Pilot Project Study: Inclusive Web-Accessibility for Persons with Cognitive Disabilities

Final Report

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TABLE OF CONTENTS

Executive summary

This report is about cognitive web accessibility. It provides insights into current needs, barriers, and solutions regarding cognitive processes and the web. These insights are based on a comprehensive literature review as well as surveys and interviews with stakeholders and end users.

Background

Cognition refers to mental processes such as memory and understanding. These processes are affected by internal factors – for instance, specific impairments – and external factors, such as stress. Cognitive ability springs from a combination of internal capacity and external context. Generally, persons with cognitive disabilities will have greater accessibility needs.

"Cognitive disability" can refer to several markedly different things, such as intellectual (learning) disability, neuropsychiatric conditions, or dementia. Furthermore, definitions and diagnostic criteria have shifted over time. For this reason, it may be better to speak of concrete user needs rather than diagnoses.

Persons with a higher need of cognitive accessibility appear to use the web to the same extent as the population at large. This is partly out of necessity since the digital transformation of society makes digital services and solutions increasingly unavoidable. In some cases, digital solutions may enhance quality of life for persons with higher cognitive accessibility needs. However, inaccessible digital solutions may exclude these groups from society.

Existing research

The literature review looked at eight distinct areas of research pertaining to cognitive web accessibility: inclusion and participation, web accessibility standardisation, technology, personal support, design considerations, law and policy, education and training, and quality of life. Based on this, the following research questions were answered.

How many people are affected by barriers to cognitive accessibility in digital environments?

Many sources use diagnoses as a proxy, assuming that a barrier encountered by one person with a particular diagnosis will be encountered by everyone with that diagnosis. This is a questionable assumption, however, there is diversity within diagnostic groups, and persons without diagnoses also experience cognitive barriers.

Our stakeholder consultation found that respondents with cognitive disabilities were about as likely to find it difficult to understand or navigate websites as those without cognitive disabilities. This indicates that the number of people affected by cognitive inaccessibility may be larger than first assumed.

What barriers to digital accessibility do persons with cognitive disabilities face?

The literature review shows that there are both technical and social barriers to access. As such, removing these barriers will require both technological innovation and changes in societal attitudes. Responses to the stakeholder consultation indicate that one important

barrier to participation concerns stigmatisation. Social stigma is hampering access to and use of tools such as assistive technology.

Several studies discuss barriers in terms of participation and inclusion as well as general access to support, including technological solutions. Fewer studies, however, look at cognitive barriers in the specific context of website design. Information on such barriers is easier to find in the standardisation literature.

The existing non-normative standards contain recommendations for web accessibility for all mental functions. Many of the same provisions can be found in the normative European web accessibility standard EN 301 549, though this instrument has a greater focus on specific functionalities.

The recommendations often address barriers such as finding information, using controls, focus, time management, comprehension, data entry, and navigation. Beyond this, survey respondents and interviewees mentioned three barriers in particular: navigation, filling in forms, and managing login details. Some also mentioned excessively complicated language.

What are the consequences of accessibility barriers for persons with cognitive disabilities?

Accessibility barriers affect the day-to-day lives of persons with cognitive disabilities, as well as their long-term quality of life. While the available research is limited, it should be highlighted that even small aspects of web design can have considerable consequences for the group. The stakeholder consultation further confirms this, with some respondents explaining that cognitive accessibility barriers have cost them employment opportunities. In this context, social stigma was again cited as a key barrier, where some employers avoid hiring persons with cognitive disabilities based on stereotypes and negative expectations.

The stakeholders further point to adverse consequences for society, such as reduced profits for private companies and increased costs for additional services for public organisations. The available literature, however, says relatively little about this.

In general, a lack of attention to cognitive user needs results in the exclusion of certain groups from digital society, and the disempowerment of persons with cognitive disabilities. If this can be addressed, persons with cognitive disabilities stand to reap considerable benefits from the use of digital solutions.

Actions to remove accessibility barriers

What has been done to remove accessibility barriers for persons with cognitive disabilities?

Public and private actors have taken several steps to address cognitive inaccessibility, ranging from general actions such as legislation and overarching guidelines, to more specific requirements and tools that meet cognitive needs in particular. These general and specific approaches represent two distinct avenues of action, both of which have been investigated in this study.

The research also shows that many of the most successful initiatives involve persons with cognitive disabilities themselves. Conversely, the current EU regulatory framework is incomplete when it comes to requirements for cognitive web accessibility, although there are more relevant guidelines in non-normative standards. The EU mandate for

development of accessibility standards in conjunction with the European Accessibility Act may make it possible to include more cognitive requirements in normative standards.

Regarding education and training, there are some initiatives aimed at persons with cognitive disabilities themselves, but relatively little for ICT professionals building web interfaces.

What were the results of the actions to remove accessibility barriers for persons with cognitive disabilities?

Few studies discuss how web accessibility requirements help users in practice. The focus of user research has been to support and encourage the development of new measures, rather than evaluating the impact of previous measures – though there are some noteworthy exceptions to this, for instance in standardisation contexts.

In comparison, there is more research on the results of practical solutions for persons with cognitive disabilities. This makes it easier to say what does and does not work.

The stakeholder consultation provided little additional information on the results of actions to remove accessibility barriers. One conclusion to be drawn from this is that awareness of what is actually being done ought to be raised.

Gaps in research and requirements

Research

The report identifies five gaps in the research on cognitive web accessibility:

- **Studies comparing and differentiating various user needs regarding cognitive accessibility, from the perspective of various user groups.** There is a need to understand more about how different aspects of cognition and different forms of cognitive disability affect accessibility.
- **Studies evaluating measures for cognitive accessibility.** While steps have been taken to improve cognitive accessibility, these steps have not been comprehensively evaluated.
- **Cross-disciplinary research.** Research into cognition is highly compartmentalised. What is done in one discipline is rarely integrated into what is done in another, even when this would have clear synergetic benefits.
- **Cognitive user needs over the lifecycle.** The available research is unevenly divided between different life stages, focusing a great deal on children and the elderly, but saying little about cognitive accessibility in adulthood or in the workplace.
- **Research into the consequences of barriers.** The impact barriers have on the individual is insufficiently described in the available research.

Requirements

It is difficult to say exactly what should be required in terms of cognitive accessibility. However, a comparison of EN 301 549 with various non-normative standards point to at least three areas of improvement:

- **Visual support for orientation, navigation, operability, and understanding.** Add more visual elements to help people use websites independently.
- **Requirements that consider the relationship between several elements on the same page or in a process.** While many of the existing requirements focus on one element at a time, a common barrier to cognitive accessibility is excessive complexity stemming from the interplay of several elements in an interface.
- **Support for individual options.** Make it easier for the user to customise the interface to their needs, including through different modalities.

Proposals to improve access

Based on the above research, the report concludes with the following practical proposals to improve independent and inclusive access to the web for persons with cognitive disabilities. In the proposals, solutions refer to technical tools that support a variety of cognitive user needs. These solutions are mainly oriented towards supporting persons with cognitive disabilities, but can also be of use to others, depending on the situation.

Web accessibility requirements:

- Study whether cognitive accessibility requirements can be added to standards that the European legislation is pointing to.
- Study whether existing cognitive accessibility guidelines can be converted into measurable requirements.
- Develop a common understanding of cognitive accessibility user needs that are used in standardisation.
- Involve end users with cognitive disabilities in standardisation.

Design-oriented guidelines:

- Increase user participation in the design of user interfaces, ICT products and services.
- Develop and spread nuanced personas that illustrate needs for cognitive accessibility.
- Raise awareness of existing universal design and accessibility guidelines and spread good practices.

Awareness-raising and training:

- Ensure future web professionals get training in cognitive accessibility.
- Raise awareness of the diversity of cognitive accessibility needs to increase knowledge and reduce stigma.

Educational initiatives:

- Study the possibility of developing training platforms where persons with cognitive disabilities can learn technology skills without stress.
- Ensure that guidance and support to digital apps, tools and interfaces is provided in plain language.

- Improve ICT training conditions for persons with cognitive disabilities.

Technical solutions:

- Take stock of and evaluate existing and publicly available technical solutions.
- Raise awareness of existing and publicly available technical solutions.
- Ensure access to assistive technology throughout the life journey.
- Provide training on assistive technology to increase independence of end users.

Personalised approaches:

- Study the feasibility of personalisation solutions such as browser extensions or built-in features.
- Provide more R&D funding for developing AI-based tools for cognitive accessibility.

Conclusions and recommendations

The study shows that there are several gaps in our knowledge regarding cognitive accessibility. Yet there is also a lot of activity within the research community. The momentum provided by the European Web Accessibility Directive could be used to further encourage this activity and convince public and private actors to do more to meet cognitive user needs. Two obstacles need to be overcome: the difficulty of standardisation from diverse user needs, and the stigma that still surrounds needs for cognitive accessibility.

The study further recommends:

- That new requirements focus on mental functions rather than diagnoses.
- The institution of both general measures and customisable solutions.
- Raising awareness that cognitive accessibility benefits everyone.

