MULTIMODAL INTERACTION DESIGN AND INPUT DEVICES

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OVERVIEW

Interaction Design Principles (GUI Versus Physical Computing)

Input Devices

- Properties, Transfer functions

Multimodal Interaction – definition and advantages

Feedback

- Non-Speech Audio Feedback
- Haptic Feedback
- Toys
- TUIs

DESIGN PRINCIPLES

Visibility

Feedback

Constraints

Mapping

Consistency

Affordance

Norman, D. (2013). *The design of everyday things: Revised and expanded edition*. Basic Books (AZ).

VISIBILITY

Modern faucets

It is not visible as to what to do!

VISIBILITY

Modern faucets

It is not visible as to what to do!

- Make relevant parts visible
- Add labels or audio feedback if necessary

FEEDBACK

Sending information back to the user about what has been done

Includes sound, highlighting, animation and combinations of these

- e.g. when screen button clicked on provides sound or red highlight feedback

Also, haptic feedback!

- This is particularly relevant for physical computing!

CONSTRAINTS

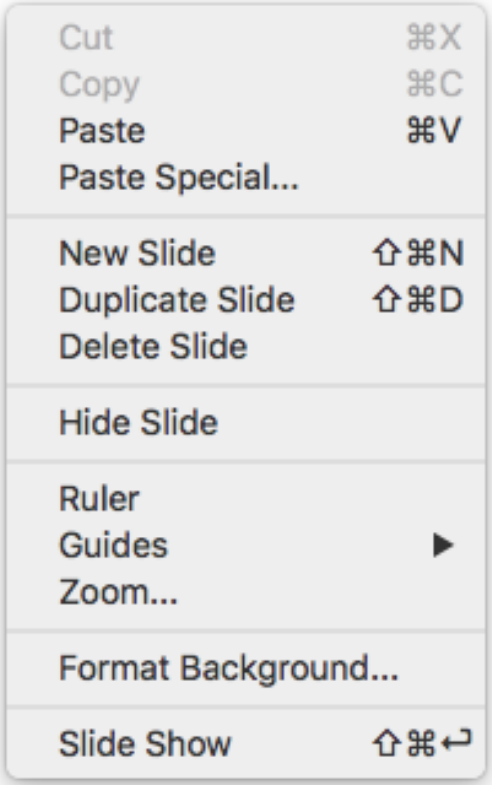
Restricting the possible actions that can be performed

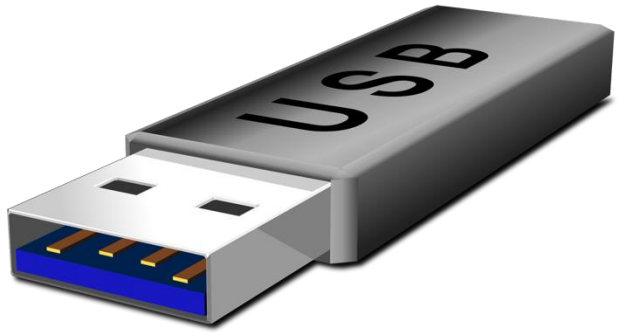
Helps prevent user from selecting incorrect options

Physical objects can be designed to constrain things

- e.g. only one way you can insert a key into a lock

CONSTRAINTS





MAPPINGS

Where do you plug the mouse?

Where do you plug the keyboard?

- top or bottom connector?

Do the color coded icons help?

From baddesigns.com

AFFORDANCES

Refers to an attribute of an object that allows people to know how to use it

- e.g. a mouse button invites pushing, a door handle affords pulling

Norman (1988) used the term to discuss the design of everyday objects

Since has been much popularised in interaction design to discuss how to design interface objects

- e.g. scrollbars to afford moving up and down, icons to afford clicking on

AFFORDANCES IN GUIS AND PHYSICAL COMPUTING

According to Norman, GUIs are virtual and do not have affordances like physical objects

GUIs are better conceptualized as 'perceived' affordances

- Learned conventions of arbitrary mappings between action and effect at the interface

In Physical Computing, you have a combination of 'real' affordances and 'perceived' affordances.

