



BodyVis:

A New Approach to Body Learning Through Wearable Sensing and Visualization

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Matthew Louis Mauriello

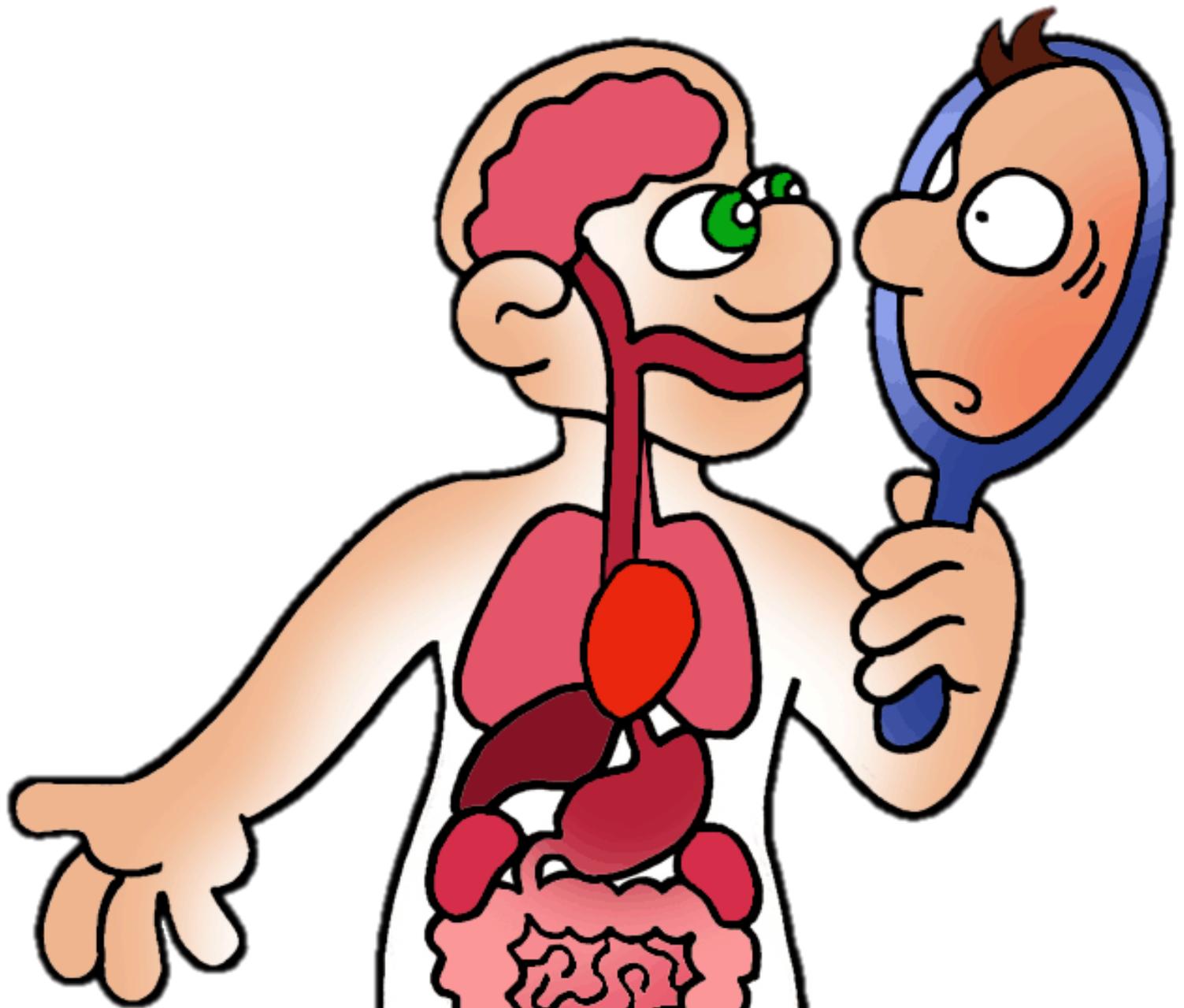
Anita Jorgensen

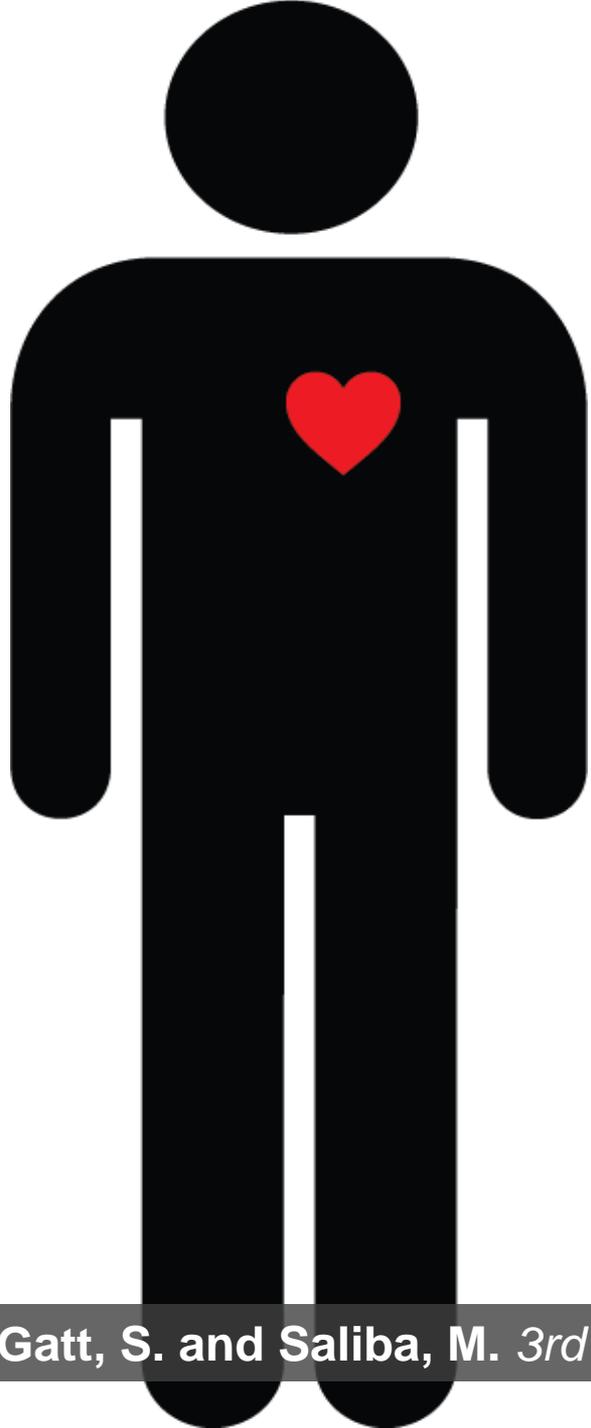
Brenna McNally

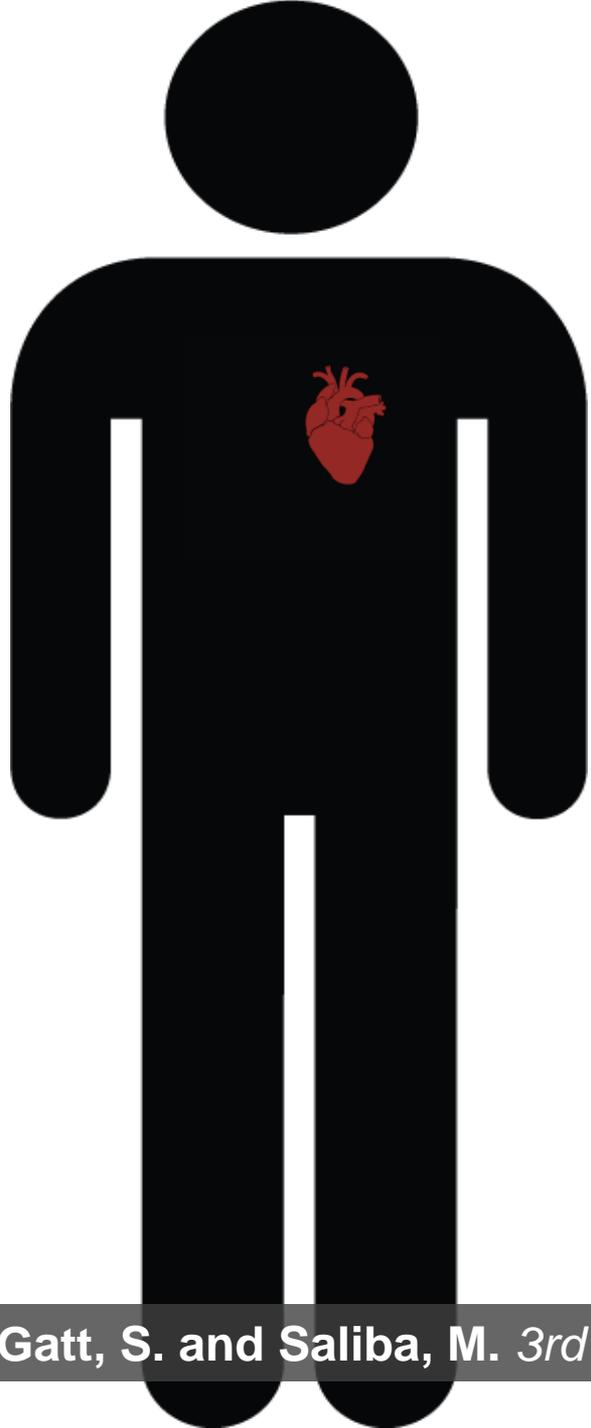
Jon Froehlich

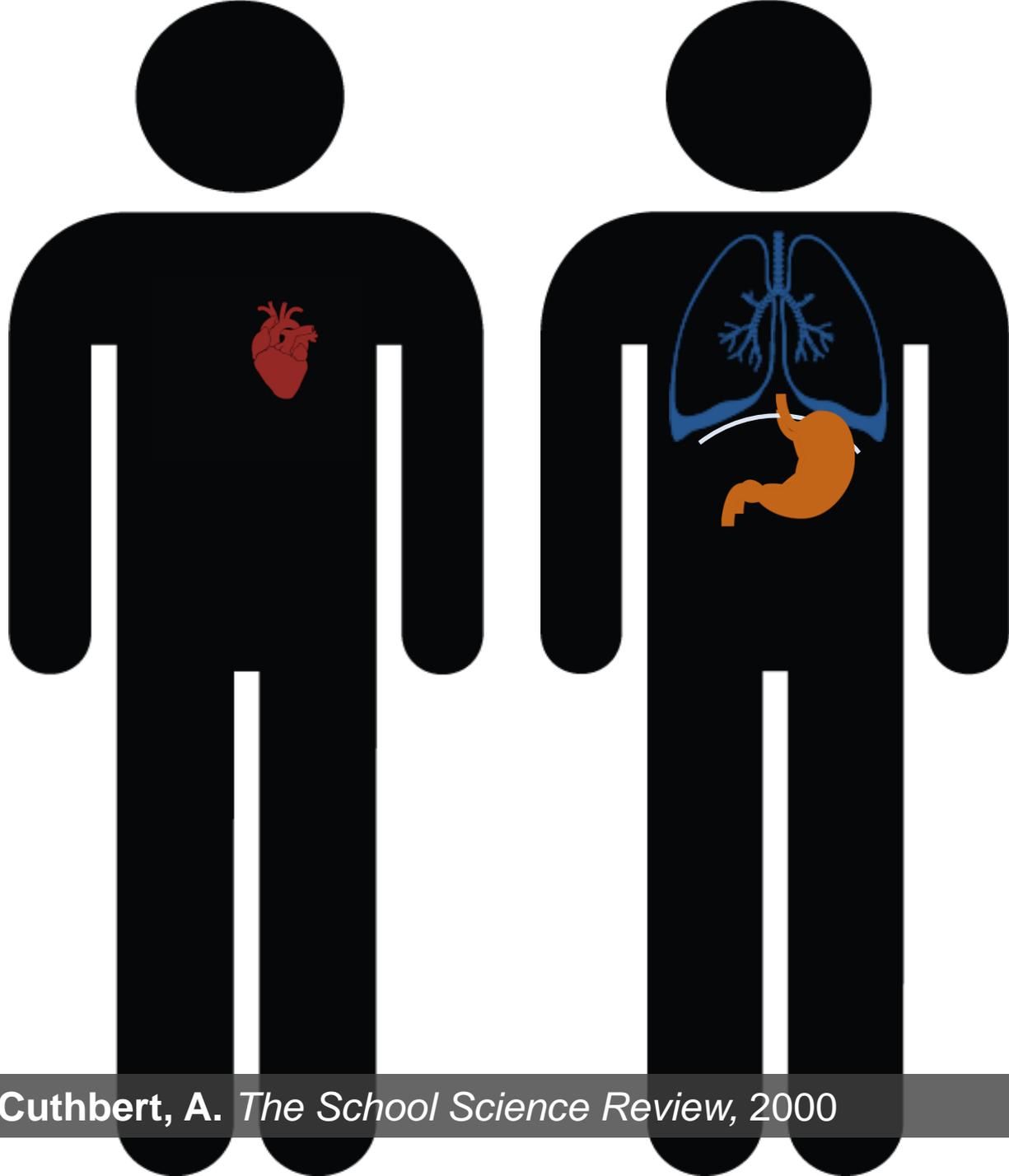
