**Multi-Modal Content Delivery**

**Add research to each section and look for issues related to multimodal.**

**Description of the Technologies**

Textual content can be made easier to understand when delivered in different modes to help people with cognitive disabilities. These modes can include the addition of:

* audio – human narration
* video – visual animation or explanatory film (both with closed captions and audio description allowing optional viewing)
* text to speech (TTS) with or without synchronised text highlighting
* contextually-relevant images;
* consistent icons and graphics to mark headings etc; and/or
* text (words and phrases) augmented by use of representative symbols

**Challenges for People with Cognitive Disabilities**

Difficulty of text comprehension by people with cognitive disabilities ranges from minimal to extreme. They may comprehend most of a web page's textual content, or none at all. While this may be related to their disability, it may just as likely be that the content is not relevant for what they wish to access.

Text is written communication and is usually more complex than the spoken word. Sentences are shortened by the use of complex language and grammar structures.

*(Halliday, M.A., (1989). Spoken and written language. Oxford University Press (Pg 79)*

Textual content consists primarily of words in sentences and paragraphs. However, it may also contain non-word content such as numbers (e.g dates and times), symbols (e.g. currency), abbreviations and structural layouts such as lists and tables.

**Effect of memory impairments**

People with cognitive disabilities may:

* have to read text several times to aid comprehension;
* repeat aloud or otherwise reiterate text multiple times to retain it; and/or
* return to sections when difficulties mean they cannot retain information because content has taken too long to read.
* struggle to recall the meaning of abbreviations and symbols.

*Alloway, T. P., & Gathercole, S. E. (2006). Working memory and neurodevelopmental disorders. Psychology Press.*

*Baddeley, A. (2012) Working Memory: Theories, Models, and Controversies*

*Annual Review of Psychology, Vol. 63: 1 -29 (Volume publication date January 2012)*

**Effect of impaired executive function**

People with cognitive disabilities may not:

* sufficiently process / understand text as they read it;
* understand text because they did not understand the text that preceded it; and/or
* be able to plan which text to read next despite clues such as headings or numbering.
* read text at a slower speed

*Cutting, L. E., Materek, A., Cole, C. A. S., Levine, T. M., & Mahone, E. M. (2009). Effects of fluency, oral language, and executive function on reading comprehension performance. Annals of Dyslexia, 59(1), 34–54. http://doi.org/10.1007/s11881-009-0022-0*

**Effect of attention-related limitations**

People with cognitive disabilities may:

* not attend to important concepts and relevant details; and/or
* be significantly distracted by extraneous text, images or sounds.
* need to repeat timed activities due to inattention.

*Hervey, A.S., Epstein, J.N. and Curry, J.F., 2004. Neuropsychology of adults with attention-deficit/hyperactivity disorder: a meta-analytic review.Neuropsychology, 18(3), p.485.*

*Blake, K.T. (200) Two Common Reading Problems Experienced By Many AD/HD Adults. May/June, 2000 edition of Attention!, 6 (5), pp. 30-33*

**Effect of impaired language-related functions**

People with cognitive disabilities may not understand text because they:

* cannot comprehend complex text written in their native language; and/or
* are confused by text written in their language, but written with vocabulary from an unfamiliar culture or subject area;
* are able to mechanically read the text but not understand its meaning e.g. abstract concepts.
* are unable to sound out or recognise letters, words or symbols;
* may have comprehension problems exacerbated by text or instructions presented in a non-native language.