Résumé (FR)

Ce rapport porte sur l'accessibilité cognitive du Web. Il donne un aperçu des besoins actuels, des obstacles et des solutions concernant les processus cognitifs et le web. Ces informations sont basées sur une analyse documentaire complète ainsi que sur des enquêtes et des entretiens avec des parties prenantes et des utilisateurs finaux.

Contexte

La cognition fait référence aux processus mentaux tels que la mémoire et la compréhension. Ces processus sont affectés par des facteurs internes – par exemple, des déficiences spécifiques – et des facteurs externes, comme le stress. Les capacités cognitives découlent d'une combinaison de capacités internes et de contexte externe. En général, les personnes souffrant d'un handicap cognitif auront des besoins d'accessibilité plus importants.

Le terme « handicap cognitif » peut désigner plusieurs choses très différentes, telles que des difficultés intellectuelles (d'apprentissage), des troubles neuropsychiatriques ou la démence. En outre, les définitions et les critères de diagnostic ont évolué au fil du temps. Pour cette raison, il est préférable de parler de besoins concrets des utilisateurs plutôt que de diagnostics.

Les personnes ayant un besoin plus élevé d'accessibilité cognitive semblent utiliser le web dans la même mesure que la population en général. C'est en partie par nécessité puisque la transformation numérique de la société rend les services et solutions numériques de plus en plus incontournables. Dans certains cas, les solutions numériques peuvent améliorer la qualité de vie des personnes ayant des besoins d'accessibilité cognitive plus élevés. Cependant, des solutions numériques inaccessibles peuvent exclure ces groupes de la société.

Recherches existantes

L'analyse documentaire a porté sur huit domaines de recherche distincts relatifs à l'accessibilité cognitive du Web : inclusion et participation, normalisation de l'accessibilité du Web, technologie, soutien personnel, considérations liées au design, droit et politique, éducation et formation, et qualité de vie. Sur cette base, les questions de recherche suivantes ont été abordées.

Combien de personnes sont touchées par les obstacles à l'accessibilité cognitive dans les environnements numériques ?

De nombreuses sources utilisent les diagnostics comme approximation, en supposant qu'un obstacle rencontré par une personne ayant un diagnostic particulier s’appliquera à toutes les personnes ayant celui-ci. Cette hypothèse est discutable, mais il existe une diversité au sein des groupes, et les personnes sans diagnostic rencontrent également des obstacles cognitifs.

Notre consultation des parties prenantes a révélé que les personnes interrogées souffrant de déficiences cognitives étaient à peu près autant susceptibles d’avoir des difficultés à comprendre ou à naviguer sur les sites Web que les personnes sans déficience cognitive.

Cela indique que le nombre de personnes touchées par l'inaccessibilité cognitive est sans doute plus important que les estimations initiales.

Quels sont les obstacles à l'accessibilité numérique auxquels sont confrontées les personnes souffrant de troubles cognitifs ?

L'analyse documentaire montre qu'il existe des obstacles techniques et sociaux à l'accès. L'élimination de ces obstacles nécessitera donc à la fois des innovations technologiques et des changements d'attitude de la part de la société. Lors de la consultation des parties prenantes, il est apparu que la stigmatisation représente un obstacle important à la participation. La stigmatisation sociale entrave l'accès et l'utilisation d'outils tels que les technologies d'assistance.

Plusieurs études traitent des obstacles en matière de participation et d'inclusion, ainsi que de l'accès général au soutien, y compris aux solutions technologiques. En revanche, moins d'études se penchent sur les obstacles cognitifs dans le contexte spécifique de la conception des sites Web. Les informations sur ces obstacles sont plus faciles à trouver dans la littérature concernant la normalisation.

Les normes non normatives existantes contiennent des recommandations pour l'accessibilité du Web pour toutes les fonctions mentales. Un grand nombre de ces dispositions se retrouvent dans la norme européenne normative d'accessibilité du Web EN 301 549, bien que cet instrument soit davantage axé sur des fonctionnalités spécifiques.

Les recommandations portent souvent sur des obstacles tels que la recherche d'informations, l'utilisation des commandes, la concentration, la gestion du temps, la compréhension, la saisie de données et la navigation. En outre, les répondants à l'enquête et les personnes interrogées ont mentionné trois obstacles en particulier : la navigation, le remplissage des formulaires et la gestion des données de connexion. Certains ont également mentionné un langage excessivement compliqué.

Quelles sont les conséquences des obstacles à l'accessibilité pour les personnes souffrant de troubles cognitifs ?

Les obstacles à l'accessibilité affectent la vie quotidienne des personnes atteintes de troubles cognitifs, ainsi que leur qualité de vie à long terme. Bien que les recherches disponibles soient limitées, il convient de souligner que même de petits aspects de la conception de sites Web peuvent avoir des conséquences considérables pour le groupe. La consultation des parties prenantes le confirme, certains répondants expliquant que les obstacles à l'accessibilité cognitive leur ont fait perdre des opportunités d'emploi. Dans ce contexte, la stigmatisation sociale a de nouveau été citée comme un obstacle majeur, certains employeurs évitant d'embaucher des personnes souffrant de handicaps cognitifs en raison de stéréotypes et de préjugés négatifs.

Les parties prenantes soulignent en outre les conséquences négatives pour la société, telles que la réduction des bénéfices des entreprises privées et l'augmentation des coûts des services supplémentaires pour les pouvoirs publics. La littérature disponible est toutefois relativement peu diserte à ce sujet.

D'une manière générale, le manque d'attention portée aux besoins cognitifs des utilisateurs entraîne l'exclusion de certains groupes de la société numérique et la perte d’autonomie des personnes souffrant de troubles cognitifs. Si l'on parvient à remédier à ce problème, les personnes souffrant de troubles cognitifs pourraient tirer des avantages considérables de l'utilisation de solutions numériques.

Actions visant à supprimer les obstacles à l'accessibilité

Quelles mesures ont été prises pour supprimer les obstacles à l'accessibilité pour les personnes souffrant de handicaps cognitifs ?

Les acteurs publics et privés ont pris plusieurs mesures pour lutter contre l'inaccessibilité cognitive, allant d'actions générales telles que la législation et les directives générales, à des exigences et des outils plus spécifiques répondant à des besoins cognitifs particuliers. Ces approches générales et spécifiques représentent deux voies d'action distinctes, qui ont toutes deux été examinées dans cette étude.

La recherche montre également que bon nombre des initiatives les plus réussies impliquent des personnes souffrant de troubles cognitifs elles-mêmes. À l'inverse, le cadre réglementaire actuel de l'UE est incomplet en ce qui concerne les exigences en matière d'accessibilité cognitive du Web, même si des orientations plus pertinentes figurent dans les normes non normatives. Le mandat de l'UE pour l'élaboration de normes d'accessibilité en conjonction avec la directive européenne sur l'accessibilité pourrait permettre d'inclure davantage d'exigences cognitives dans les normes normatives.

En ce qui concerne l'éducation et la formation, il existe quelques initiatives destinées aux personnes souffrant de troubles cognitifs elles-mêmes, mais relativement peu pour les professionnels des TIC qui créent des interfaces Web.

Quels ont été les résultats des actions visant à supprimer les obstacles à l'accessibilité pour les personnes souffrant de handicaps cognitifs ?

Peu d'études traitent de la manière dont les exigences d'accessibilité du Web aident les utilisateurs dans la pratique. La recherche sur les utilisateurs s'est concentrée sur le soutien et l'encouragement du développement de nouvelles mesures, plutôt que sur l'évaluation de l'impact des mesures précédentes – bien qu'il y ait quelques exceptions remarquables à cela, par exemple dans les contextes de normalisation.

En comparaison, il existe davantage de recherches sur les résultats des solutions pratiques pour les personnes souffrant de troubles cognitifs. Il est donc plus facile de dire ce qui fonctionne et ce qui ne fonctionne pas.

La consultation des parties prenantes a fourni peu d'informations supplémentaires sur les résultats des actions visant à supprimer les obstacles à l'accessibilité. Une conclusion à en tirer est qu'il convient de mieux faire connaître ce qui se fait réellement.

Lacunes de la recherche et exigences à rencontrer

Recherche

Le rapport identifie cinq lacunes dans la recherche sur l'accessibilité cognitive du Web :

- **Des études comparant et différenciant les divers besoins des utilisateurs en matière d'accessibilité cognitive, du point de vue de divers groupes d'utilisateurs.** Il est nécessaire de mieux comprendre comment les différents aspects de la cognition et les différentes formes de handicap cognitif affectent l'accessibilité.

- **Études évaluant les mesures d'accessibilité cognitive.** Si des mesures ont été prises pour améliorer l'accessibilité cognitive, ces mesures n'ont pas été évaluées de manière exhaustive.
- **Recherche interdisciplinaire.** La recherche sur la cognition est très compartimentée. Ce qui est fait dans une discipline est rarement intégré à ce qui est fait dans une autre, même lorsque cela donnerait lieu à des synergies bénéfiques.
- **Les besoins des utilisateurs en matière de cognition tout au long du cycle de vie.** La recherche disponible est inégalement répartie entre les différentes étapes de la vie, se concentrant beaucoup sur les enfants et les personnes âgées, mais en disant peu sur l'accessibilité cognitive à l'âge adulte ou sur le lieu de travail.
- **Recherche sur les conséquences des obstacles.** L'impact des obstacles sur l'individu est insuffisamment décrit dans les recherches disponibles.