CHI 2015

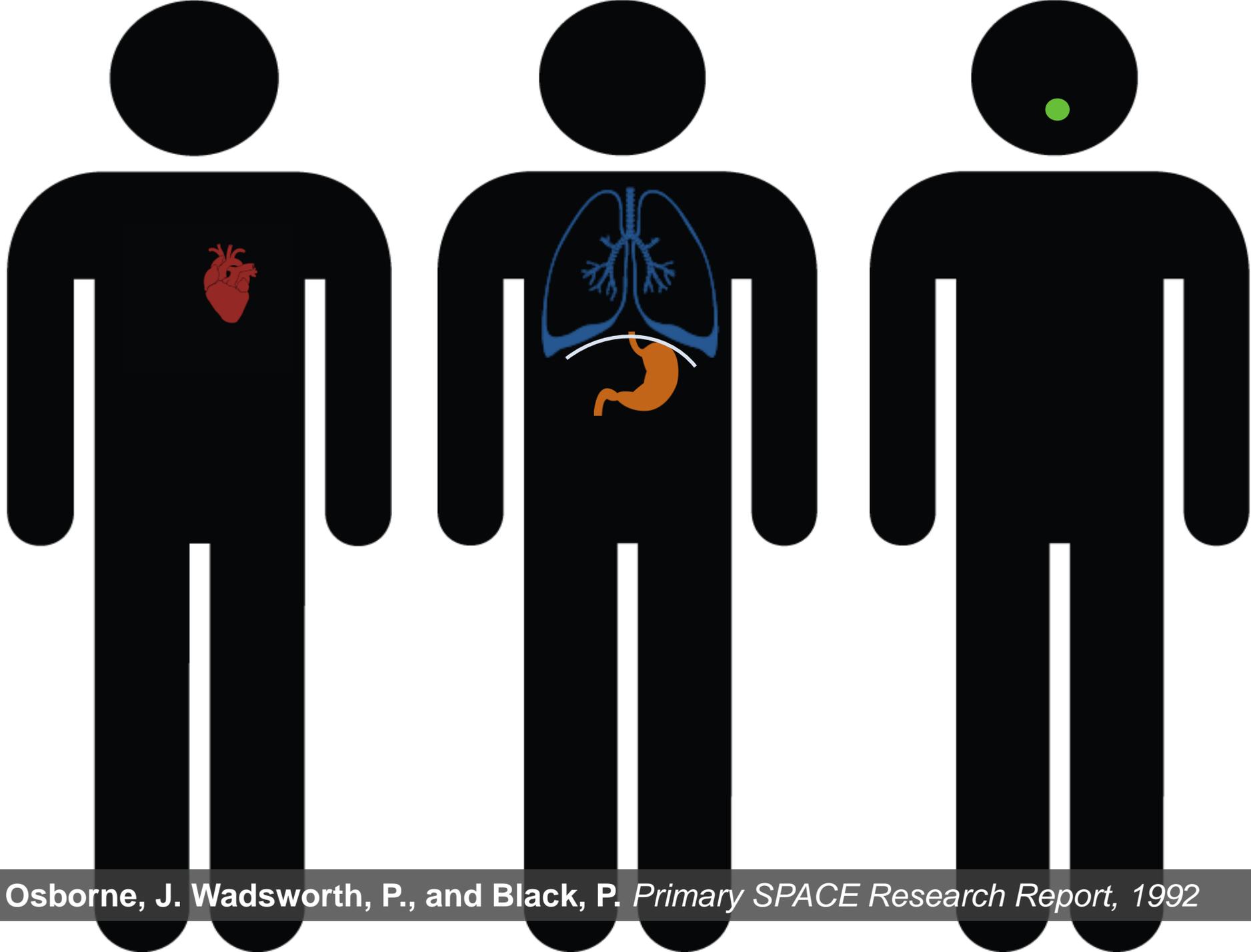
April 19, 2015







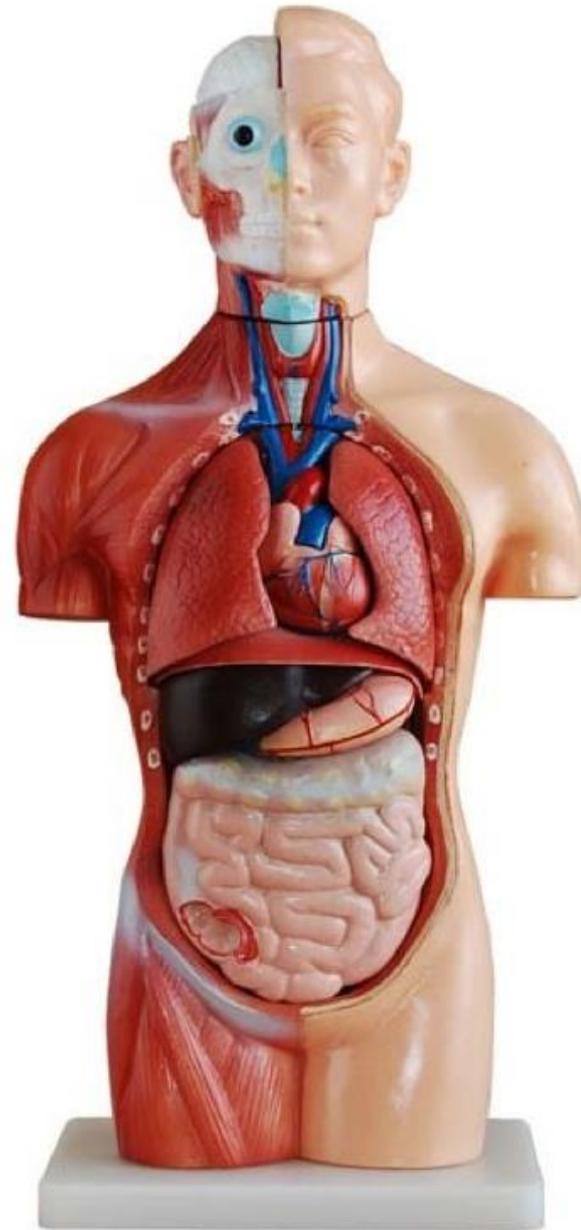




Osborne, J. Wadsworth, P., and Black, P. *Primary SPACE Research Report, 1992*

Existing Teaching Techniques

3D Models

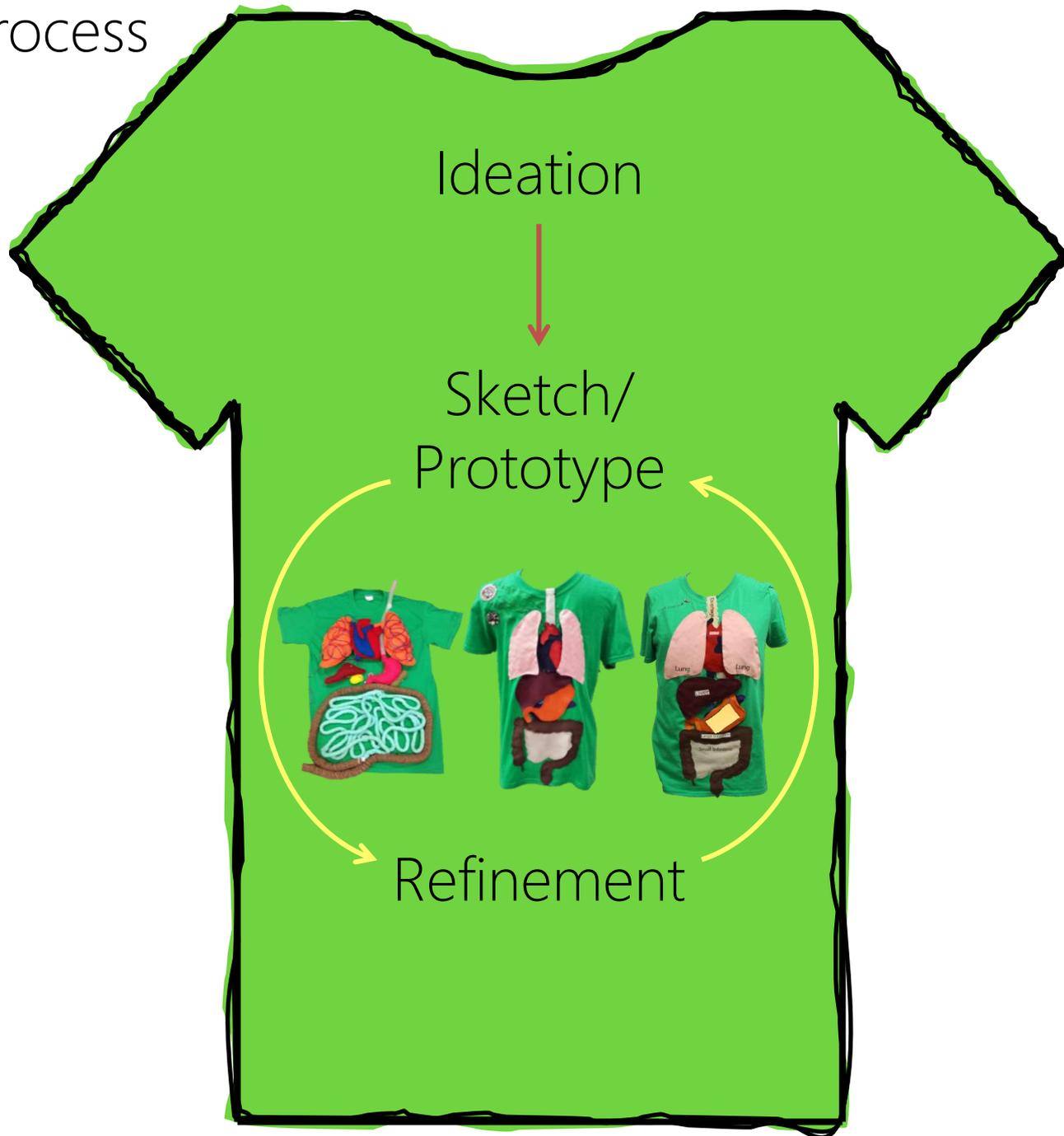


Existing Teaching Techniques

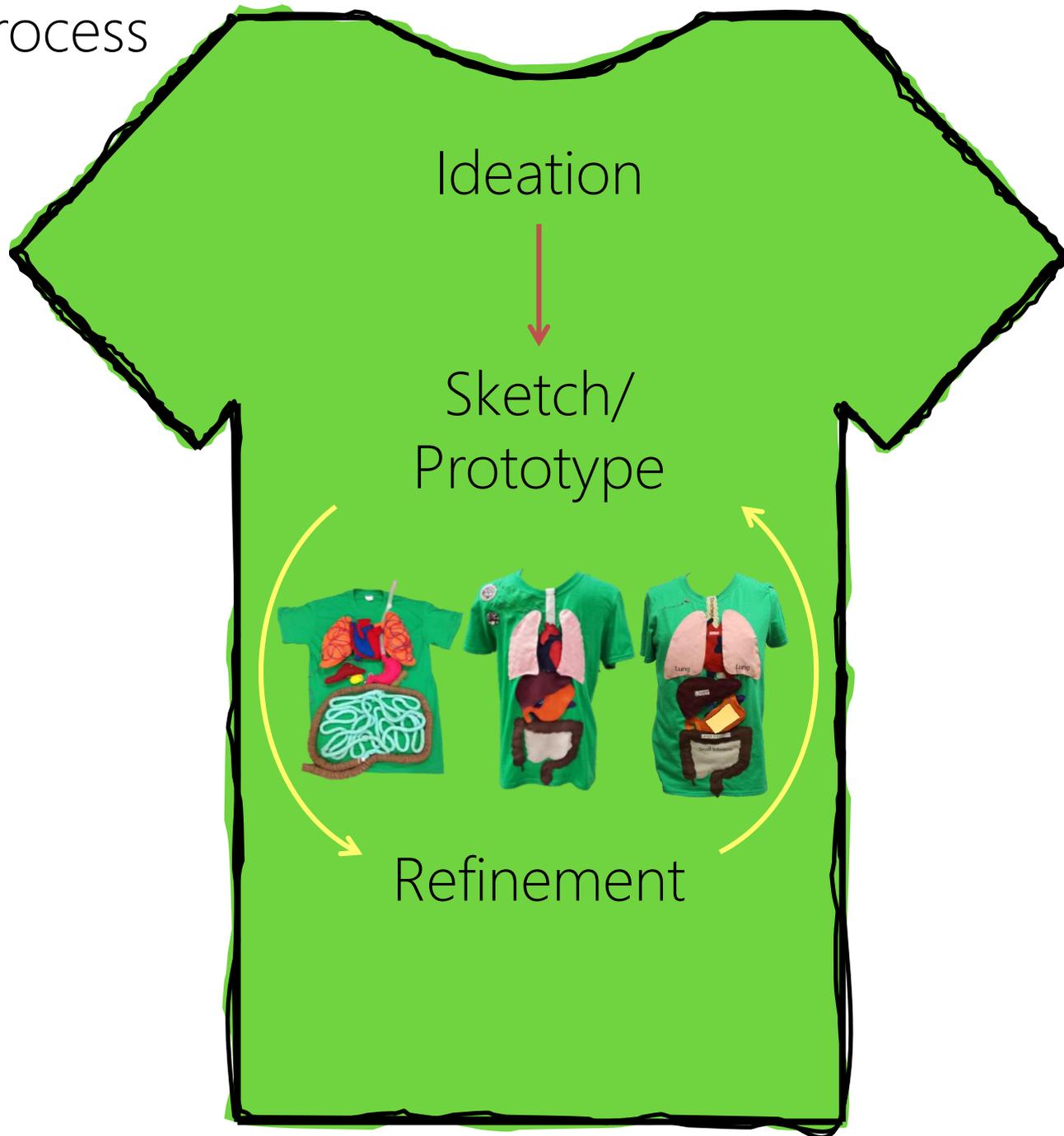
(((Responsive)))

Our Approach?