*Young, A. R. , Beitchman, J. H. , Johnson, C., Douglas, L., Atkinson, L., Escobar, M. and Wilson, B. (2002), Young adult academic outcomes in a longitudinal sample of early identified language impaired and control children. Journal of Child Psychology and Psychiatry, 43: 635–645. doi: 10.1111/1469-7610.00052*

*Patterson, Karalyn;  Hodges, John R. (1992) Deterioration of word meaning: Implications for reading, Neuropsychologia, Volume 30, Issue 12, December 1992, Pages 1025-1040, ISSN 0028-3932,* [*http://dx.doi.org/10.1016/0028-3932(92)90096-5*](http://dx.doi.org/10.1016/0028-3932(92)90096-5)*. (http://www.sciencedirect.com/science/article/pii/0028393292900965)*

**Effect of impaired literacy-related functions**

Some people with cognitive disabilities may not:

* cope with sounds or syllables that comprise words;
* understand text because it is not literal and written plainly; and/or
* comprehend text-only instructions in order to adequately follow them.

**Effect of perception-processing limitations**

Many people with cognitive disabilities may not:

* comprehend text that can't be enlarged without distortion;
* recognize characters if they do not form words, or are shown in different fonts or styles, e.g., italics.
* may struggle to accurately track text across the screen due to its layout
* experience visual distortion due to the layout of the content.

*Poulson, D. and Nicolle, C., 2004. Making the Internet accessible for people with cognitive and communication Impairments. Universal Access in the Information Society, 3(1), pp.48-56.*

**Effect of reduced knowledge**

Some people with cognitive disabilities may not comprehend content because:

* they do not have relevant background knowledge; and/or
* background concepts are not explained simply.
* may have lost required background knowledge due to an acquired disability.

Zoltan, B., 2007. *Vision, perception, and cognition: A manual for the evaluation and treatment of the adult with acquired brain injury*. Slack.

*Fairweather,P & Trewin, S. (2009)* [*Cognitive impairments and Web 2.0*](http://link.springer.com/10.1007/s10209-009-0163-2) *Universal Access in the Information Societyvol. 9 (2) p. 137-146*

**Proposed Solutions**

Textual content can be provided or supported in a variety of alternative modes / formats as described below. Ideally, people with cognitive disabilities should be able to choose that content is delivered in the mode they comprehend best. (This is an important component of the proposed [Global Public Inclusive Infrastructure](http://gpii.net/).)

**Text To Speech**

Text To Speech (TTS) is hardware and/or software that produces human speech by a device such as a computer. Most TTS reads text aloud in a synthesized voice. Other TTS converts symbols, such as those employed by augmentative and alternative communication (AAC), into spoken speech. While TTS uses the same speech generation as Screen Readers, the tools are designed for sighted readers and usually do not speak aloud navigation information or information not presented on the screen. At their simplest level, TTS tools speak aloud text copied to the clipboard.

Many people with cognitive disabilities, such as Dyslexia, may have the capacity to use a tool for selecting text to be read aloud through TTS. However, people with severe cognitive disabilities, such as intellectual disabilities, may require simpler TTS delivery or additional support alongside the speech output.

A common example is a TTS widget embedded in a website. An alternative is a [CSS speech module, as proposed by the W3C](http://www.w3.org/TR/css3-speech/). Advantages include that there is nothing to download and install; and learning how to use a TTS widget or a CSS speech module is dramatically simpler than installing and learning a separate application.

The TTS should be limited to relevant content, and exclude such text as found in menus, footers, and advertisements. Another helpful feature is the visual highlighting of text as it is read aloud. Such features may help people with cognitive disabilities who need additional support to comprehend the TTS delivery.

**Video**

Video is a short film clip of moving visual images with or without audio. Video may be provided to aid comprehension or consumption of textual information but can still provide many barriers to users with cognitive and sensory disabilities.

