

**Building User Interfaces**

***Designing for***  
**Accessibility**

**Professor Yuhang Zhao**

# What we will learn today?

- What is accessibility?
- Accessible design
- Assistive technologies

# What is accessibility?

## Definitions

**Usability:** The effectiveness, efficiency, and satisfaction with which a specified set of users can achieve a specified set of tasks in a particular environment. — ISO 9241-11

**Accessibility:** The usability of a product, service, environment, or facility by people with the widest range of capabilities. — ISO 9241-20



## From Accessibility to Disability

*Accessibility* is the extent to which an interactive product is accessible by as many people as possible.

The primary focus of accessible design is making systems accessible to individuals with *disabilities*.

# Disability<sup>1</sup>

**Definition:** A *disability* is any condition of the body or mind (impairment) that makes it more difficult for the person with the condition to do certain activities (activity limitation) and interact with the world around them (participation restrictions).

Disability can change over time with age or recovery, and the severity of the impact of disability can change over time. Fewer than 20% are born with a disability, although 80% of people will have a disability once they reach 85.

<sup>1</sup>CDC

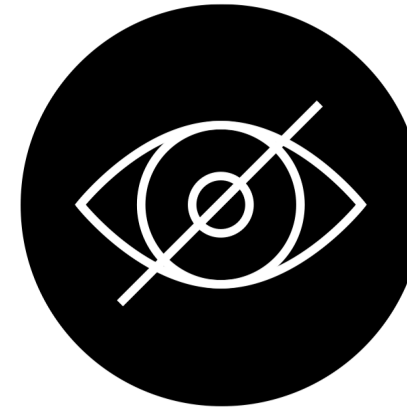
## Three Dimensions of Disability<sup>2</sup>

1. **Impairment** in a person's body structure or function, or mental functioning (e.g., loss of a limb, loss of vision, or memory loss)
2. **Limitation in activities** (e.g., difficulty seeing, hearing, walking, or problem solving)
3. **Restrictions in participation** in activities of daily living (e.g., working, engaging in social and recreational activities, and obtaining health care)

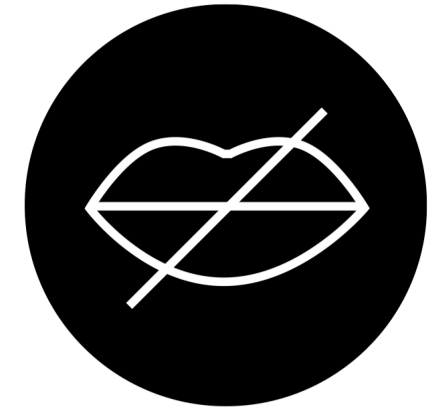
<sup>2</sup> Source: World Health Organization

## Types of Impairment: Anatomical<sup>3</sup>

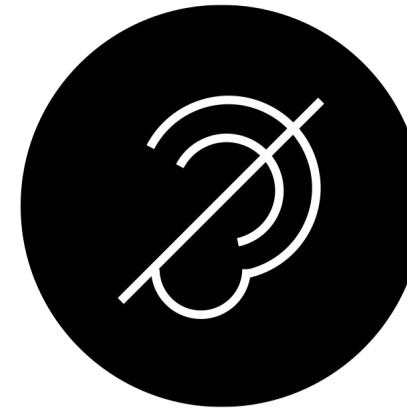
1. Sensory impairment
2. Physical impairment
3. Cognitive impairment



Can't see



Can't speak



Can't hear



Can't touch

<sup>3</sup>Image source: [Microsoft Inclusive Design Toolkit](#)

## Sensory Impairment

Involves impairment in one or more senses, such as loss of vision or hearing.



Cataract



Age Related Macular Degeneration



Diabetic Retinopathy



Glaucoma

## Physical Impairment

Involves loss of function to one or more parts of the body, e.g., congenitally or after stroke or spinal-cord injury.

## Cognitive Impairment

Includes cognitive deficits, such as learning impairment or loss of memory/cognitive function due to aging or conditions such as Alzheimer's disease.



## Common Impairments

- Visual
- Motor/Mobility
- Auditory
- Seizures
- Learning

## Visual Disabilities

**Definition:** Impairments in vision, including low vision, blindness, and color blindness.

## Motor/Mobility

**Definition:** Muscular or skeletal impairments in the hands or arms that affect user input as well as impairments that affect mobility, where users are in a wheelchair or bedridden, and thus the context of use.

## Auditory

**Definition:** Deficits that affect hearing at different levels of severity, including deafness.

## Seizures

**Definition:** Neurological impairments, such as photosensitive epilepsy, that result in sensitivity to light, motion, and flickering on screen, which might trigger seizures.

## Cognitive/Learning

**Definition:** Congenital, developmental, and traumatic (e.g., traumatic brain injury) conditions that result in cognitive or learning challenges.

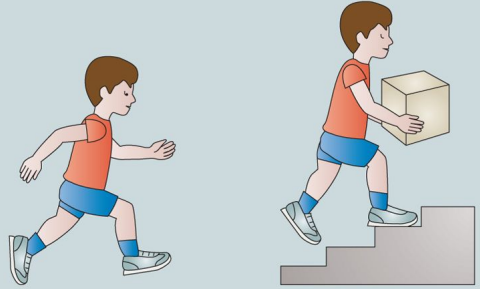
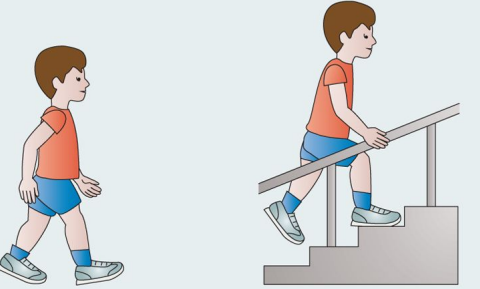
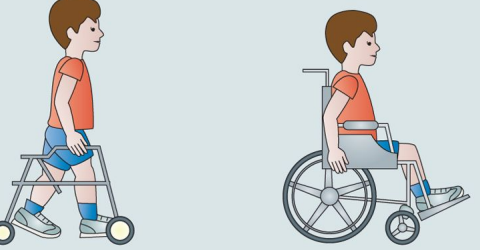

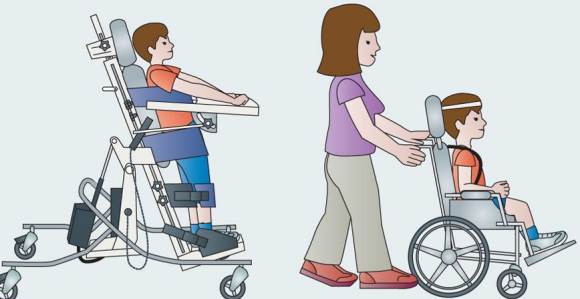
# Variability<sup>4</sup>

Impairments can vary in severity or structure depending on the source and nature of the impairment.