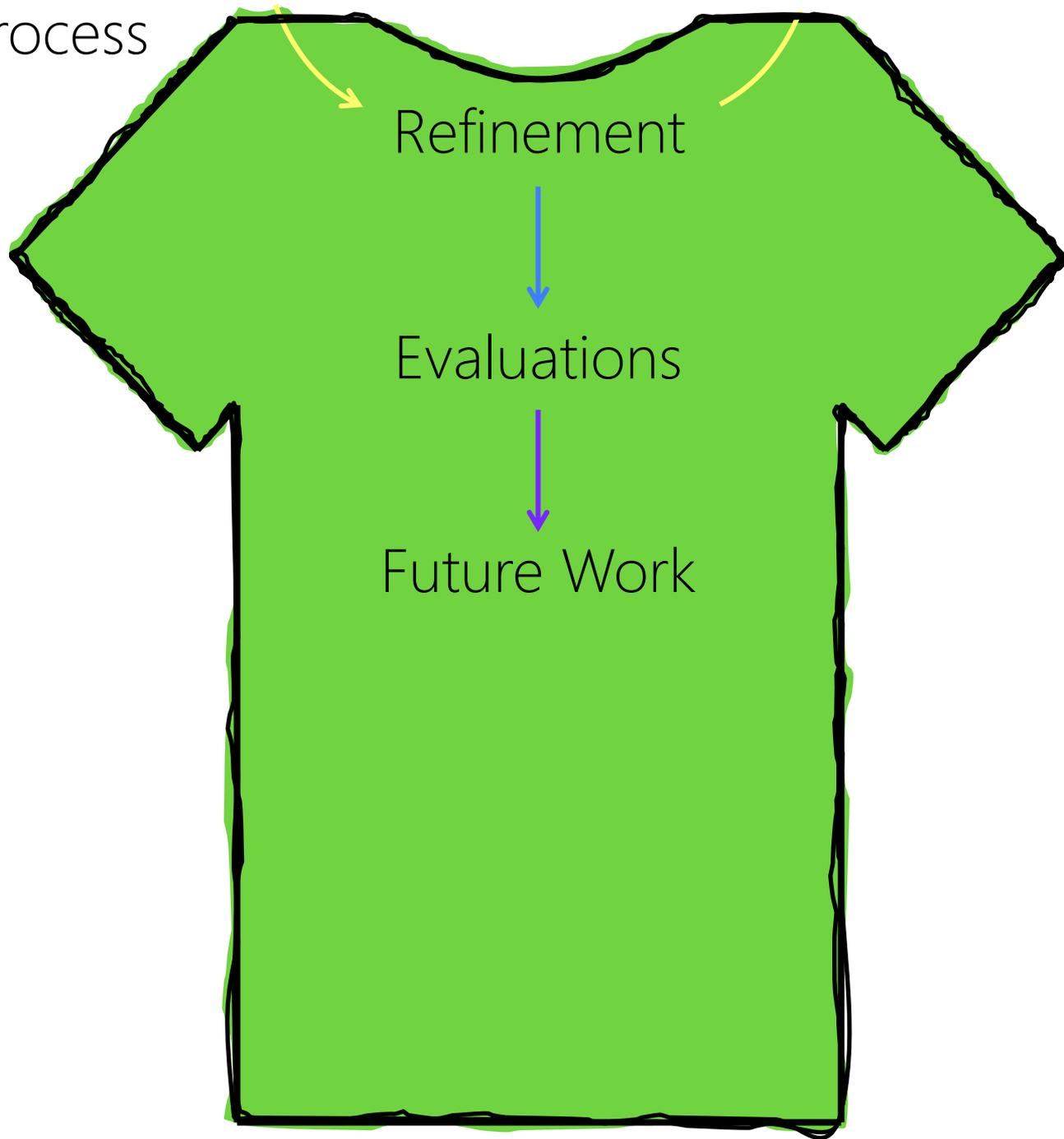
Design Process



Design Process



Design Process

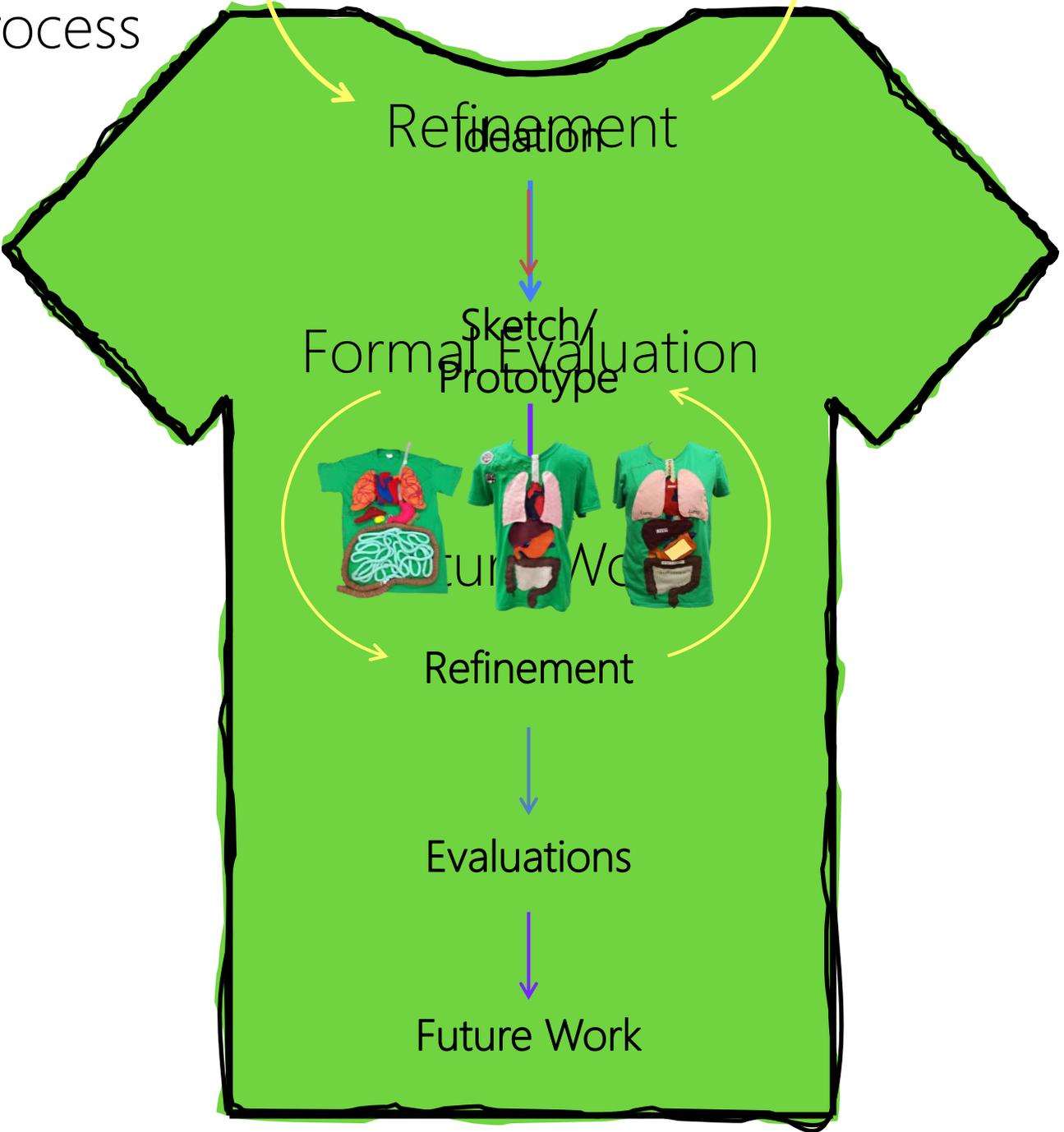


Refinement

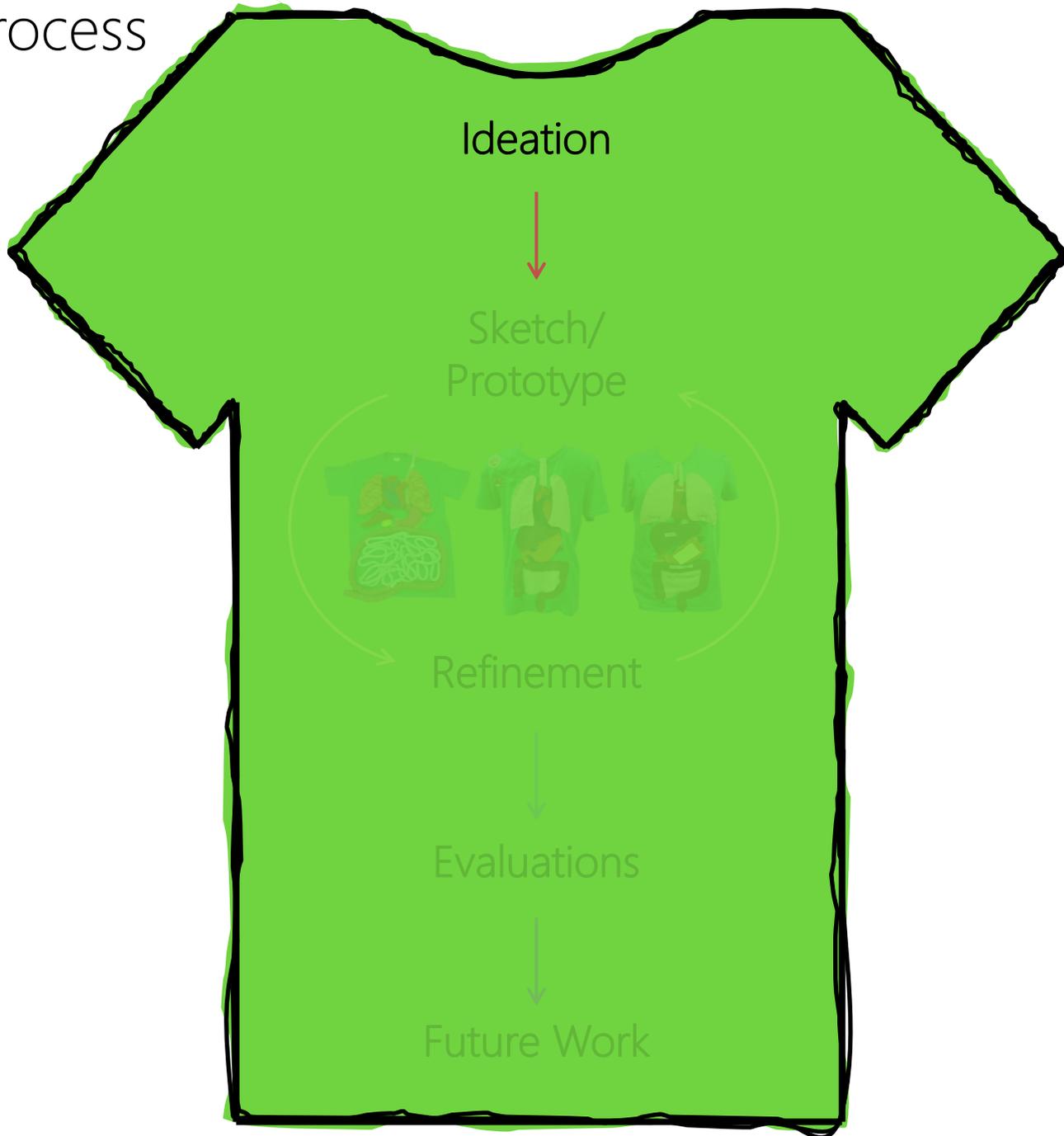
Evaluations

Future Work

Design Process



Design Process



Design Goals



Multiple senses



Link action to representation



Multiple timescales



Robust & lightweight



Active, playful, hands-on engagement



Personal relevance



Collaborative learning

Design Goals



Multiple senses



Link action to representation



Multiple timescales



Robust & lightweight



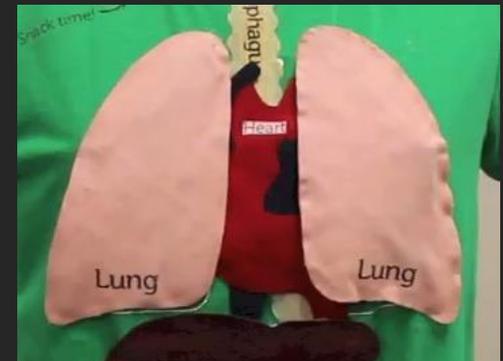
Active, playful, hands-on engagement



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Personal relevance



Collaborative learning



Design Process





Sensors detect
CO₂ levels in air

Amount of lights
reflect CO₂ levels

Prototype 1

Plush, Colorful, Interactive



Participatory Design 1

Prototype 1

Plush, Colorful, Interactive



Participatory Design Lessons Learned

Prototype 1

Plush, Colorful, Interactive



Prototype 2

A New Lightweight Design



Lessons Learned

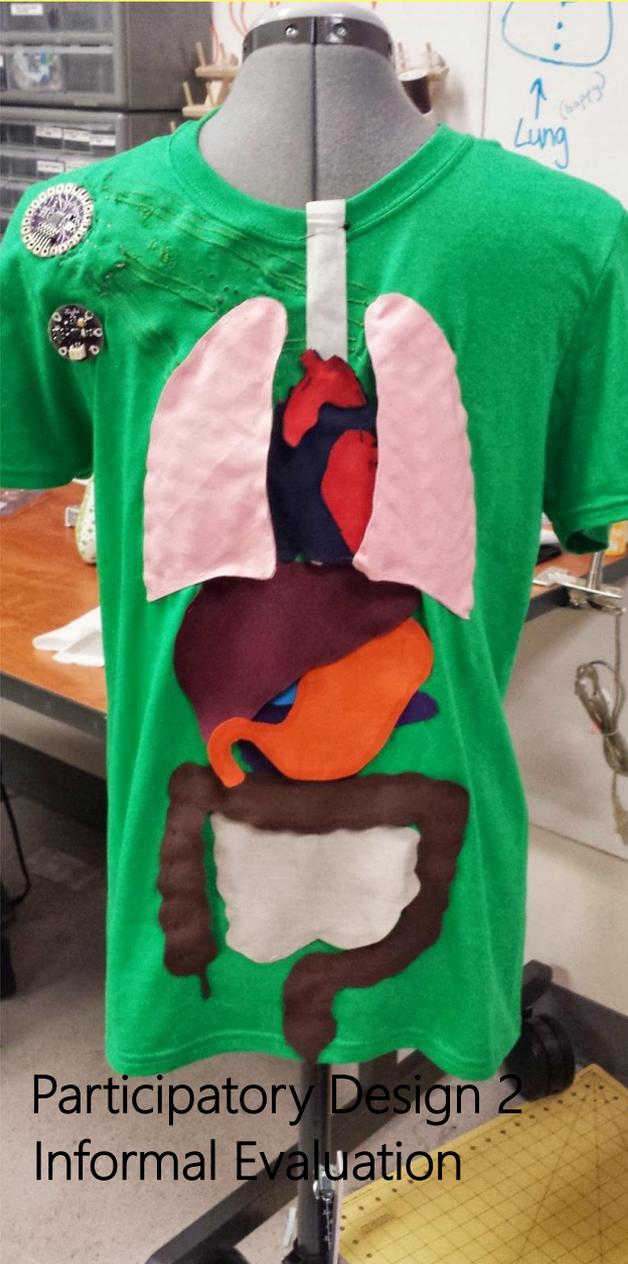
Prototype 1

Plush, Colorful, Interactive



Prototype 2

A New Lightweight Design



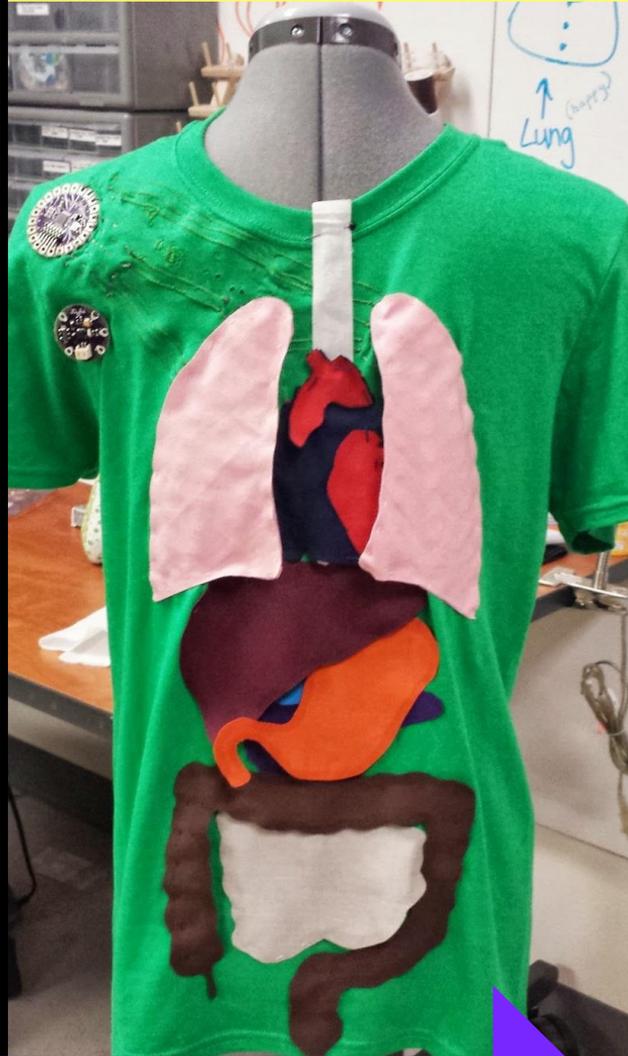
Lessons Learned

Participatory Design 2
Informal Evaluation

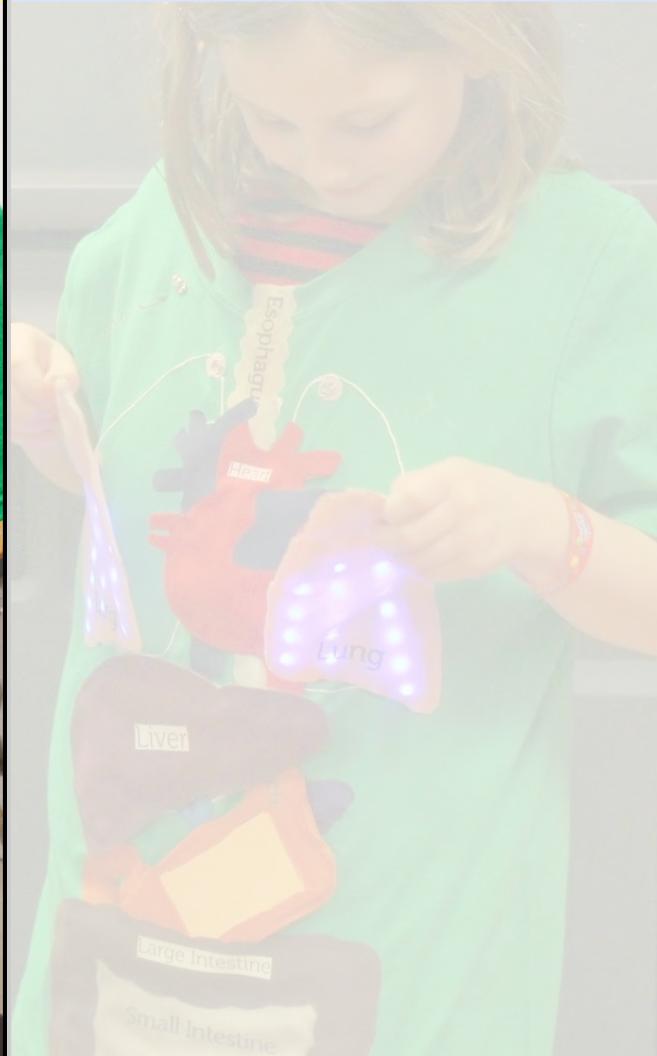
Prototype 1
Plush, Colorful, Interactive



