children learn to assist one another by showing others things they figured out and using their words, not their hands.

Bonus: Allow children to freely program their robots or try more complex blocks like loops or recording audio.

### 3 Session Three: Teach Your Bot the Rules

Learning Goals: have children train their robot to play rock, paper, scissors.

Part 1: Train your robot (5 minutes)

*Last time we had a lot of fun programming the robot. You figured out how to make the robot speak, change colors, and drive around. You built something new. That means that you're all engineers. Congratulations!*

*I asked before if robots always have to follow the rules. **Do you think robots always have to follow the rules?** Today we're going to find out how robots follow the rules by teaching our robots to play a game: Rock, Paper Scissors.*

*(Take out the rock, paper, scissors cards and poster.) Do you know the rules to rock paper scissors? Let's put them on the poster. There are three rules: rock beats scissors, scissors beat paper, and paper beats rock. Now we're going to teach the robot these rules using our tablets. On the first page tap each square and put the shapes in the square. When you're done, hit the train button and your robot will speak out the rules it knows.*

Part 2: Program your robot (10-15 minutes)

*Now the robot is almost ready to play the game but we need to teach it one more important thing. Do you know what it is? We need to teach the robot how to be a good sport. That means the robot needs to say and do nice things whether it wins or loses. We're going to use these triggers to program the robot to react to when it wins or loses. (Explain what the three game triggers mean for the robot.)*

Part 3: Play your robot (7 minutes)

Finally, children will be able to play against their robot. Let them play for a few rounds.

Questions for discussion and reflection: *Is the robot following the rules you taught it? Does it always follow the rules? What if you changed the rules, would it still follow them? Did you notice that the robot tries to guess what you will play next. Why does the robot do that and how does he guess? The robot gets better at playing the game with practice. Do you think the robot can get smarter than you at the game? If yes, but you taught the robot all of the rules so does that mean you're still smarter? If no, then why not?*



*Now I'm going to pause the robots so that we can answer some questions about this game.*

Assessment: Rock Paper Scissors Assessment (See Appendix A)

Bonus: Allow children to retrain or reprogram their robots. See if children notice that the robot tries to predict the child's next move to become better at playing.

## **4 Session Four: Train Your Bot**

Learning Goals: have children see that robots can learn to guess by using a food sorting game where children give the robots some examples of food and the robot learns about them.

Part 1: Yummy for my tummy (5 minutes)

*I have here a bunch of different foods. (Take out picture cards of different foods). Let's sort these foods into two group: foods that are good for you and food that are bad for you.*

*Now, let's look at the two groups we've made. What do some of the foods in the good group have in common (food group, color, sweetness, etc.)? Now what what the bad group? We can see that a lot of the foods in each group have things in common.*

Part 2: Train your robot (5-10 minutes)

*We have to teach our robot about what foods are good and bad. But unlike yesterday with rock, paper, scissors, there are more than three rules. Actually, how many foods are there in the world? That's right. It would take forever to teach the robot about every food one by one, so we're going to give the robot a few examples to help it learn.*

Give each child some of the foods from the healthy list and unhealthy list to train their robot. Every robot will only get some of the foods in their training examples, but not all.

Part 3: Test your robot (10+ minutes)

*Great, so now our robot knows about a few foods, let's ask it to guess where this new food goes. (The robot will give an answer and explain its reasoning e.g., I put the tomato in the unhealthy group because a lot of unhealthy foods are red). Why did the robot make that guess? (Make sure children are paying attention to robot's reasoning).*

*Let's test the robot with all of the foods and see how many does it gets right or wrong? Which ones seem to be hardest for the robot?*

Bonus: Train the robot in some new way: foods you like and foods you don't like or opposites.

Assessment: Food Classification Assessment (See Appendix A)

## 5 Session Five: Create with Your Bot

Learning Goals: have children learn about music and emotions and how robots do not always follow the rules, they can be creative too.

Part 1: It makes me want to dance (5 minutes)

*Let's listen to some music.* (Hum three songs, one fast and bright, one fast and somber, one slow and somber). *Which one of those songs sounded happy to you? Why? Which one sounded sad? What about the other song? Some ways that we can make music sound like different emotions is by changing the speed and whether the song goes up or down.*

Part 2: Train your robot (5 minutes)

*Now we're going to teach the robot about music. On the tablet we can tell the robot to play music that goes up or down and fast or slow. The robot will play back music after we play to it. Let's see what happens when we play music with the bars (on the tablet) in the middle. See, the robot plays back the same song. Now let's try with the speed all the way down. Was that the same song just a bit slower? OK, let's try the other bar. Was that the same song?*

Have each child teach their robot which tempos and which chord progressions make what emotions. Train the robot with four emotions: happy, sad, scared and excited.

Part 3: Make some noise (10-15 minutes)

*Now, let's play whatever song we would like and have the robot change it.* Allow each child use the piano on the tablet to make and record a song for their robot to play. Then, use the music emotions to have the robot remix the song.

Bonus: Play and record a robot symphony where each robot plays their robot songs one at a time and has their robot dance to it.

Assessment: Generative AI Assessment (See Appendix A)

## **6 Session Six: Closing and Post-Tests**

Learning Goals: allow children to have time to ask any lingering questions and reflect on what they learned in a group setting

Have everyone talk about their one favorite thing that they learned about robots.

Assessments (15-20 minutes): Perception of Robots questionnaire