

# Sonification:

## Sound as Information Carrier in HCI



# What is Sonification?

Sonification is the use of non-speech audio to represent data and information.

<http://www.icad.org/websiteV2.0/References/nsf.html>



- What is Sonification?
  - Non-speech audio à info
- When Using Sonification in HCI?
- Why Sonification Works?
- How to Sonify Information?
- How to Design Sonification?



# When Visual Communication Fails



Eyes Blocked



Eyes Occupied



Eyes Fooled



Eyes Alone cannot Provide Full Experiences

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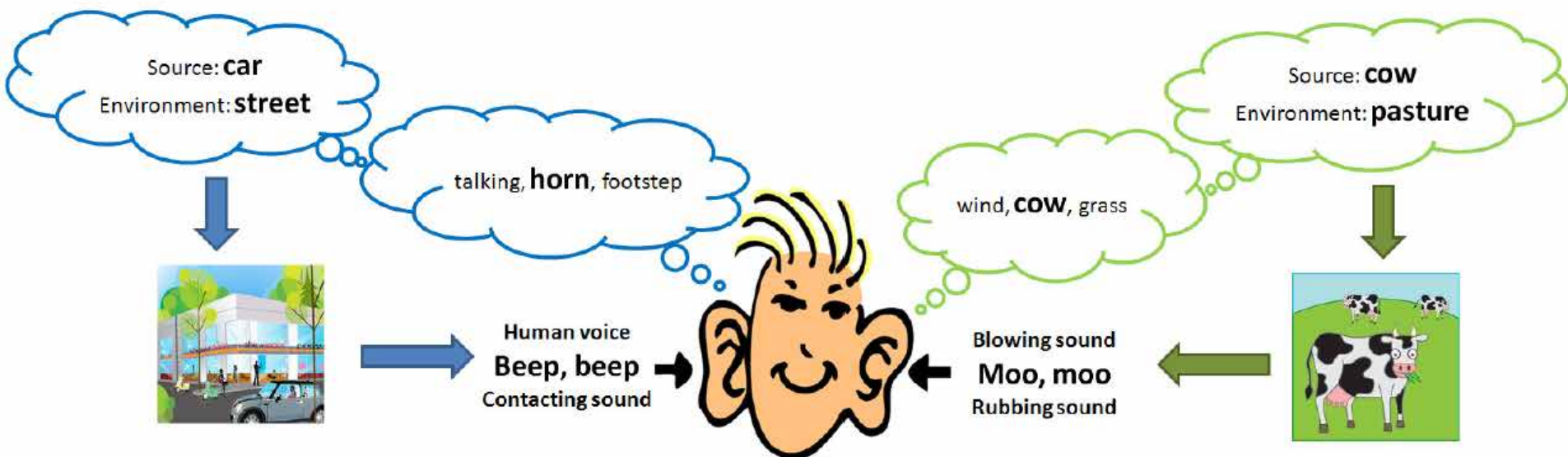




# Music vs. Everyday Listening



- Music Listening: capture the pitch, loudness, timbre, and changes of the sounds
- Everyday Listening: perceive auditory events (e.g. the sources, position and interactions)



(Gaver, 1993)



- What is Sonification?
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- When Using Sonification in HCI?
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- Why Sonification Works?
  - Everyday and music listening
- How to Sonify Information?
  - Computer events
  - Real world information
  - Large-scale data
- How to Design Sonification?

# Computer Event 1: Earcon

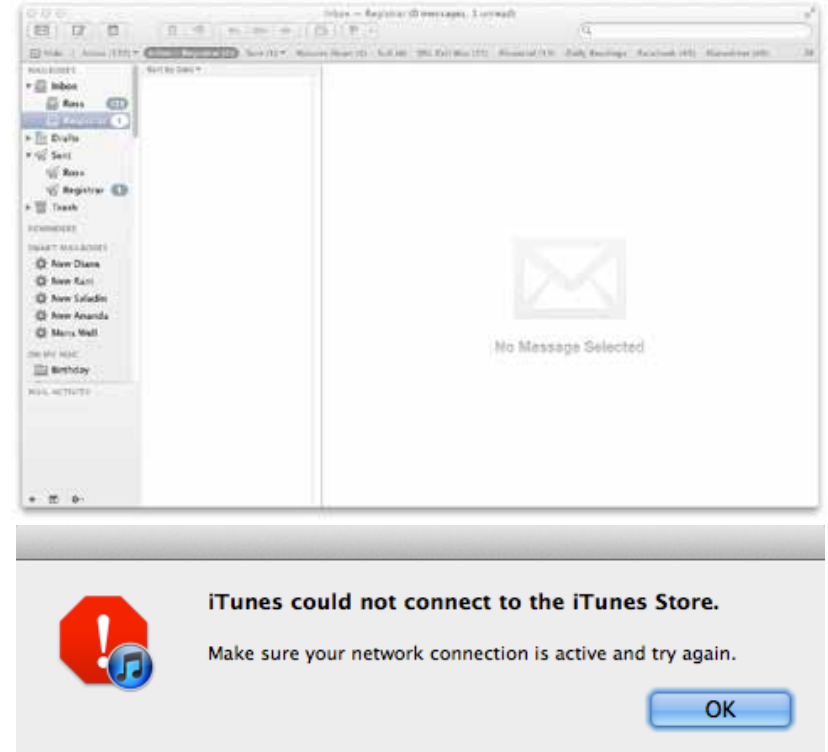
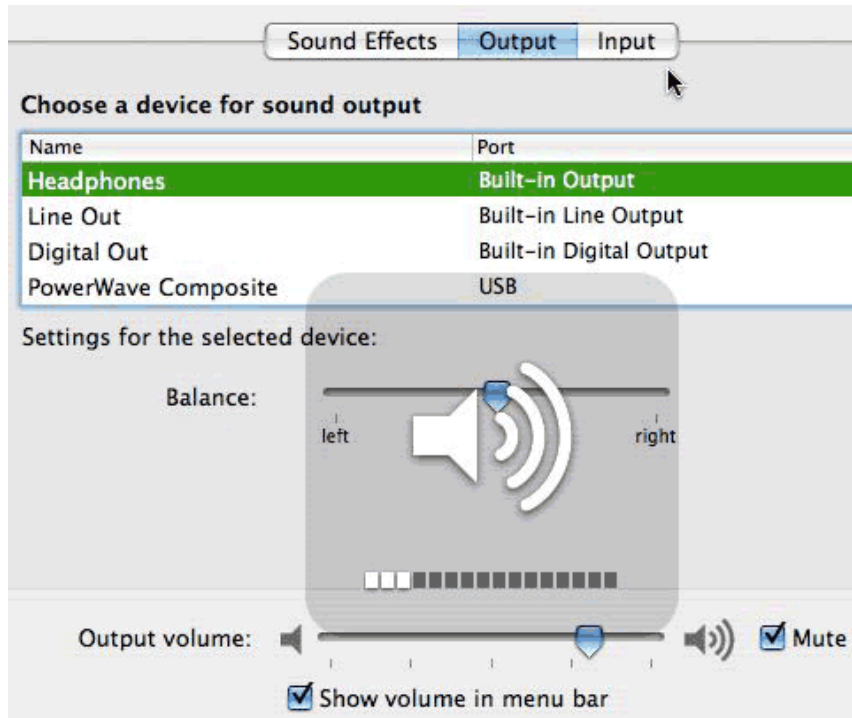