Prototype 2
A New Lightweight Design



Prototype 3
The Current Design



Participatory Design 1

Goals

Explore potential design options

Gain insight into how children understand their bodies



Cooperative Inquiry



Lungs inflate
+ deflate
Contraction
by internal breaths

Small in the
function as
roller coaster

Findings



Color
Organ Functionality



Movement
Within the body

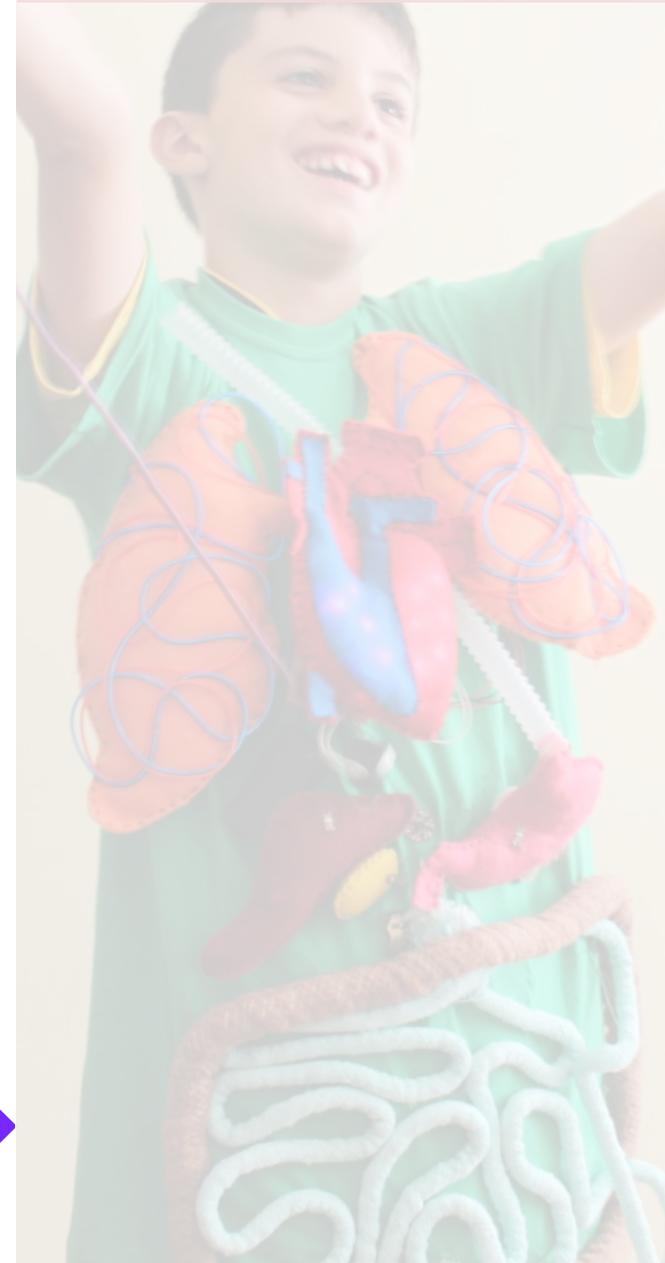


Sound
Playfulness



Light
Action

Prototype 1
Plush, Colorful, Interactive



Participatory Design 1



Prototype 1
Development

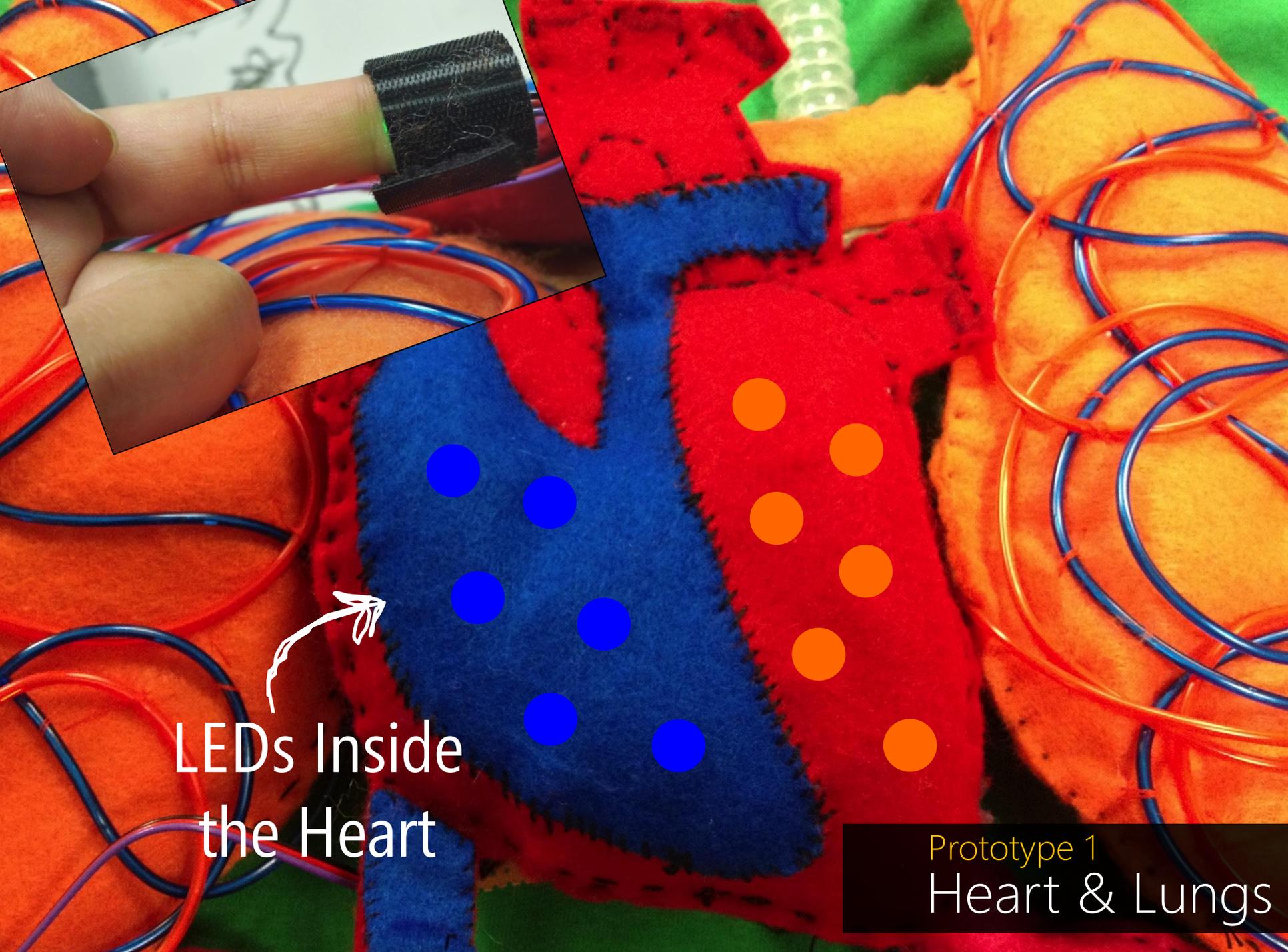


Pillow
Stuffing

Prototype 1
Development



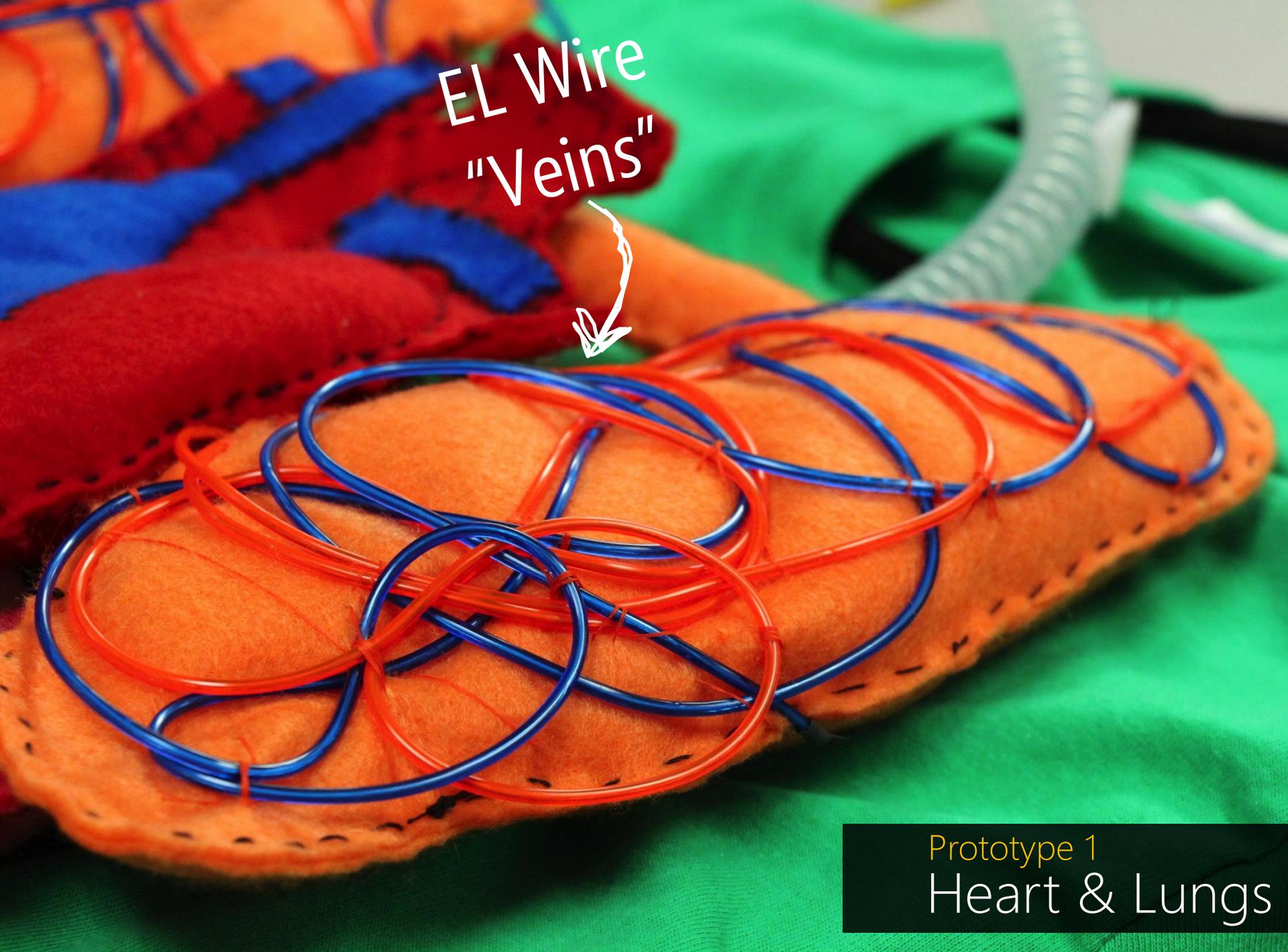
Prototype 1
Development



LEDs Inside
the Heart

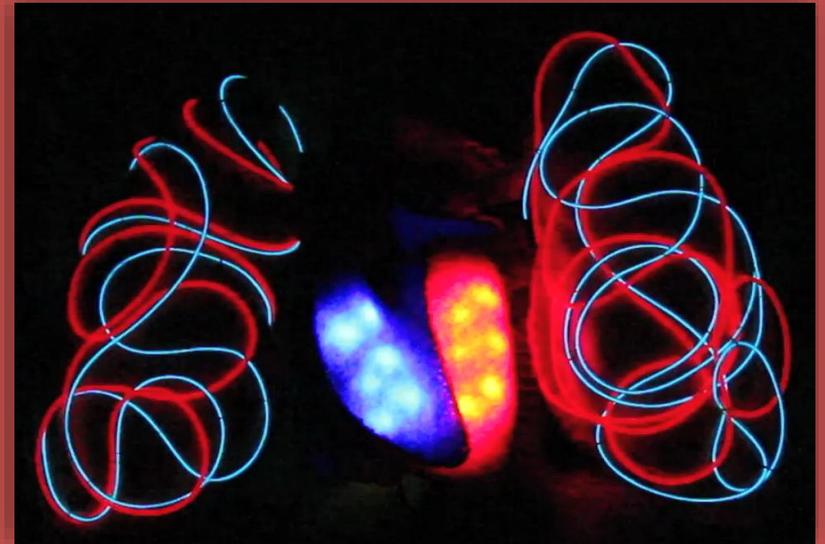
Prototype 1
Heart & Lungs

EL Wire
"Veins"