Exigences

Il est difficile de dire exactement ce qui devrait être exigé en termes d'accessibilité cognitive. Toutefois, une comparaison de la norme EN 301 549 avec diverses normes non normatives fait apparaître au moins trois domaines d'amélioration :

- **Le support visuel pour l'orientation, la navigation, l'opérabilité et la compréhension.** Ajouter plus d'éléments visuels pour aider les personnes à utiliser les sites Web de manière autonome.
- **Des exigences qui prennent en compte la relation entre plusieurs éléments sur une même page ou dans un processus.** Alors que bon nombre des exigences existantes se concentrent sur un seul élément à la fois, un obstacle courant à l'accessibilité cognitive est la complexité excessive découlant de l'interaction de plusieurs éléments au sein d'une interface.
- **Prise en charge des options individuelles.** Faire en sorte que l'utilisateur puisse plus facilement adapter l'interface à ses besoins, y compris par le biais de différentes modalités.

Propositions pour améliorer l'accès

Sur la base des recherches susmentionnées, le rapport se conclut par les propositions pratiques suivantes visant à améliorer l'accès indépendant et inclusif au Web pour les personnes souffrant de handicaps cognitifs. Dans ces propositions, les solutions font référence à des outils techniques qui prennent en charge un grand éventail de besoins cognitifs des utilisateurs. Ces solutions sont principalement destinées à aider les personnes souffrant de troubles cognitifs, mais peuvent également être utiles à d'autres personnes, selon la situation.

Exigences d'accessibilité du Web :

- Étudier si les exigences en matière d'accessibilité cognitive peuvent être ajoutées aux normes auxquelles la législation européenne se réfère.
- Étudier si les directives existantes en matière d'accessibilité cognitive peuvent être converties en exigences mesurables.

- Développer une compréhension commune des besoins des utilisateurs en matière d'accessibilité cognitive, utilisée dans la normalisation.
- Associer les utilisateurs souffrant de troubles cognitifs au travail de normalisation.

Recommandations en matière de conception :

- Accroître la participation des utilisateurs à la conception des interfaces utilisateur, des produits et des services TIC.
- Développer et diffuser des personas nuancés qui illustrent les besoins en matière d'accessibilité cognitive.
- Faire connaître les lignes directrices existantes en matière de conception universelle et d'accessibilité et diffuser les bonnes pratiques.

Sensibilisation et formation :

- Veiller à ce que les futurs professionnels du Web soient formés à l'accessibilité cognitive.
- Sensibiliser à la diversité des besoins en matière d'accessibilité cognitive pour améliorer les connaissances et réduire la stigmatisation.

Initiatives pédagogiques :

- Étudier la possibilité de développer des plateformes de formation où les personnes souffrant de troubles cognitifs peuvent acquérir les compétences technologiques sans stress.
- Veiller à ce que les conseils et l'assistance concernant les applications, outils et interfaces numériques soient fournis en langage clair.
- Améliorer les conditions de formation aux TIC pour les personnes souffrant de handicaps cognitifs.

Solutions techniques :

- Faire le point sur les solutions techniques existantes et accessibles au public et les évaluer.
- Sensibiliser aux solutions techniques existantes et accessibles au public.
- Garantir l'accès aux technologies d'assistance tout au long de la vie.
- Fournir une formation sur les technologies d'assistance afin d'accroître l'indépendance des utilisateurs finaux.

Approches personnalisées :

- Étudier la faisabilité de solutions de personnalisation telles que des extensions de navigateur ou des fonctions intégrées.
- Fournir davantage de fonds de R&D pour le développement d'outils basés sur l'IA pour l'accessibilité cognitive.

Conclusions et recommandations

L'étude montre qu'il existe plusieurs lacunes dans nos connaissances en matière d'accessibilité cognitive. Pourtant, la communauté des chercheurs est très active dans ce domaine. L'élan donné par la directive européenne sur l'accessibilité du Web pourrait être utilisé pour encourager davantage cette activité et convaincre les acteurs publics et privés de faire plus pour répondre aux besoins cognitifs des utilisateurs. Deux obstacles doivent être surmontés : la difficulté de normalisation issue de la diversité des besoins des utilisateurs, et la stigmatisation qui entoure encore les besoins d'accessibilité cognitive.

L'étude recommande en outre :

- que les nouvelles exigences se concentrent sur les fonctions mentales plutôt que sur les diagnostics.
- la mise en œuvre à la fois de mesures générales et de solutions personnalisables.
- de faire prendre conscience que l'accessibilité cognitive bénéficie à tous.

1. Introduction

ICF, in partnership with Funka, were commissioned by the Directorate-General for Communications Networks, Content and Technology (DG CONNECT) in March 2021 to undertake a Pilot Study on Inclusive Web-Accessibility for persons with cognitive disabilities. A website has been developed and updated during the study to present progress, interim results, and the final results of the study. The study concluded with final reporting in February 2022.

1.1 Specific objectives for the study

The general objective of the study was to provide the European Commission with a comprehensive and evidence-based overview of existing research/studies, legislation, and measures taken by both public and private sector organisations, including standardisation, regarding digital accessibility for persons with cognitive disabilities, as well as to identify gaps in research and web accessibility requirements for persons with cognitive disabilities. The specific objectives were:

- To provide a comprehensive overview of existing research/studies in Europe regarding the autonomy and participation of persons with cognitive disabilities in the digital domain.
- To identify barriers to autonomy and participation of persons with cognitive disabilities in the digital domain.
- To propose practical solutions to remove barriers and increase independent and inclusive access to the digital domain for persons with cognitive disabilities.

1.2 Study scope

The **scope** of the study takes into account:

- the main cognitive disability types (such as, mild cognitive disability, intellectual impairments, Downs syndrome, Autism Spectrum Disorders (including Asperger's Syndrome), Attention deficit hyperactivity disorder (ADHD), Dyslexia, traumatic brain injury, age-related cognitive impairments, dementia syndrome, including Alzheimer's disease, speech and language related cognitive impairments such as aphasia and apraxia) and aimed to include other types of cognitive disabilities affecting memory, perception, orientation, attention, communication, problem solving, and comprehension);
- the main cognitive functions: attention, reading, writing, tasks, calculating, choices, time, memory, understanding.

In terms of the link between cognitive functions, disability types and user needs, it is based on established frameworks for describing cognitive functions and user needs, such as the list provided in Annex A of the standard ETSI EG 203 350[1] (as referred to in the offer).

[1] ETSI EG 203 350 V1.1.1 (2016-11), Guidelines for the design of mobile ICT devices and their related applications for people with cognitive disabilities

The **geographical scope** of the study entails qualitative and quantitative data from EU Member States, as well as data from third countries (including the USA, Canada, and Norway). In particular, the study includes a literature review in English as well as, German, Spanish and Swedish, aiming to cover all EU Member States and third countries, such as the USA, Canada, and Norway (as an EFTA state). The study also includes more extensive data collection from three EU countries (Germany, Spain, and Sweden) through in-depth interviews. The choice of these countries is justified by the fact that in these countries, important research on web accessibility for persons with cognitive disabilities has been conducted. This choice was approved by DG CONNECT in the kick-off meeting.

1.3 Research questions of the study

The specific research questions for this study (RQs) are:

1. What are the existing research/studies in Europe on the autonomy and participation of persons with cognitive disabilities in the digital environment?
2. How many people are affected by barriers related to cognitive accessibility in digital environments, both in general, and in particular, regarding the specific barriers identified in the study?
3. What are the main barriers of accessibility of digital environments by persons with cognitive disabilities and how can they be classified?
4. What are the consequences of accessibility obstacles to persons with cognitive disabilities?
5. What actions have been taken to remove accessibility obstacles for persons with cognitive disabilities?
6. What were the results of actions/policies/standards to remove accessibility obstacles for persons with cognitive disabilities?
7. What are gaps identified in research and in the web accessibility requirements regarding persons with cognitive disabilities?
8. What are potential solutions to improve accessibility for persons with cognitive disabilities?

1.4 Study structure

The study is divided in the following sections:

- Section 1 presents the scope of the study and the structure of the report.
- Section 2 provides a background to cognition in the context of web accessibility and the state of research on cognitive user needs.
- Section 3 outlines the literature consulted and the research areas identified in the review. (RQ 1)
- Section 4 presents the findings from the literature review and the stakeholder consultation in reference to the study questions about barriers to cognitive accessibility and the consequences of these barriers. (RQs 2-4)
- Section 5 presents the findings from the literature review and the stakeholder consultation in reference to the study questions about actions to remove accessibility barriers for persons with cognitive disabilities. (RQs 5-6)
- Section 6 provides an analysis of the gaps identified in research and the web accessibility requirements. (RQ 7)

- Section 7 provides practical proposals to improve independent and inclusive access to online services. (RQ 8)
- Section 8 wraps up the study findings and analysis with concluding remarks.

1.5 Key terms and acronyms used in the study

The list of key terms has been developed to facilitate the reading of the study. This means that the definitions of the terms have been elaborated specifically for the context of the study and do not necessarily reflect or correspond to official definitions that may figure in legislative acts.

