Speech and Language

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Abstract

This chapter introduces speech and language from a clinical speech and language therapy perspective. It describes key challenges that can impact upon speech and language with a focus on the needs of individuals with aphasia, an acquired language disorder. The specific impact that aphasia may have upon Web accessibility is discussed with reference to existing work which illuminates what we currently do and do not know about speech, language and Web accessibility. The authors provide guidance for accommodating the needs of users with aphasia within the design of Web interactions and propose future directions for development and research.

1. Introduction

The term 'speech and language' can be used to encompass descriptions of both the way in which we produce verbal communication and the underlying knowledge, organisation and use of words and discourse. Using this definition, speech and language pervade many aspects of our lives. Beginning with our earliest interactions as babies, speech and language enable us to learn from and influence the people and artefacts within our environment. Our capacity to use speech and language varies across the lifespan, between individuals and across different environments. Web interactions typically presuppose a certain level of speech or language capacity and can preclude users with either permanent or situational speech and language needs. Using insights from the field of speech and language therapy/pathology, this chapter first

introduces the reader to a range of speech and language needs and then provides more detailed discussion of one specific condition (aphasia) before discussing the ways in which such a language need might impact upon Web accessibility.

1.1 Demographics on Speech and Language Needs

There are around 40 million people in the United States of America[1] living with communication disabilities and 2.2 million in the United Kingdom (DWP, 2013). Estimates suggest that 1-2% of the population have need of speech and language therapy services at any one time and around 20% of people will experience speech and language difficulties within their lifespan (Law et al. 2007). One of these difficulties is aphasia, a disorder of language typically caused by stroke. Estimates suggest there are around 2 million people in the United States of America[2] and 350,000 in the United Kingdom[3] currently living with aphasia.

1.2 Specific Speech and Language Needs

When considering the range of individuals affected by speech and language issues, difficulties can be distinguished into those which mainly affect speech, and those which mainly affect language. Within the clinical realm of speech and language therapy/pathology, 'speech' refers to the way we say sounds and words, while 'language' relates to the actual words we use or understand and the ways we use them.[4]

Issues affecting speech production can include physical conditions which affect the face, mouth, tongue or vocal cords (including cleft lip and palate, head and neck cancer, muscle weakness or spasticity) and also conditions which affect speech fluency (such as stammering

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[1] https://www.asha.org/About/news/Quick-Facts/

[2] https://www.aphasia.org/aphasia-faqs/

[3] https://www.stroke.org.uk/what-is-stroke/what-is-aphasia/aphasia-and-its-effects

[4] https://www.asha.org/public/speech/development/language_speech.htm

or apraxia of speech). Challenges with speech perception include hearing and auditory processing issues.
Issues related to language can affect one or more of four key domains – language production through speech or sign, language comprehension through speech or sign, language production through writing and language comprehension through reading. Conditions can be present from birth (for example developmental language disorder, dyslexia or learning difficulties) or acquired later in life (for example though brain injury or dementia with resultant aphasia). Individuals with aphasia will form the focus of this perspective on speech and language Web accessibility, however the wider lessons may be applied to a range of language needs, including people with low levels of literacy, non-native language users, those with developmental dyslexia and, with regards to situational disabilities, those with other issues which are placing demands on their cognitive system. It is worth noting that the closest developmental counterpart to aphasia – developmental language disorder – has currently received comparatively little exploration in relation to Web accessibility. Readers are encouraged to consider insights from both this chapter and the chapter "Cognitive and Learning Disabilities" within this book, to inform their understanding of Web accessibility for individuals with developmental language needs.

2. Overview of Aphasia

Any of the factors reported in section 1.2 can have an influence on an individual's opportunity to fully engage with Web content and functionality. Here, we focus on the needs of people with language difficulties – specifically those with aphasia following a brain injury such as stroke.

Aphasia can impact upon any or all of the four key language components: reading, writing, spoken or signed language production and spoken or signed language comprehension. Difficulties may vary according to the size and location of the associated brain injury.