Prototype 1
Heart & Lungs

Prototype 1



Prototype 1

Plush, Colorful, Interactive



Participatory Design Lessons Learned

Prototype 1

Plush, Colorful, Interactive



Prototype 2

A New Lightweight Design



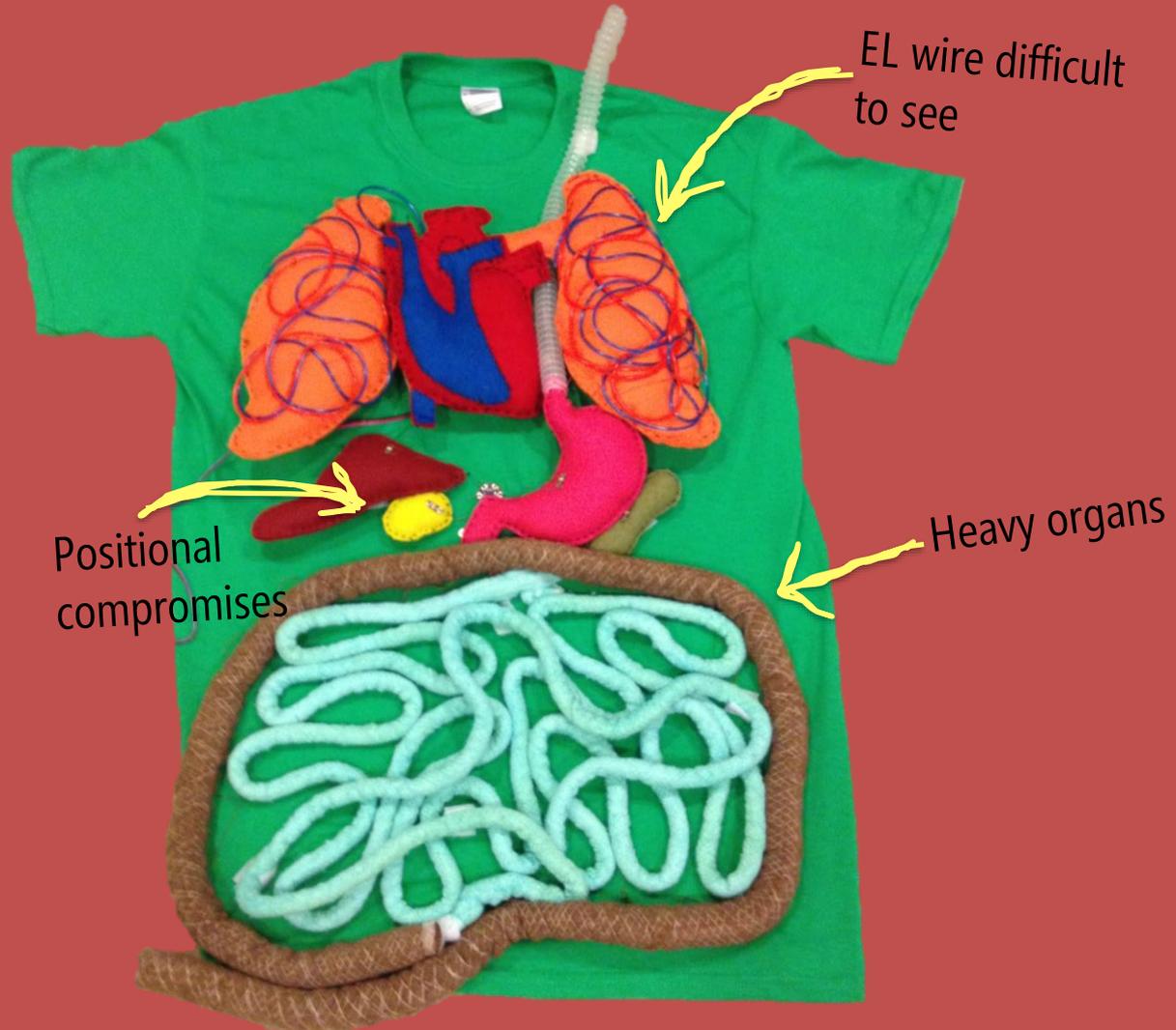
Lessons Learned

Prototype 1 Issues



Unreliable
heartrate
sensor

Prototype 1 Issues



Prototype 1

Color

Light

Sound

Movement

Visual Design

Wearer Comfort

New animation approaches

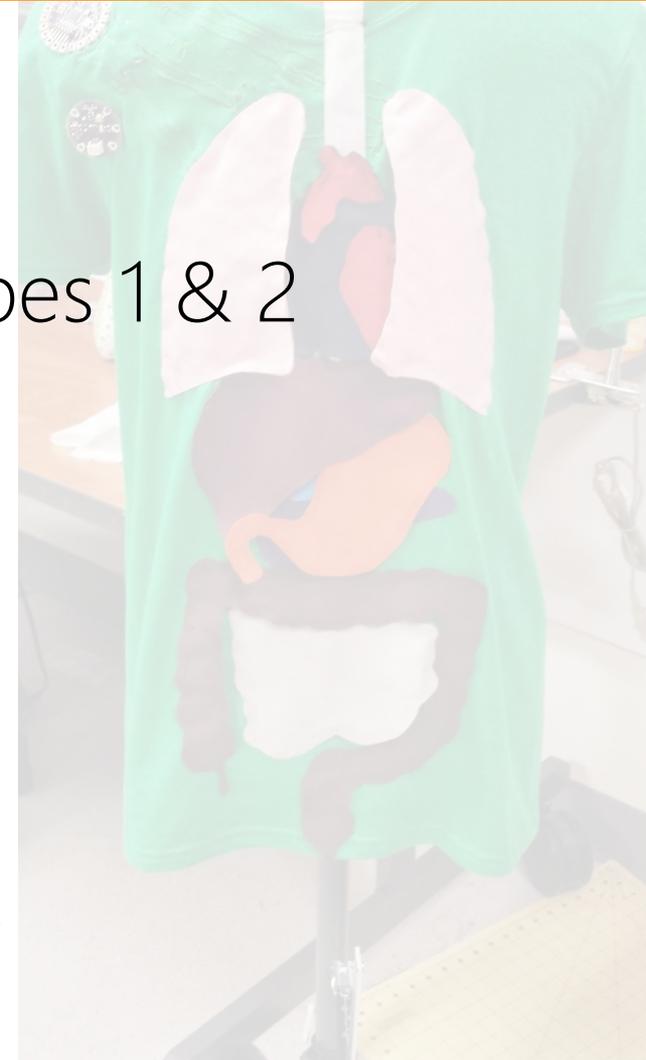


Goals

Gain feedback on Prototypes 1 & 2

Co-design improvements

Lessons Learned



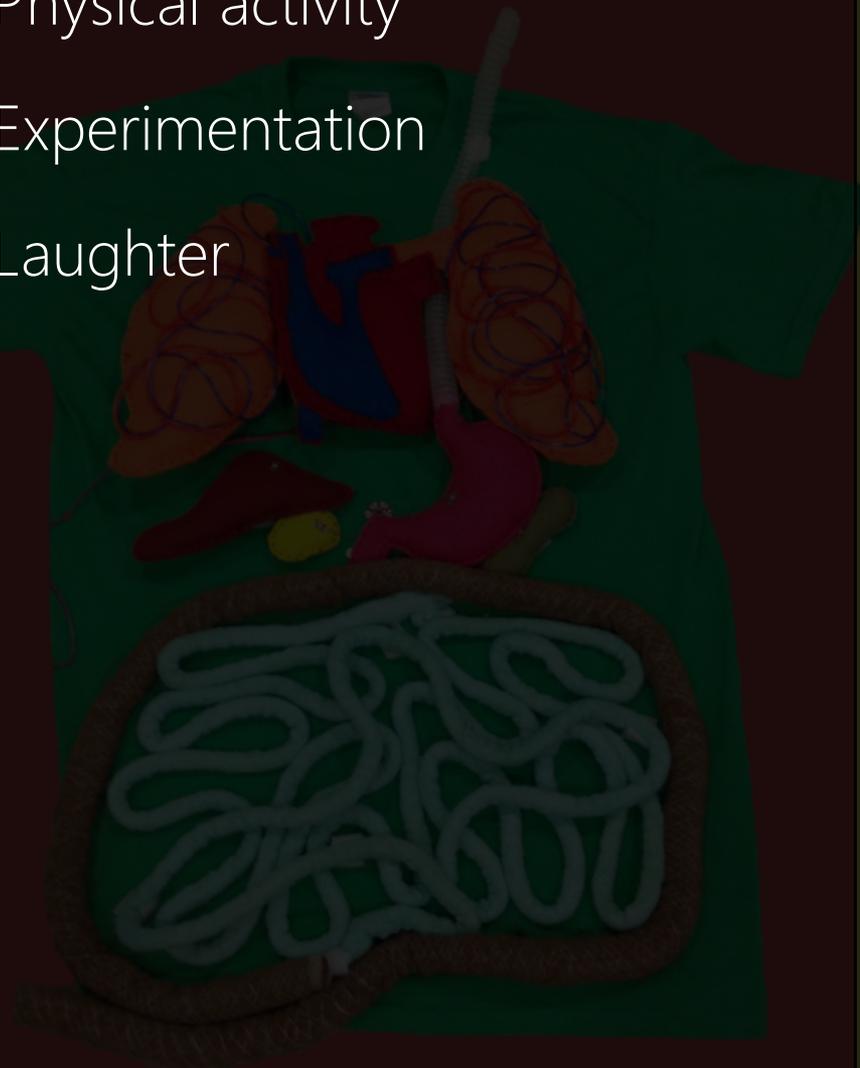


Prototype 1

Physical activity

Experimentation

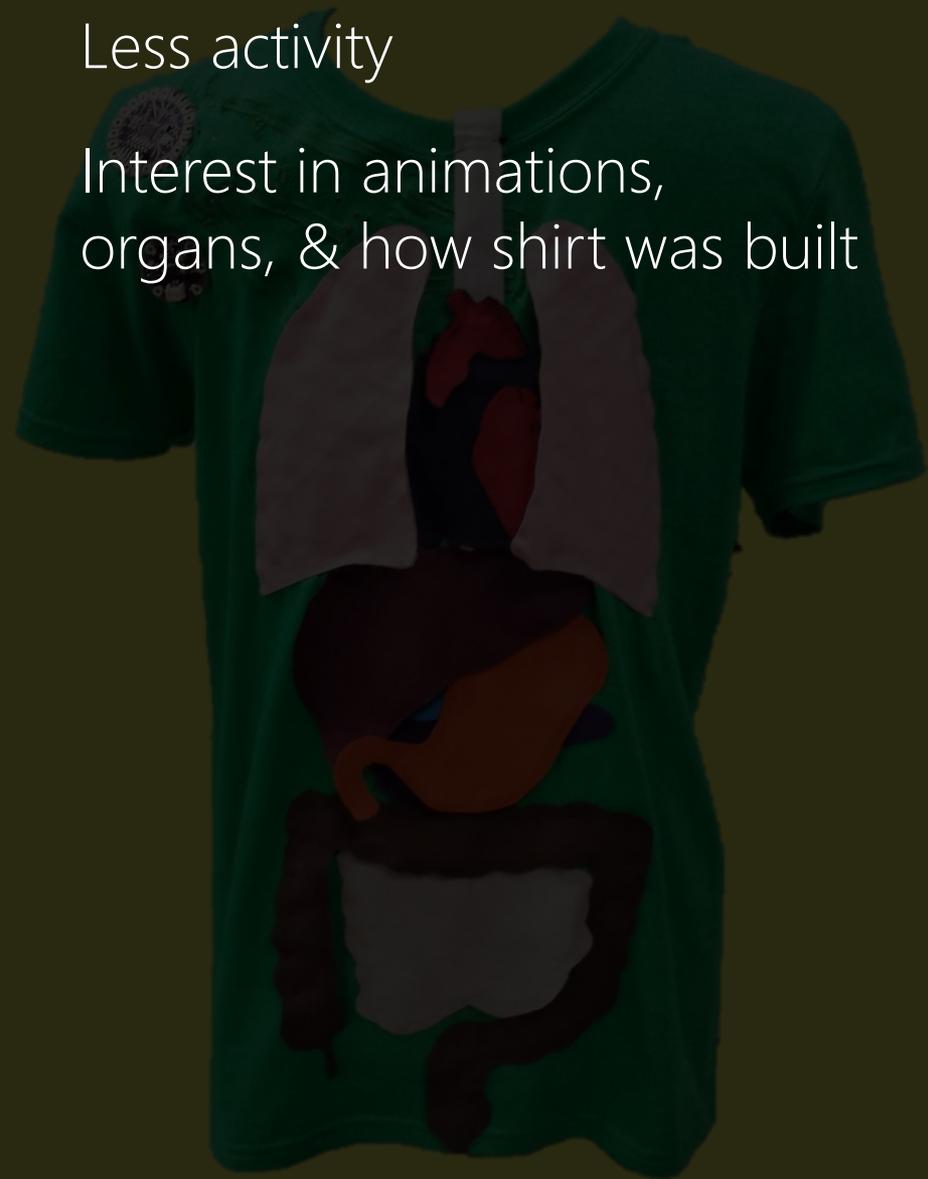
Laughter



Prototype 2

Less activity

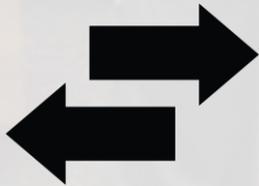
Interest in animations,
organs, & how shirt was built