Video with captions and/or audio description (which communicates important information not described or spoken in the main sound track ) provides additional modalities to aid comprehension,. For example, see ["Autistic spectrum, captions and audio description".](http://mindfulresearch.co.uk/2011/08/29/autistic-spectrum-captions-and-audio-description/)

WCAG 2.0 Success Criterion References:

* [1.2.2 Captions (pre-recorded):](http://www.w3.org/TR/UNDERSTANDING-WCAG20/media-equiv-captions.html) Captions are provided for all pre-recorded audio content in synchronized media, except when the media is a media alternative for text and is clearly labeled as such. (Level A)
* [1.2.5 Audio Description (pre-recorded):](http://www.w3.org/TR/UNDERSTANDING-WCAG20/media-equiv-audio-desc-only.html) Audio description is provided for all pre-recorded video content in synchronized media. (Level AA)
* [1.2.7 Extended Audio Description (pre-recorded):](http://www.w3.org/TR/UNDERSTANDING-WCAG20/media-equiv-extended-ad.html) Where pauses in foreground audio are insufficient to allow audio descriptions to convey the sense of the video, extended audio description is provided for all pre-recorded video content in synchronized media. (Level AAA)

**Text with Contextually-Relevant Images**

An image is a picture, a representation of a visual perception.

User research has shown that text comprehension is significantly enhanced where accompanied by contextually-relevant images. A picture of an object may be easier to recognize than a textual description of it. If images are provided for decorative reasons ---WCAG success criteria on alt-tags

Diagrams and charts as visual representations could be helpful for presenting information that would otherwise be textual to describe processes or flows. Employing [HTML Canvas, as proposed by the W3C](http://www.w3.org/TR/2dcontext/), diagrams and charts could be interactive and have additional descriptions for their parts to aid comprehension.

**Text with Consistent Icons, Symbols and Graphics**

An icon is a small image or drawing that commonly represents a function. A graphic is a drawing of a visual perception or an abstract concept, or is otherwise a representation of an object or an idea.

Text accompanied by consistent iconography helps convey meaning, such as by associating discrete textual passages with each other. Similarly, a pie-chart graphic may help convey meaning easier to comprehend than a table of statistics but any charts should also be linked to a simple explanation and/or table for those who also have visual impairments.

Small numbers are usually read aloud correctly although problems can arise with longer numbers. Different countries have different conventions on separating long numbers [W3C link]. Text to speech voices are likely to try to best fit the conventions for the locality of the voice to the number. In addition, there are 2 conventions for marking a decimal point – a period or a comma. Authors should use the convention appropriate for the language and audience for which they are writing and ensure content is marked up for the correct language.[[1]](#footnote-1)

Symbols within text may not be read correctly if the user’s computer voice does not have a text equivalent. Consider using <abbr> tags to define uncommon symbols that will not be read aloud.[[2]](#footnote-2)

Some mathematical symbols that are created in an accessible way (namely using well formatted Math ML or LaTeX) can be read aloud with text highlighting using certain assistive technologies or browser add-ones.

**Text Replaced or Augmented by Symbol Sets**

A symbol is a sign that represents or suggests an idea, an object, an action, or a belief.

Symbol sets can be used for augmentative and alternative communication (AAC) to support people with cognitive disabilities who have severe speech and/or language difficulties. This can include those who may understand speech, but who are unable to express what they wish to say, perhaps because of a physical disability. (It is common for people with cognitive disabilities to also have physical disabilities.) Ideally, [interoperable symbol sets could be used to replace or to augment web-based text](https://w3c.github.io/coga/issue-papers/symbols-non-verbal.html).

**Text with aids to aid comprehension**

**[something about linking to definitions, semantic linked data and other resources]**

**Ease-of-Use Ideas**

Text should be written clearly and simply using the following attributes:

* plain-language standards relevant to language and culture;
  + (Examples for English include:
  + literal explanations, e.g., without jargon, slang, and metaphors;
  + active voice, not passive voice; and
  + no or minimal use of acronyms and abbreviations.)
* visual and organizational structures, e.g., headings and bulleted lists;
* large font size; and
* sans-serif font

Plain language and clear structure will help comprehension of text-to-speech users.

Further information <http://usability.com.au/2004/12/an-accessibility-frontier-cognitive-disabilities-and-learning-difficulties-2004/>

## Multi-modal approach

Issues with working memory may affect ability to multi-task so multi-modal approach needs to be used judiciously with user choice depending on the tasks in hand and the setting.

