Accessibility
User Impairments

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Slidedeck inspired by Dr Kami Vaniea

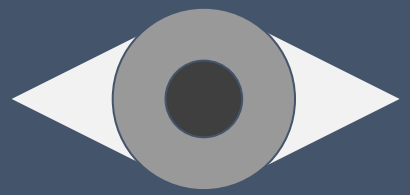
User Impairment

In 2021/22, 24% of all people in the UK have some form of disability (11% children, 23% of working-age adults, 45% adults over state pension age)*

- Visual impairment
- Hearing impairment
- Physical impairment
- Speech impairment
- Dyslexia
- Autism
- Learning disability
- Age group related impairments

*https://commonslibrary.parliament.uk/research-briefings/cbp-9602/#:~:text=How%20many%20people%20have%20a,24%25%20of%20the%20total%20population

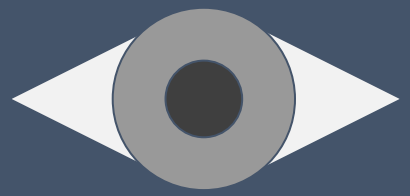
Visual Impairment



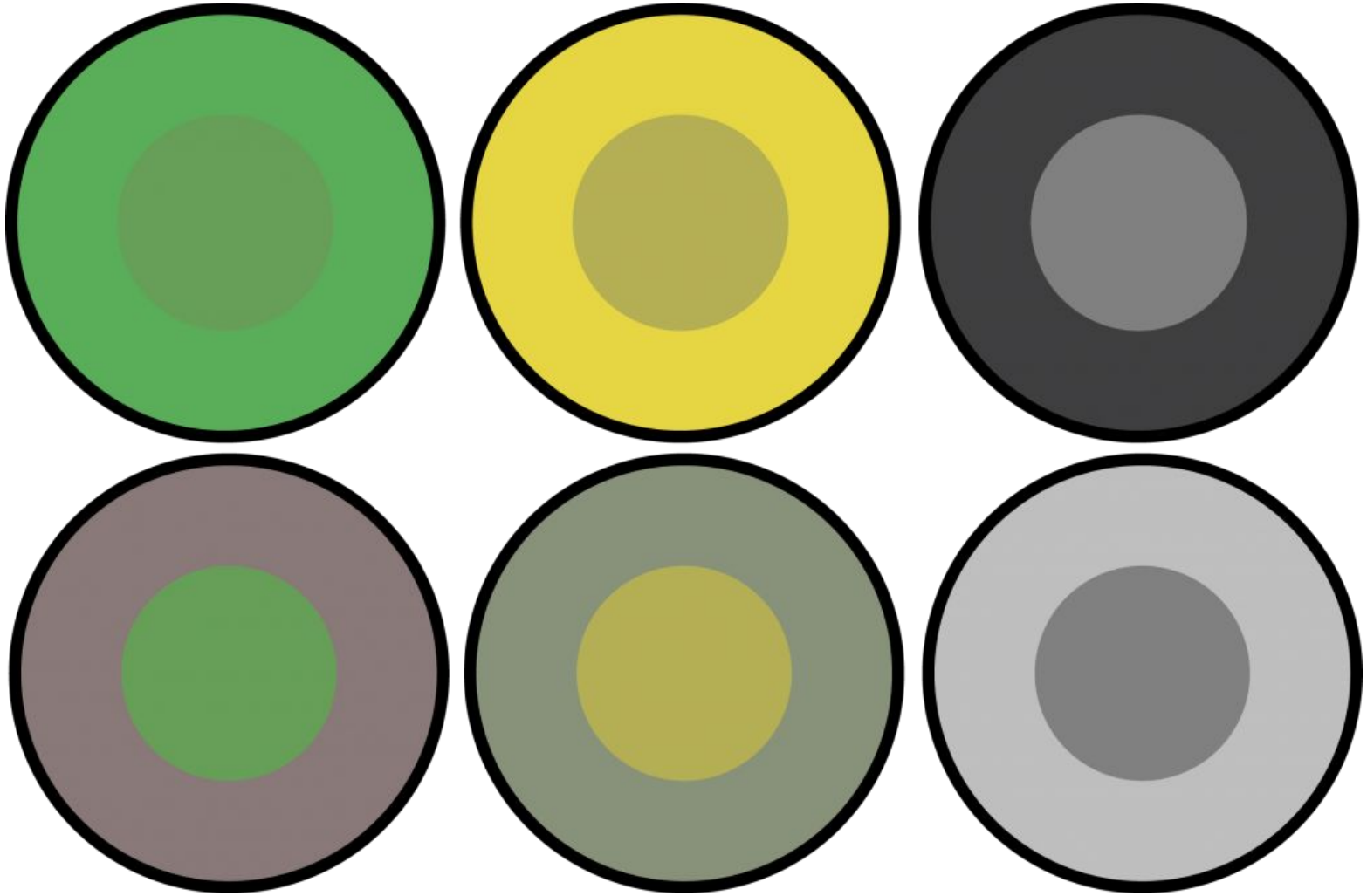
- At least 2.2 billion people have a near or distance vision impairment (WHO*)
- 2015 - over two million people in the UK were living with sight loss**
- One in five people aged 75 and over were living with sight loss**
- Most people experiencing sight loss are not blind and most previously had good sight
- Severe personal and ecological impact*