Key terms in the literature	Explanation
Accessibility	Accessibility means that products, services or environments are created in a way that they are usable by as many people as possible - including persons with disabilities.
Assistive technology / assistive devices	Assistive technology (AT) is any item, piece of equipment, hardware device or software that is used to help the functional capabilities of persons with disabilities.
Attitudinal barriers	Attitudinal barriers are behaviours, perceptions, and assumptions that discriminate against persons with disabilities in general. These barriers often emerge from a lack of understanding, which can lead people to ignore, to judge, or have misconceptions about a person with a disability.
Barriers	Barriers to accessibility are conditions or obstacles that prevent individuals with disabilities from using or accessing knowledge and resources as effectively as individuals without disabilities.
Cognition	Cognition is about acquiring knowledge and understanding through thought, experience, and the senses. In psychology, cognition often refers to information processing, meaning mental processes for taking in, sorting, and understanding information from the world around us.
Cognitive functions (mental functions)	Brain-based skills which are needed in the acquisition of knowledge, manipulation of information, and reasoning. This study refers to the main cognitive functions as: attention, reading, writing, managing tasks, calculating, managing choices, managing time, memory and understanding.

Key terms in the literature	Explanation
Cognitive load	Cognitive load refers to the amount of information that working memory can hold at one time.
Cognitive overload / Information overload	Cognitive overload or information overload means that the amount or intensity of the information exceeds the individual's processing capacity, and the person cannot use the information or proceed with the tasks effectively anymore. Cognitive overload affects individuals differently, and each person's threshold is different.
Cognitive process (mental process)	Using any of the cognitive functions for the acquisition, storage, interpretation, manipulation, transformation, and use of knowledge. These processes encompass such activities as attention, perception, learning and problem solving.
Universal design (inclusive design, design for all)	Universal Design is the design and composition of an environment, be it physical or digital, so that it can be accessed, understood and used to the greatest extent possible by all people regardless of their age, size, ability or disability.
Digital divide	The digital divide refers to the gap between those who have access and benefit from digital information and communications technology and those that do not.
Digital literacy	Digital literacy means having the skills to live, learn, and work in a digital society. It includes the ability to find, evaluate and communicate information on digital platforms.
Digitalisation (digitisation)	Digitalisation, in the broader sense refers to the trend of changing to the use of digital technologies to carry out activities which have previously been done "on paper". Digitalisation involves making existing activities more efficient though the use of digital technologies.
Disability (vs Impairment)	**Disability** means any restriction or lack of ability to carry out tasks or activities of daily life. Examples of cognitive disabilities include difficulties to read or understand text, to focus on carrying out a task, to keep relevant information in the memory, etc. **Impairment** describes problems with a structure or organ of the body, resulting in the loss of physical or mental abilities. Cognitive impairments can range from mild to severe.

Key terms in the literature	Explanation
Easy-to-read (easy read)	"Easy-to-read" means presenting written information in a simplified way to make it easier to understand for persons with intellectual disabilities.
Functional performance statements	Functional performance statements in the European Standard EN 301 549 explain the functionality that is needed in the system to enable users with different abilities to locate, identify and operate functions in technology and to access the information provided.
Guideline vs requirement	A guideline is a set of statements or recommendations that helps reaching a desired outcome. Guidelines are not mandatory and can be broadly defined or detailed. An example of a guideline is the five principles of plain text. Requirements, on the other hand, are compulsory conditions to be fulfilled in order to comply with rules or regulations.
Invisible disability	Invisible disabilities are disabilities that are not immediately apparent to others. It can be a physical, mental, or neurological condition that can’t be seen from the outside. Examples include autism spectrum disorders, depression, ADHD, dyslexia, epilepsy, etc.
Inclusion	The fact or policy of providing equal opportunities and resources for people who might otherwise not get them. For example, people who are disabled or belong to minority groups.
Measurable requirements (measurable criteria)	Measurable requirements provide information that makes it possible to verify whether the requirements have been met, and to evaluate the extent to which they have been met.
Normative vs non-normative standard	A standard is a document produced by a standardisation organisation describing a repeatable, harmonised, agreed way of doing something. Legislation sometimes refers to standards in order to detail requirements or to provide a recognised way to comply with the regulations. A standard used in this way is a normative standard. Non-normative standards can range from guidelines to measurable requirements, but they are not referenced by legislation.

Key terms in the literature	Explanation
Overlays	An accessibility overlay tool is an automated software solution in the form of an add-on to websites, that claims to detect and fix web accessibility issues. It usually presents a series of toolbar controls that modify the presentation of the page they're on, for example changing the contrast or text size.
Participation	Participation refers to the participation of persons with disabilities in the community, in social and economic life and in democratic processes.
Personalisation (individualisation)	Personalisation involves tailoring the user experience to meet the needs and preferences of the individual user. Rather than developing complex solutions for a wide range of users, designing sites in a way that they can be personalised to the needs of each user provides a more efficient solution for accessibility. Examples of personalisation include hiding extra content to help focusing on key information or using symbols to represent words.
Plain language	Plain language is written and spoken communication that is clear, direct and precise.
Simplification	Simplification is a method to render a text easier to read and understand or a digital interface easier to understand and navigate, by simplifying its content and layout.
Social stigma	Social stigma is the disapproval of, or discrimination against, an individual or group, that is based on a negative set of beliefs about people with specific characteristics.
Usability	Usability refers to the ease of access and/or use of a product or website. Usability means that users should find it easy to use a design interface, be able to achieve their goal easily and be able to learn easily how to use the interface. For websites, in short, it means how easily they can be used and understood.
User needs vs usage needs	User needs refer to a set of solutions that make content usable for one or more user group (e.g., users with hearing impairment) or for individual users. Usage need, on the other hand, means specific support needed by an individual in the context of using an ICT device.

Key terms in the literature	Explanation
User participation	User participation refers to the involvement of users in the process of creating and developing a product, a service or a digital interface.
Acronyms	
ADA	Americans with Disabilities Act of 1990. A law that prohibits discrimination in the United States of America against persons with disabilities in places of employment, schools, transportation, and all public and private places which are open to the general public.
ADAAA	Americans with Disabilities Act Amendments Act. The 2008 amendment to the ADA, aiming to protect the right of persons with disabilities to enjoy "digital knowledge".
COGA	W3C's Cognitive and Learning Disabilities Accessibility Task Force.
DPO	Disabled Persons' Organisation.
EN 301 549 (HEN 301 549)	Harmonised European Standard EN 301 549 on Accessibility requirements for ICT products and services. The standard is the main reference for web accessibility in the EU. The Web Accessibility Directive refers to it as a harmonised standard, meaning that if a website, a mobile application or a digital document is complying with the requirements in the standard, it is presumably complying with the Directive.
ICF	International Classification of Functioning, Disability and Health by the World Health Organisation. A framework for describing and organising information on functioning and disability. It provides a standard language and a conceptual basis for the definition and measurement of health and disability.
ICT	Information and Communication Technologies. The term refers to all communication technologies, including the internet, wireless networks, cell phones, computers, software, middleware, video-conferencing, social networking, and other media applications and services enabling users to access, retrieve, store, transmit, and manipulate information in a digital form.
PSB	Public Sector Body.

Key terms in the literature	Explanation
SEN	Special Educational Needs. A child has special educational needs if they have a learning problem or disability that make it more difficult for them to learn than most children their age.
UDL	Universal Design for Learning. A framework to improve and optimise teaching and learning for all people, based on scientific insights into how humans learn. The UDL guidelines emphasise the need to provide multiple means to engage students, presenting information and expressing the acquired knowledge.
UNCRPD	United Nation Convention on the Rights of Persons with Disabilities.
W3C	World Wide Web Consortium. An international community where Member organisations, a full-time staff and the public, work together to develop Web standards.
WAD	Web Accessibility Directive: Directive (EU) 2016/2102 of the European Parliament and of the Council of 26 October 2016 on the accessibility of the websites and mobile applications of public sector bodies.
WCAG	Web Content Accessibility Guidelines by the W3C, providing a standard for web content accessibility to meet the needs of individuals, organisations, and governments internationally.

2. Background to cognitive web accessibility and to the research on user needs

2.1 Introduction

Before going into the details of the research messages, this section sets the scene for cognitive accessibility on the web and the state of research on cognitive user needs. The section introduces key concepts and assumptions that are commonly used in research related to cognition and web accessibility.

2.2 Cognition in the context of web accessibility

According to the Oxford English dictionary, cognition is about acquiring knowledge and understanding through thought, experience, and the senses[2]. There are many mental functions involved in this process – memory, understanding, attention, executive functions etc. This makes both the cognitive process and cognition as a concept rather complex.

In psychology, cognition often refers to information processing, meaning mental processes for taking in, sorting, and understanding information from the world around us[3]. In short, all our senses collect information and send signals to the brain asking it to decide about what we should do next with this information, if anything. While doing this, we use different mental functions, most often at the same time.

The processes of information processing and understanding can be affected by both internal and external factors. Internal factors include impairments in one or more mental functions. External factors include issues such as information overload, stress, or sleep deprivation. It is, for example, well researched that stress has a highly disruptive impact on the working memory for persons with no impairments[4].