Be aware that there are several other definitions of affordances

DESIGNED AND PURPOSEFUL CHAOS?

Purposefully designing products that play with the mentioned design principles might incite users to different styles of use?

Obscuring visibility –entice users to explore use?

Inconsistent feedback –generate curiosity?

Incorrect mappings and affordances –challenging preconceptions?

Yellow Blue Black

DESIGNING INPUT DEVICES

INPUT DEVICES

Input devices sense physical properties of people, places, or things.

An interaction designer must consider:

- The physical sensor
- Feedback
- Ergonomics
- Interplay between all of the interaction techniques.

PROPERTIES

Most devices sense

- Linear position
- Motion, or force

Rotary devices sense

- Angle
- Change in angle
- Torque

This determines the mapping from input to output, or transfer function.

PROPERTIES

Number of Dimensions: devices sense 1+ input dimensions e.g.

- a basic mouse senses 2 linear dimensions of motion
- a knob senses 1 angular dimension
- a 6 degree-of-freedom magnetic tracker measures 3 position dimensions and 3 orientation dimensions.

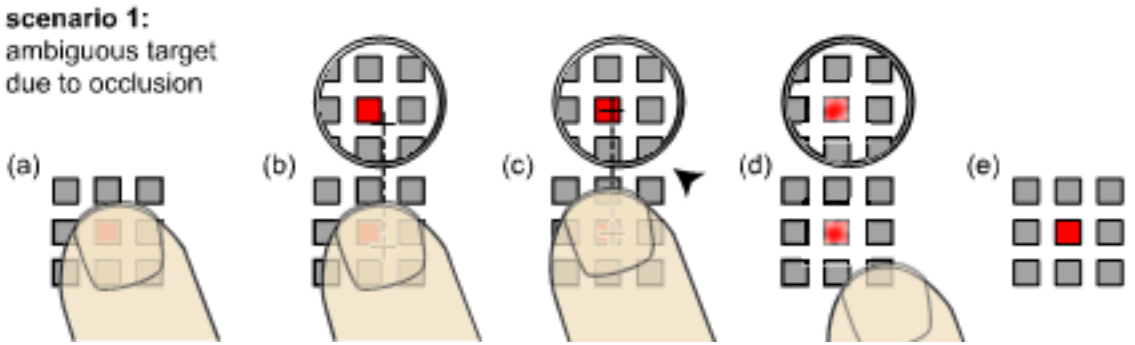
PROPERTIES

Indirect vs. Direct:

- Mouse: indirect input device (the user must move the mouse to indicate a point on the screen)
- Touchscreens: direct input device (the device has a unified input and display surface)
- Direct devices are not necessarily easier to use than indirect devices
  - Lack of buttons
  - Occlusion

OCCLUSION

Daniel Vogel and Patrick Baudisch. 2007. Shift: a technique for operating pen-based interfaces using touch. In Proceedings of CHI '07. ACM. DOI: https://doi.org/10.1145/1240624.1240727



PROPERTIES

Usability aspects to consider:

Device acquisition time: the average time to move one's hand to a device

Homing time: the time to return from a device to a"home" position (e.g. return from mouse to keyboard).

PROPERTIES

Additional metrics:

- pointing speed and accuracy
- error rates
- learning time
- footprint
- user preference
- comfort
- cost

Other important engineering parameters include sampling rate, resolution, and accuracy

TRANSFER FUNCTIONS

TRANSFER FUNCTIONS

A transfer function is a mathematical transformation that scales the data from an input device.

A transfer function that matches the properties of an input device is known as an appropriate mapping.

For force sensing input devices, the transfer function should be a force-to-velocity function:

- E.g., the force one exerts on the IBM Trackpoint isometric joystick controls the speed at which the cursor moves.

Other appropriate mappings include position-to-position or velocity-to-velocity functions, used with tablets and mice, respectively.