*https://www.who.int/news-room/fact-sheets/detail/blindness-and-visual-impairment
**https://www.rnib.org.uk/professionals/health-social-care-education-professionals/knowledge-and-research-hub/key-information-and-statistics-on-sight-loss-in-the-uk/

Visual Impairment

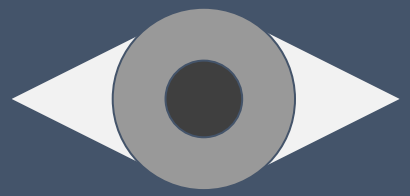


Colour is a huge issue



Mauderer, M, Conte, S , Nacenta, MA & Vishwanath, D 2014, ' Depth perception with gaze-contingent depth of field '. in Conference on Human Factors in Computing Systems – Proceedings. ACM Press – Association for Computing Machinery, New York, pp. 217-226. https://sachi.cs.st-andrews.ac.uk/research/interaction/deepview/

Visual Impairment



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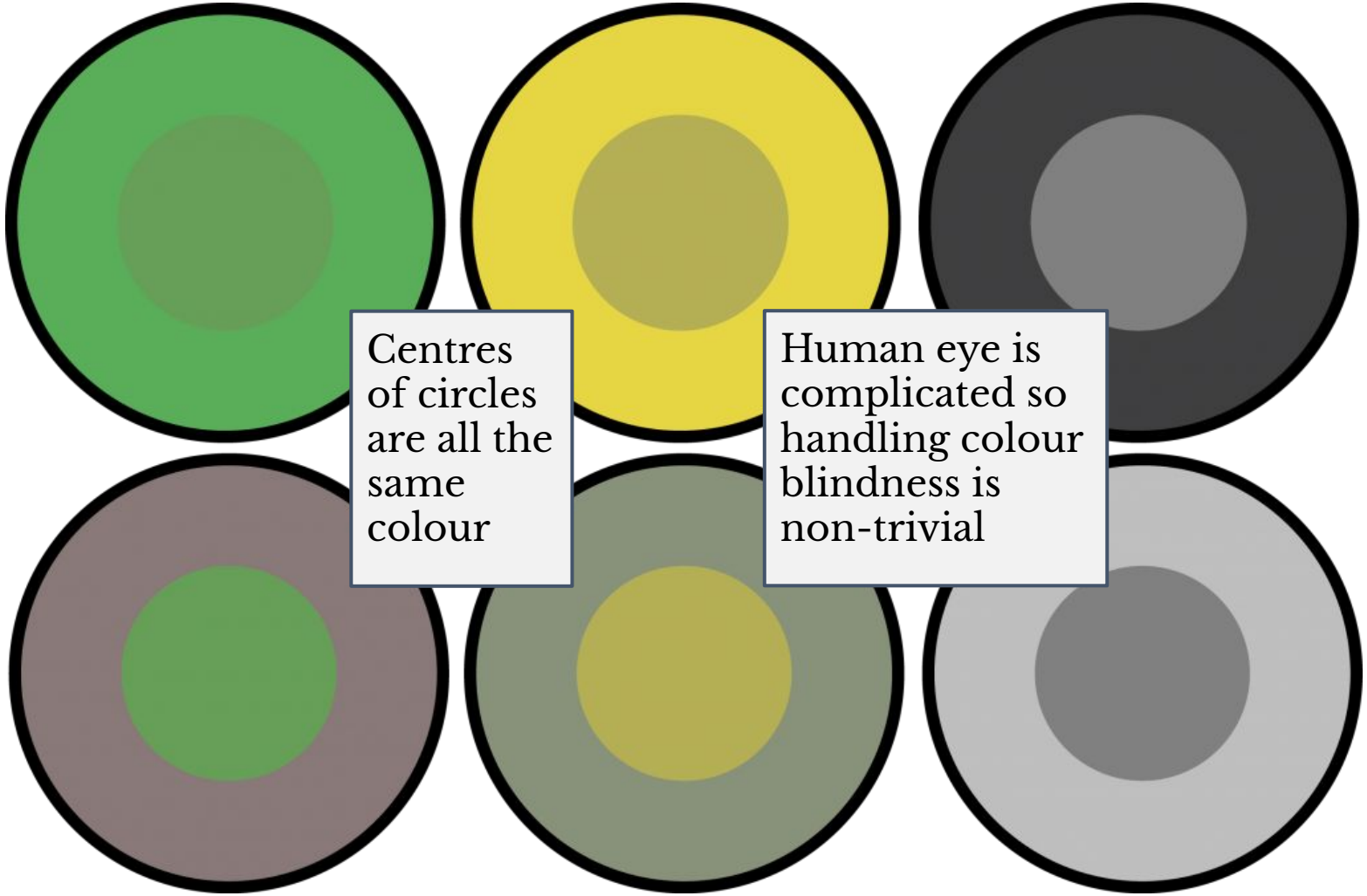

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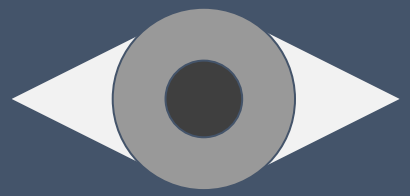
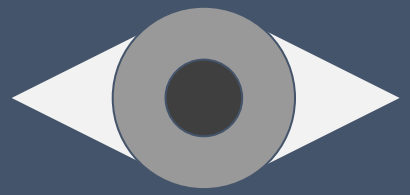
Visual Impairment



Basic Approaches

- larger text, larger buttons, magnify options
- text to speech engines (including OS level tools such as Narrator*)
- Alternative text for non-text elements
- significant contrast between your text and background
- enable scanning by putting important words at the front of paragraphs and links
- use a “Skip to Main Content” link at the beginning of each page
- headings are clear and a computer could identify them as headings (<h1>title</h1>) for screen reader
- beware keyboard traps where someone with only a keyboard can get in but not out