- **Non-verbal audio messages** about some **computer object, operation or interaction** on a UI
- Brief **successions of pitches** arranged in such a way as to produce a **tonal pattern** (pitch, timbre, rhythm, register, and dynamics)

(Blattner, 1989; Brewster, 1998)



# Computer Event 2: Auditory Icon



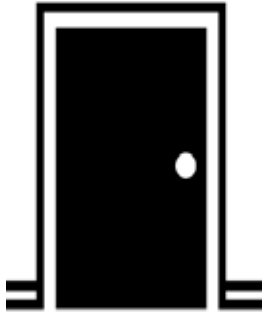
- Everyday sounds used in a computer to help match the computers events

(Gaver, 1989; Garzonis, 2009)

# Real World 1: Musicon



Lock the Door



Rembrandts :  
“I’ll be there for you”

Take your Keys



Ray Parker:  
“Ghostbusters”

Take your Medicine

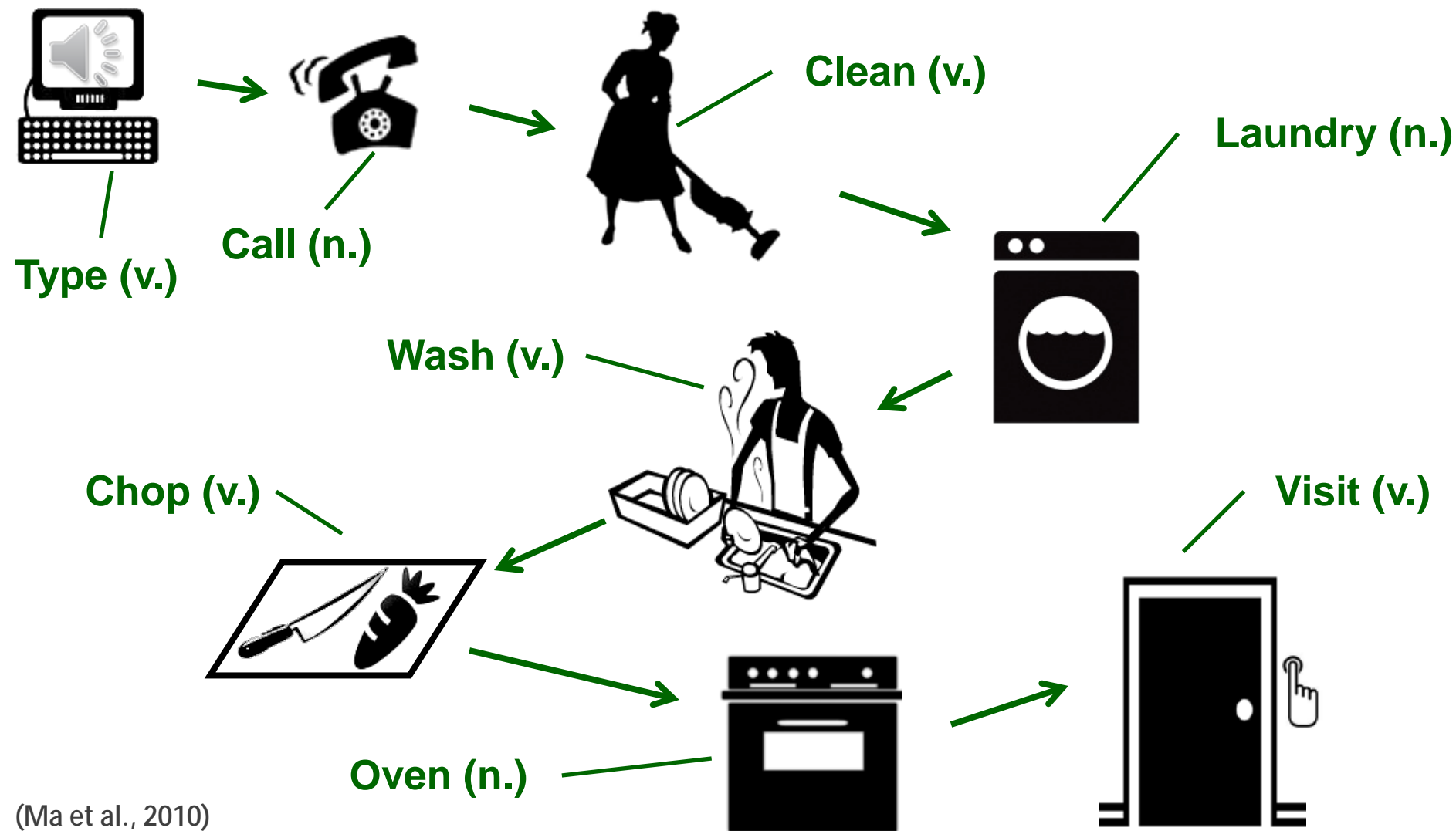


John Williams:  
“Jurassic Park”

- Musicons are shorts clips of instrumental music used for information presentation

(McGee-Lennon et al., 2011)

# Real World 2: Soundnail



(Ma et al., 2010)