**Severity:** Children with cerebral palsy can have basic mobility or completely depend on a caretaker.

**Structure:** Vision impairments can include color blindness, peripheral-only vision, no light perception

<sup>4</sup> Image source

GMFCS expanded and revised between 6 <sup>th</sup> and 12 <sup>th</sup> birthday: descriptors and illustrations	
	<b>GMFCS level I</b> Children walk at home, school, outdoors and in the community. They can climb stairs without the use of a railing. Children perform gross motor skills such as running and jumping, but speed, balance and coordination are limited.
	<b>GMFCS level II</b> Children walk in most settings and climb stairs holding onto a railing. They may experience difficulty walking long distances and balancing on uneven terrain, inclines, in crowded areas or confined spaces. Children may walk with physical assistance, a hand-held mobility device or use wheeled mobility over long distances. Children have only minimal ability to perform gross motor skills such as running and jumping.
	<b>GMFCS level III</b> Children walk using a hand-held mobility device in most indoor settings. They may climb stairs holding onto a railing with supervision or assistance. Children use wheeled mobility when travelling long distances and may self-propel for shorter distances.
	<b>GMFCS level IV</b> Children use methods of mobility that require physical assistance or powered mobility in most settings. They may walk for short distances at home with physical assistance or use powered mobility or a body support walker when positioned. At school, outdoors and in the community children are transported in a manual wheelchair or use powered mobility.
	<b>GMFCS level V</b> Children are transported in a manual wheelchair in all settings. Children are limited in their ability to maintain antigavity head and trunk postures and control leg and arm movements.

## Types of Impairment: Temporal













1. *Permanent* impairment
2. *Temporary* impairment
3. *Situational* impairment



## Permanent Impairment<sup>5</sup>













Congenital or long-term conditions, such as color blindness, missing body parts, etc.

<sup>5</sup>Image source: [Microsoft Inclusive Design Toolkit](#)

	Permanent	Temporary	Situational
Touch	 One arm	 Arm injury	 New parent
See	 Blind	 Cataract	 Distracted driver
Hear	 Deaf	 Ear infection	 Bartender
Speak	 Non-verbal	 Laryngitis	 Heavy accent

## Temporary Impairment<sup>6</sup>

Impairments that improve over time, such as recovery after illness or accidents, e.g., a broken arm.













	Permanent	Temporary	Situational
Touch	 One arm	 Arm injury	 New parent
See	 Blind	 Cataract	 Distracted driver
Hear	 Deaf	 Ear infection	 Bartender
Speak	 Non-verbal	 Laryngitis	 Heavy accent

<sup>6</sup> Image source: [Microsoft Inclusive Design Toolkit](#)

## Situational Impairment<sup>7</sup>

Impairments introduced by context, such as environments with low light or noise.

<sup>7</sup>Image source: [Microsoft Inclusive Design Toolkit](#)

	Permanent	Temporary	Situational
Touch	 One arm	 Arm injury	 New parent
See	 Blind	 Cataract	 Distracted driver
Hear	 Deaf	 Ear infection	 Bartender
Speak	 Non-verbal	 Laryngitis	 Heavy accent

## How do we achieve accessibility?

Two ways to address accessibility problems:

1. Accessible design
2. Assistive technologies

# Accessible Design

# Medical Model of Disability

Disability as personal attribute

**In the context of health experience, a disability is any restriction or lack of ability (resulting from an impairment) to perform an activity in the manner or within the range considered normal for a human being.**

# **Social Model of Disability**

Disability as context dependent

**Disability is not just a health problem. It is a complex phenomenon, reflecting the interaction between features of a person's body and features of the society in which he or she lives.**

Social Model \*:

**People are disabled by barriers in society, not by their impairment or difference.**

\* Shakespeare, Tom. "The social model of disability." *The disability studies reader 2* (2006): 197-204.

# Mismatch between Abilities and Environment<sup>8</sup>

Context-dependent disability results from a mismatch between abilities and the environment:

Ability + Context = Disability

<sup>8</sup> Image source: [Microsoft Inclusive Design Toolkit](#)

Between humans

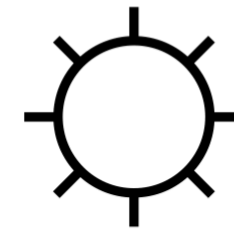


Can't type

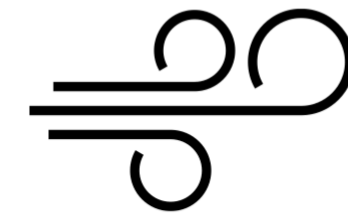


Can't hear

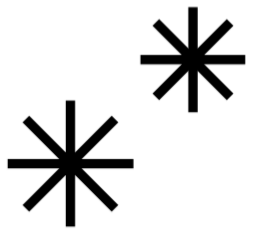
Human+ environment



Glare from sun



Windy



Cold

Human+ object



Left-handed user



Narrow door



Tall shelf



## Universal Design<sup>9</sup>

**Definition:** The design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design.

<sup>9</sup> Ron Mace, 1996

# The Main Premise of Universal Design<sup>10</sup>

Design solutions that benefit some individuals may benefit the whole society. E.g., in the US, only 26K people are suffer loss of upper extremities. Designs that would benefit these 26K would also benefit another 21M people with temporary or situational disabilities.

<sup>10</sup> Image source: [Microsoft Inclusive Design Toolkit](#)



## An Example: Closed Captioning<sup>11</sup>

Although closed captioning was originally developed for individuals with hearing impairments, they now also benefit reading in noisy environments and learning to read.

<sup>11</sup> Image source: [Microsoft Inclusive Design Toolkit](#)



# Principles of Universal Design

1. Equitable use
2. Flexibility in use
3. Simple and intuitive use
4. Perceptible information
5. Tolerance for error
6. Low physical effort
7. Size and space for approach and use

## The Principles of Universal Design

The design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design.