Visual Impairment



Examples of assistive technologies*

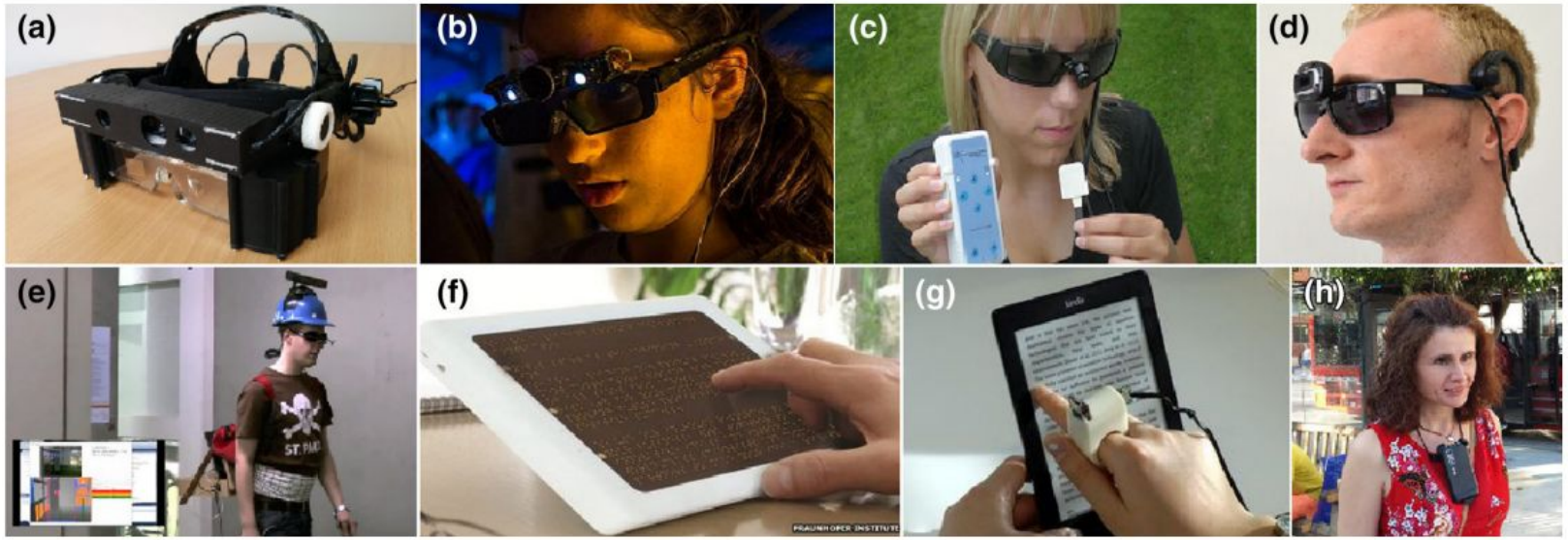


Fig. 1 Examples of Assistive Technology from current research for Visually Impaired and Blind people. **a** *Assisted Vision project*: award winning augmented reality smart glass developed at University of Oxford ([44], photo credit: Dr Stephen Hicks). **b** *AI lenses*: a prototype of Artificial Intelligence based lenses from the Center for Research and Advanced Studies (CINVESTAV), Mexico (photo credit: CINVESTAV). **c** *BrainPort V100*: a non-surgical assistive device that aids blind people in seeing with their tongues ([3,85], photo credit: Wicab). **d** *EyeMusic*: a sensory substitution device that conveys visual information via an auditory experience of musical notes, developed at the Hebrew University of Jerusalem ([1], photo credit: Maxim Dupliy, Amir Amedi and Shelly Levy-Tzedek). **e** *NAVI*: a low-cost, Microsoft Kinect-based proof of concept of a mobile navigational aid developed at the University of Konstanz, Germany ([117], photo credit: University of Konstanz). **f** *Anagraphs project*: a Braille e-book reader from the Fraunhofer Institute, Germany which operates by thermo hydraulic micro-actuation (photo credit: Fraunhofer Institute; http://www.anagraphs.eu). **g** *FingerReader*: a small finger-worn form factor from the MIT Media Lab that assists blind users with reading printed text on the go ([98,99], photo credit: Fluid Interfaces Group, MIT Media Laboratory). **h** 3-D smartphone for aerial obstacle detection for the visually impaired and blind individuals developed by University of Alicante, Spain ([94], photo credit: J. M. Saez)

*Bhowmick, A., & Hazarika, S. M. (2017). An insight into assistive technology for the visually impaired and blind people: state-of-the-art and future trends. Journal on Multimodal User Interfaces, 11(2), 149-172.

Hearing Impairment

Photo by National Cancer Institute on Unsplash

We rely on the ability to hear a lot.

Photo by Jamie Street on Unsplash

Hearing Impairment

Two types of hearing impairments*

- hearing loss
  - ‘People who are hard of hearing usually **communicate through spoken language** and can benefit from hearing aids, cochlear implants, and other assistive devices as well as captioning.’
- deafness
  - ‘Deaf people mostly have profound hearing loss, which implies very little or no hearing. They often use sign language for communication.’