2.1 Written Language Production

Writing and typing can be affected by a number of factors in aphasia. These can include difficulties in being able to find the desired words from the internal lexicon, difficulties in composing grammatically accurate sentences and difficulties in spelling. One further important factor is the common co-occurrence of hemiplegia (paralysis) or hemiparesis (weakness) of one arm and hand. In aphasia the right hand is usually affected. This may mean that linguistic challenges are exacerbated by reduced dexterity and a dependence on a person's non-dominant left hand for writing and typing. For example, precise typing or continuous control of computing devices (e.g., mouse, touchpad or graphics tablet) is likely to be particularly challenging.

2.2 Written Language Comprehension

Written language comprehension is often impaired in aphasia. This problem may be additional to the production difficulties or may stand alone; i.e. skills in reading and writing can dissociate in aphasia. People with aphasia may find it difficult to extract meaning from individual written words and across sentences and paragraphs – experiencing challenges at a single word level and / or at a grammatical level. Written language comprehension difficulties can also make it hard to self-monitor the accuracy of any written language a person has produced themselves – giving rise to additional challenges in the online proof-reading and spell checking non-aphasic readers typically employ to check and correct their written errors. Further, this inability to self-correct may mean that errors created by compensatory features such as auto-correct and spellcheckers may go unidentified, meaning that correctly spelt - but nonetheless incorrectly selected - words may be mistakenly included.

2.3 Spoken or Signed Language Production

As for written language, spoken or signed languages can be variably affected from one individual to another. The most common feature

of aphasia is anomia – a difficulty in finding the target word or sign to express a thought or to name a person or an object. Whilst a person's ability to understand an object's use and to recognise a known individual is retained, their capacity to find the label for that object or individual from within their lexicon is reduced or diminished. A variety of outcomes may occur in response to these word-finding difficulties, including production of similar sounding or looking words or signs, similar meaning words or signs or the production of neologisms or non-words/non-signs. For speech users, additional challenges in producing the desired speech sounds for a target word can also co-occur when individuals experience accompanying apraxia of speech (a difficulty in eliciting volitional speech movements).

2.4 Spoken or Signed Language Comprehension

Comprehension of spoken or signed language is the final feature which can be affected for individuals with aphasia. Again, comprehension might be affected in the extraction of meaning at the level of the individual word or sign, and/or at the phrase or discourse level. Many factors are known to affect comprehension in aphasia. For example, concrete or highly imageable words are typically understood more easily than abstract words (Bird et al, 2003). Similarly, highly familiar words are easier than rare terms. At the level of the sentence, complex structures such as embedded clauses and passives are particularly problematic (Thompson et al, 1997). As noted for written language comprehension, challenges here can make it difficult for a person to monitor the accuracy of their own spoken or signed language production reducing opportunities for error monitoring and self-correction.

3. Supporting Access to Written, Spoken or Signed Communication

Within the discipline of speech and language therapy, a number of approaches have been established that can support individuals with aphasia to access the four key components of language use

previously identified. Some facilitatory strategies for both face-to-face and Web communication are outlined next.

3.1 Written Language Production - What Helps?

Some individuals with aphasia can make use of retained spoken abilities to support their written language production. For example, those with strengths in spoken language may be able to use speech-to-text software to support their written language production (Caute and Woolf, 2016). Tools developed for people with dyslexia, which provide features such as word prediction, spell checking and text-to-speech reading back, can also be facilitative (Marshall et al, 2018). [See "Technology for Dyslexia" within this book for further, detailed discussion of this topic.] Therapy techniques developed for handwriting have also been adapted for computer delivery and use. An example of a multi-media input method, is presented in the W^2ANE tool (Ma et al, 2009), which authors propose may support people with aphasia to construct communicative phrases. Within the context of Web accessibility then, we see support for features such as speech-to-text, word prediction, spell checking and multi-media input.

3.2 Written Language Comprehension - What Helps?

Adaptation of written materials can greatly improve access for individuals with aphasia. For example, while the dense and detailed text of a printed novel may prove impenetrable, increasing the text size and reducing the number of words presented on a page – through the use of an e-reader – can greatly improve access to written language for some readers with aphasia (Caute et al, 2016). Simplified phrase structure, the use of lots of white space and the judicious inclusion of associated, clear images can all further improve an individual's access to written language (Herbert et al, 2012). Technology can also be used to supplement written text with more accessible modalities. For example, Moffat et al (2004) show that word triplets, which accompany text with graphics and sound, give people with aphasia more opportunity to comprehend written words. The lessons for Web accessibility here are in support of re-

sizable text, good use of white space, clear image use and multimodal delivery of content.