- 1 Equitable Use**  
 The design is useful and marketable to people with diverse abilities.
- 2 Flexibility in Use**  
 The design accommodates a wide range of individual preferences and abilities.
- 3 Simple and Intuitive Use**  
 Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or education level.
- 4 Perceptible Information**  
 The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.
- 5 Tolerance for Error**  
 The design minimizes hazards and the adverse consequences of accidental or unintended actions.
- 6 Low Physical Effort**  
 The design can be used efficiently and comfortably and with a minimum of fatigue.
- 7 Size and Space for Approach and Use**  
 Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.

Center for Universal Design at NC State  
 Web: design.ncsu.edu/ucd | E-mail: cued@ncsu.edu

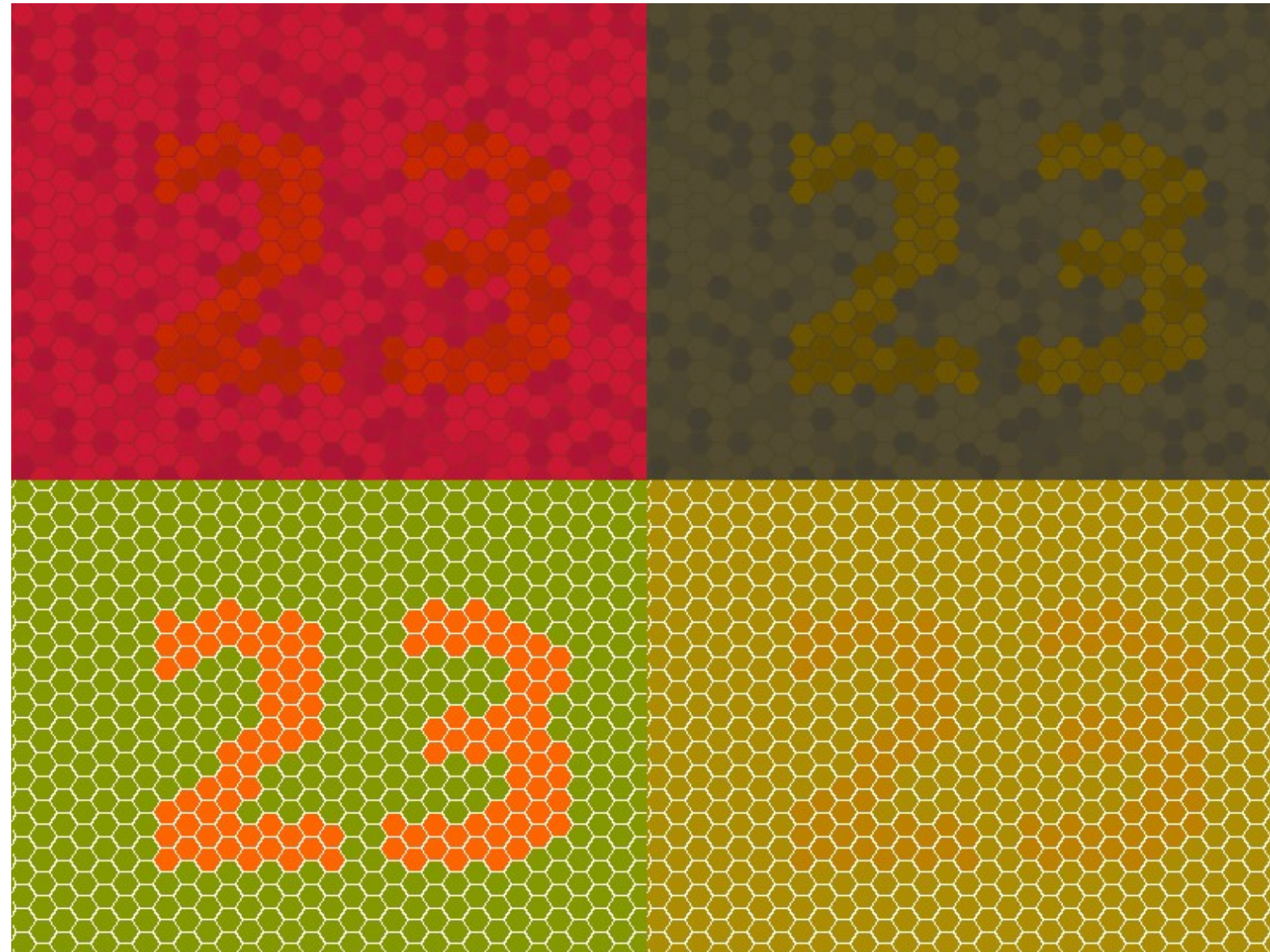
<sup>12</sup> Image source: Interaction Design Foundation

## Principle 1: Equitable use

**The design is useful and marketable to people with diverse abilities.**

1. Provide the same means of use for all users: identical whenever possible; equivalent when not.
2. Avoid segregating or stigmatizing any users.
3. Provisions for privacy, security, and safety should be equally available to all users.
4. Make the design appealing to all users.





<sup>13</sup> Example source: [Interaction Design Foundation](#); Image source: Johannes Ahlmann

## Principle 2: Flexibility in Use

**The design accommodates a wide range of individual preferences and abilities.**

1. Provide choice in methods of use.
2. Accommodate right- or left-handed access and use.
3. Facilitate the user's accuracy and precision.
4. Provide adaptability to the user's pace.



OneNote Online

File Home Insert Draw View Print Tell me what you want to do Open In OneNote Give Feedback To Microsoft

Sample Class Notebook

Heat Transfer Project

Sunday, February 17, 2013 12:16 PM

Chapter 5 - Transient cond...  
Chapter 6 - convection  
Chapter 7 - Correlations fo...  
Chapter 8 - Internal Flow  
Ch. 9. correlations  
Chapter 10- Boiling and C...  
Chapter 12. Radiation  
Chapter 13