*World Health Organisation:
https://www.who.int/news-room/fact-sheets/detail/deafness-and-hearing-loss

Hearing Impairment

Basic Approaches

- Video Captions
- Computers can help people with hearing loss through auto transcription (STT)
- Gesture-based interfaces (e.g. signed programmes*)
- Visual cues in addition to audio

Photo by Nicole Meng-Schneider. CC BY-NC

*https://www.bbc.co.uk/iplayer/help/questions/accessibility/sign-language

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Physical Impairment

- Limited control over movement
- Fine and gross motor skills impaired
- Difficulties with:
  - fine mouse movements
  - quick actions (e.g. double clicks)
  - precise motions
- Hard time reaching and pushing buttons

By ²⁰¹⁰⁰ - Photo created by ²⁰¹⁰⁰, as documented at Wikipedia fr, Public Domain, https://commons.wikimedia.org/w/index.php?curid=802513

Physical Impairment

Basic Approaches

- limited number of interactive objects
- creating simpler layouts that make items easier to reach
- using larger buttons that will reduce error rates (See video on Fitt's law)
- touch targets in easily accessible places (on lower half of a (mobile) screen)
- alterations to mouse sensitivity, speech control and alternative input types

Physical Impairment

Examples of assistive technology

- Speech or eye tracker input
- Motorised gloves
- Smart wheelchairs (self-driven wheelchairs)
- Self-driven cars
- Brain-Computer interface (BCI)

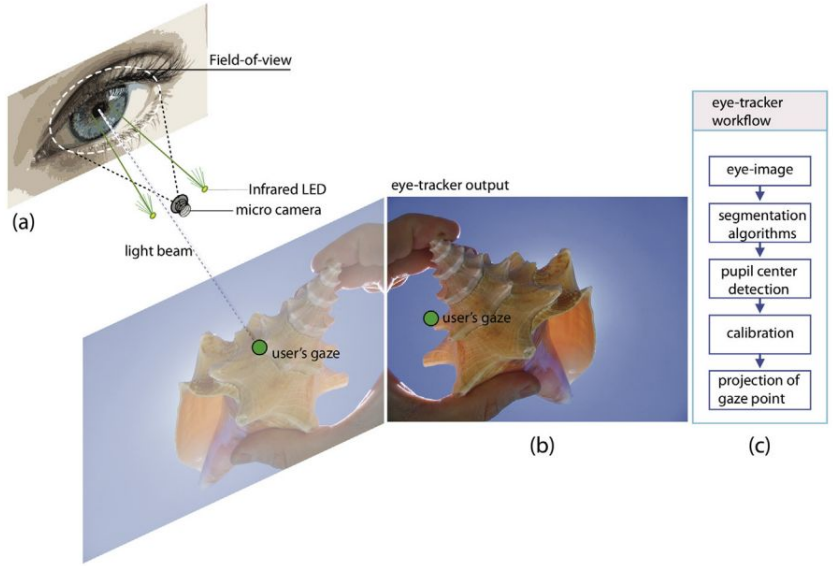
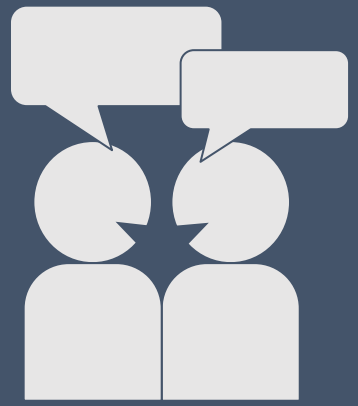


Fig. 1. Diagram of the operation of an eye-tracker. (a) User's field-of-view, (b) eye-tracker output, (c) general eye-tracker workflow.