Findings



Sound
Organ Functionality



Movement
Within the body



Stomach Animation

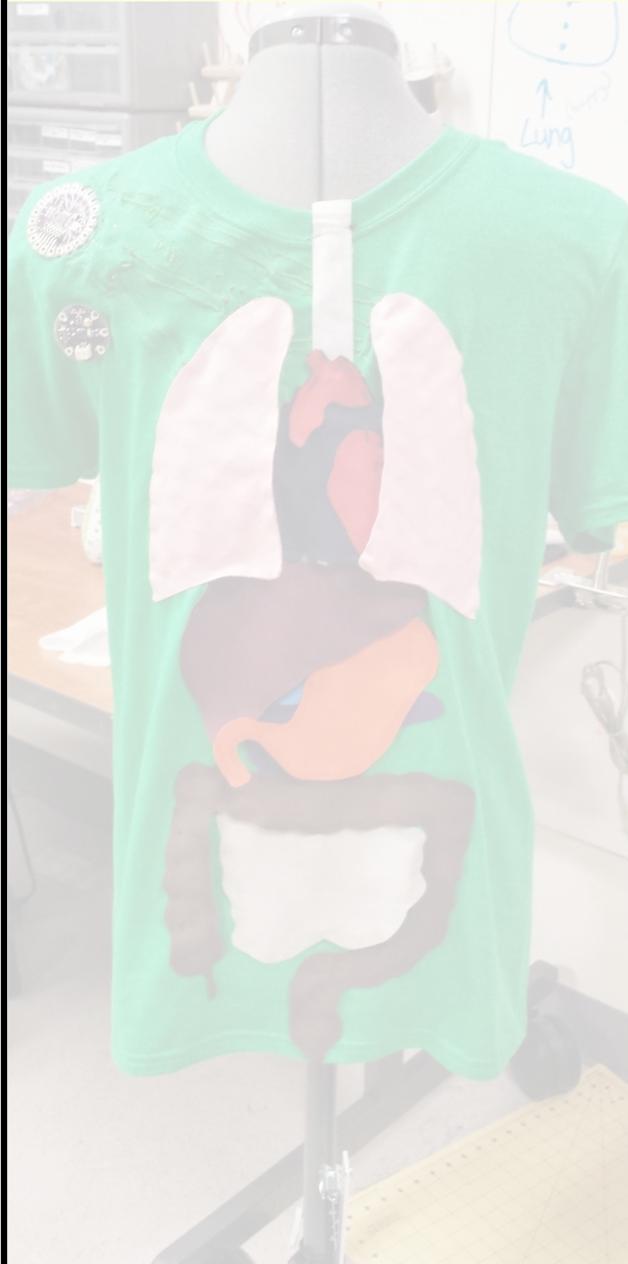


Prototype 1 & 2
Informal Evaluation

Prototype 1
Plush, Colorful, Interactive



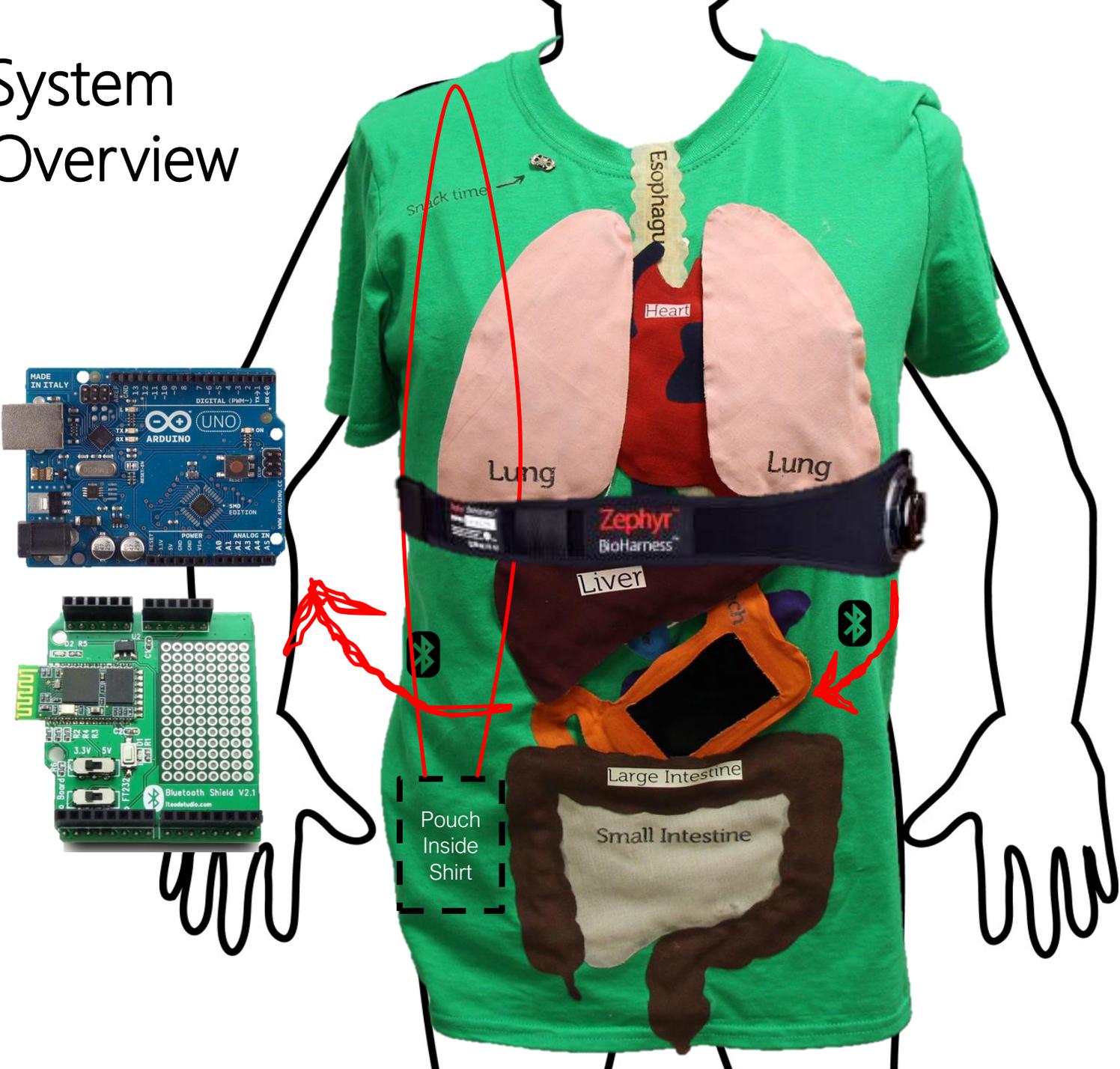
Prototype 2
A New Lightweight Design



Prototype 3
The Current Design

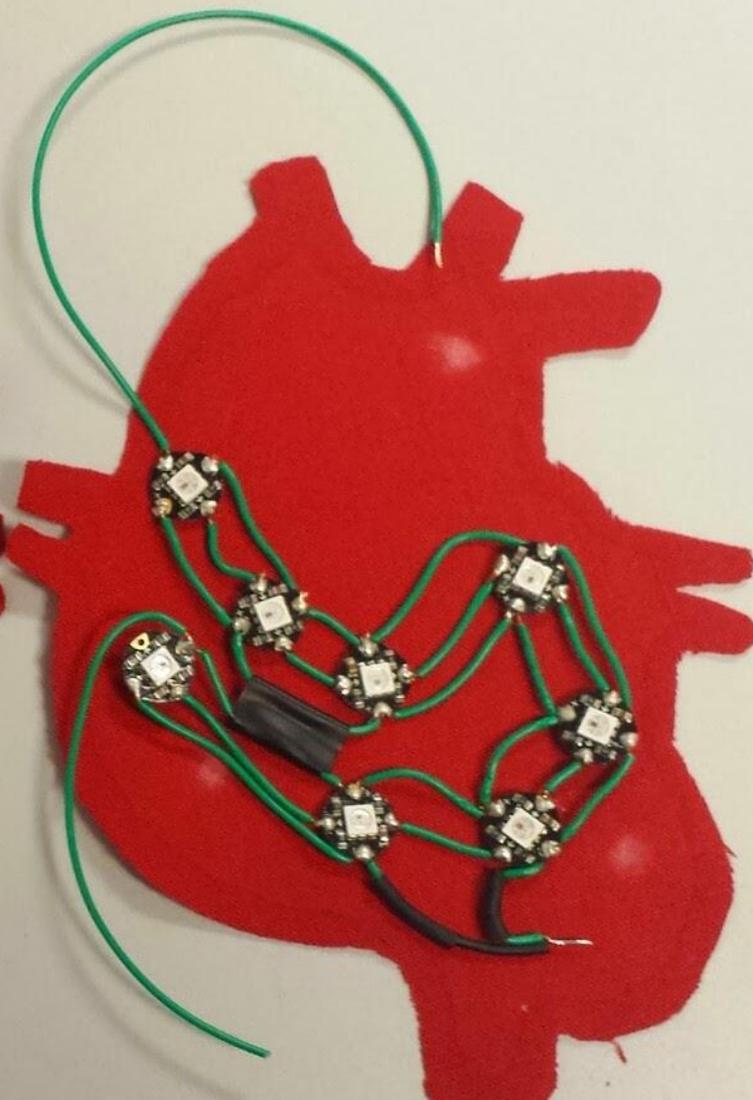


System Overview





Prototype 3
Development



Prototype 3
Development



Prototype 3
Detachable Organs

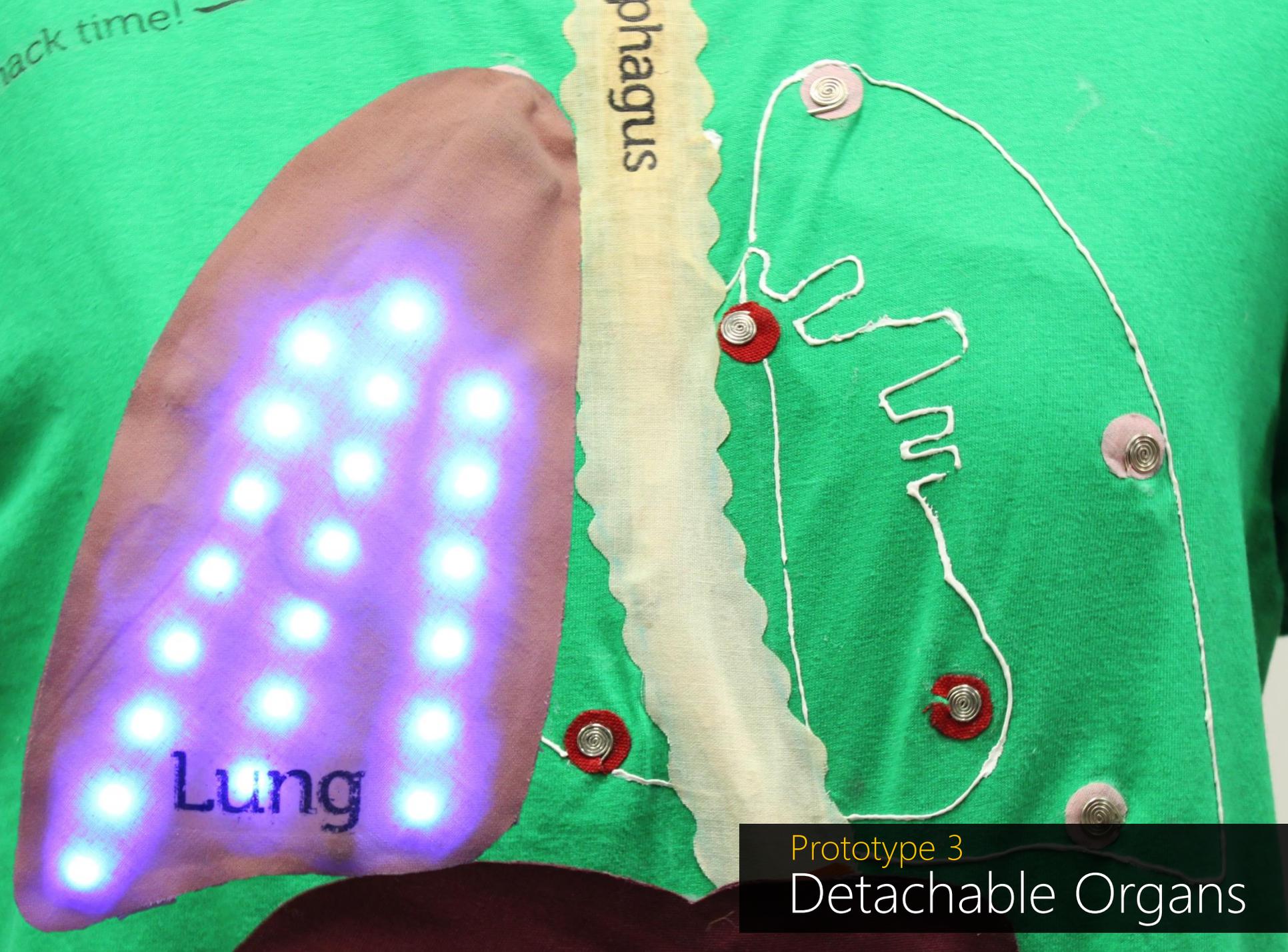


Prototype 3
Detachable Organs

back time!

phagus

Lung



Prototype 3
Detachable Organs



Heart Rate:
60 bpm

Breathing Rate:
15 bpm

Prototype 3
Heart & Lungs



sophnagus

>> x3

time! →

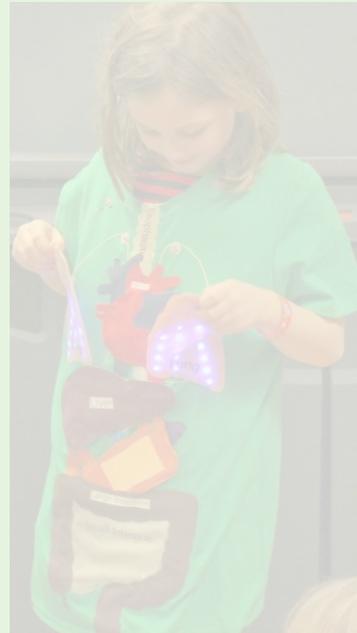
Design Process



Evaluations

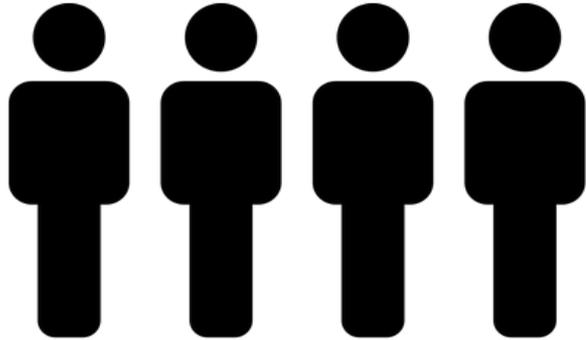


Study 1
Teacher
Interviews

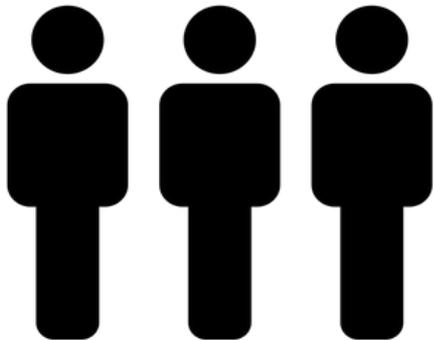


Study 2
Design
Deployments

Participants



Private School



Public School

Seven 1st – 4th grade
science teachers
(one male)

Analysis

We pursued an iterative coding scheme with a mix of both **deductive** and **inductive** codes.

Interview Findings

Part 1: Teaching Approaches A formative inquiry on teaching approaches for body learning, common body misconceptions in children, and learning challenges

Part 2: A BodyVis design probe where we solicited feedback to Prototypes 1 and 3

Interview Findings

Part 1: Teaching Approaches



Resources & Materials



Engagement



Body Learning Challenges

Interview Findings

Part 2: Designing Approaches



Learning Potential



Learning Potential

"...something like this would definitely get them interested and motivated to learn more about [their bodies]."

- T2

"..that link with what's actually happening in one's own body is really fantastic."

- T6

Interview Findings

Part 2: Design Probe



Learning Potential



BodyVis Learning Activities



BodyVis Learning Activities

Physical activities

Peer collaboration

Low-tech anatomical model



Interview Findings

Part 2: Design Probe



Learning Potential



BodyVis Learning Activities



Concerns



Concerns

"...[if] one of the sensors stops working, how can we replace [it]?"