TRANSFER FUNCTIONS

A common example of an inappropriate mapping is calculating a velocity based on the position of the mouse cursor

- such as to scroll a document.

The resulting input is difficult to control

FURTHER READING

Hinckley, K., Jacob, R. J., Ware, C., Wobbrock, J. O., & Wigdor, D. (2014). Input/Output Devices and Interaction Techniques.

SUMMARY

Interaction Design Principles (GUI Versus Physical Computing)

Input Devices

- Properties
- Transfer functions

MULTIMODAL INTERACTION

OVERVIEW

Multimodal Interaction – definition and advantages

Feedback

- Feedback Issues

Non-Speech Audio Feedback

Haptic Feedback

Sensory Substitution and Assistive Technology

TUIs

MULTIMODAL INTERACTION

Interaction with the virtual and physical environment through natural modes of communication

- i. e. the five human senses (de fem sanser)
- Føle-, lugte-, smage-, høre- og synssansen

Human interaction with the world is inherently multimodal

This applies to input and output.

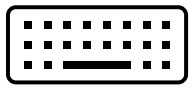
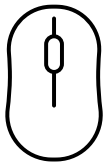
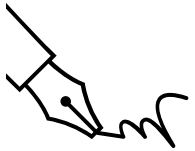
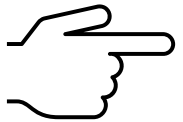




DEFINITIONS

Multimodal input means using two or more types of input

- speech, pen, touch and multi-touch, gestures, gaze, head and body movements, and virtual keyboard.


DEFINITIONS

Multimodal output means the system gives feedback through two or more ways

- like a visual display with sound or touch feedback (e.g. your phone)

ADVANTAGES OF MULTIMODAL INTERACTION

Help **match** the user's **ability** to sense and communicate.

Combine computer skills with real-world tasks by making human-computer interaction feel more **natural**.

Improve **reliability** by using multiple sources of information.

Personalize the experience by using different types of input based on what the user prefers or needs.

- If one type of input isn't available (e.g., noisy places), another can be used to keep the interaction going.

FEEDBACK

FEEDBACK

Active feedback is under computer control.

Passive feedback is not, and may result from internal sensations within the user's own body

ACTIVE FEEDBACK

Visual feedback

Mechanical sounds and vibrations produced by a device provide positive feedback for the user's actions.

PASSIVE FEEDBACK

The shape of the device and the presence of landmarks can help users acquire a device without having to look at it.

Proprioceptive and Kinesthetic Feedback - internal sensations of body posture, motion, and muscle tension may allow users to feel how they are moving an input device without looking at the device

- This is important when the user's attention is divided between multiple tasks and devices.

FEEDBACK ISSUES

FEEDBACK ISSUES - KINESTHETIC CORRESPONDENCE

Graphical feedback on the screen should correspond to the direction that the user moves the input device.

However, users can easily adapt to certain kinds of non-correspondences:

- when the user moves a mouse forward and back, the cursor actually moves up and down on the screen.

FEEDBACK ISSUES - LATENCY

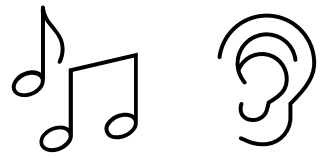
Feedback timing is incredibly important

Even more for haptic feedback (>58 milliseconds) than visual feedback (75-100 milliseconds)

Topi Kaaresoja, Eve Hoggan, and Emilia Anttila. 2011. Playing with tactile feedback latency in touchscreen interaction: two approaches. In Proceedings of INTERACT'11, Springer-Verlag.

NON-SPEECH AUDIO FEEDBACK

NON-SPEECH AUDIO FEEDBACK



Boings, bangs, squeaks, clicks etc.