Sort by

Cheapest

▼

coles express

Coles North Perth

247 Walcott Street

117.7

woolworths

Woolworths Morley

60 Russell St Cnr Walter Rd

118.9

woolworths

Woolworths Floreat

Lot 100 Floreat Forum Shop Cntr

118.9

woolworths

Woolworths Dianella

372 Grand Promenade

118.9

woolworths

Woolworths Osborne

401 Scarborough Beach Rd

118.9

united

United Mount Lawley

791 Beaufort Street

120.7

United Northbridge

31 Fitzgerald Street

Northbridge, WA, 6003

122.5

6 hours ago

Call

Directions

Buy fuel

Edit station

Delete

Update price

148

126

136

148

123

125

148

129

148

126

148

coles express

woolworths

united

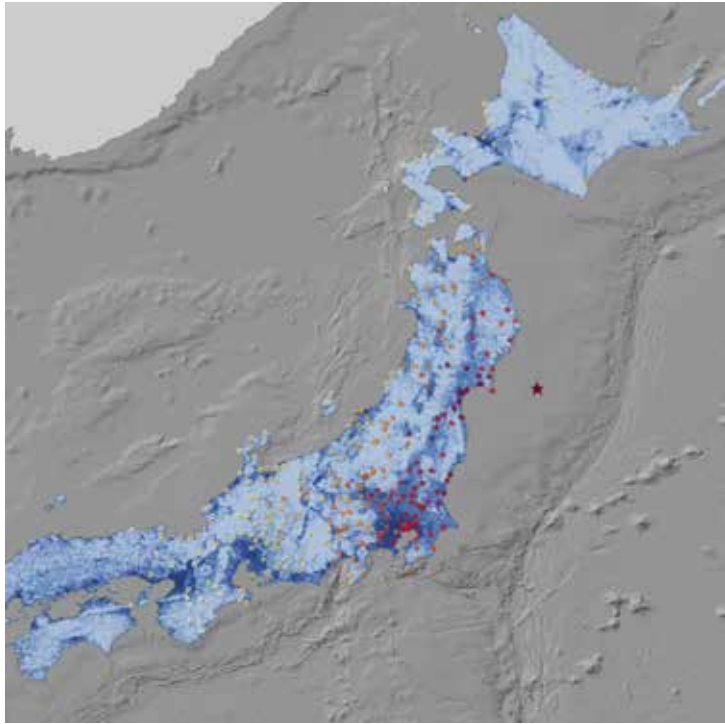
coles express

woolworths

COMP4901G Xiaojuan Ma

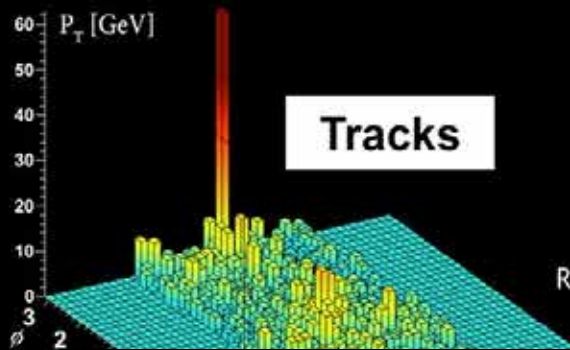
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# Big Data: Open Your Ears to Data



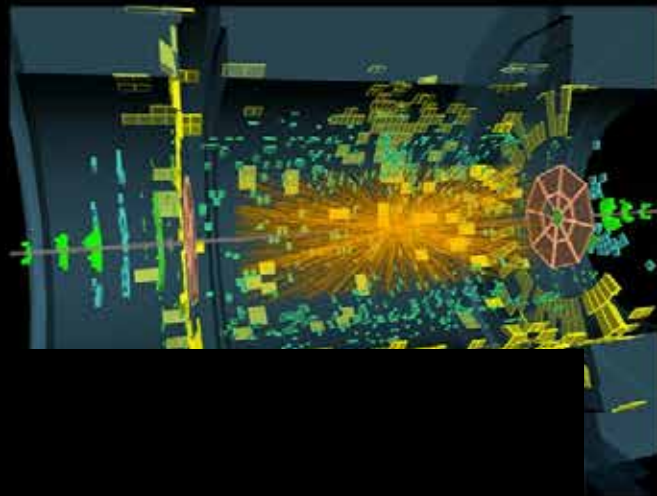
- Auditory display is the use of sound to communicate information and data from a computer to the user.



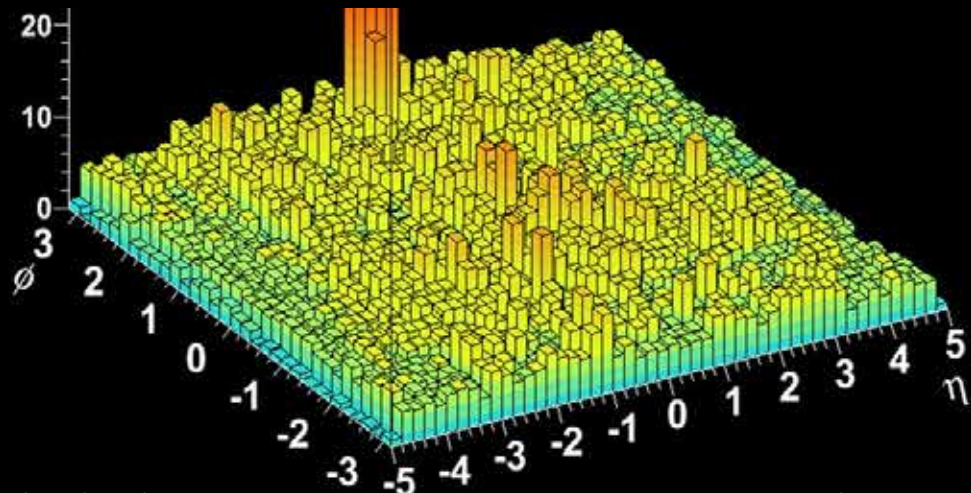
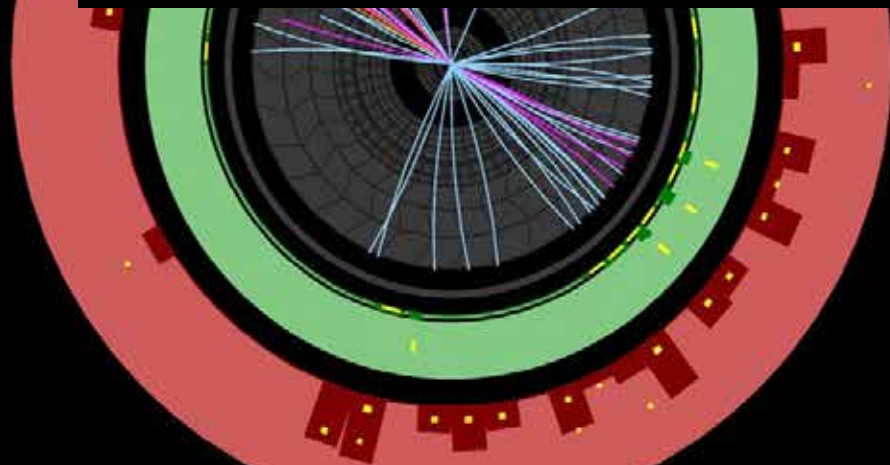


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# The Higgs Boson Song : A Sonification of the ATLAS Data by Domenico Vicinanza





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# Sonification Design Guidelines?



- Use Distinctive Sounds
  - e.g. Glass clicking instead of glass scratching
- Use Familiar Sounds
  - e.g. Songs that people would relate to
- Use Unambiguous Sounds
  - e.g. Crowd sound to distinguish a swimming pool from a lake instead of just using water sound

# Research Directions



- Cultural and Age Differences
  - Culture: e.g. Christmas sounds for holiday
  - Age  
  - Others such as gender differences
- Combination of Sounds and Pictures
  - Complementing/enhancing each other?
  - Distracting/confusing when not matched?

