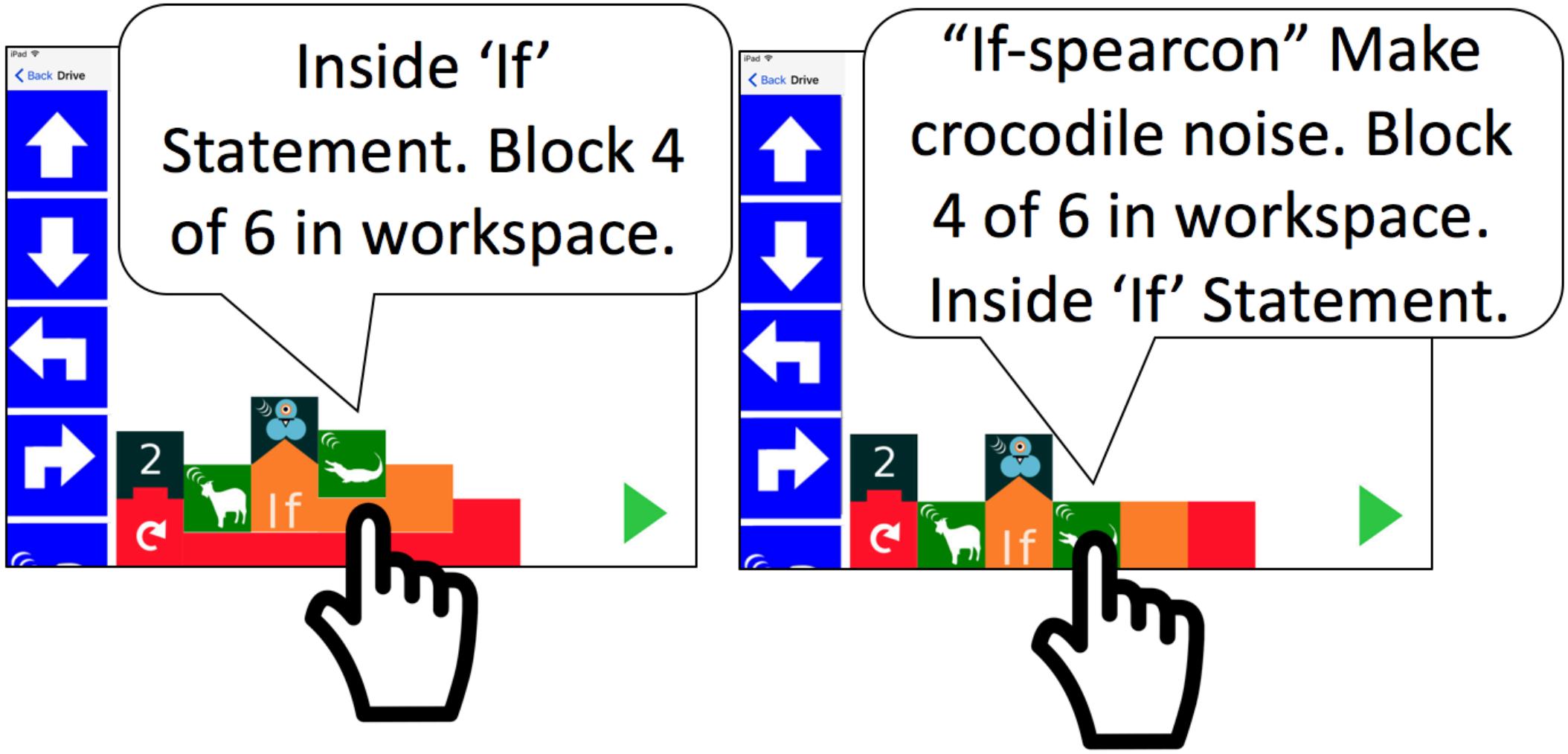
Physical programming inclusive of young children with visual disabilities


4 FishChomp- Scratch
SCRATCH
New
Open
Save
Save As
Share!
Undo
Language
Extras
Want Help?
4 FishChomp
Motion
Control
Looks
Sensing
Sound
Numbers
Pen
Variables
when clicked
when space key pressed
when hungry fish clicked
wait 1 secs
forever
repeat 10
broadcast
broadcast and wait
when I receive
forever if
if
if
hungry fish
Export Sprite
x: 6 y: -72 direction: 3
Scripts
Costumes
Sounds
when clicked
switch to costume open-mouth
forever if distance to mouse-pointer > 10
point towards mouse-pointer
move 3 steps
when I receive got-me
play sound chomp
repeat 2
switch to costume closed-mouth
wait 0.3 secs
switch to costume open-mouth
Click the green flag.
Move the mouse to eat
the small fish
mouse x: 168
mouse y: -428
Stage
goldfish 2
1 script
goldfish 3
1 script
goldfish 1
1 script
hungry fish
2 costumes
2 scripts
instructions