It is important to note that the ability of a person to understand information in a certain situation is a combination of their capacity and the context. Cognitive functions emerge in a specific context, which means that there is no such thing as a neutral human being who passively observes the environment without being influenced by it.[5] With a helpful context, persons with cognitive impairments will be able to process information easily, while a stressful and unhelpful context make it difficult for everyone to understand information, including persons without cognitive impairments. For example, persons coming to a new environment or that are stressed because of a deadline can experience the same difficulties completing certain tasks as persons with brain damage after an accident[6].

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[2] Oxford English Dictionary

[3] https://www.simplypsychology.org/cognitive.html

[4] Luethis, M., Meier, B., Sandi, C., 2008. 'Stress Effects on Working Memory, Explicit Memory and Implicit Memory for Neutral and Emotional Stimuli in Healthy Men', Frontiers in Behavioural Neuroscience 2008:2:5

[5] Karlsson, T., Classon, E., Rönnberg, J., 2014. 'Den hjärnvänliga arbetsplatsen - kognition, kognitiva funktionsnedsättningar och arbetsmiljö', Arbetsmiljöverket

[6] ibid

Moreover, mental functions vary from person to person, but for all of us there are limits on how much information the brain can take in and process at the same time. For example, research from cognitive psychology show that the short-term memory can only hold 7 elements (plus or minus 2) at the same time[7].

In general, accessibility is good for everyone, necessary for some. In view of the above-mentioned research on cognition, it is arguably even more true that cognitive accessibility really is for everyone.

2.3 Persons with a higher need of cognitive accessibility

Even though everyone benefits from cognitive accessibility, there are persons that have an even higher need of support on cognition.

All cognitive disabilities have an impact on the mental processes by which we understand and interpret the world around us. This sounds straightforward enough, but the terms used in research and practice concerning cognitive disabilities may often refer to several rather different things. A cognitive disability could, for instance, be an intellectual disability, impacting learning and comprehension abilities. However, it might also refer to a neuropsychiatric condition, such as an autism spectrum disorder (ASD) or ADHD. Neuropsychiatric conditions may manifest as difficulties with social situations or concentration, but they are not typically associated with lower intellectual functioning. There are also some cognitive disabilities that are age-related, such as syndrome of dementia and Alzheimer's disease. These disabilities are often associated with memory loss. Other disabilities affecting cognition include Down's syndrome, traumatic brain injuries, aphasia, and apraxia, both of the latter impairing speech and language abilities (cf. cognitive accessibility user research collected by W3C[8]).

In addition, there are different ways and habits of categorising and defining cognitive disabilities, with diagnostic criteria shifting both over time and between geographic contexts. One can point, for instance, to the changing definitions – and terminology – applied to intellectual disability in the US[9], or to the fact that estimates of the prevalence of ADHD vary wildly from country to country[10].

In addition to the lack of convergence on definition of cognitive disabilities and statistics, there is no direct relationship between specific cognitive diagnoses and specific barriers on the web. Two individuals with the same diagnosis or disability may have entirely divergent needs and preferences in terms of how they use the internet. Conversely, a barrier that a person with a cognitive disability encounters may also be encountered by persons who do not consider themselves to have any cognitive disabilities. For that reason, it can often be more useful to talk about user needs based on a typology of mental functions, such as the typology in the International Classification of Functioning,

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[7] Miller, G., 1955. 'The magical number seven plus or minus two, some limits on our capacity for processing information', Psychological Review Vol. 101, No 2. 343-352

[8] W3C. (2015, January 15). Cognitive Accessibility User Research. Retrieved from W3C: https://www.w3.org/TR/coga-user-research/

[9] Tassé, M. J., 2016, September. 'Defining intellectual disability: Finally, we all agree... almost', Retrieved from American Psychological Association: https://www.apa.org/pi/disability/resources/publications/newsletter/2016/09/intellectual-disability

[10] Polanczyk, G., de Lima, M. S., Horta, B. L., Biederman, J., and Rohde, L. A., 2007. 'The worldwide prevalence of ADHD: a systematic review and metaregression analysis', American Journal of Psychiatry, 164(6), pp. 942-948.

Disability and Health (ICF), developed by the WHO[11]. This is the approach that is most used in standardisation.

The mental functions refer to functions of the brain that we use, for example, for cognitive processes such as taking in and processing information. Examples of mental functions are:

Memory
Language functions related to for example reading and writing,
Attention-related functions such as keeping focus
Functions used in social interactions
Functions related to emotional response in different situations

Illustration 1 provides a somewhat simplified overview of the mental functions involved in cognition, adapted from the ICF framework by the WHO. A more detailed discussion on how organisations involved in standardisation of web accessibility requirements describe user needs related to cognition can be found in section 4.2.

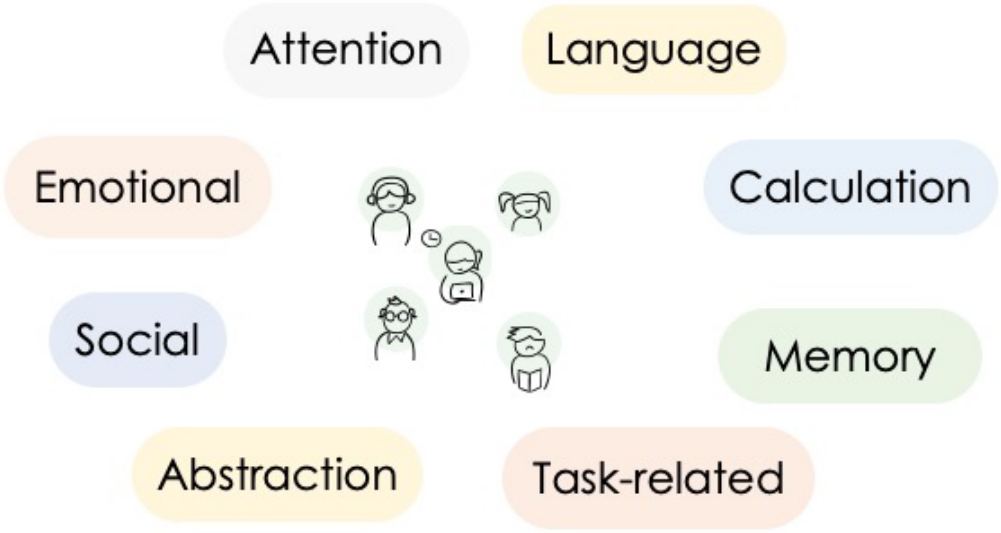


Illustration 1: Simplified description of mental functions related to cognitive processes

For the sake of completeness, we have been looking at sources defining user needs both in relation to the diagnoses referred to in the terms of reference (ToR) of this study, as well as needs related to the mental functions, as commonly defined in the standardisation literature. The diagnoses and the mental functions are listed in section 1.2 "study scope".

2.4 Internet use among persons with a higher need of cognitive web accessibility

At an overall level then, cognitive accessibility is about making it easier for all of us to use our mental functions to understand, learn, complete tasks, etc. Beyond these general

[11] https://www.who.int/standards/classifications/international-classification-of-functioning-disability-and-health

issues, some persons have more needs in some specific areas. This is where the complexity comes in.

The group of persons with a specific need of cognitive accessibility is very diverse. The level of independence and abilities vary largely between individuals, both within and between the established categories of cognitive disabilities. Many persons have impairments that are limited in scope and live fully independent lives. This is the case for most persons that are neurodivergent, for example, on the autism spectrum.

Overall, we have not found any studies that show that persons with cognitive impairments have less need for web-based services than others or that these services are considered less important for any particular group.

In Sweden, the annual "Swedes with Disabilities and the Internet" survey collects information on the web habits of persons with various disabilities. This survey, which mirrors another survey that Sweden's official statistics agency carries out on a larger scale in the general population, shows that persons with disabilities use the internet for the same reasons as anyone else – but in different ways, and with different challenges. This is partly out of sheer necessity. The digital transformation of Swedish society has already advanced so far that web-based solutions for banking, shopping, public services, and other everyday activities are practically unavoidable.[12] In a Spanish study looking at internet use among persons with Down's syndrome, the most visited websites were YouTube, administration websites and medical services websites[13], suggesting that internet is used both for public services and social interactions.

A study conducted in Salamanca and Madrid (Spain) on internet and cell phone usage among young adults with intellectual disabilities reveals that their patterns of ICT usage are comparable with people without disabilities, particularly in terms of cell phone usage. However, young adults with intellectual disabilities are more likely to make more social and less academic use of ICTs in comparison with other groups, primarily due to a lack of access to ICT tools in learning contexts.[14]

At the other end of the age spectrum, longitudinal research studies show that there is a correlation between the participation of older adults in activities outside their homes and their use of digital technology. A gradual abandonment of activities over time is accompanied by the abandonment of personal ICT tools. However, this observed association does not necessarily imply a causal link between participation and use of ICT tools. The longitudinal study also shows that older adults will continue to use digital everyday services, such as ATMs, even after they are no longer active using personal ICT tools, such as tablets or smartphones.[15]

In the survey that was conducted as part of the stakeholder consultation, all respondents that self-identified as having a disability reported that they use the internet to search for

[12] Begripsam, 2020. Svenskarna med funktionsnedsättning och internet 2019. Stockholm: Begripsam/PTS.