boundary

inside

center

$r=R$

$L=H$

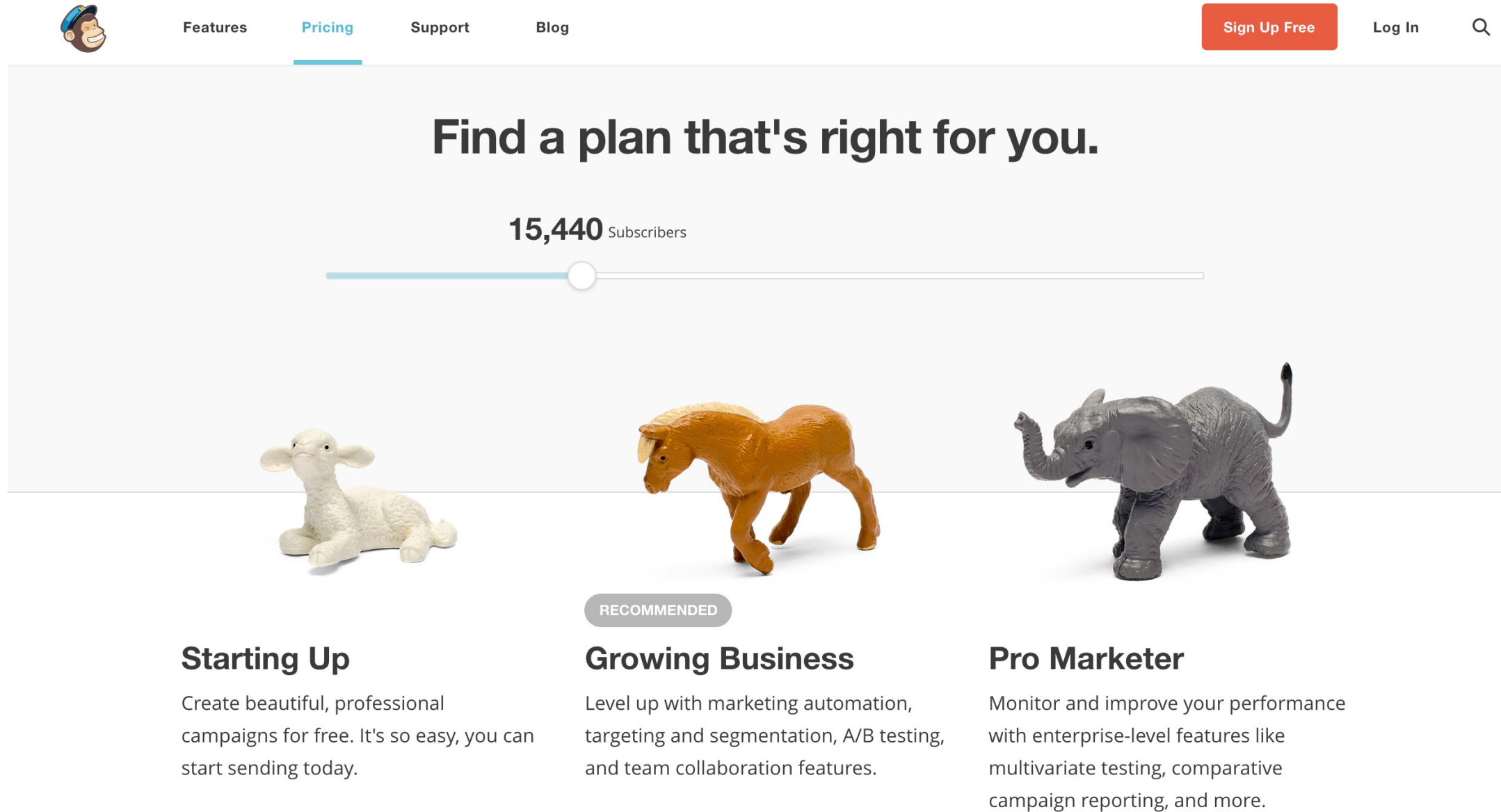
Good Pronunciation

<sup>14</sup> Image source

## **Principle 3: Simple and Intuitive Use**

**Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.**


1. Eliminate unnecessary complexity.
2. Be consistent with user expectations and intuition.
3. Accommodate a wide range of literacy and language skills.
4. Arrange information consistent with its importance.
5. Provide effective prompting and feedback during and after task completion.



Features Pricing Support Blog Sign Up Free Log In


## Find a plan that's right for you.

15,440 Subscribers



### Starting Up


Create beautiful, professional campaigns for free. It's so easy, you can start sending today.



RECOMMENDED

### Growing Business

Level up with marketing automation, targeting and segmentation, A/B testing, and team collaboration features.



### Pro Marketer


Monitor and improve your performance with enterprise-level features like multivariate testing, comparative campaign reporting, and more.

<sup>15</sup> Example source: [Interaction Design Foundation](#)

## Principle 4: Perceptible Information

**The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.**

1. Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information.
2. Provide adequate contrast between essential information & surroundings.
3. Maximize "legibility" of essential information
4. Differentiate elements in ways that can be described (i.e., make it easy to give instructions or directions).
5. Provide compatibility with a variety of techniques or devices used by people with sensory limitations.



**TEDxHouston** · Filmed June 2010 · 20:19  
Brené Brown: The power of vulnerability

Watch next  
**Barry Schwartz: Our loss of wisdom** >

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< Return to talk

## Subtitles and Transcript

Select language

English
▼

**0:12** So, I'll start with this: a couple years ago, an event planner called me because I was going to do a speaking event. And she called, and she said, "I'm really struggling with how to write about you on the little flyer." And I thought, "Well, what's the struggle?" And she said, "Well, I saw you speak, and I'm going to call you a researcher, I think, but I'm afraid if I call you a researcher, no one will come, because they'll think you're boring and irrelevant."

0:36 (Laughter)

0:37 And I was like, "Okay." And she said, "But the thing I liked about your talk is you're a storyteller. So I think what I'll do is just call you a storyteller." And of course, the academic, insecure part of me was like, "You're going to call me a what?" And she said, "I'm going to call you a storyteller." And I was like, "Why not 'magic pixie'?"

0:56 (Laughter)

0:59 I was like, "Let me think about this for a second." I tried to call deep on my courage. And I thought, you know, I am a storyteller. I'm a qualitative researcher. I collect stories; that's what I do. And maybe stories are just data with a soul. And maybe I'm just a storyteller. And so I said, "You know what? Why don't you just say I'm a researcher-storyteller." And she went, "Ha ha. There's no such thing."