*Price, Geraldine A. (2006) Creative solutions to making technology work: three case studies of dyslexic writers in higher education. ALT-J, Research in Learning Technology, 14, (1), 21-38 Download* [*http://core.kmi.open.ac.uk/display/1154564*](http://core.kmi.open.ac.uk/display/1154564)

*Sanderson, A. H. (1999) Information technology and dyslexia: a case of ‘horses for courses’, paper presented at the Dyslexic learners: a holistic approach to support, De Montfort University, Leicester.*

However there is an overwhelming amount of research that shows that a multi-modal approach can “enhance assimilation of information” when **text and numerical information are read aloud** [1][2][3][4], **video options are provided**[4][5] and there are **multiple means of navigation and interaction**[6] with **clear layout, headings and use of imagery** [4].

1. Shany, M. & Biemiller, A. (1995). Assisted reading practice: Effects on performance for poor readers in grades 3 and 4. Reading Research Quarterly 30, 382-395.
2. Hecker, L., Elkind, J. & Katz, L., 2002. Benefits of Assistive Reading Software for Students with Attention Disorders. , 52(December).
3. Gy, A., 2006. Main Study Using mobile technology for teaching a second language to dyslexic students. , (229647), pp.1–62.
4. Jan Lacina Editor & Victoria Brown (2010) Review of Research: Digital Media Learning Supports Individuals with Cognitive Disabilities, Childhood Education, 87:1, 68-71, DOI: 10.1080/00094056.2010.10521443
5. Deibel, K., 2007. Studying Our Inclusive Practices : Course Experiences of Students with Disabilities. , pp.2–6.
6. Doyle, J., Bertolotto, M., & Wilson, D. (2009). Towards multimodal mobile gis for the elderly. In *Multimodality in Mobile Computing and Mobile Devices: Methods for Adaptable Usability.* (pp. 301-320). IGI Global. [10.4018/978-1-60566-978-6.ch013](http://dx.doi.org/10.4018/978-1-60566-978-6.ch013)

### Ideas for structured navigation

“acquiring autonomy in navigating through the internet can be fundamental for developing more autonomy and choice-making in the daily life of people with cognitive disabilities” (Sevilla et al, 2007)

*Javier Sevilla, Gerardo Herrera, Bibiana Martínez, and Francisco Alcantud. 2007. Web accessibility for individuals with cognitive deficits: A comparative study between an existing commercial Web and its cognitively accessible equivalent. ACM Trans. Comput.-Hum. Interact. 14, 3, Article 12 (September 2007). DOI=http://dx.doi.org/10.1145/1279700.1279702*

### Use of video and imagery

### “Good cues for individuals without EMI (episodic memory impairment) can be more subtle and less central to the experience, whereas good cues for those with memory impairment need to cover the important highlights of the experience so that they can re-learn and re-construct the forgotten experience […] Individuals with EMI are more easily cognitively overloaded, which leads to a need for systems to present a smaller number of only the most powerful cues.”

### *Matthew L. Lee and Anind K. Dey. 2007. Providing good memory cues for people with episodic memory impairment. In Proceedings of the 9th international ACM SIGACCESS conference on Computers and accessibility (Assets '07). ACM, New York, NY, USA, 131-138. DOI=http://dx.doi.org/10.1145/1296843.1296867*

Interesting statement published in UK magazine “*All public sector bodies and all organisations which receive substantial support from or are licensed to provide public services should be subject to a statutory requirement on the provision of multimodal information. This requirement should be progressively extended from the largest to smaller organisations*.”

* Carey, K., 2006. BROADBAND & DISABILITY A humanITy Paper Sponsored by BT In association with Ability magazine and E-Access Bulletin. , (September).

1. https://www.slightfuture.com/webdev/html5-input-number-localization [↑](#footnote-ref-1)
2. www.stemreader.org/notation-dictionary. [↑](#footnote-ref-2)