[13] Alonso-Virgós, L. et al., 2018. Sensors (Basel). 2018 Nov; 18(11): 4047.

[14] Jenaro, C., Flores, N., Cruz, M.; Pérez, M. C., Vega, V., and Torres, V. A., 2018. 'Internet and cell phone usage patterns among young adults with intellectual disabilities', Journal of Applied Research in Intellectual Disabilities (JARID), 31(2), 259–272.

[15] Gaber, S., 2020. 'The participation of older people with and without dementia in public space, through the lens of Everyday Technology use', Thesis for Doctoral Degree (PhD), Karolinska Institutet, Stockholm. ISBN 978-91-8016-084-1

information and to chat with people or attend meetings on a daily basis. The survey revealed that persons with and without self-identified cognitive disabilities had very similar patterns in their use of internet-based services. For example, over 60% of both the persons with and without disabilities reported using online banking services on at least a weekly basis.

On the positive side, the research from this study suggests that digital technologies can be very beneficial to enhance capacity and increase independence for persons with disabilities in general, and also persons with cognitive impairments, specifically. For example, in the above-mentioned survey, many respondents argue that online solutions and alternatives have improved their quality of life. There is also some more targeted research showing that the introduction of digital technologies can be highly beneficial in increasing independence, for example, among persons with communicative and cognitive disabilities[16]. This research also suggests that by using a social networking site, persons with cognitive disabilities could form or maintain social relationships and obtain a higher level of self-esteem[17].

There is a broad consensus among the persons interviewed for the study that inability to use digital tools and services leads to exclusion, which in turn leads to poor outcomes for overall health and well-being. This aspect is further investigated in section 4.3.

[16] Buchholz, M., Ferm, U., Holmgren, K.,2020. 'Support person's views on remote communication and social media for people with communicative and cognitive disabilities', Disability and Rehabilitation Volume 42 2020, issue 10.

[17] Shpigelman, C.-N., Gill, C.J., 2014. 'How do adults with intellectual disabilities use Facebook?', Disability & Society, November 2014. Available from: https://www.researchgate.net/publication/273332100/

3. Overview of existing research / studies

The first research question of the study was to find out about the existing research/studies in Europe on the autonomy and participation of persons with cognitive disabilities in the digital environment. In order to get an overview of the existing research, the study started with a literature review, which was later enhanced through complementary workshops and interviews. The methodology for the literature review, including the keywords used to search for literature, is provided in detail in Annex 2.

At an overview level, the desk research included literature and documents in the following categories:

- academic literature (peer-reviewed publications)
- standards (guidelines and reports from standardisation organisations),
- grey literature (conference papers, PhD dissertations as well as reports and other material from research projects outside peer-reviewed publications),
- initiatives from public and private entities (legislative documents, policy documents, reports produced by public and private entities).

To provide a structured response to what the existing research/studies in Europe cover in relation to the topic of the study, the findings have been sorted into eight main research themes. A mapping of all sources against the research themes can be found in Annex 2. It should be noted that the categories are not meant to be exhaustive or mutually exclusive. Their main function is to structure the report to support the analysis and the conclusions, and to facilitate for any reader who want to go back to the sources to learn more about certain theme or topic. Section 3.1 presents an overview of the research themes.

3.1 Research areas covered

The research spans over many disciplines and themes. To provide a coherent framework for the overview and analysis of the findings, the sources have been grouped into eight main research areas:

1. **Inclusion and participation**

   Inclusion and participation is the broadest theme in the literature review. It covers all aspects of public and social life, including employment and the workplace, democratic processes and social context (i.e. where social interactions take place). Another strand of the literature on inclusion and participation deals more specifically with participation in ICT design and development processes.

2. **Web accessibility requirements and standardisation**

   Within the theme of web accessibility requirements and standardisation, the literature includes both normative standards (e.g., standards that the legislation is pointing to) as well as informative guidelines. The literature on web accessibility requirements includes both guidelines for target groups with specific cognitive impairments (such as mild dementia, intellectual disabilities, autism, dyslexia), as well as guidelines that are beneficial for everyone.

3. **Technology**

   This theme deals with a broad variety of technical solutions to promote cognitively inclusive access to ICT. The consulted literature covers both innovation of new solutions and the availability and design of assistive technology for persons with cognitive impairments).

4. **Personal support**

   Studies under this theme deal with situations where individual and personalised support is needed to promote independent access to the web by persons with specific needs for cognitive accessibility. Personalised solutions can include both technological solutions with a possibility for personalised settings, as well as access to support from personal assistants.

5. **Design considerations**

   Much of the literature under this theme discusses general ICT design considerations for target groups with specific cognitive needs. The studies are focused, in many cases, on a particular condition, such as mild dementia, intellectual disabilities, autism or dyslexia. Another part of the literature on design concerns the development of broader best practice guidelines for inclusive ICT.

6. **Legal frameworks and initiatives from public organisations**

   This theme mainly reports on existing legal frameworks to protect and support persons with cognitive disabilities in their web use. The theme also includes literature on public sector initiatives to promote cognitive accessibility, such as research programmes or the issuing of guidelines.

7. **Education and training**

   Much of the literature in this theme deals with different aspects of education and training for persons with cognitive disabilities. The sources concern both access to training on ICT and how ICT used in education can become more cognitively accessible. In addition, this theme also includes studies relating to training, education and awareness-raising for ICT professionals to become more versed in cognitive web accessibility.

8. **Quality of life**

   Under this theme we have gathered sources related to different aspects of the everyday life of persons with cognitive disabilities. Part of the literature deals with the use of web and related ICT services by persons with cognitive disabilities. Related to the everyday use is also the question of empowerment (e.g., taking control over the ICT use and over the means to communicate with ICT). In addition, sources under this theme also deal with questions of how ICT use relates to the overall health of persons with cognitive disabilities.

These research areas provide the structure for the findings presented in sections 4 and 5. To facilitate reading, the research areas covered are presented in the introductions of these sections.

3.2 Availability of studies under the identified research areas

It should be noted that the research themes derive from the literature found for each of the research questions. They are only reflective of the sources consulted in this study and are not intended to be exhaustive. Nor was the study designed to find literature in all the research areas for each of the research questions.

That said, some general observations can be made on the availability of sources under the different research areas. For example, the most frequent theme in academic literature is design considerations, followed by inclusion and participation. This means that in the sample that we have looked at, there seem to be more studies on practical means to improve independency by ICT design, than papers that treat inclusion and participation in more general terms. Other prominent themes include technical solutions and education and training, suggesting that much of the literature on cognition is focusing on not only studying the situation in terms of inclusion but also investigating solutions to improve participation.

In terms of the scope and quality of sources, most of the more ambitious academic studies that we have found concern design elements or technical solutions such as personalisation. In both themes, European research teams are well represented in the literature. In terms of regulations and guidelines, a varied selection of sources related to cognition in the standardisation literature has been found. It has been harder to find sources that specifically mention cognitive accessibility in the legal frameworks and among initiatives by public and private entities. This could suggest that cognitive accessibility is still lagging behind physical accessibility regarding the level of public awareness.

More information on the findings for each of the research themes can be found in sections 4-6, under each respective research question.

Annex 1 provides a mapping of research areas by type of sources. Eventual gaps in the literature are discussed in section 6.

4. Extent of issues with cognitive accessibility

This section presents the findings from the literature review and stakeholder consultation on the research questions relating to barriers of cognitive accessibility and the consequences thereof.

4.1 How many people are affected by barriers related to cognitive accessibility in digital environments?

There is limited availability of statistics on the number of people affected by barriers related to cognitive accessibility in digital environments. There are a few studies concentrating on specific diagnoses. For example, a 2017 study[18] project, focused on creating a care organisation model using innovative technologies for patients with cognitive impairment in Italy, Spain, Sweden, and Israel, provided some relevant statistics concerning persons with dementia. For example, the study explained that a large number of those diagnosed with dementia demonstrating mild cognitive impairments are hospitalised each year.

There are different ways and habits of categorising and defining cognitive disabilities, with diagnostic criteria shifting both over time and between geographic contexts. One can point, for instance, to the changing definitions – and terminology – applied to intellectual disability in the US[19], or to the fact that estimates of the prevalence of ADHD vary wildly from country to country.[20]

These discrepancies make it hard to accurately quantify the prevalence of cognitive disabilities. There are further methodological challenges to gathering statistics on cognitive disabilities. There are few central population registers on disabilities, cognitive or otherwise, and surveys with population samples have a well-known tendency to under-sample hard-to-reach groups, such as persons with cognitive disabilities[21]. In the context of web, the user research by W3C COGA Task Force also includes examples illustrating the difficulties in finding reliable data. Their research strives to identify statistics on learning and cognitive disabilities, mainly in the US and UK. They, for example, note that dyslexia is a hidden disability, and that according to some studies, it

[18] Vainstein, G., Adamit, T., Chaimov, N. and Idar, D., 2017. 'Digital Environment for Cognitive Impairment (DECI) Clinical Study-A Multi-Centre, Prospective, Randomized Study Funded by the European Union', In: The Practice of Patient Centered Care: Empowering and Engaging Patients in the Digital Era, p.89. Available from: https://ebooks.iospress.nl/pdf/doi/10.3233/978-1-61499-824-2-89

[19] Tassé, M. J., 2016, September. 'Defining intellectual disability: Finally, we all agree... almost', Retrieved from American Psychological Association: https://www.apa.org/pi/disability/resources/publications/newsletter/2016/09/intellectual-disability

[20] Polanczyk, G., de Lima, M. S., Horta, B. L., Biederman, J., and Rohde, L. A., 2007. 'The worldwide prevalence of ADHD: a systematic review and metaregression analysis', American Journal of Psychiatry, 164(6), pp. 942-948.