Commonly used for warnings and alarms

Evidence to show they are useful

- fewer typing mistakes with key clicks
- video games harder without sound

Language/culture independent, unlike speech

EARCONS (ABSTRACT, MUSICAL SOUNDS)

DSB Jingle (direkte lydlink)

DSB jinglen (DSB gavotte) er udarbejdet af komponisten Niels Viggo Bentzon (1919-2000) i 1984. Grundtemaet blev i forskellige udførelser anvendt som opmærksomhedssignal på stationer, i tog og på færger. Desuden blev temaet også benyttet som telefonventetone på en række DSB stationer. Den letgenkendelige jingle består af tonerne D Eb Bb, der udtales DSB.

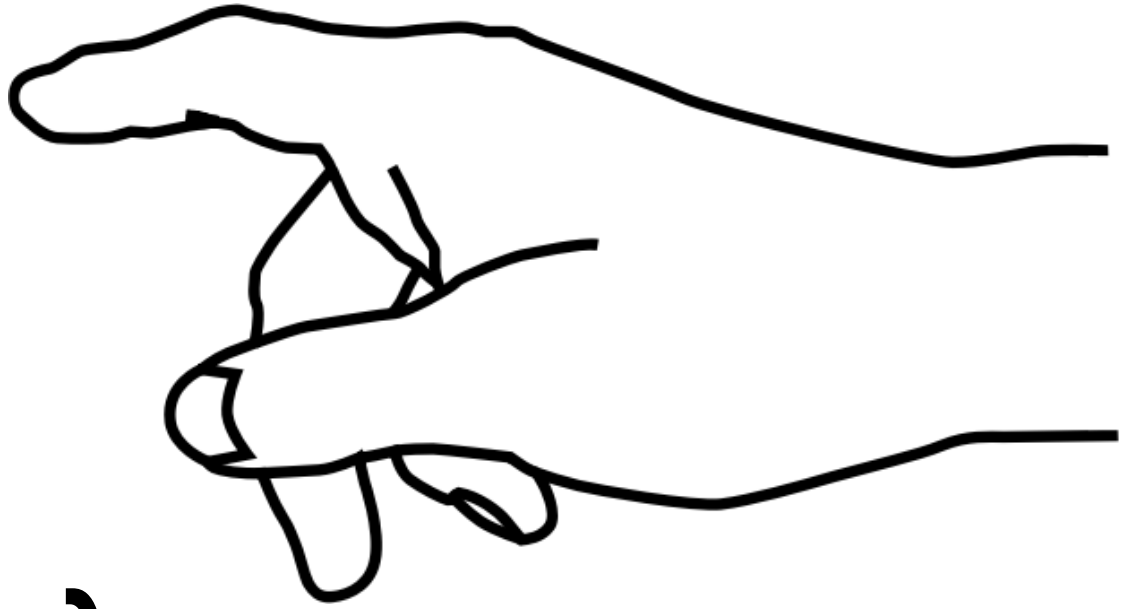
AUDITORY ICONS (EVERYDAY SOUNDS)

The SonicFinder, An Interface That Uses Auditory Icons

William W. Gaver

University of California, San Diego
and
Apple Computer, Inc.

HAPTICS (TOUCH)



HAP·TIC ('HAP-TIK)

adj. Of or relating to the sense of touch.
[Greek haptikos, from haptesthai, to grasp, touch. (1890)]


07:30
DRV2603 CapTouch EVK
A/1 B/2
SELECT

HAPTIC INTERFACES

The study of haptic interfaces focuses on human touch and interaction with the environment through touch.

Touch-based feedback is used less in today's interactive systems compared to sound and visuals.