3.3 Spoken or Signed Language Production - What helps?

Individuals with spoken language difficulties can be aided by the use of external referents, such as pointing to an image or object, circumlocution (the process of describing the features of a target word/sign or production of a related word/sign) and the use of gesture. Some individuals might also use strengths in written language to support their expression, by writing key words or numbers. Others might be able to utilize drawing to help get their message across. Co-communicators can also assist by giving the individual plenty of time to speak or sign and by presenting alternative options where appropriate. A number of computer tools have been used to support spoken language production in aphasia. An example is sentence shaper (Linebarger et al., 2007) which enables the person to compose, edit and create chunks of spoken discourse. Mainstream video conferencing technologies, such as Skype can also support remote communication, and help to overcome some of the particular challenges of using the telephone – a medium which obscures all but the auditory information being presented by a speaker. Lessons for Web accessibility in this domain, include the provision of additional time to produce spoken inputs, the capacity to capture and re-use small segments of speech, the use of non-verbal input methods such as touch selection and the support of video-based chat as an alternative to voice only interaction.

3.4 Spoken or Signed Language Comprehension - What helps?

It is not always obvious whether someone has understood what has been spoken or signed to them. One way to support individuals with aphasia is to check if they have understood at appropriate intervals in conversation. Additionally, simplifying the language that is being used, repeating key points and using gesture, writing and drawing can all serve to aid comprehension. Slowing the rate of speech is also important to aid understanding. When considering Web access, we can look to evidence from Fridriksson et al (2009), who found

that for language therapy, where words were presented in both audio and video format (i.e. showing the speakers face in addition to hearing their voice), individuals made significant improvements in word learning. A contrasting condition where words were presented in audio only format did not produce therapeutic improvements. This indicates that the provision of video instruction/presentation in addition to audio presentation, can enhance access to digital audio spoken content. When looking to enhance access to video media further, we can consider the preferences of participants in a study by Rose et al (2010), who expressed a clear desire for the use of subtitling alongside video content. The lessons here speak for inclusion of check-in points to ensure that a user has understood the audio or video content provided, opportunities to slow the rate of speech audio, the provision of a video of a speaker's face alongside any audio narration and the provision of subtitles to accompany video content.

3.5 Physical and Perceptual Barriers Caused by Stroke - What helps?

The physical barriers relating to right-sided weakness can mean that people with aphasia have difficulty engaging with complex, small interfaces due to the fact that they are often using one hand to interact. One viable support feature here is to increase the size of any interactive features in the interface. The use of only one hand is also an essential factor to consider for mobile computing. Ensuring that mobile devices have a stand is often critical. Separate to this, additional stroke-related visual impairments, such as hemianopia, may also affect an individual's ability to visually scan a computer screen. Clear, central placement of any journey-critical navigation can help to address this.

4. Other Accessibility Issues

Beyond specific aspects directly related to the language content presented on the Web, research has revealed a number of more subtle ways in which aphasia can impact upon digital interactions. Menger et al (2016) for example, highlight issues around

remembering password and login details. Likewise, Greig et al (2008) and Moffat et al (2004) both cite the need for simple navigation methods within interfaces – avoiding the use of complex hierarchical menus. In a review of accessibility for mobile computing, Brandenburg et al (2013) additionally advocate the use of multimodal content and input (e.g by supplementing written text with pictures and/or spoken words), aphasia-friendly text (e.g. clear font, short sentences, adequate use of spacing), large "buttons", a predictable, consistent interface and visually simplistic screens.