# References



- Gaver, William W. "Everyday listening and auditory icons." PhD diss., University of California, San Diego, 1988.
- Gaver, William W. "Auditory icons: Using sound in computer interfaces." *Human-computer interaction* 2, no. 2 (1986): 167-177.
- Brewster, Stephen A., Peter C. Wright, and Alistair DN Edwards. "An evaluation of earcons for use in auditory human-computer interfaces." In *Proceedings of the INTERACT'93 and CHI'93 conference on Human factors in computing systems*, pp. 222-227. ACM, 1993.
- Blattner, Meera M., Denise A. Sumikawa, and Robert M. Greenberg. "Earcons and icons: Their structure and common design principles." *Human-Computer Interaction* 4, no. 1 (1989): 11-44.
- Garzonis, Stavros, Simon Jones, Tim Jay, and Eamonn O'Neill. "Auditory icon and earcon mobile service notifications: intuitiveness, learnability, memorability and preference." In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pp. 1513-1522. ACM, 2009.
- McGee-Lennon, Marilyn, Maria Wolters, Ross McLachlan, Stephen Brewster, and Cordelia Hall. "Name that tune: musicons as reminders in the home." In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pp. 2803-2806. ACM, 2011.

# Thank you J



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# A Full Body Experience

$\frac{3}{4}$  Haptic Communication



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# When Sight and Hearing are Limited



# Definition of Haptic Interaction



- Haptics = touch, tactile, force-feedback, using force/resistance, texture, heat, vibration
- Haptic Interaction
  - Augment the amount of information that can be presented to the user by visual means alone
  - Increase the sense of immersion experienced
- Application Areas of Haptic Interaction
  - Medicine, entertainment, education, robotics, etc.

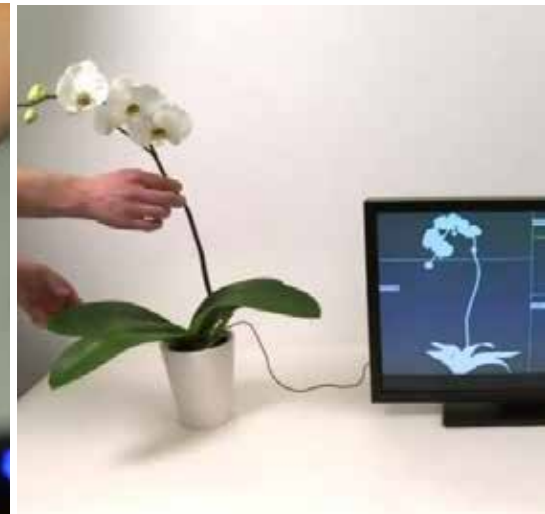
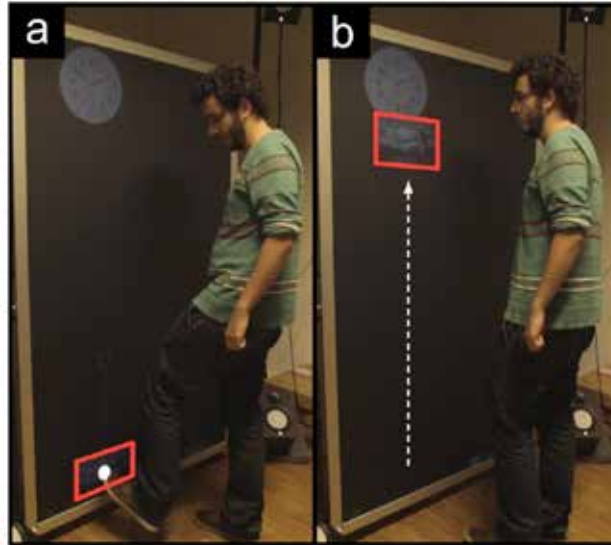
# Haptics as Input – Direction?