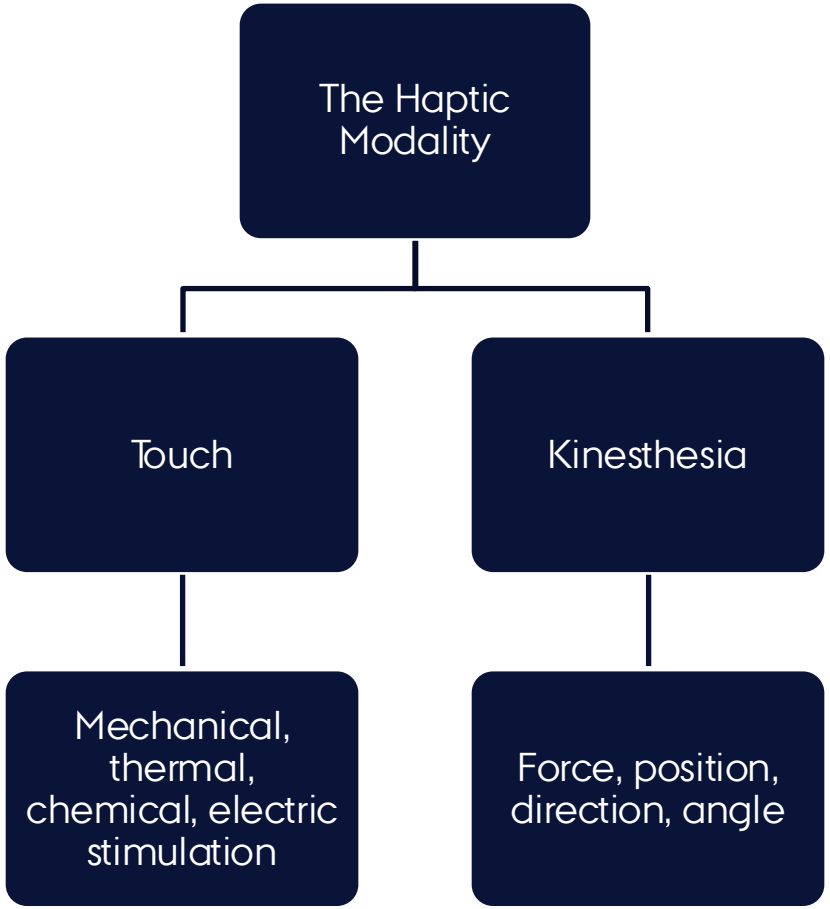
By adding haptic feedback to user interfaces, we can recreate the physical sensation of pressing a button, holding a ball or even create completely new touch sensations.

MOBILE TOUCHSCREENS

Touchscreens don’t have physical keyboards

Touchscreen buttons cannot provide the natural haptic response that physical buttons can when touched

Short vibrations when you touch buttons or icons on the screen make devices easier to use


The Haptic Modality
Touch
Kinesthesia
Mechanical, thermal, chemical, electric stimulation
Force, position, direction, angle

OTHER TYPES OF HAPTIC FEEDBACK

FORCE-FEEDBACK DEVICES

Force feedback devices apply pressure to the user's hand.

- Categorized according to the degrees of freedom (DOF).
  - 1 DOF: steering wheels;
  - 2 DOF: joysticks;
  - 3 to 6 DOF: high-precision devices