[21] Delbosc, A., Currie, G., 2010. 'Designing inclusive transport surveys: Sampling disadvantaged people', The 33rd Australasian Transport Research Forum Conference. Canberra: Social Research in Transport Clearinghouse.

is thought to affect 10% of the population, while other studies have shown figures ranging from 20% to 35% of a specific population.[22]

It is also important to note, that the digital divide does not affect all groups of persons with cognitive disabilities in the same way. The level of internet use, the difficulties faced, and thus digital exclusion can be different depending on the diagnoses or the functional impairment, as well as gender, demographic, and socio-economic factors. For example, people with autism, ADHD and bipolar disorder used the internet more than other subgroups. Furthermore, women with aphasia were reported to use the internet the least and, in many disability groups, larger proportions of men than women reported not feeling digitally included when responding to a targeted survey in Sweden. People with cognitive disabilities, therefore, should not be treated as a homogeneous group when planning policy or actions aiming to increase participation in the digital society.[23]

Taken from a slightly different angle, the answer to the question of how many people are affected by barriers related to cognitive accessibility in digital environments is simple: everyone.

Although there are few studies looking specifically at how persons without cognitive disabilities experience cognitive barriers on the web, there is some evidence from research studies showing that everyone benefits from cognitive accessibility. For example, one study shows how the implementation of WCAG requirements also benefit persons without disabilities[24]. There are also unpublished user tests from a study on measurable cognitive criteria that indicates that all users, with or without disabilities were supported by the implementation of cognitive requirements.[25]

Moreover, the stakeholder consultation provided an indication that barriers related to cognitive accessibility are affecting everyone.

Among respondents self-identifying as persons without cognitive disabilities, a third of them found the web difficult or very difficult to use in general.

When asked about particular barriers on the web, persons self-identifying as persons without cognitive disabilities reported experiencing issues to the same extent as persons self-identifying as having cognitive disabilities:

[22] Seeman, L., Cooper, M., 2021. 'Cognitive Accessibility User Research W3C Editor's Draft 10 May 2021', Available from: https://w3c.github.io/coga/user-research/

[23] Johansson, S., Gulliksen, J. and Gustavsson, C., 2020. 'Disability digital divide: the use of the internet, smartphones, computers, and tablets among people with disabilities in Sweden', Universal Access in the Information Society (2021) 20, p.105–120. Available from: https://www.researchgate.net/publication/339778258_Disability_digital_divide_the_use_of_the_internet_smartphones_computers_and_tablets_among_people_with_disabilities_in_Sweden

[24] Schmutz, S., Sonderegger, A., Sauer, J., 2016. 'Implementing Recommendations from Web Accessibility Guidelines', Human Factors, The Journal of the Human Factors and Ergonomics Society

[25] Kjellstrand, S., Laurin, S., 2021. Criteria for cognitive accessibility in the digital environment, presentation of criteria and project results

Persons without cognitive disabilities	Persons with cognitive disabilities
62% find it difficult or very difficult to find information on a webpage	60% find it difficult or very difficult to find information on a webpage
50% find it difficult to navigate, find their way on website	50% find it difficult to navigate, find their way on a website
57% find it difficult to fill in forms	50% find it difficult to fill in forms

It should be noted that the survey was publicly open and that the participants are therefore self-selected. The survey and its results should therefore be seen as a small scoping exercise designed to provide additional information to the literature, rather than as an investigation representing larger segments of the population.

However, even though the survey is limited in scope, still gives an indication that many barriers are common to persons with and without cognitive impairments alike.

One of the study interviewees, from the industry sector, explained that from their experience of collaborating with users with and without disabilities, persons with cognitive impairments were the first to react on and define cognitive barriers that persons without cognitive impairments also detected, but had more difficulties identifying as specific barriers.

Conclusions

There are different ways of defining how many people are affected by barriers related to cognitive accessibility. One way displayed in several of the sources found is to use diagnoses within the cognitive spectrum as a proxy. In these cases, it is assumed that persons with a particular diagnosis will encounter similar difficulties and barriers. This method should be accompanied by a few reservations. Firstly, the quality of the statistics regarding people with diagnoses is uncertain, as the data collection processes vary, and few take the specific needs of the target audience into account. This means that, in most cases, only people who ask for medical support, benefits or assistive technology are covered by the statistics. This challenge is nowadays recognised by many statistical agencies and there are initiatives to bridge the gap. For example, in Sweden, the yearly investigation called “The Swedes and the internet” is complemented with a parallel study focusing on people with disabilities, to make sure their needs are considered. This is also reflected in fact that the sources that we have found are approximate and statistics vary largely between countries and over time, suggesting that they may not be entirely reliable.

Secondly, the only way to see if a person is affected by a barrier is to verify this through a user test or, at the very least, to ask the person in question. It is not certain that everyone with the same diagnosis has the same experience, as individual needs and abilities vary widely in any diagnosis group. In addition, as was evident from the stakeholder dialogue in the first workshop of the study, persons without diagnoses can experience the same barriers.

An important conclusion for this question would therefore be that statistics on cognitive impairments can be used to get a sense of the minimum size of the target group, but should not be the only way to define how many people are affected by the barriers.

In addition, there is evidence from psychological research, as well as surveys and user research, that persons without (diagnosed) cognitive impairments are also affected by barriers of cognitive accessibility. There is therefore a strong argument to be made that preventing and dealing with barriers is beneficial for everyone, regardless of their abilities.

The key question when it comes to promoting cognitive accessibility lies in the details: which users are most affected by which barriers and what type of solutions are most beneficial in which situations? The following sections of the study take a deeper look into the specifics of barriers, consequences and solutions.

4.2 What are the main barriers of accessibility of digital environments by persons with cognitive disabilities and how can they be classified?

Barriers, that persons with cognitive disabilities face when using ICT go beyond cognitive and linguistic limitations. ICT usage can also be limited by the lack of appropriate training or support, frequent changes in website interfaces, attitudinal barriers (overprotection, sheltering from using the Internet), organisational culture, and again, economic barriers.[26]

In this section we look at barriers related to: inclusion and participation, technology, design considerations, personal support, web accessibility requirements and standardisation, and education and training.

Inclusion and participation

Technological and structural barriers coupled with discriminatory attitude towards people with cognitive disabilities contribute to their exclusion from the web. Some factors that have a negative impact on the possibility to access ICT and web-based services include poverty, lack of inclusive education, inadequate job training, and negative expectations[27]. In addition, persons with cognitive disabilities face greater social stigma concerning their abilities, which further removes them from utilising technology in comparison to individuals with physical disabilities[28].

[26] Werner, S., Shpigelman, C.-N., 2019. 'Information and communication technologies: where are persons with intellectual disabilities? (Commentary)', Israel Journal of Health Policy Research, 9 January 2019.

[27] Blanck, P., 2014. 'eQuality: the struggle for web accessibility by persons with cognitive disabilities', Cambridge university, pp.23-31. Available from: https://onlinelibrary.wiley.com/doi/abs/10.1002/bsl.2101

[28] Friedman, M.G., Bryen, D.N., 2007. 'Web accessibility design recommendations for people with cognitive disabilities', Technology and disability, 19(4), pp.205-212. Available from: https://www.researchgate.net/profile/Mark-Friedman-2/publication/284481795_Web_accessibility_design_recommendations_for_people_with_cognitive_disabilities/links/5653fa6e08aeafc2aabb63be/Web-accessibility-design-recommendations-for-people-with-cognitive-disabilities.pdf

As pointed out by the WHO, various environmental factors can create barriers for persons with disabilities. They are equally relevant in relation to persons with cognitive disabilities, affecting policymaking or policy implementation, from different aspects, such as:

- inadequate policies and standards, that either are not concerned with the needs of people with disabilities, or are not enforced,
- negative attitudes (beliefs and prejudices) of the population,
- the lack of provision of services or problems with service delivery,
- inadequate funding for the implementation of policies and plans,
- lack of accessibility,
- lack of consultation with and involvement of persons with disabilities or their representative organisations regarding decisions that affect their lives (and all decisions affecting people's life in general will also have an effect on persons with disabilities,
- and finally, the lack of comparable data on disabilities and evidence on effective programmes.[29]

Another important barrier when it comes to participation is stigmatisation. There is very little information on this topic in the literature. In the stakeholder consultation however, several interviewees, from both the research community and from organisations representing persons with disabilities, mentioned that the perceived stigma concerning needs for cognitive support is hindering persons with cognitive disabilities from accessing and using tools such as assistive technology.

Web accessibility requirements and standardisation

In the standardisation literature, barriers related to cognitive accessibility are categorised through the definition of user needs and/or functional performance statements.