https://www.youtube.com/watch?v=7t84lGE5TXA

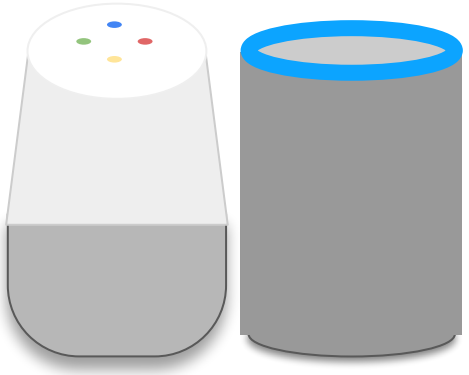
Enrique Cáceres, Miguel Carrasco, Sebastián Ríos, Evaluation of an eye-pointer interaction device for human-computer interaction, Heliyon, Volume 4, Issue 3, 2018, https://doi.org/10.1016/j.heliyon.2018.e00574

Speech Impairment



- Caused by:
  - developmental disorders
  - neurological disorders
  - genetic syndromes
  - hearing loss
  - illness
- Difficulties:
  - articulation, or making sounds
  - phonological processes or hearing and repeating sound patterns
- Accents (e.g. Scottish), non-native speakers, or people with hearing loss

https://youtu.be/Avp9aUkM5g0



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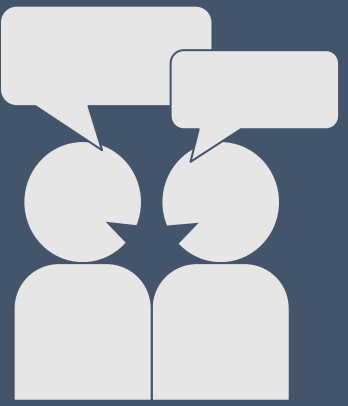


Basic Approaches and Assistive Technology

- Augmentative and alternative communication (AAC) (icons, symbols, charts, photos, signing etc)
  - DynaVox Compass
- Hearing aids
- Computing technologies quite helpful for:
  - Synthesized speech (i.e. helping a user speak)
  - Typing instead of speaking

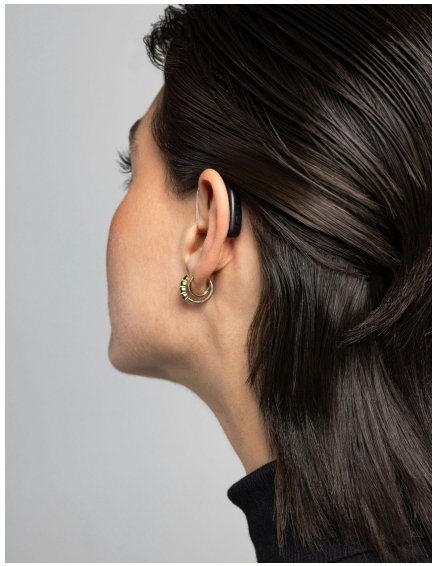
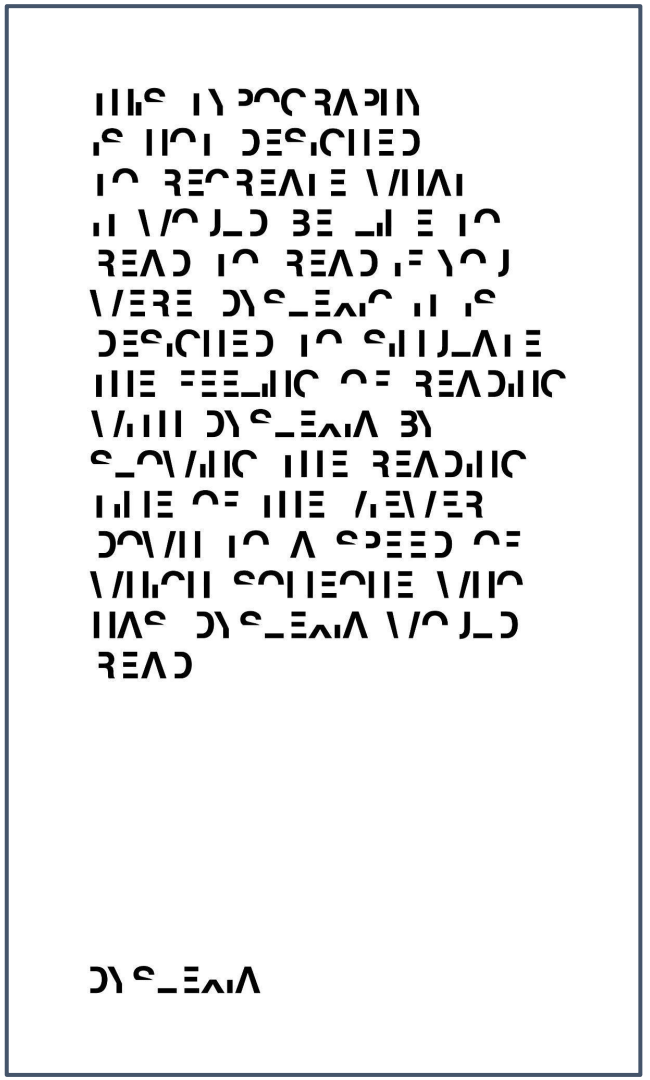