http://www.sensable.com/

DYNAKNOB

Reshaping Interaction with Rotary Knobs:
Combining Form, Feel and Function

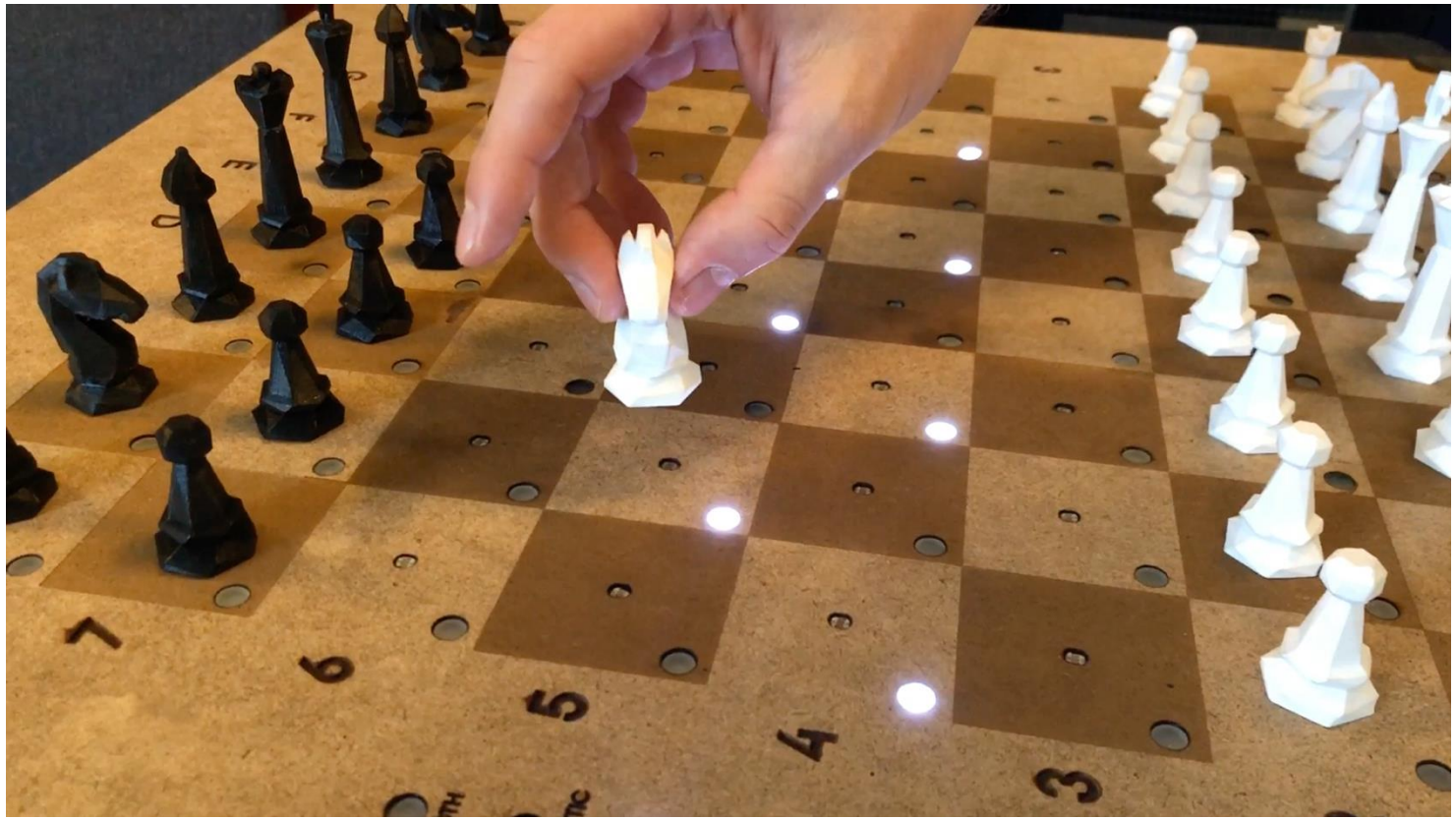
Anke van Oosterhout
Eve Hoggan

AARHUS
UNIVERSITY

DIS2020

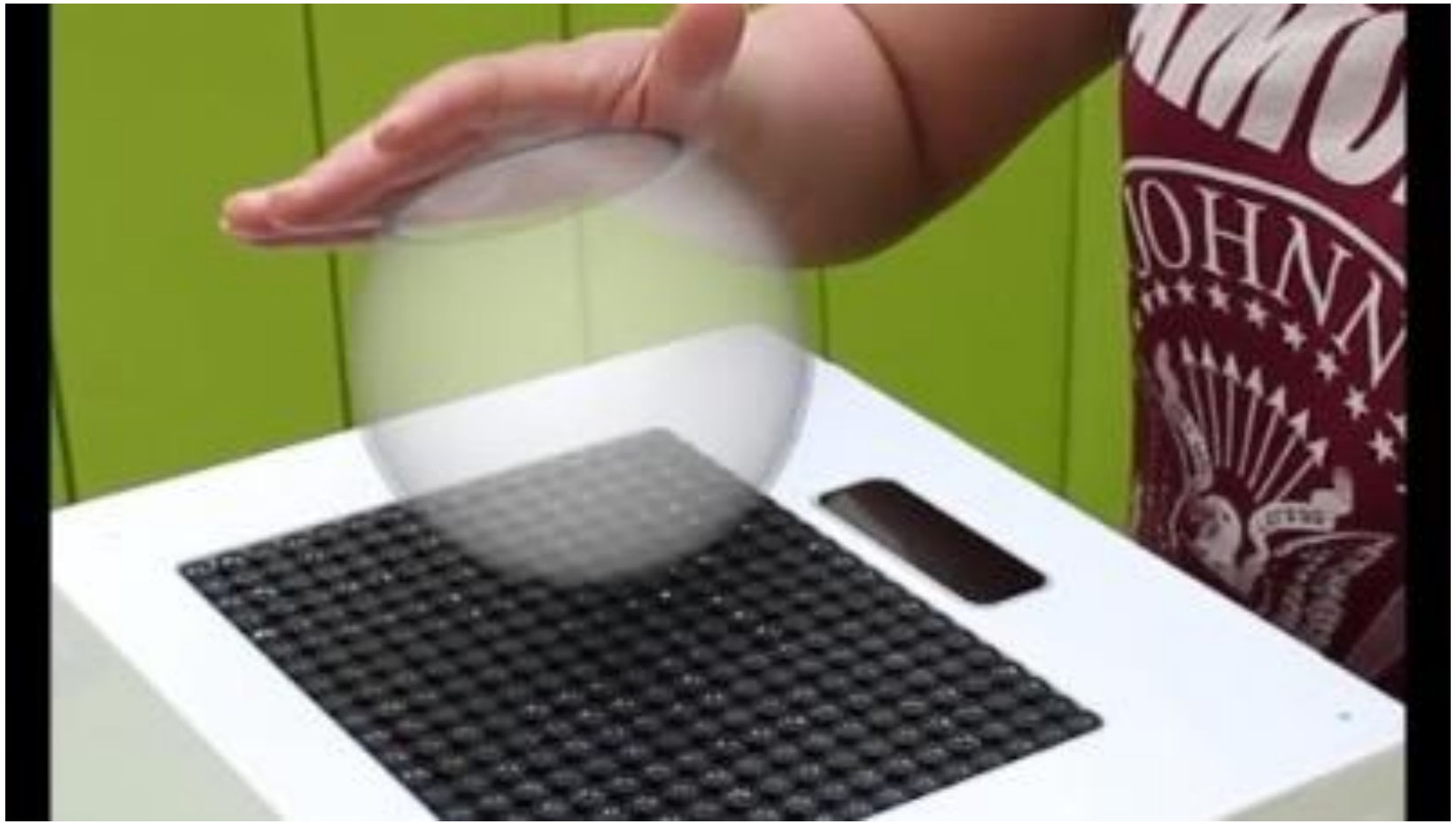
MAGNETS

MAGNETIC HAPTIC FEEDBACK



MID-AIR TOUCH

ULTRASONIC TOUCH

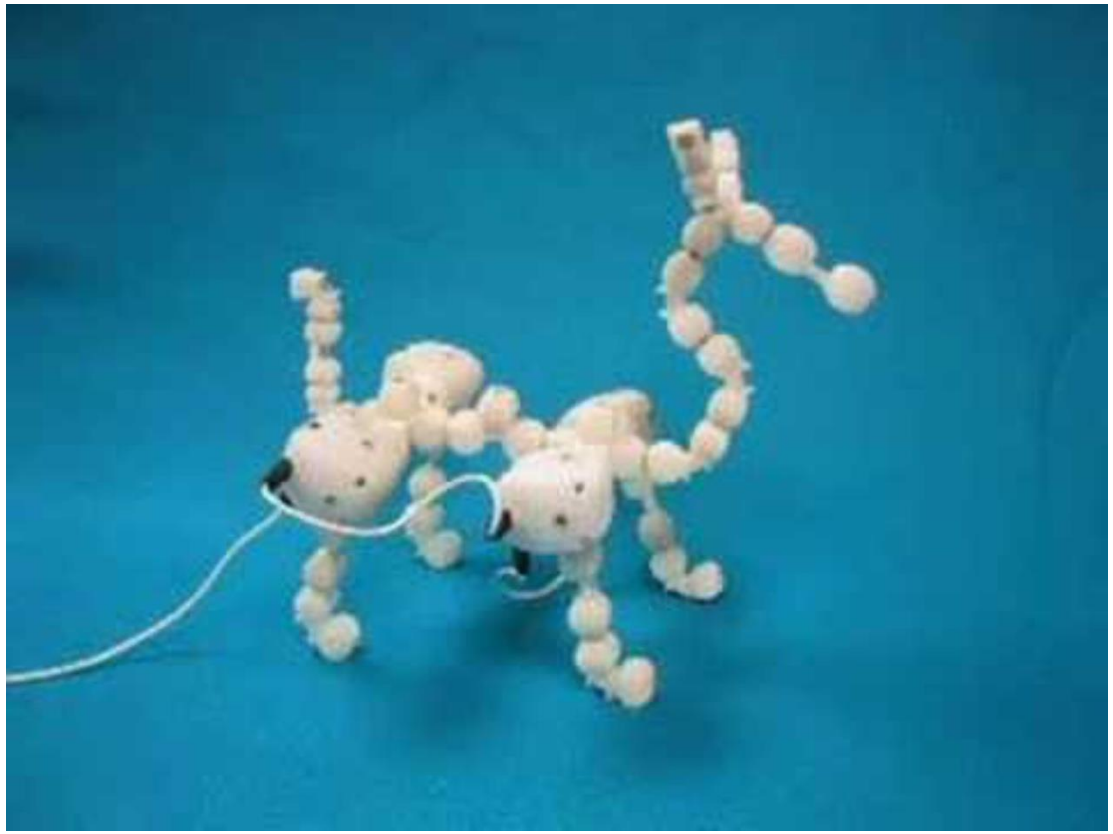


MULTIMODAL TOYS

Learning Method	Retention
Hearing	26%
Seeing	30%
Seeing and hearing	50%
Speaking	70%

J.E. Stice, Engineering Education, pp. 291-296, 1987

TOPOBO 2003 MIT HAYES RAFFLE



SIFTEO CUBES