- T1

Interview Findings

Part 2: Design Probe



Learning Potential



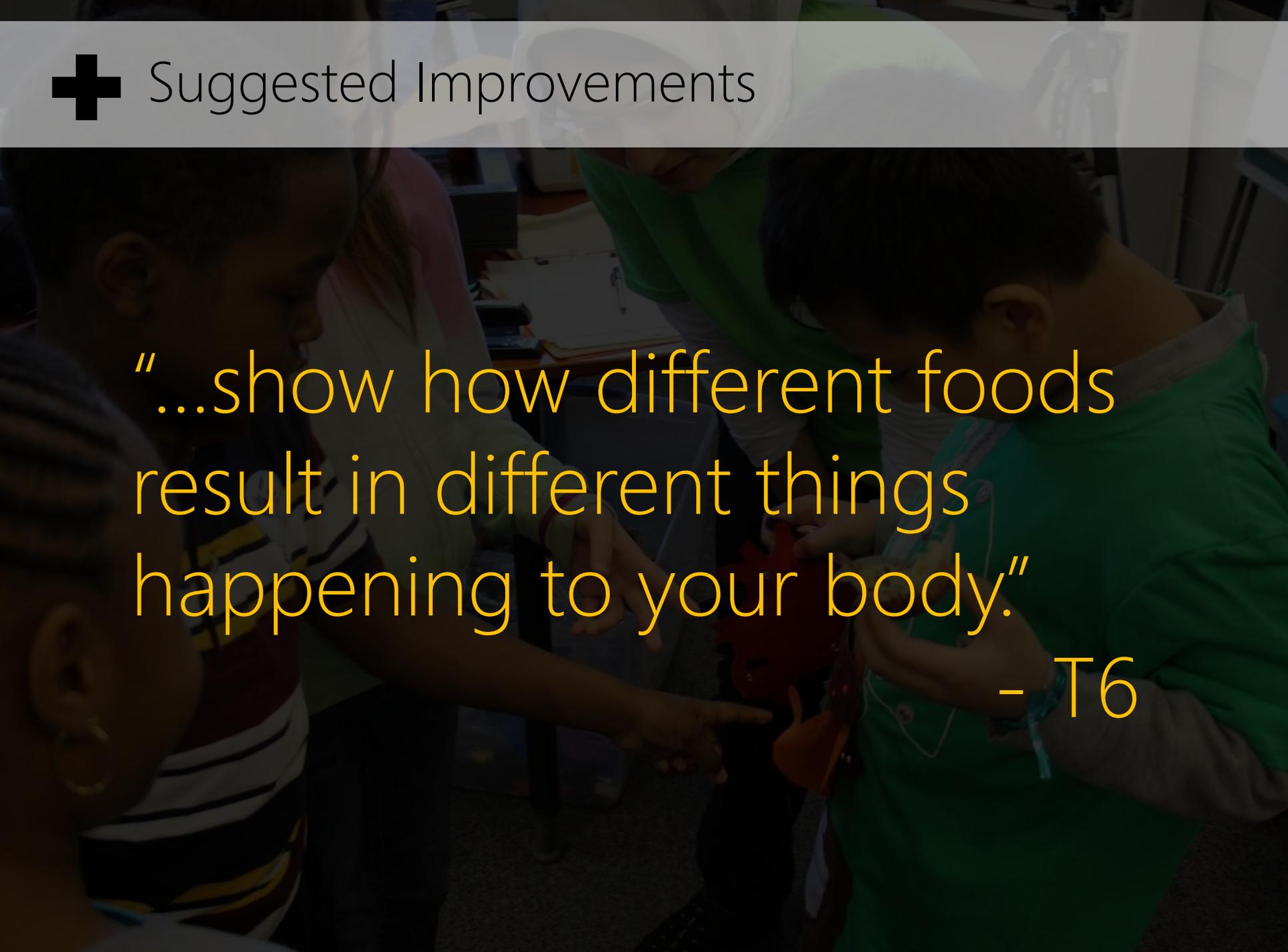
BodyVis Learning Activities



Concerns



Suggested Improvements

A group of children in a classroom setting, looking at something together. The image is dimly lit and serves as a background for the text.

+ Suggested Improvements

“...show how different foods result in different things happening to your body.”

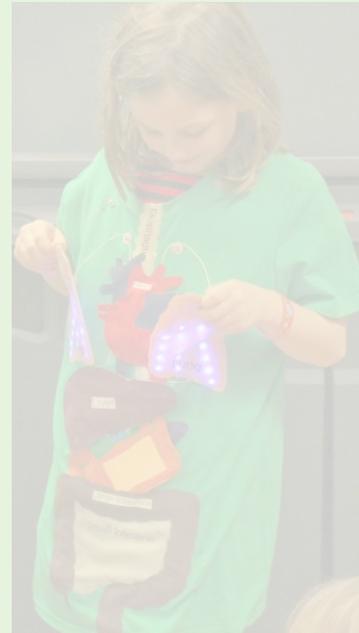
- T6

Evaluations



Study 1

Teacher
Interviews



Study 2

Design
Deployments

Three Deployment Sites

Site 1



Site 3



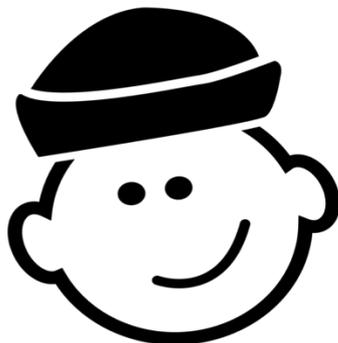
Site 2



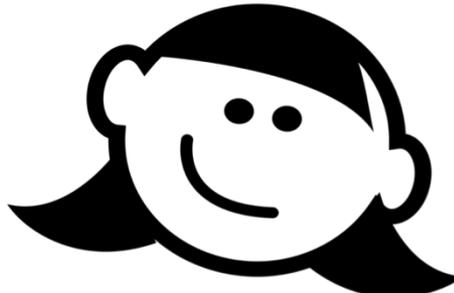
Participants

6-12

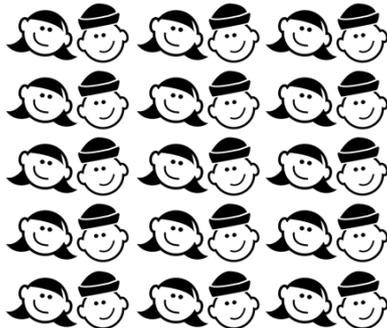
Ages



12 Boys



18 Girls



30

Participants

Analysis

After reviewing session data to develop an initial codebook, we analyzed **physical actions** with audio/video data.

We also used open-coding to analyze **children's spoken questions**.

Procedure



Introduction &
Pre-Study
Questionnaire



BodyVis
Overview



Interactive Trial



Post-Study
Questionnaire



Free Play

Deployment Findings



Overall reactions

? Overall reactions

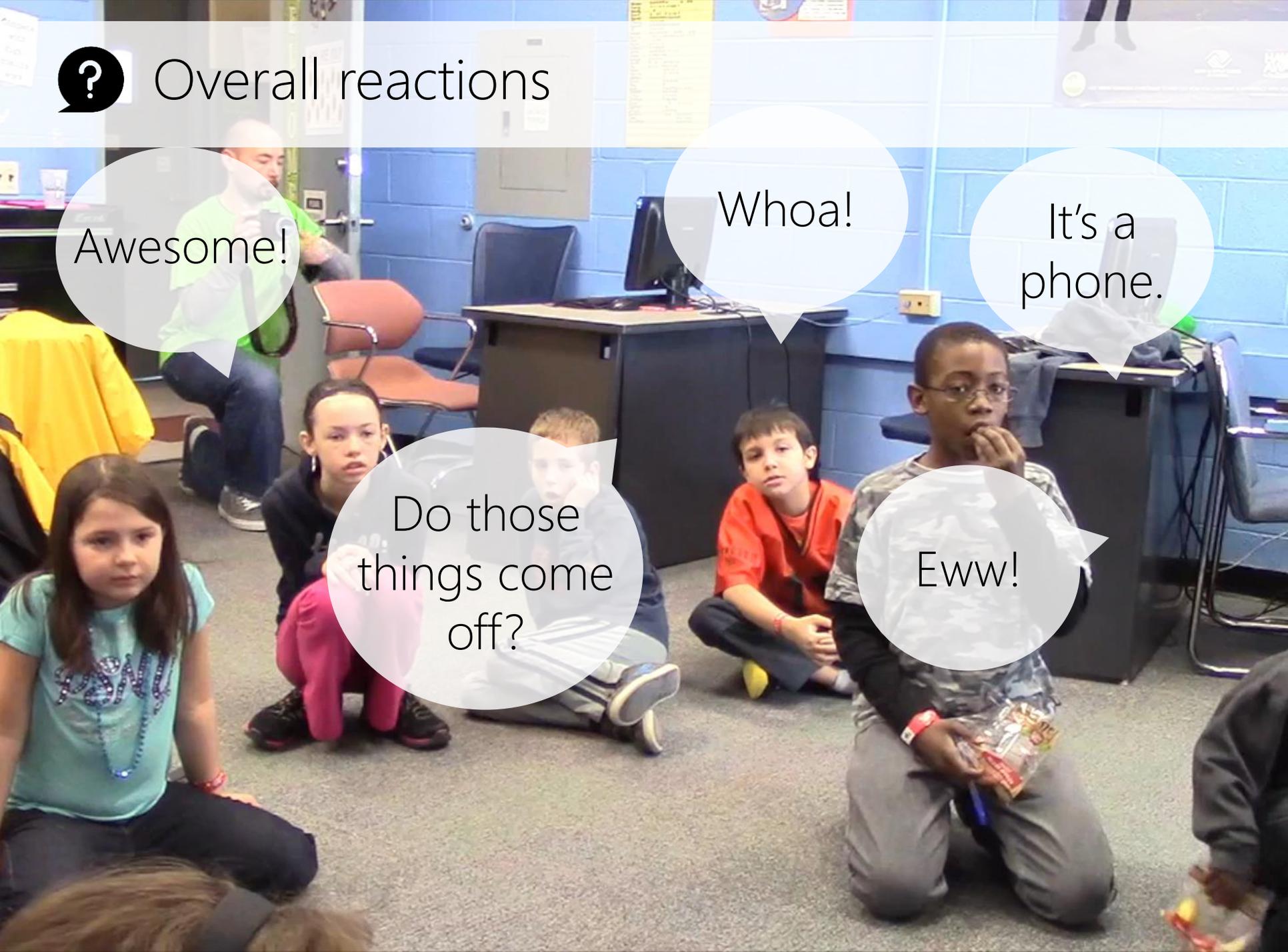
Awesome!

Whoa!

It's a phone.

Do those things come off?

Eww!



Deployment Findings



Overall reactions



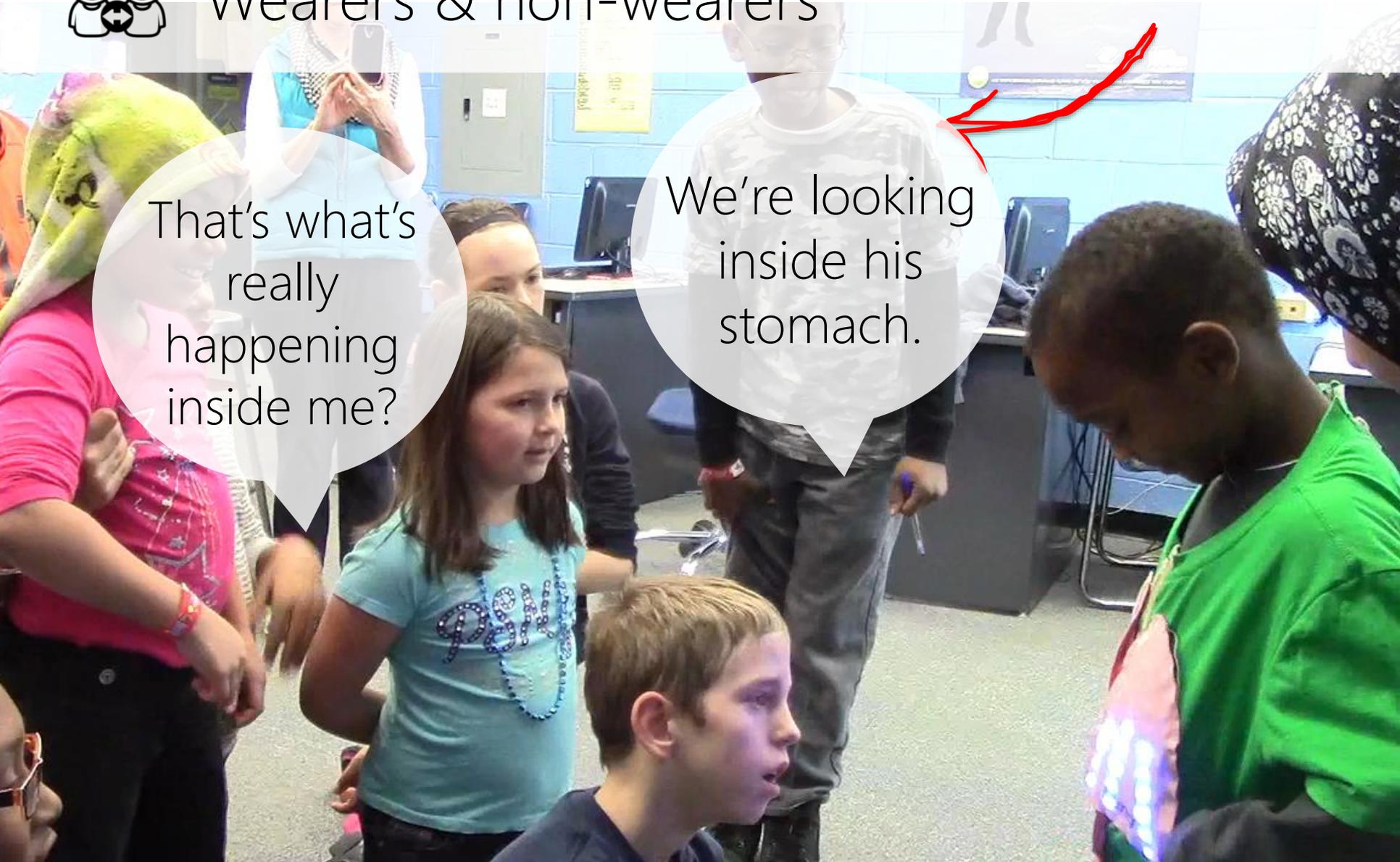
Wearers & non-wearers



Wearers & non-wearers

That's what's really happening inside me?

We're looking inside his stomach.