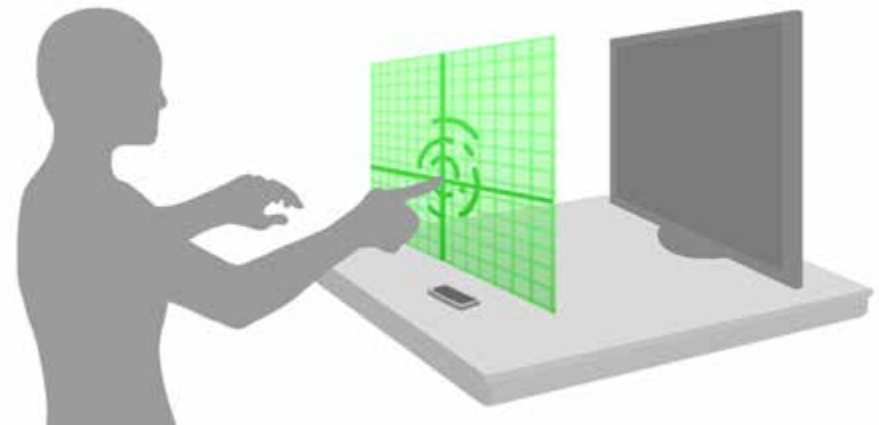
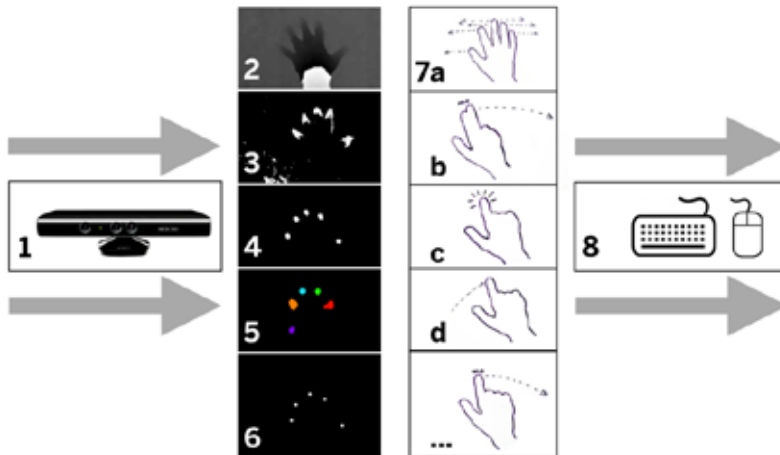
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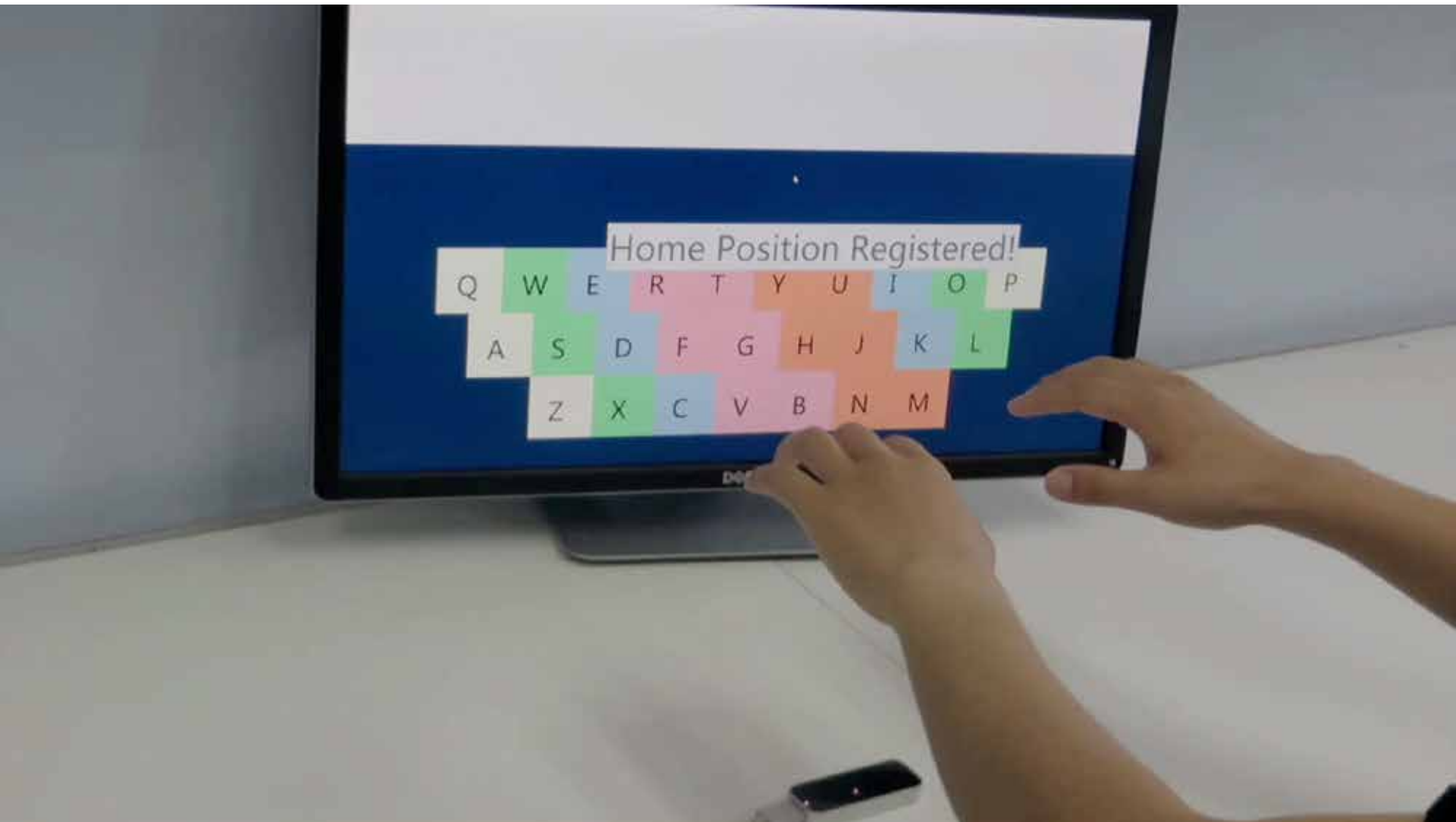


# Haptics as Input (Touch)



# Haptics as Input (Gesture)





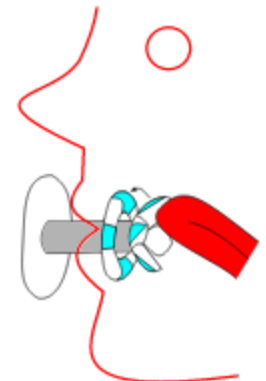
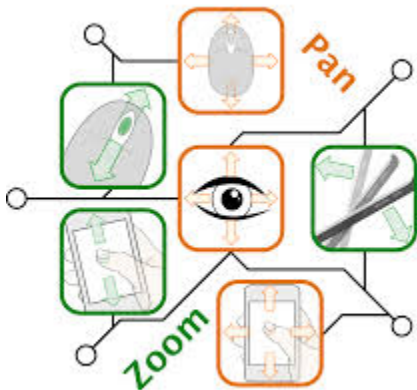
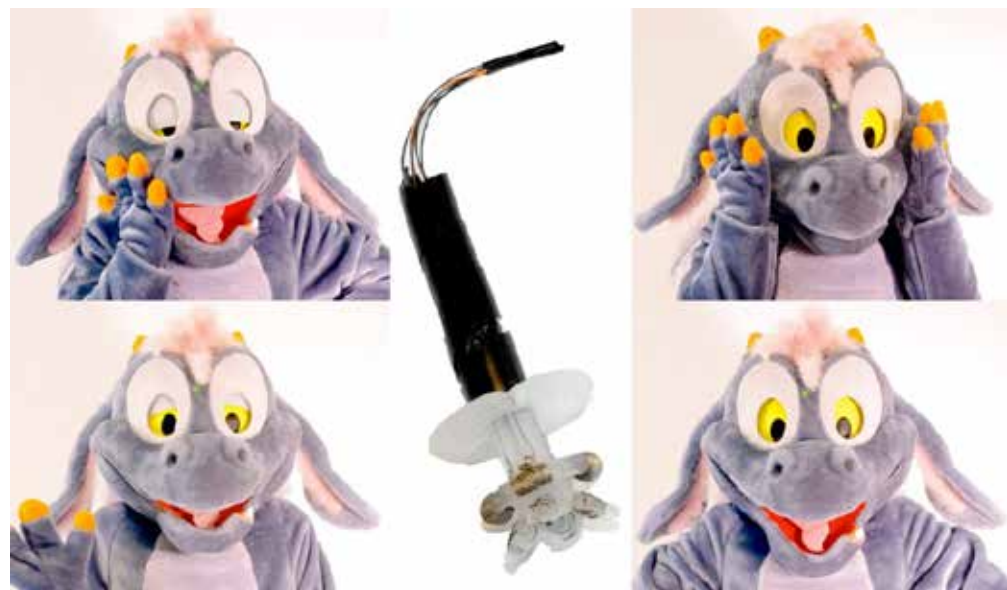
<http://dl.acm.org/citation.cfm?id=2807504>