1:25 (Laughter)

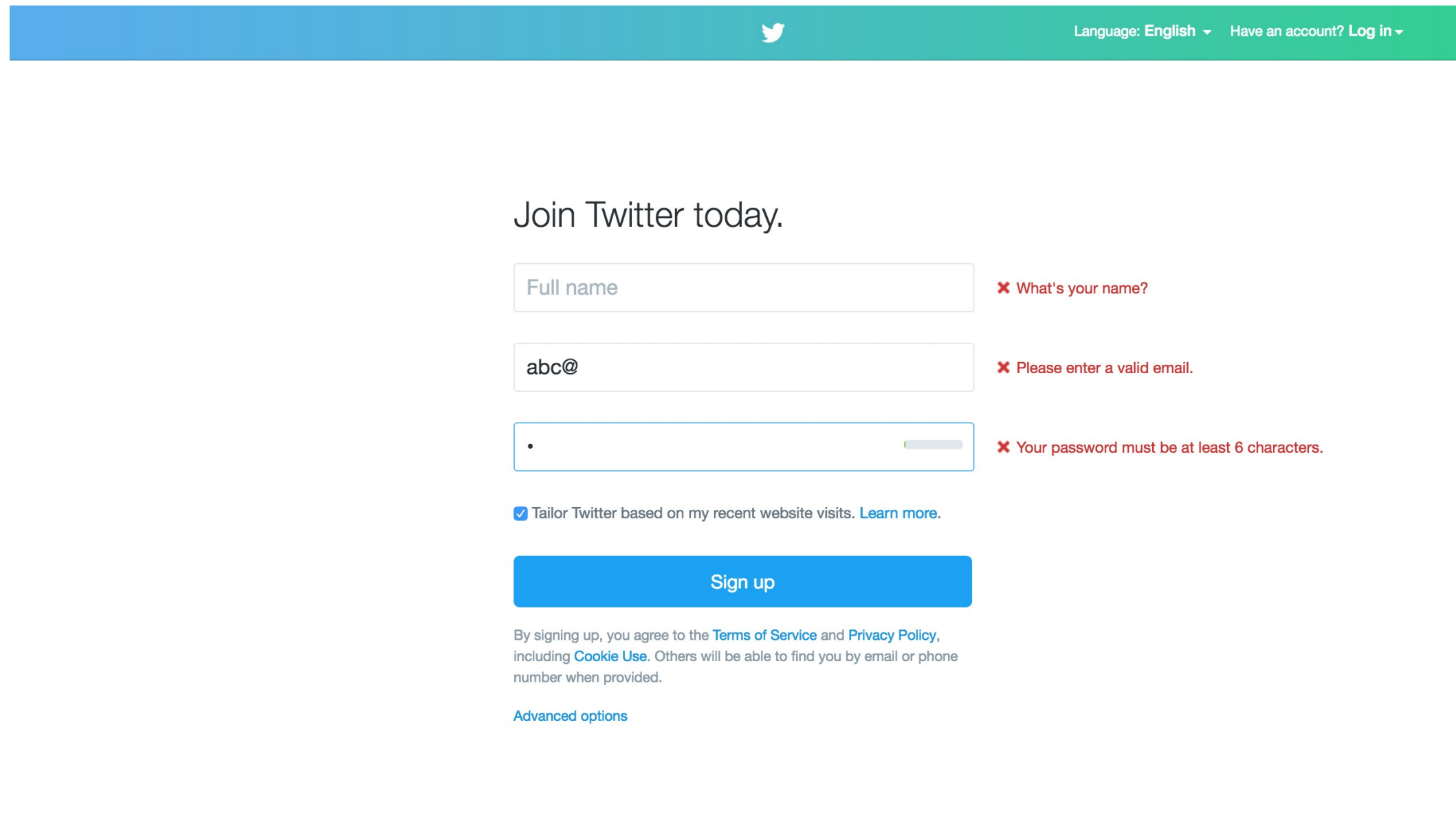
1:27 So I'm a researcher-storyteller, and I'm going to talk to you today -- we're talking about expanding perception -- and so I want to talk to you and tell some stories about a piece of my research that fundamentally expanded my perception and really actually changed the way that I live and love and work

<sup>16</sup> Image source: [Interaction Design Foundation](#)

## Principle 5: Tolerance for Error

**The design minimizes hazards and the adverse consequences of accidental or unintended actions.**

1. Arrange elements to minimize hazards and errors: most used elements, most accessible; hazardous elements eliminated, isolated, or shielded.
2. Provide warnings of hazards and errors.
3. Provide fail safe features.
4. Discourage unconscious action in tasks that require vigilance.



The image shows the Twitter sign-up page with a teal header bar. The header contains the Twitter logo and navigation links for "Language: English" and "Have an account? Log in". The main heading is "Join Twitter today.". Below it are three input fields: "Full name", "Email", and "Password". Each field has a red error message to its right: "What's your name?", "Please enter a valid email.", and "Your password must be at least 6 characters." respectively. There is a checked checkbox for "Tailor Twitter based on my recent website visits." with a "Learn more" link. A blue "Sign up" button is centered below the fields. At the bottom, there is a disclaimer about terms of service and privacy policy, and a link for "Advanced options".

Language: English ▾ Have an account? Log in ▾

## Join Twitter today.

Full name ✘ What's your name?

abc@ ✘ Please enter a valid email.

• ✘ Your password must be at least 6 characters.

Tailor Twitter based on my recent website visits. [Learn more.](#)

[Sign up](#)

By signing up, you agree to the [Terms of Service](#) and [Privacy Policy](#), including [Cookie Use](#). Others will be able to find you by email or phone number when provided.

[Advanced options](#)