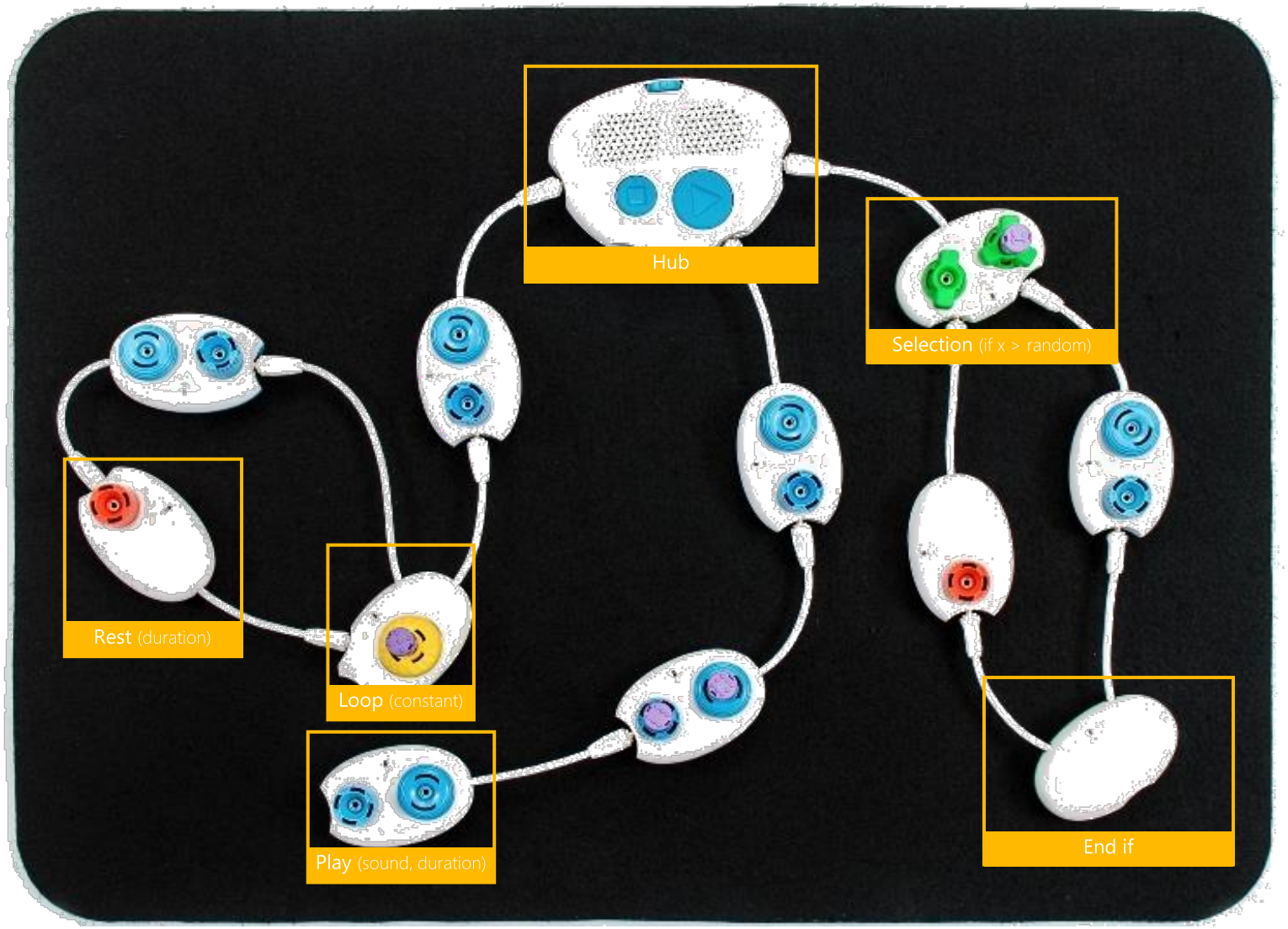
Milne, Lauren R., and Richard E. Ladner. "Blocks4All: overcoming accessibility barriers to blocks programming for children with visual impairments." *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*. 2018.

Hadwen-Bennett, A., Sentance, S., & Morrison, C. (2018). Making programming accessible to learners with visual impairments: A literature review. *International Journal of Computer Science Education in Schools*, *2*(2), 3-13.

Challenges

1. Assistive technology proficiency
2. Significant memory demand
3. Lack conceptual cognitive structures

Project Torino




```
THREAD 1 Violin
  PLAY C6 for ½ a beat
  LOOP constant(5) times
    PAUSE for 2 beats
    PLAY C6 for 1 beat
  END LOOP
END THREAD
```