<https://www.google.com/atap/project-soli/>

# Haptics as Input (Others)



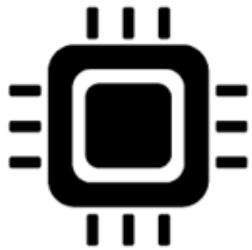
[http://www.cs.cmu.edu/~rys/researchprojects/tongue\\_device/](http://www.cs.cmu.edu/~rys/researchprojects/tongue_device/)



Modality + Medium  
(Design Space)



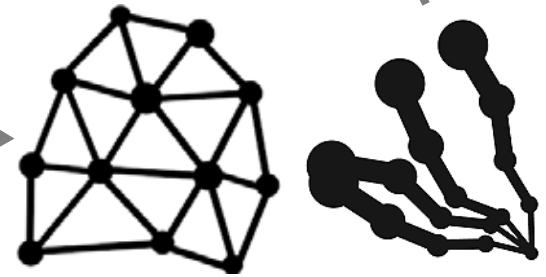
User Evaluation  
(Human Ability)



Sensors



Data + Feature



Models  
(Detect + Recognize)

# How to Input Text with Google Glass?





"One-Dimensional Handwriting: Inputting Letters and Words on Smart Glasses" (to appear in CHI2016)

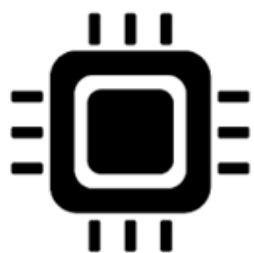


Modality + Medium  
(Design Space)

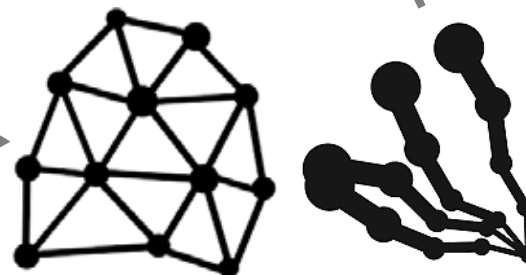


User Evaluation  
(Human Ability)

User- vs. Designer-Defined



Sensors



Models  
(Detect + Recognize)





<https://www.informatik.uni-augsburg.de/lehrstuehle/hcm/projects/finished/external/ecute/img/userdefinedGestures.png>

# Haptics as Output



## Surround Haptics

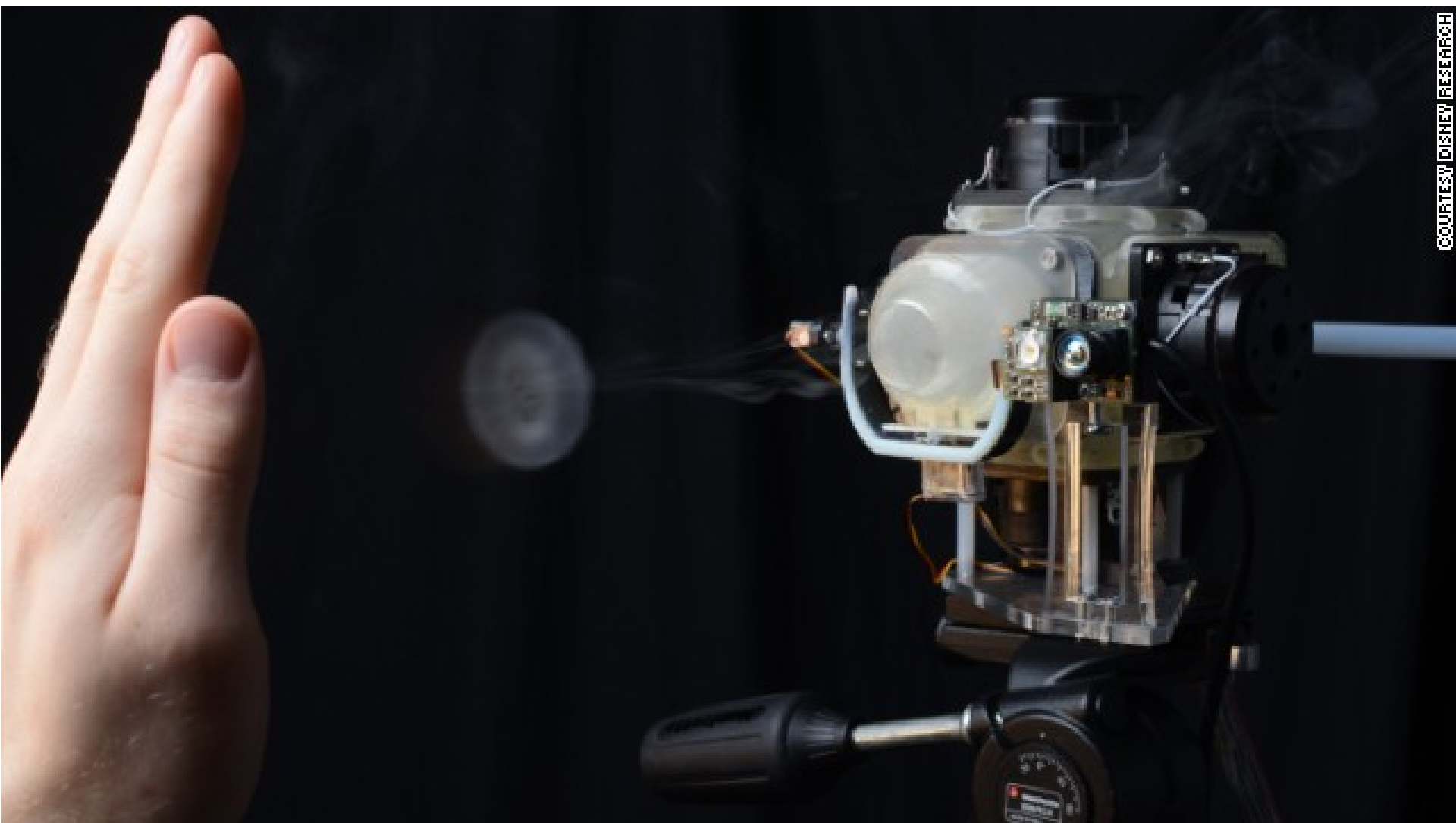


(Israr et al., 2011)