Photo by GN Group on Unsplash

https://leo.zeitverlag.de/artikel-detail-aktuelles/bilder-woerterbuch.html

Dyslexia

- Cognitive disability which impacts reading, writing, and spelling
- Understand spoken content, but struggle with same content written
- “It's estimated that up to 1 in every 10 to 20 people in the UK has some degree of dyslexia.” (NHS)
- Spelling correction is helpful, but most spell checkers are not trained on dyslexic people’s spelling patterns
- Dyslexic person may have difficulty pulling the correct spelling from a list



By Daniel Britton - http://danielbritton.info/dyslexia, CC BY-SA 2.0, https://en.wikiversity.org/w/index.php?curid=216187

What reading is like if you have dyslexia:
https://edition.cnn.com/2016/03/05/health/dyslexia-simulation/index.html

Autism

Individuals with autism have difficulties with:

- Social interaction – issues relating to others
- Communication – issues understanding verbal and textual language including expressions
- Imagination – problems with rigidity of thought processes leading to repetitive behaviour

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Common Interface Issues

- Rigid interfaces (Heuristic: Flexibility)
- Sounds that cannot be controlled
- Lack of explanation (Heuristic: Help)
- Tend toward literal interpretation of content
- Jokes or “funny” descriptions can be confusing

Autism

Basic Approaches

- Computers help because they are often consistent, predictable, and impersonal.
- User is in control allowing management of the repetitive behaviour and inflexibility
  - Always add flexibility and options to adjust
- Information that might distract attention from the main task can be eliminated
- Text-to-speech, or speech-to-text help with language issues

Learning Disabilities

- Difficulties associated with:
  - Perception
  - Memory
  - Cognition
  - Communication

Learning Disabilities

Basic Approaches

Wearables:

- to support people with LD, e.g. tools to detect so-called ‘stranger danger’
- for family support – help ease worries
- for health support – e.g. detect low/high heart rate, extreme stress, seizures and perform an action accordingly, e.g. notifying co-workers and family
- for productivity – help with reading and spelling

Photo by Onur Binay on Unsplash

Photo by FLOUFFY on Unsplash

Age

Older Population

May have a series of difficulties, including:

- Communication (e.g. aphasia)
- Physical mobility (e.g. work-related injuries, Parkinson's disease)
- Eye-related problems (e.g. cataract, AMD)
- Hearing problems (e.g. presbycusis)

Age

Younger Population

- Child Developmental Sequence – Piaget's developmental stages
- Challenges include:
  - (Reading) Comprehension
  - Gross and fine motor skills (very young children)
  - Motivation:
    - "Computers for kids **need to be fun** like a friend, but can make me smart for school. They should also be **friendly** like my cat. The real thing is that they shouldn't make me have to type since I don't like that. I can talk much better!"* (Researcher Notes April 3, 1999, Quote from an 8 year-old child).
- The myth of "digital native generation"

*Druin, A. (2002). The role of children in the design of new technology. Behaviour and information technology, 21(1), 1-25.

Impairment Types

- **Permanent**

e.g. Paralysis, visual impairments

- **Temporary**

e.g. injury, eye infection

- **Situational**

e.g. Language barriers, sun glare

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User Impairments

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