BUSINESS
INSIDER

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Feedback

- Non-Speech Audio Feedback
- Haptic Feedback
- Toys
- TUIs

BUYING YOUR OWN TOOLS - SUGGESTIONS

Soldering iron

https://www.av-cables.dk/loddekolbe-2/

https://arduinotech.dk/shop/ts100-soldering-iron-65w-digital-lcd-oled-programmable-controller/

https://dk.rs-online.com/web/p/loddestationer/2237521?gb=b

Hand tools –various, ifixittoolkits are pretty good

https://www.proshop.dk/Kabinet-Tilbehoer/iFixit-Essential-Electronics-Toolkit/2688175

https://www.proshop.dk/Kabinet-Tilbehoer/iFixit-Pro-Tech-Toolkit/2688173

BUYING YOUR OWN TOOLS - SUGGESTIONS

Multimeters–buy an autoranging one if you can

https://www.av-cables.dk/multitester/professionel-digital-multitester-mtm01.html

https://elektronik-lavpris.dk/p116581/dmt-2010-digital-multimeter/

Components, wires, soldering tin etc.

https://www.amazon.de/Elegoo-%C3%9CBERARBEITETES-Stromversorgungsmodul-Jumperkabel-Potentiometer/dp/B01M7N4WB6/ref=sr_1_6?keywords=arduino-set&qid=1566984170&s=gateway&sr=8-6

BRING ARDUINO NEXT WEEK

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