## Embedded Haptics

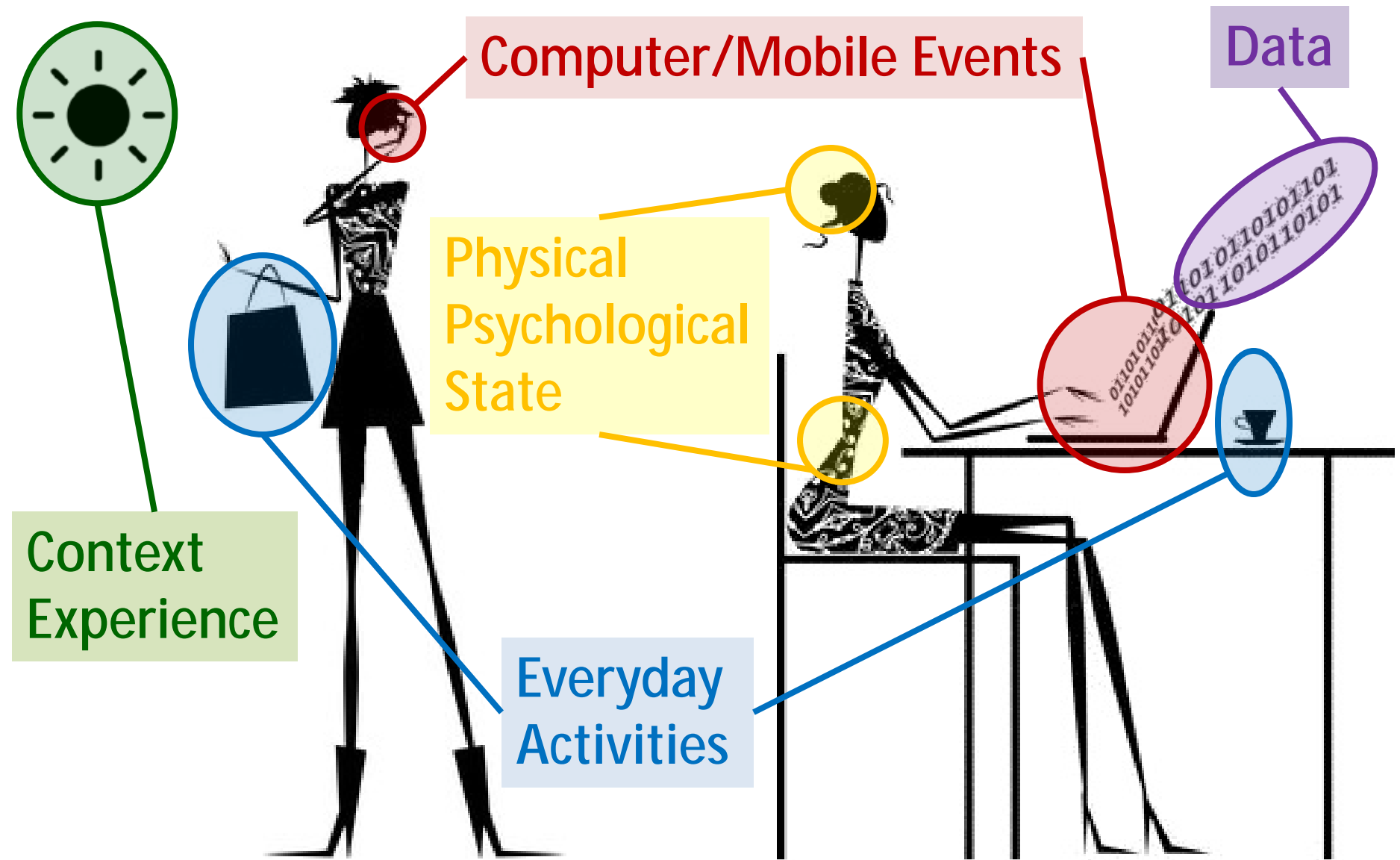


(Lopes & Baudisch, 2013)



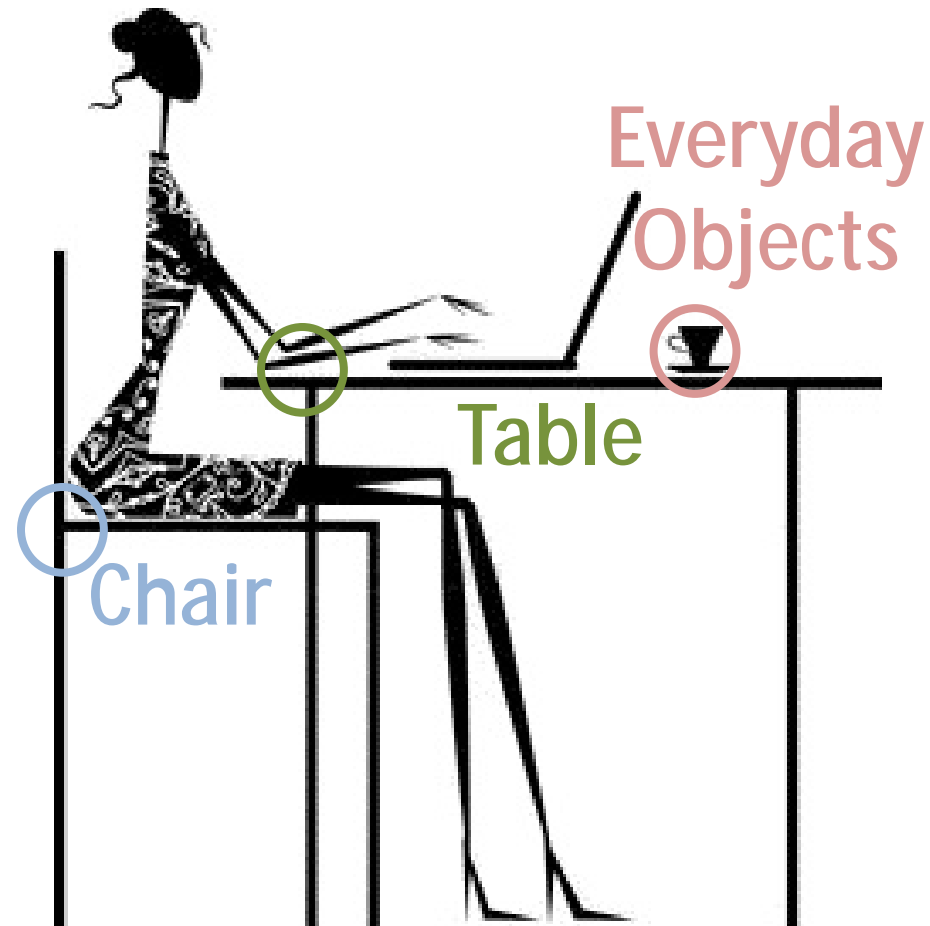
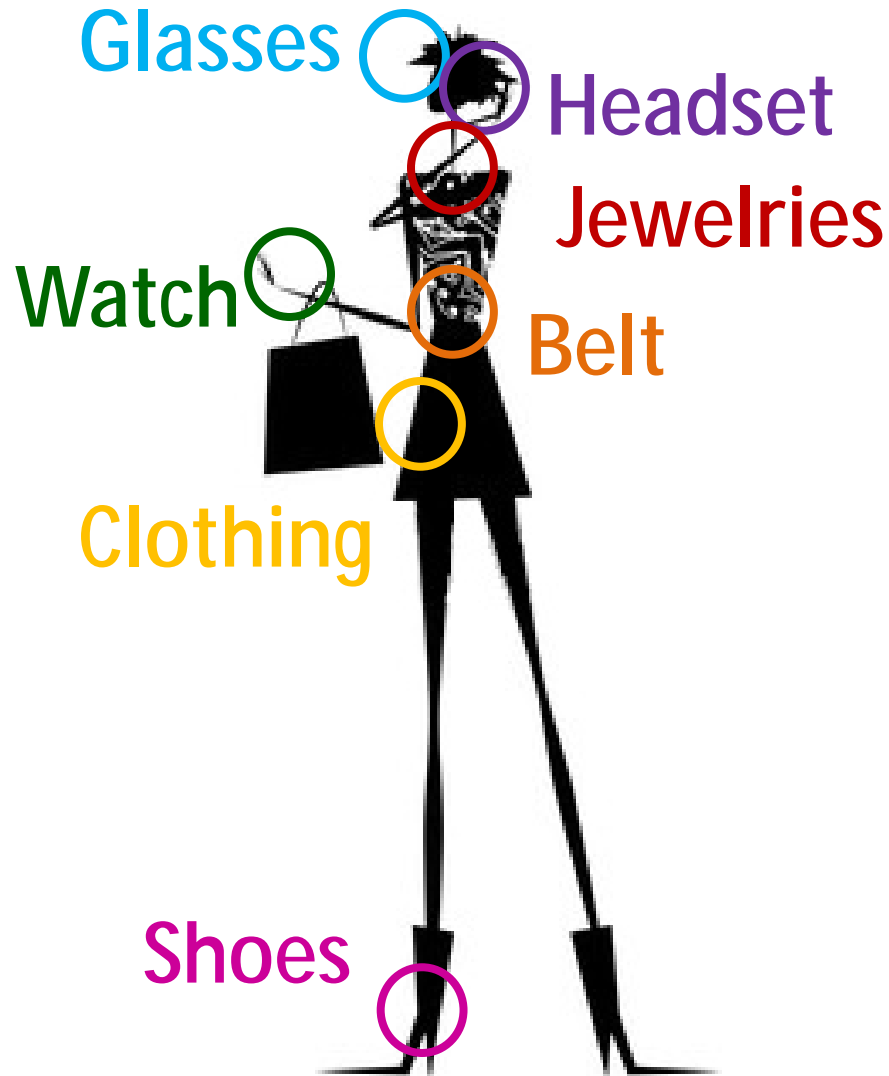
<https://www.disneyresearch.com/project/aireal/>