5. Aphasia-specific Recommendations

Our group, at City, University of London, has run a series of research projects that have appraised existing technologies (Marshall et al, 2018; Woolf et al., 2016; Caute & Woolf., 2016) and developed new tools (Galliers et al., 2017; Roper et al., 2016; Galliers et al., 2011) for people with aphasia. Using inclusive techniques, such as co-design, all our work has involved people with aphasia from the outset (Roper et al., 2018; Grellmann et al., 2018; Wilson et al., 2015). We have drawn on this work to develop a checklist of dos and don'ts for developers and researchers to consider when designing Web and other digital experiences for people with aphasia. Based on a synthesis of the evidence and experience garnered through collaborations between researchers in Human Computer Interaction and research speech and language therapists in Language and Communication Science, we propose the following[5]:

Do

- Keep text short and simple
- Include a text label with every icon
- Minimise distractions

[5] A poster of these dos and don'ts can be downloaded from blogs.city.ac.uk/inca/outputs. The format is based on the gov.uk accessibility poster set available via https://accessibility.blog.gov.uk/2016/09/02/dos-and-donts-on-designing-for-accessibility/

- Let users control the pace of the interaction
- Limit the number of steps

Don't

- Use complex sentences
- Rely on image or text alone
- Clutter the screen
- Use timeouts
- Use complex user journeys

The above list is non-exhaustive and evolving. We hope, however, it will provide a starting point for researchers and developers to reference when considering the needs of users with aphasia and other language needs within the process of Web design.

6. Discussion

The preceding discourse has sought to illustrate a variety of factors which should be considered when approaching the question of Web accessibility in specific relation to issues of language. We make a case for considering needs along four parameters – written production, written comprehension, spoken or signed production and spoken or signed comprehension. Researchers and developers have a host of tools at their disposal to extend and supplement existing Web design, from word prediction and spell-checking, through to labelled, picture-based input and the multi-modal presentation of information. Issues can be further addressed through the adherence to the presented summary list of dos and don'ts. Within the wider context readers are encouraged to refer to the chapter "Standards, Guidelines and Trends" within this book for details of the W3C, (World wide Web Consortium) Web Content Accessibility Guidelines version 2.1. (WCAG 2.1, 2018). Here, in addition to the needs of those with cognitive or speech disabilities (whose challenges have been identified in previous versions of the guidelines), this most recent version specifically acknowledges, for the first time, the need to consider the requirements of users with language disabilities when designing for the Web.

7. Future Directions

Looking forward, video and voice present interesting future challenges and opportunities for users with language needs. The increasing ubiquity of video media online offers new opportunities for access to Web content for many people with language disabilities. Existing work on effective methods for supporting access to written language content presentation, should now be extended to consider the most effective methods for ensuring access to video content. Additionally, increasingly prevalent speech recognition interfaces such as Amazon Echo and Google Home, may offer good opportunities for spoken language practice for users with language needs, but should offer alternative input modes too – to avoid alienating users with unclear or unpredictable speech and language expression.

We now consider the future implementation of accessibility guidance. As is the case for other cognitive or learning difficulties, many of the linguistic barriers to Web access cannot be identified through the use of automated accessibility checkers. For this reason, we argue that – particularly for the group of users with language needs - the practice of user testing is particularly important in order to achieve accessible Web interactions. Important work is yet to be done to establish the most effective methods to accommodate users with speech and language needs within the user testing context. Alongside the exploration of video and speech accessibility for the Web, operationalising user testing methods for people with speech and language needs provides a rich seam of future research in the field.

8. Author's opinion of the field

The increasing recognition of speech and language needs as a discernible accessibility issue marks definite progress in the path towards improving Web access for users affected by speech and/or language disabilities. Further research on this area is necessary in order to determine how needs are currently being met (or not) for members of this population. Within this chapter, we have drawn upon existing evidence from the fields of human computer interaction, and speech and language therapy/pathology. We believe

that pursuing collaborative work across these disciplines will serve to further distil the knowledge so it may be applied most effectively to the topic of Web accessibility. Perhaps most critical to achieving this aim however, will be the consultation of and advocacy by users with speech and language needs themselves.

9. Conclusions

Aphasia is a highly prevalent disability with profound consequences for those affected. Social isolation and reduced quality of life are common. Engagement with technology could ameliorate some of these effects. However, the risks of digital exclusion in aphasia are high. The linguistic impairments of aphasia mean that the language demands of many technologies cannot be met; and additional stroke related impairments affecting physical and sensory functioning add to the barriers. Good, aphasia friendly design can mitigate many of these risks and open up the benefits of the digital world to this group. The benefits do not stop there. Design that includes people with aphasia will open technologies to many other disadvantaged groups, such as people with low levels of literacy, second language users and people with cognitive difficulties. By designing for aphasia, we can design for a more inclusive world.

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