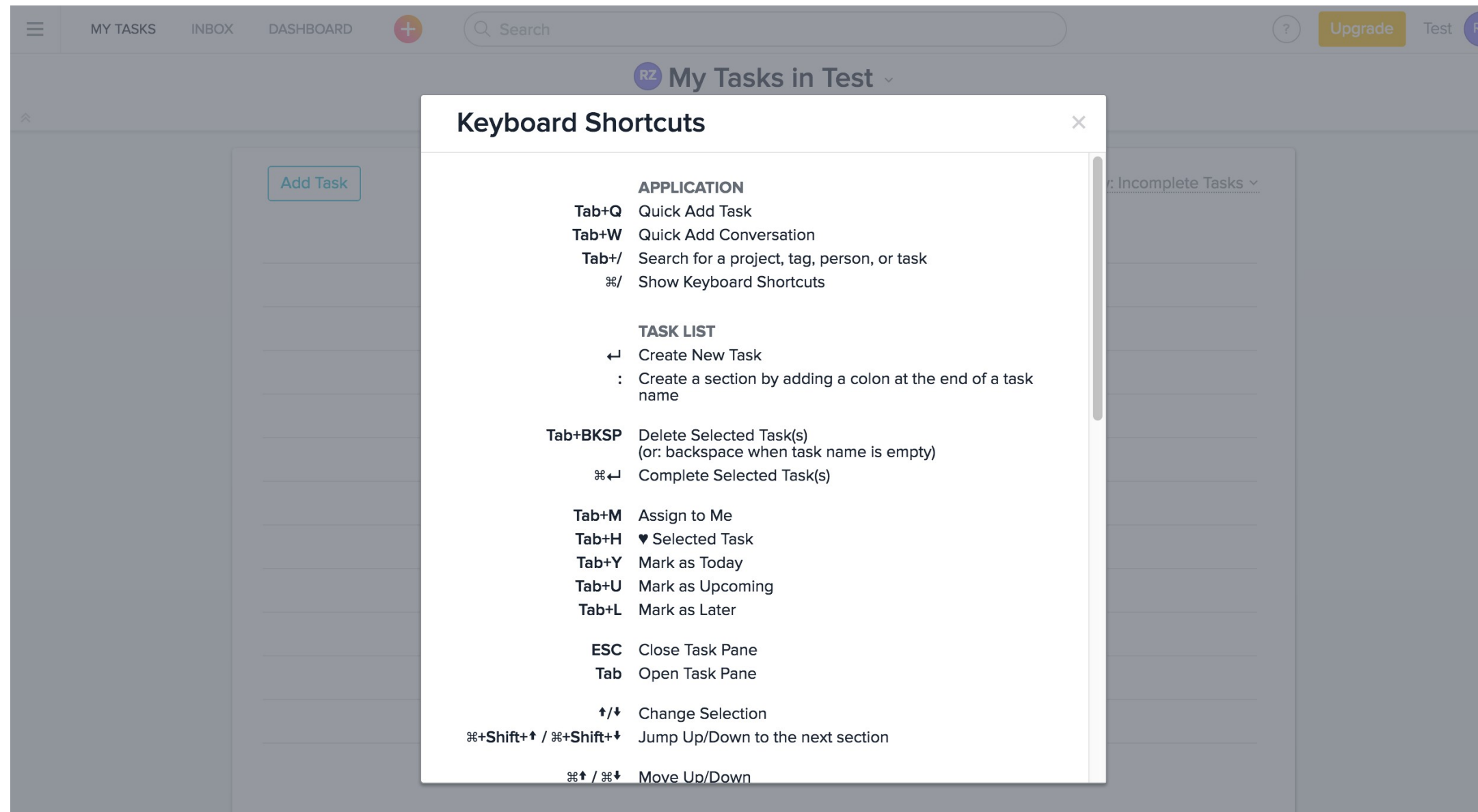
<sup>17</sup> Image source: [Interaction Design Foundation](#)

## Principle 6: Low Physical Effort

The design can be used efficiently and comfortably and with a minimum of fatigue.

1. Allow user to maintain a neutral body position.
2. Use reasonable operating forces.
3. Minimize repetitive actions.
4. Minimize sustained physical effort.





<sup>18</sup> Image source: [Interaction Design Foundation](#)

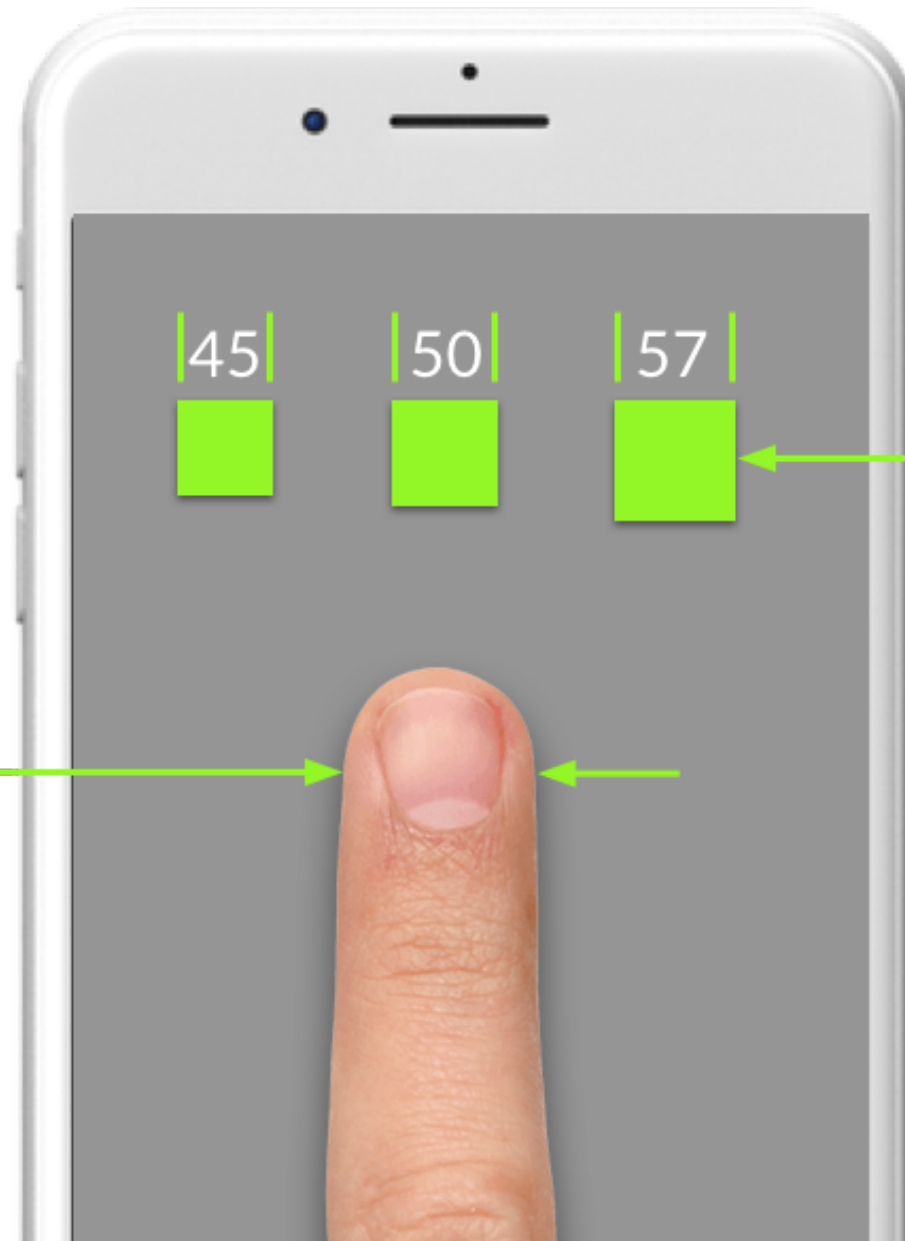
## Principle 7: Size and Space for Approach and Use

**Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.**

1. Provide a clear line of sight to important elements for any seated or standing user.
2. Make reach to all components comfortable for any seated or standing user.
3. Accommodate variations in hand and grip size.
4. Provide adequate space for the use of assistive devices or personal assistance.<sup>19</sup>

<sup>19</sup> Image source on next slide

iPhone 8  
375 x 667 pixel screen size



touch target size range  
.63 - .79"  
(16 - 20 mm)

In Sketch pixels: 45 - 57

Average finger  
width about  
0.67" (17mm)

# Assistive Technologies

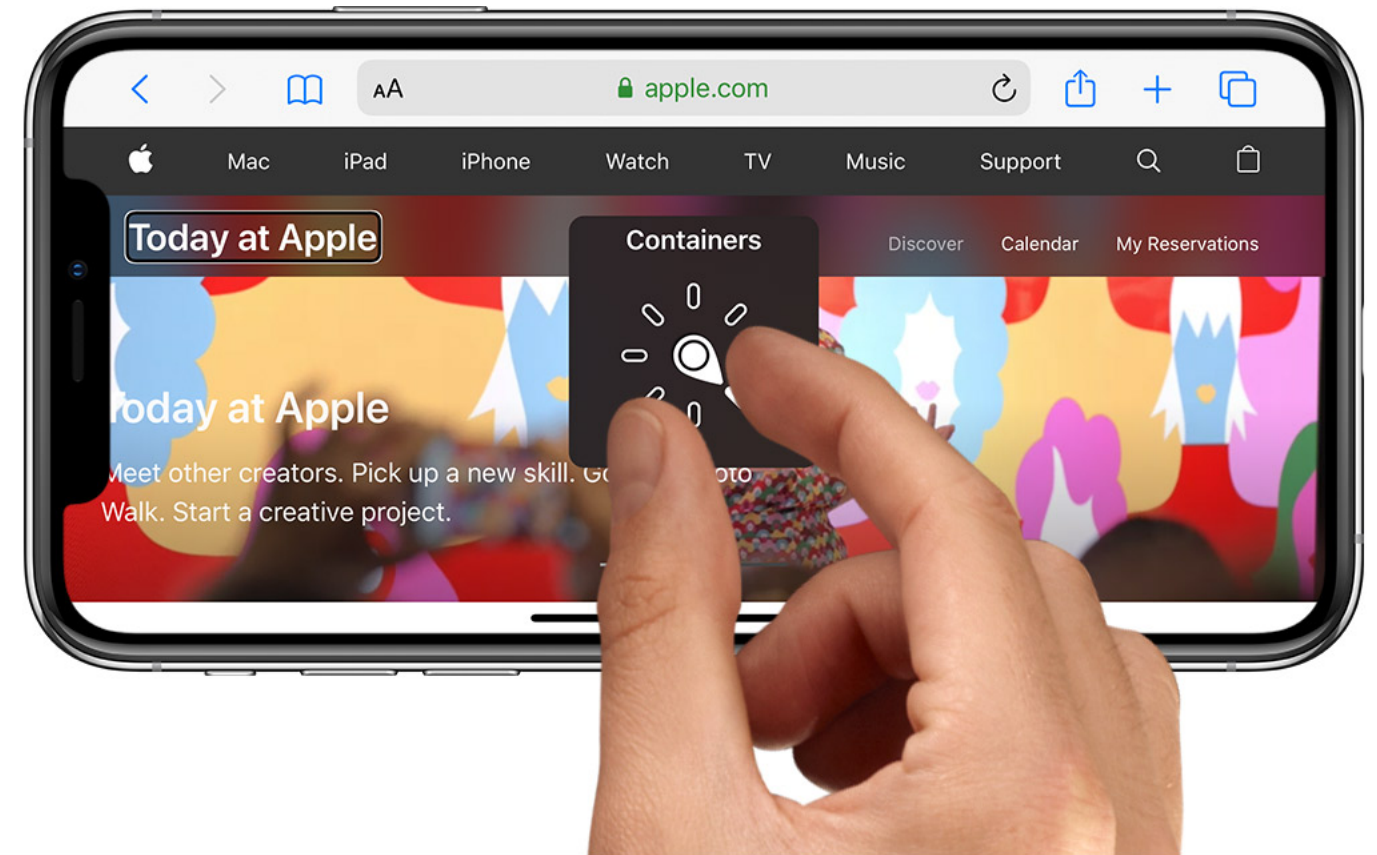
## What are assistive technologies?

**Definition:** Specialized tools that close accessibility gaps.

## Screen Readers<sup>20</sup>

**Definition:** Software used by individuals with vision impairments to read screen content.

- JAWS for Windows
- VoiceOver for MacOS, iOS
- NVDA



<sup>20</sup> [Image source](#)



## Screen Magnification<sup>21</sup>

**Definition:** Enlarges text or graphics on screens to improve visibility of content for individuals with limited vision.



<sup>21</sup> Image source



## Text Readers<sup>22</sup>

**Definition:** Tools that read out loud text on screens to support vision and learning disabilities.

<sup>22</sup> Image source





## Braille for the Web<sup>23</sup>

**Definition:** A mechanical device that translates textual content on the screen into Braille.

<sup>23</sup> [Image source](#)



## Alternative Input Devices

**Definition:** Specialized tools that help individuals with motor impairments who cannot use a mouse or keyboard with pointing.