# Types of Information to Convey

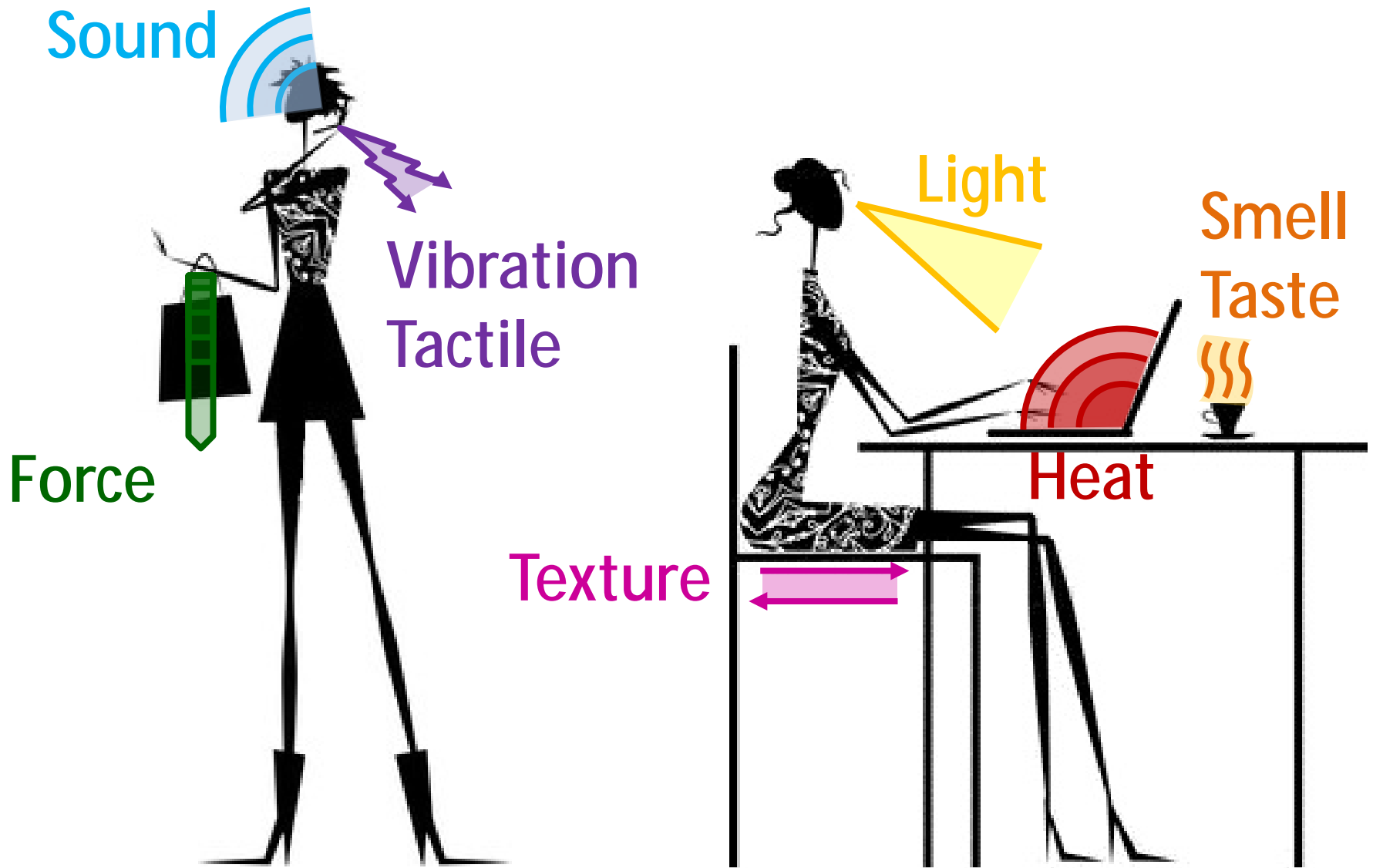


# Communication Medium

## Wearable vs. Ambient



# Sensory Input







# Thank you J



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