Deployment Findings



Overall reactions



Wearers & non-wearers



Removing/reattaching organs

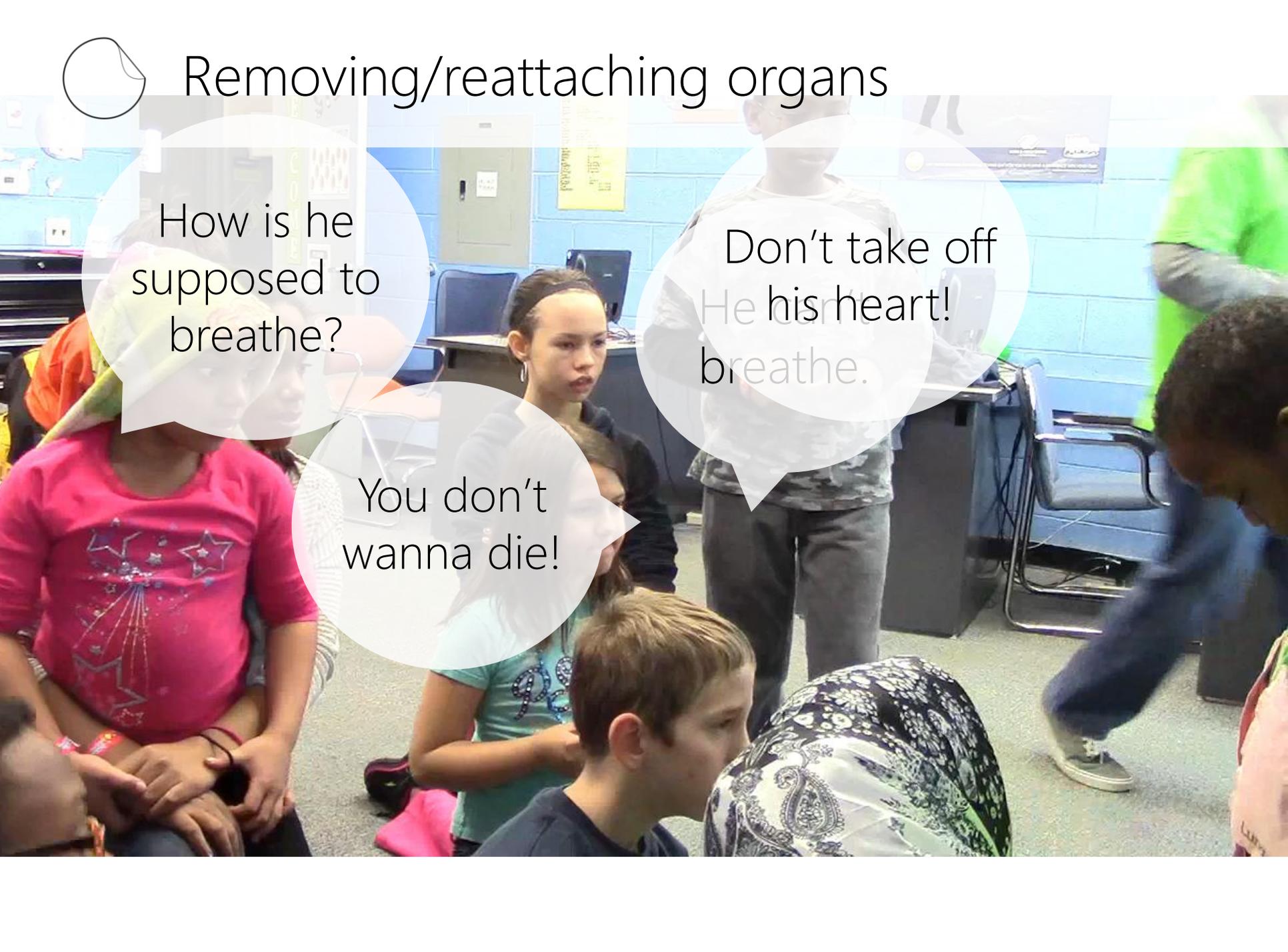


Removing/reattaching organs

How is he supposed to breathe?

Don't take off
He his heart!
breathe.

You don't
wanna die!





Removing/reattaching organs



Site 1



Site 2

Deployment Findings



Overall reactions



Wearers & non-wearers

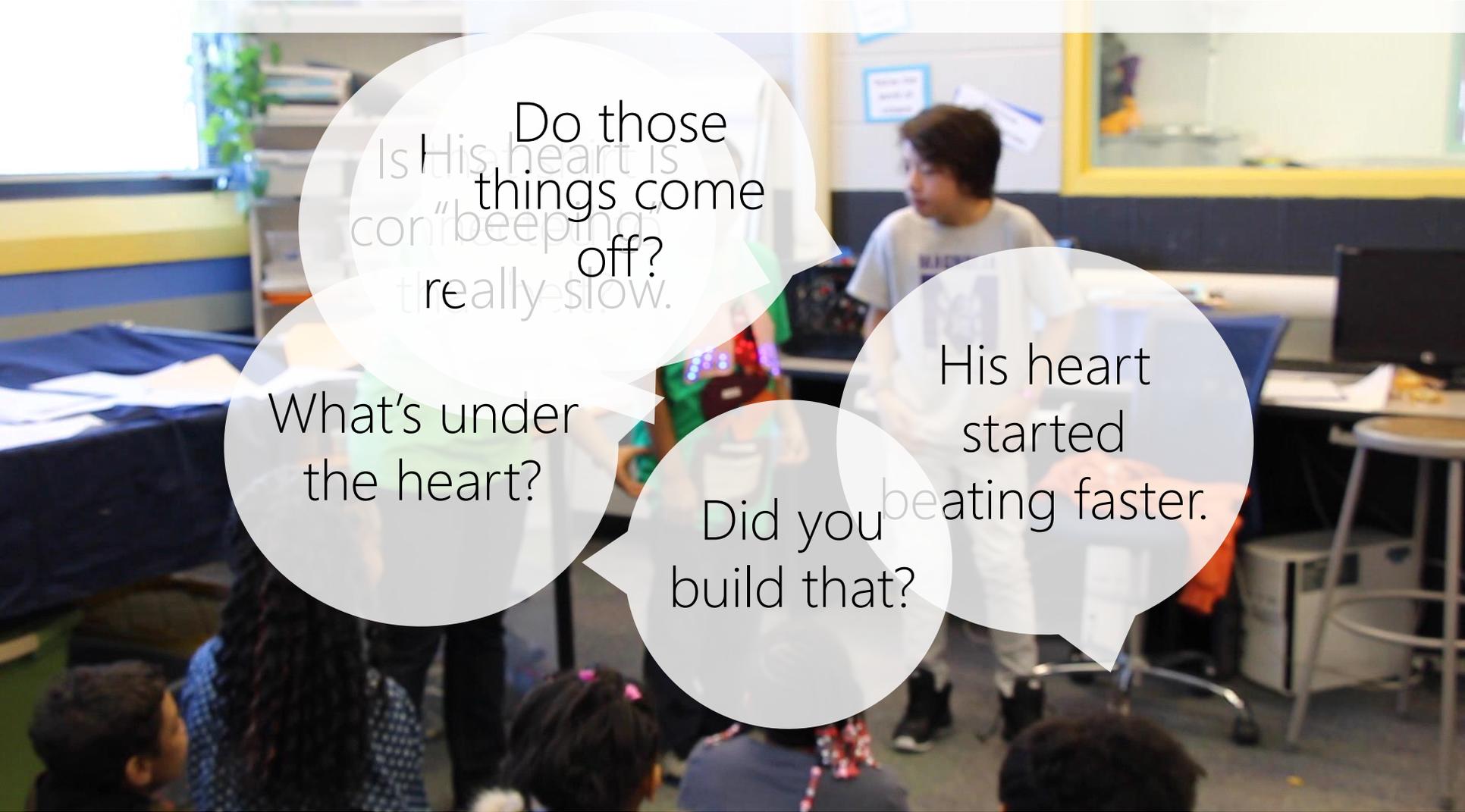


Removing/reattaching organs



Common questions/observations

?! Common questions/observations



Do those things come off?
Is his heart is really slow.
"beepings"

What's under the heart?

Did you build that?

His heart started beating faster.

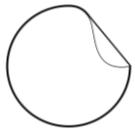
Deployment Findings



Overall reactions



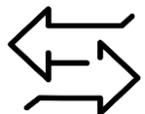
Wearers & non-wearers



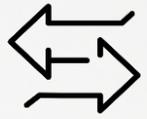
Removing/reattaching organs



Common questions/observations



Disembodied BodyVis



Disembodied BodyVis

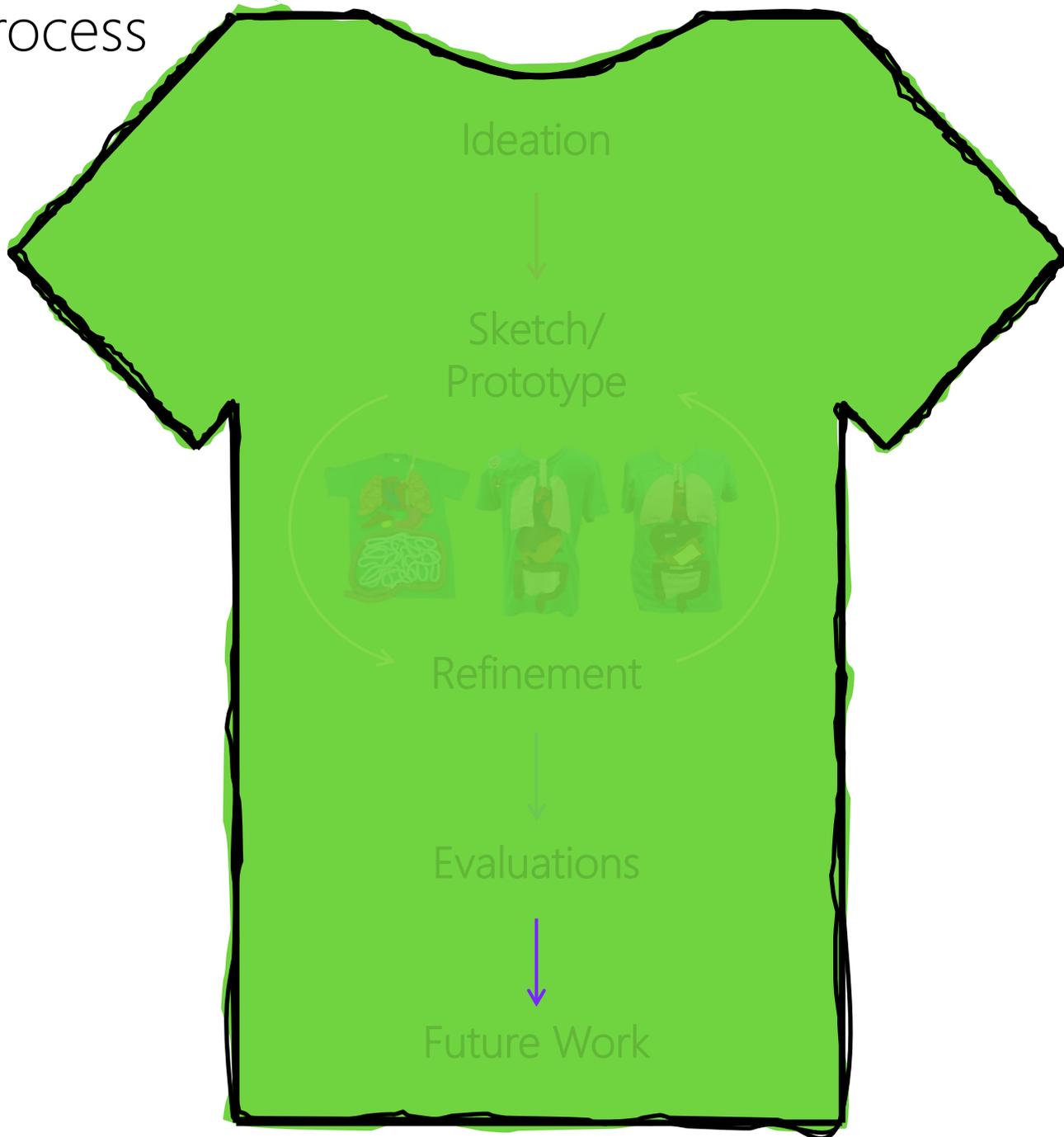


Bioharness

Working,
Cool science,
Mentors,
Trips,
Team work,
Competitions,
...and fun!



Design Process



Representation

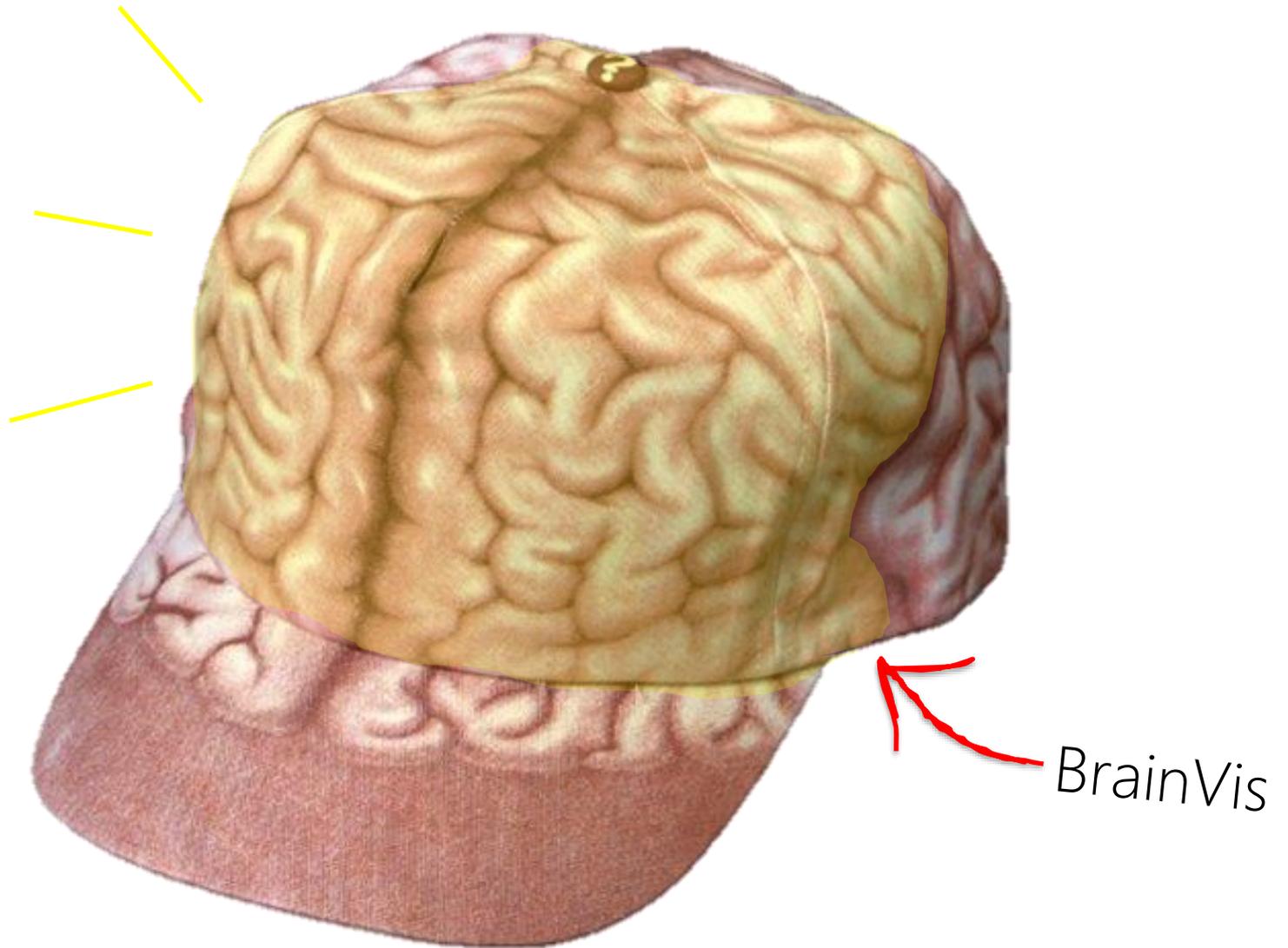
Prototype 1: Blood Flow



Prototype 3: Air Flow



Expanding Body Parts



Health Literacy



Summary

This work contributes to the field of **wearables** and **tangibles** for learning.

We introduce a new approach and system called BodyVis for **children's body learning**, which combines **biometric sensing** and **interactive visualization** to provide new insights into anatomy and physiology.



The BodyVis Team



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