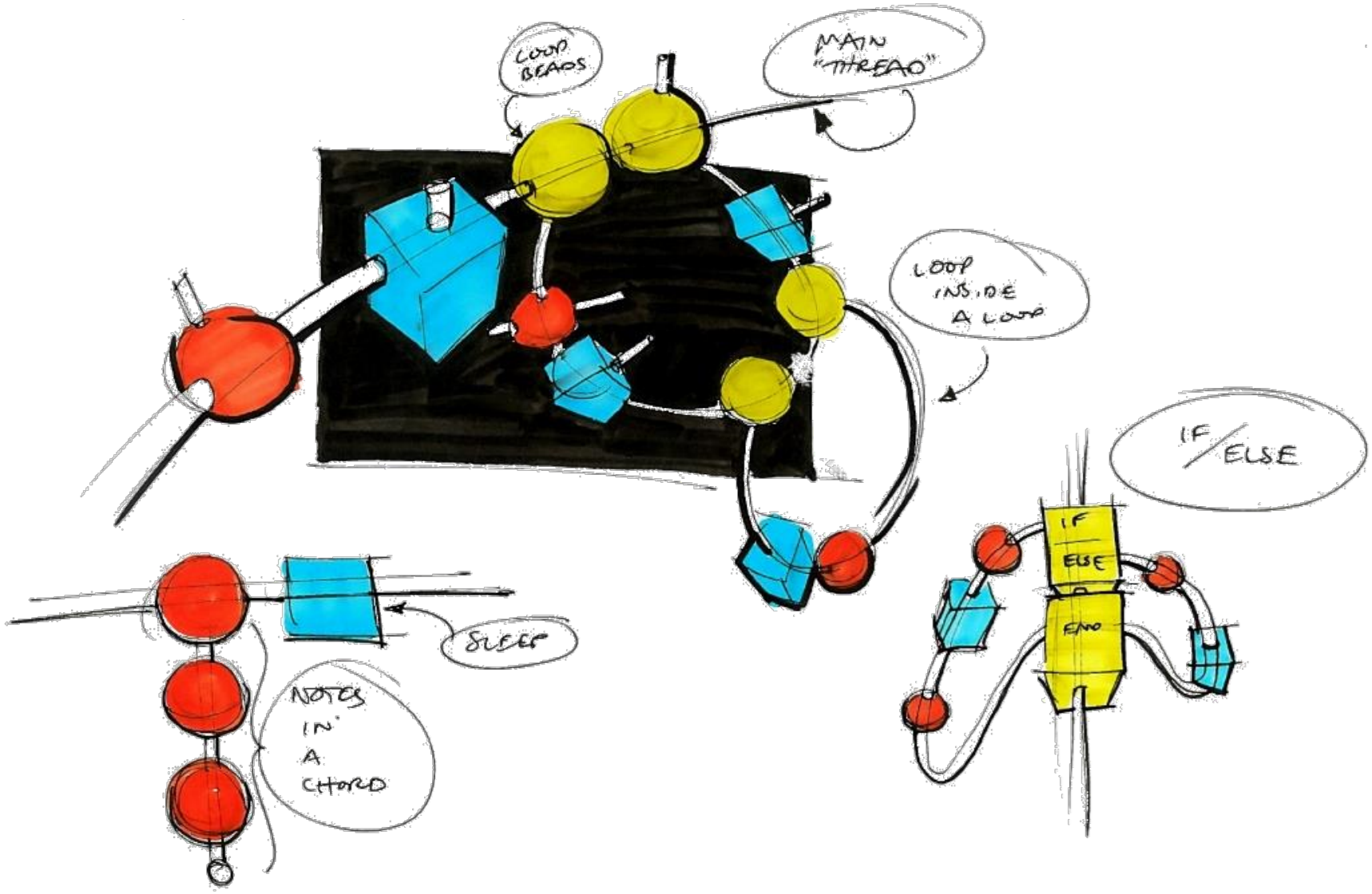
```
THREAD 3 Violin
  PLAY C5 for ½ a beat
  PLAY constant(C8) for constant(½ a beat)
  PLAY E8 for a ¼ beat
END THREAD
```

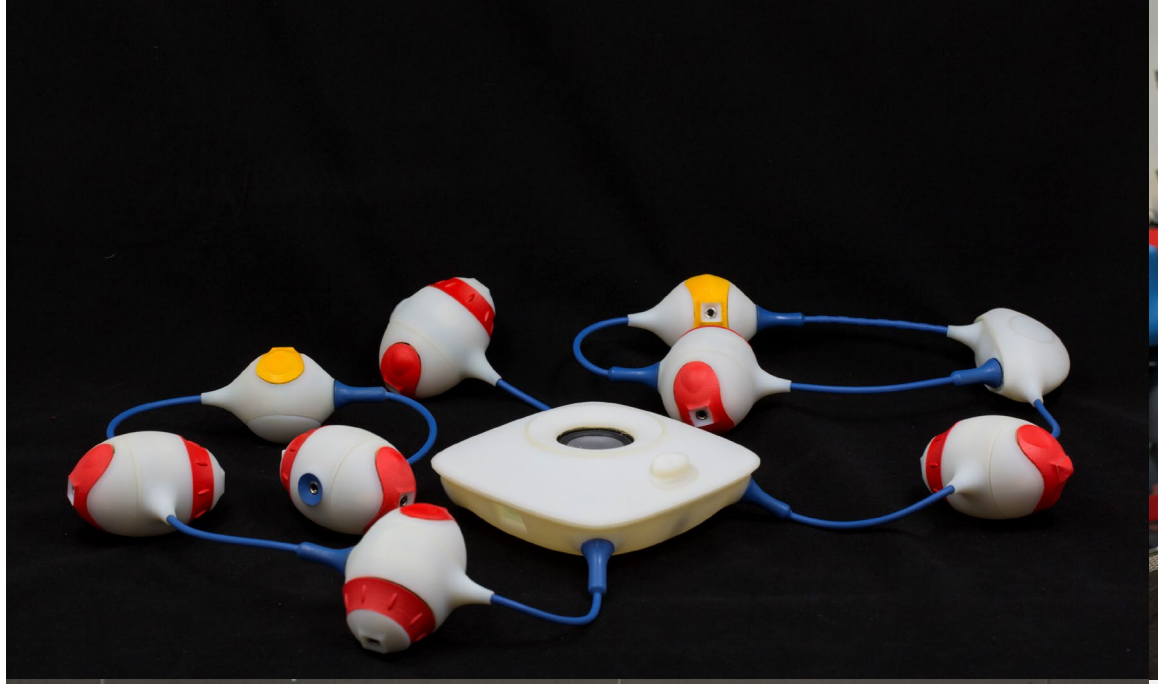
```
THREAD 4 Natural Sounds 1
  IF 8 is greater than random
    PAUSE for ½ a beat
  ELSE
    PLAY Glass Break for 1 times speed
  END IF
END THREAD
```