- Head/mouth wands/pointers
- Motion/eye tracking
- Single-switch (e.g., sip-and-puff)
- Speech input



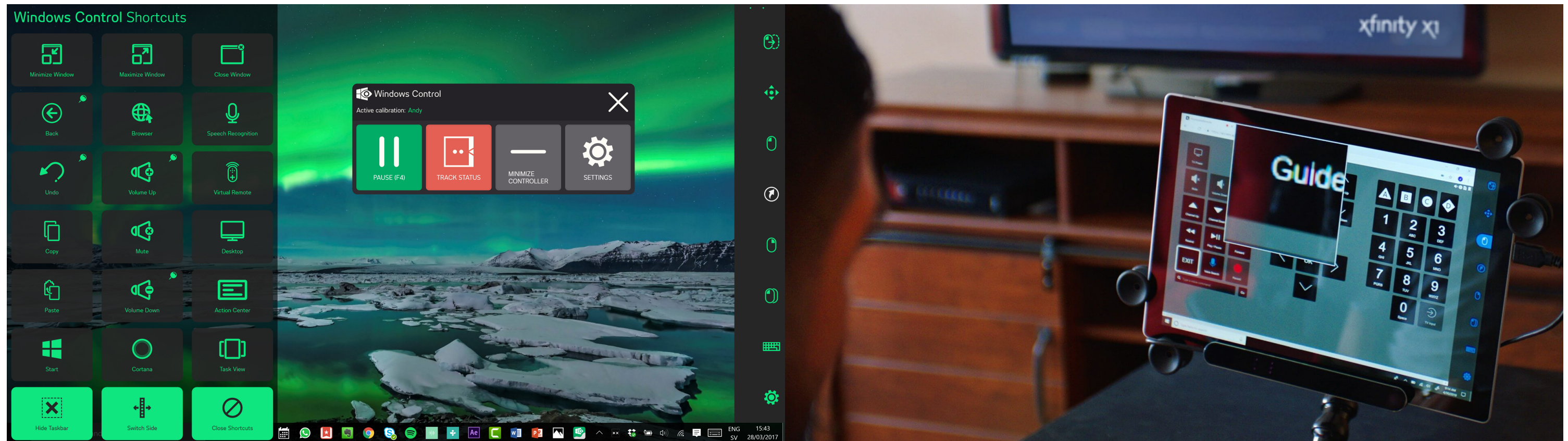
# Head/mouth wands/pointers<sup>24</sup>



<sup>24</sup> Image source



# Motion/eye tracking<sup>25</sup>



<sup>25</sup> Image source: left, right

## Single-switch (e.g., sip-and-puff)<sup>26</sup>



<sup>26</sup> Image source



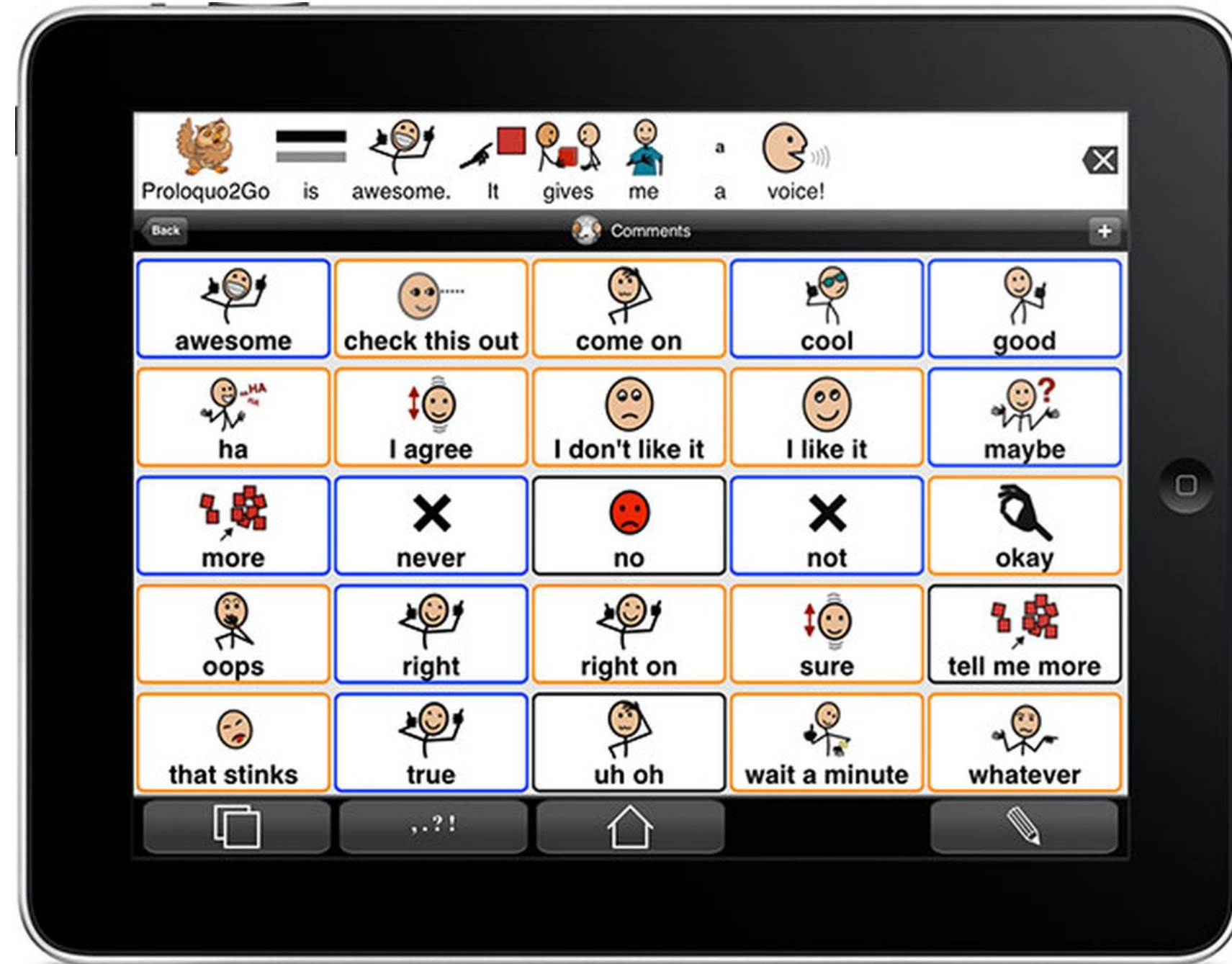
## Speech input<sup>27</sup>



<sup>27</sup> Image source

# Alternative & Augmentative Communication<sup>28</sup>

**Definition:** Tools that help individuals who are unable to use verbal speech to communicate.



<sup>28</sup> [Image source](#)







## Accessibility Testing Tools

- WAVE—evaluates the overall level of accessibility for any given website.
- Color Oracle— displays your site's colors in a manner similar to how a user with color blindness would see the page.
- Image Analyzer— examines website images and tests their compliance with accessibility standards.

# In-class Activity

Try out an assistive technology:

1. **Task 1:** Put a new iPhone in the shopping cart on the Apple site.
2. **Task 2:** Write a new email to your friend.

Report on an observation (e.g., an issue you encounter, a misunderstanding you might have, or a principle you identify on how the accessibility feature works).

# What did we learn today?

- What is accessibility?
- Accessible design
- Assistive technologies