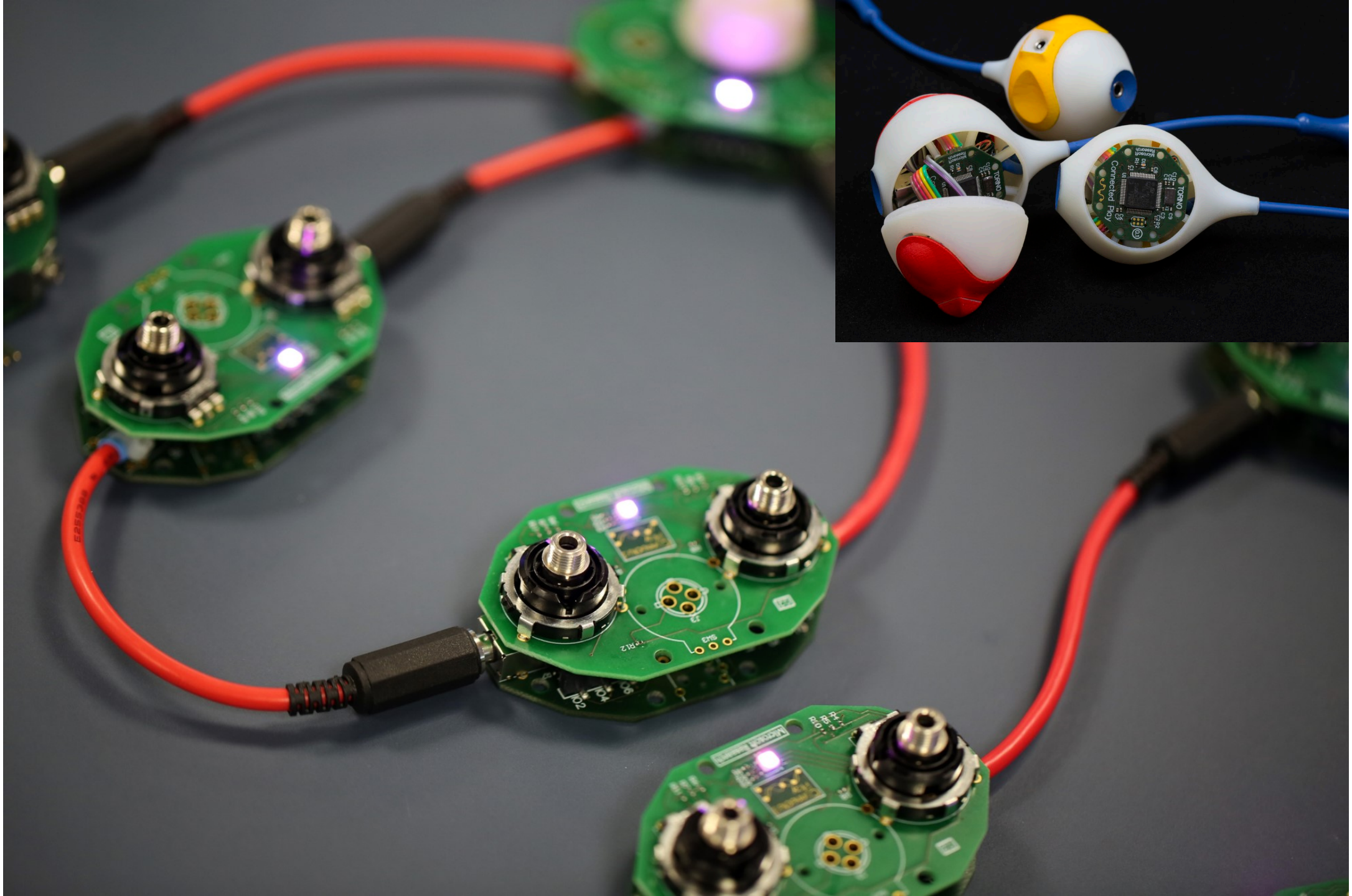
Torino Design Journey

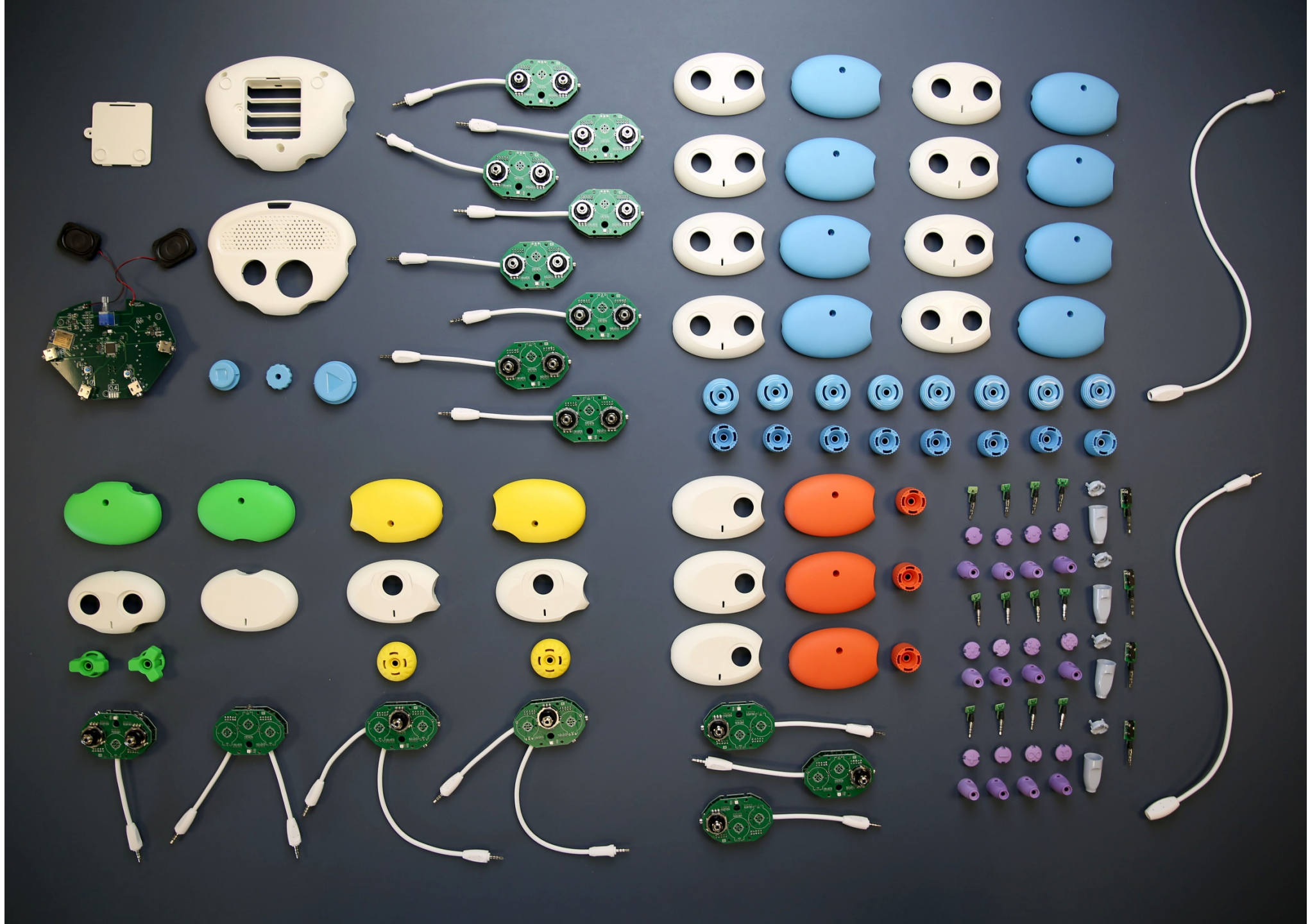

Louisa
Calypso


BLOCKS
BLOCKS


LOOP BEADS
MAIN "THREAD"
LOOP INSIDE A LOOP
IF/ELSE
IF
ELSE
END
SLEEP
NOTES IN A CHORD




TORNO
Connected Play

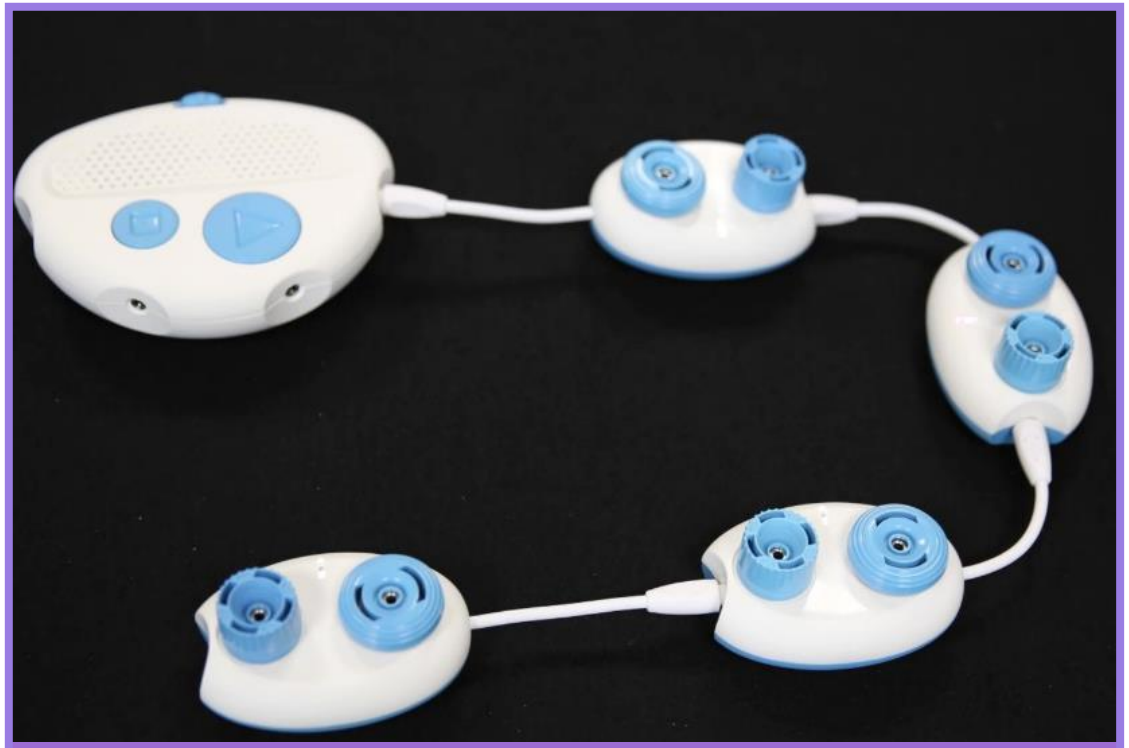


Design Principals

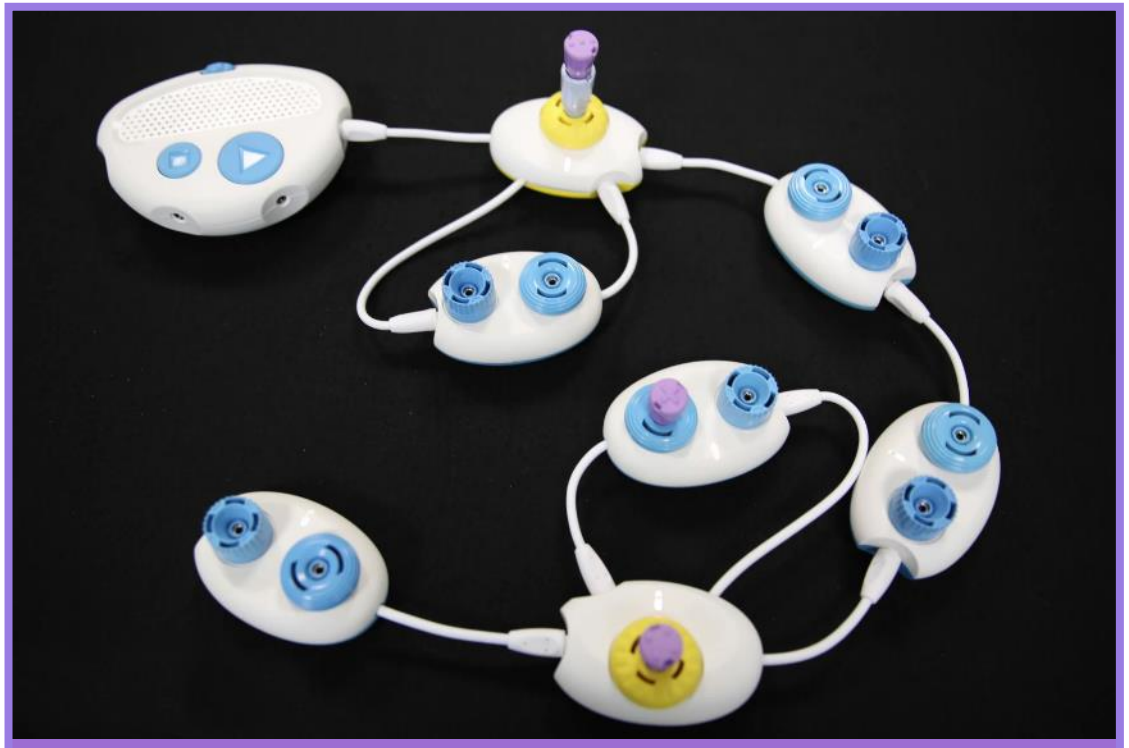
1. Persistent Program Overview

2. Liveness

3. Low Floor, High Ceiling



Sequence



Complex program


Microsoft Research

4. Works across Visual Abilities

5. Enables progression

Torino Beta Study

Torino Beta

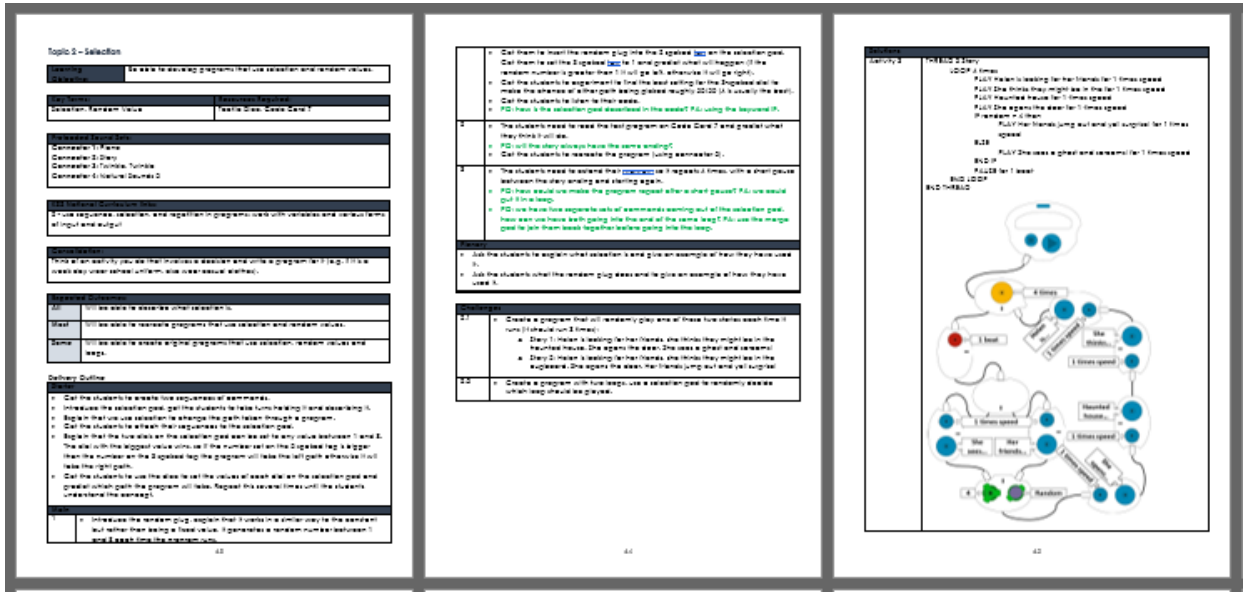
75 Children

30 Teachers

24 Local Authorities

RNIB supporting blind and partially sighted people

Deployment



Morrison, C., Villar, N., Hadwen-Bennett, A., Regan, T., Cletheroe, D., Thieme, A., & Sentance, S. (2019). Physical Programming for Blind and Low Vision Children at Scale. *Human–Computer Interaction*, 1-35.

Measuring Computational Learning

Method Considerations

1) Students are diverse in their abilities;
2) Teachers are non-specialists;
3) Data collection by researchers is restricted due to logistics.

Method Approach

1) Validated questionnaire to measure engagement;
2) Measurement of motivational construct;
3) Teacher reported learning outcomes.

What do teacher's think?

Statement	
I think Torino is a good tool for teaching coding to visually impaired children.	4.9(5)
I found some of the computing concepts hard to understand.	2.4(1)
Teaching with Torino helped me to improve my own computing subject knowledge.	4.2(5)
The teachers' guide was hard to follow.	1.7(1)
I would like to use Torino to teach coding in the future.	4.8(5)

1 = disagree strongly; 5 = agree strongly

100% of teachers strongly agreed or agreed that they would like to use Torino to teach coding in future.

Engagement

How excited do you get before a Torino session?

4.32/5

Motivation

How many stars would you like to give yourself now for your coding / programming ability?

Pre 

Post 

R = -.73

1. Persistent Program Overview

"I should mention that we made good use of the tip relating to 'tracing' the programme. For some students this is really important and aids their understanding. The students felt it and described it. (T18)"

2. Liveness

"Currently entry level environments such as Scratch are either inaccessible to my students or provide very dry feedback i.e. text based output that is then read using a screen reader. The same output could easily be achieved by writing in a text editor. The perceived relevance of programming can be lost because of this. One of the advantages of a product such as Torino is that it provides immediate feedback to students from the very first plugging in of a 'play pod'. The physical nature of the device removes some of the abstraction of creating and running a programme using an IDE. (T17)

3. Low Floor, High Ceiling

"In the last Torino session, the two higher-ability learners were creating their own tunes using the piano sounds and making use of loops, nested loops, pauses and variables. They enjoyed having the freedom to try out what they had learned previously." (T4)

4. Works across Visual Abilities

"The pupils have worked extremely well together and have helped each other to rapidly pick up many of the concepts and vocabulary used. Here is a video of successful joint working and happy collaboration!"

Teacher Reported Learning

Use of Correct Vocabulary

When completing activities, the children now often use correct key terms – 'sequence', 'thread', 'parameter' etc. (T10)

Problem-Solving

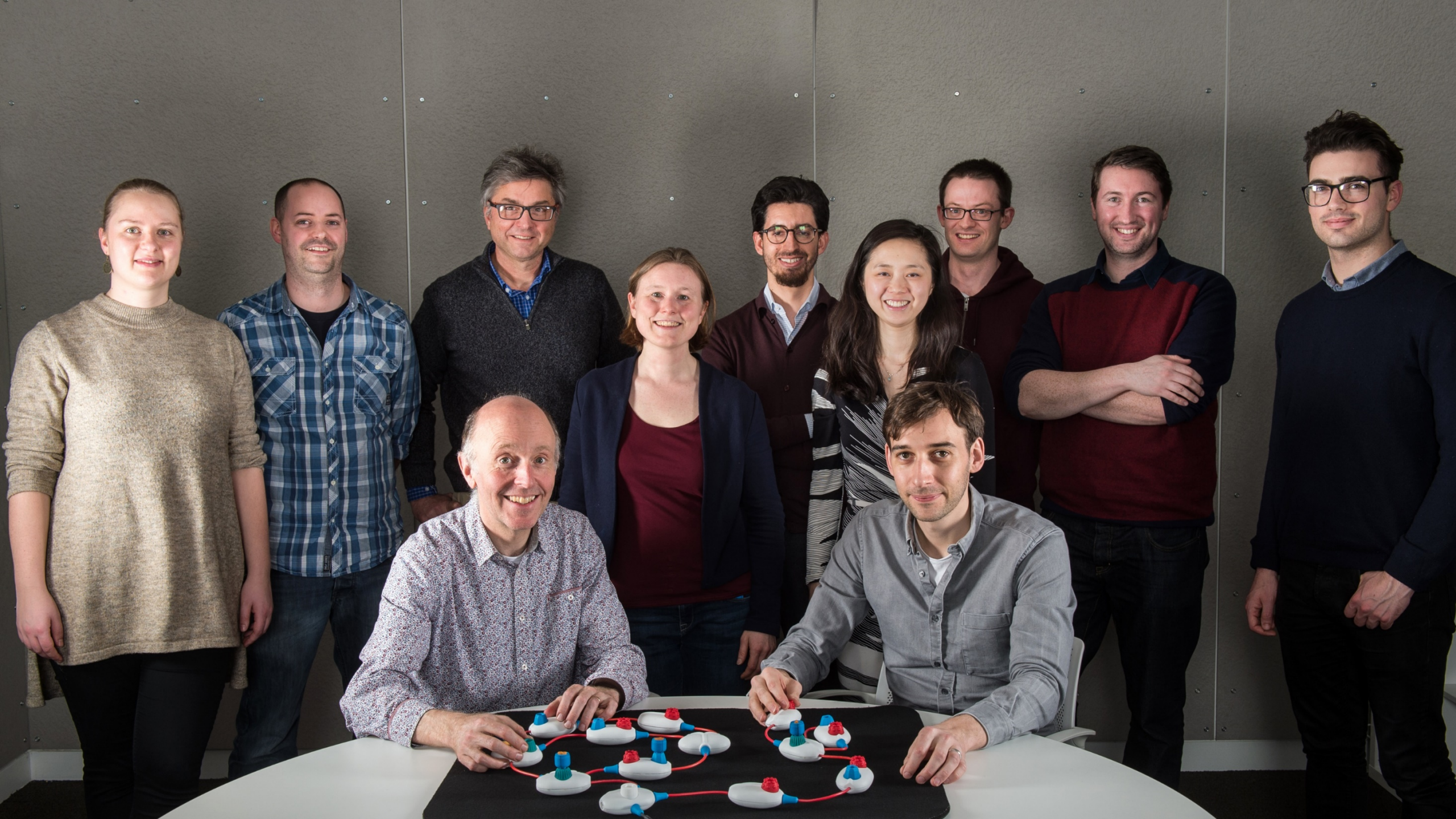
The most noticeable impact on progress has been the development of problem solving skills. During the first handful of Torino sessions, the children struggled to identify where to start when repeating an example task. Now, they are quick in identifying roles for each other, tracing and building the sequence of code. (T1)

Inclusive Education

The students, all with a visual impairment from different schools, learned how to work together as a team.

code jumper™


Project Torino Code View
THREAD 1 Square Lead
LOOP 3 times
PLAY F5 for 1 beat
PLAY E5 for 1 beat
PLAY C5 for 1 beat
END LOOP
END THREAD
THREAD 2 Piano
LOOP 8 times
PLAY C6 for ½ a beat
PLAY D6 for ½ a beat
END LOOP
END THREAD
THREAD 3 ChoirAahs
PAUSE for 2 beats
PAUSE for 2 beats
PAUSE for 2 beats
PLAY F5 for 1 beat
PLAY E5 for 1 beat
PLAY C5 for 1 beat
END THREAD
THREAD 4 ChoirAahs
END THREAD



Questions for Discussion

1. How might a physical programming language help young children without a visual impairment who are struggling to learn using a block-based language?

2. What can we learn from the success of students physically following their code?

3. How should we measure success of a new programming language?

4. Physical programming can be exciting, but its more expensive than software. How can we enable such opportunities?