A review of the requirements and guidelines for dealing with barriers shows that the definition of user needs varies across the sources, both in terms of content and detail. Whereas some make explicit reference to the mental functions developed by the WHO in the International Classification of Function, Disability and Health[30], others use a more simplified definition of cognition with no reference to how the definition came about[31], while others do not use classifications as a basis, but instead use results from user tests as the basis[32]. Where guidelines refer to categories of diagnoses, the requirements are

[29] World Health Organization and the World Bank Group, 2011. World report on Disability, p.262-263. Available from: https://www.who.int/teams/noncommunicable-diseases/sensory-functions-disability-and-rehabilitation/world-report-on-disability

[30] For example, ISO CD 21801-1:2020 "Cognitive accessibility – Part 1: General guidelines"

[31] For example, ETSI EG 202 116 V1.2.2 (2009-03) "Guidelines for ICT products and services; Design for all"

[32] For example, ETSI EG 203 301, Using UCI to enhance communications for disabled, young, and elderly people

not as such mapped to a specific diagnosis. For example, in the ETSI guidelines on mobile communications technologies, a selection of eight cognitive diagnoses have been used as background research for detailing the usage needs. And it is these usage needs, such as focusing attention, reading, writing, etc that are mapped against each requirement[33].

There is no direct relationship between specific cognitive diagnoses and specific barriers on the web. Two individuals with the same diagnosis or disability may have entirely divergent needs and preferences in terms of how they use the internet. Conversely, a barrier that a person with a cognitive disability encounters may also be encountered by a person without any cognitive disabilities. This has for example been demonstrated in a series of user tests conducted with persons with and without cognitive disabilities in a recent research study on criteria for cognitive accessibility on the web[34]. To be able to focus more precisely on the specifics of the barriers, many sources in standardisation often use a typology of mental functions instead. This is the approach taken by the standardisation body ETSI, which has based its design guidelines for cognitive accessibility in mobile applications on an identified set of usage needs, including the following cognitive functions:[35]

- focusing, directing, shifting attention,
- reading,
- writing,
- carrying out and completing tasks,
- calculating,
- making choices,
- managing time,
- recalling from long-term and short-term memory,
- comprehension.

The full list of usage needs and their definitions can be found in the Annex 1 of the guidelines for cognitive accessibility in mobile applications[36]. Within this general framework, the guidelines include recommendations that specifically deal with barriers connected to each of the usage needs. For example, one barrier highlighted in the guidelines for cognitive accessibility in mobile applications concerns being able to predict how long a task will take. The guideline links this particular recommendation to the usage needs of: carrying out a task, completing a task, managing time and adapting to time demands[37]. In the concluding section below, a brief overview of barriers commonly dealt with in the non-normative standards is listed.

[33] ETSI EG 203 350 V1.1.1 (2016-11), Guidelines for the design of mobile ICT devices and their related applications for people with cognitive disabilities

[34] Kjellstrand, S., Laurin, S., 2021. Final report of research project "Criteria for cognitive web accessibility", funded by Swedish Innovation agency Vinnova. Project results are available at: www.cogreq.eu

[35] ETSI EG 203 350 V1.1.1 (2016-11), Guidelines for the design of mobile ICT devices and their related applications for people with cognitive disabilities.

[36] ibid

[37] ibid

Technology

One of the barriers identified in the literature is limitations in the availability of assistive technologies for people with cognitive impairments. One of the key barriers here is the system of provision of assistive technology. For example, in Sweden, the devices officially classified as assistive technology only include devices that are mostly used by persons with severe cognitive impairments. These include, for example, communication devices for persons with speech and language impairments. However, persons with moderate or mild cognitive impairment may need other types of devices or ICT systems that are not covered by the existing framework for economic support for the use of assistive technology[38].

- In relation to the use of information technology in a classroom setting for pupils with cognitive disability, several barriers have been identified including lack of technical infrastructure, such as unstable Internet access, as well as the incompatibility of available technologies with the learning needs of students. The latter is a result of a lack of understanding of the different needs of learners. A lack of experience with various applications or operations of technology, as well as a lack of technical support often prevent learners with cognitive disabilities to access digital environments[39].

- Reviewed literature on available technology used by primary carers of individuals with cognitive disability show that they often face barriers in the form of incompatibility, where existing systems in their care facility are incompatible with digital devices. This issue is identified to be a part of a wider lack of technical

[38] Bartfai, A., Boman, I.L., 2011. 'Policies concerning assistive technology and home modification services for people with physical and cognitive disabilities in Sweden', NeuroRehabilitation, 28(3), pp.303-308. Available from: https://www.academia.edu/download/47759876/Policies_concerning_assistive_technology20160803-31760-1pvuv9p.pdf

[39] Bartfai, A., Boman, I.L., 2011. 'Policies concerning assistive technology and home modification services for people with physical and cognitive disabilities in Sweden', NeuroRehabilitation, 28(3), pp.303-308. Available from: https://www.academia.edu/download/47759876/Policies_concerning_assistive_technology20160803-31760-1pvuv9p.pdf; Williams, P., 2005. 'Using information and communication technology with special educational needs students: The views of frontline professionals', In Aslib Proceedings. Emerald Group Publishing Limited. Available from: https://www.researchgate.net/profile/Peter-Williams-27/publication/241880906_Using_information_and_communication_technology_with_special_educational_needs_students_The_views_of_frontline_professionals/links/0deec5313201495686000000/Using-information-and-communication-technology-with-special-educational-needs-students-The-views-of-frontline-professionals.pdf

infrastructure, such as unstable internet access, faulty notifications systems including alarms and communication devices[40].

- A related issue is the frequent updates and changes to apps and software. This issue was raised by several interviewees in organisations working to support older adults and persons with cognitive impairments. Every time there is a change, the end-users need to relearn parts of how to use the interface. For persons that have difficulties using ICT, this may become a big obstacle and a potential set back. It also creates difficulties for persons teaching ICT to end-users, since the teaching material needs to change.

Personal support

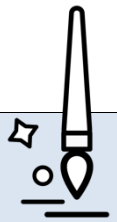
Studies analysing the educational programmes of German libraries and public training centres reveal that these programmes rarely meet the requirements of people with intellectual disabilities, their formal caregivers, or social institutions.[41] Key barriers to the achievement of digital literacy for people with intellectual disabilities include the high degree of personal or organisational effort required, and limited knowledge on behalf of caregivers and social institutions. To improve access to ICTs for people with intellectual disabilities, educational programmes can create spaces for open exchange on topics related to digitalisation, improve awareness amongst staff members on the need to improve digital accessibility, and adopt Universal Design for Learning (UDL) guidelines.

Interviewees that are working with persons with cognitive disabilities, either in research or in education and daily support, also noted that there is a gap when it comes to providing both training and assistance in ICT to persons with cognitive disabilities. One particular issue that was raised by stakeholders concerns support for using digital services that, for example, require the use of digital personal passwords or identification documents. Often, the services are too complex for persons with intellectual disabilities to be able to use these independently. However, carers and support staff are not always legally allowed to help with these kinds of services.

[40] Bartfai, A., Boman, I.L., 2011. 'Policies concerning assistive technology and home modification services for people with physical and cognitive disabilities in Sweden', NeuroRehabilitation, 28(3), pp.303-308. Available from: https://www.academia.edu/download/47759876/Policies_concerning_assistive_technology20160803-31760-1pvuv9p.pdf

[41] Heitplatz, V. N., 2020. 'Fostering digital participation for people with intellectual disabilities and their caregivers: Towards a guideline for designing education programs', Journal of Social Inclusion, 8(2), 201-212.

Design considerations



Persons with intellectual disabilities often have problems with processing language and numbers, both when reading or hearing information, identifying relevant information, and breaking it down into processable units, and might need more time to respond to online stimuli. A complex layout or overloaded webpages can cause difficulties in focusing or processing information. Also, going through processes can be difficult for persons with memory deficit problems and, in general, persons with lower literacy read a text word by word (instead of scanning it), making it more burdensome to get to the relevant information, with the risk of even missing it.[42]

Similarly, a review of literature on the use of ICT by persons with intellectual disabilities shows that using the internet requires the activation of a large array of cognitive skills, and that the difficulty increases with the complexity of the interface and the number of steps involved.[43]

Pages with a lot of information or elements can also be problematic for persons without learning difficulties but with limitations in executive functions. For example, a user study of the accessibility of transport-planning websites shows that presenting many options on a single page created difficulties for persons with autism.[44]

The complexity of interfaces was raised by interviewees working in research, support for persons with cognitive disabilities, but also by private companies trying to improve the interfaces to make them more cognitively accessible. The complexity was expressed as including both many design elements, and also the complexity of language and an overload of information on the same page. One challenge described by a private sector actor was how to make the whole process of a customer friendly, that is, the customer journey. This requires collaboration within a larger team of designers and developers where persons are responsible for different parts of the process.

Authentication and passwords is an example of a complex area, as it spans different components including design, understandable texts, ethics, and security. One study identifies logins requiring passwords as a major obstacle for persons with mental impairments. The mental effort required to manage logins brings the interaction with the digital service to a halt, as the login is perceived as a difficulty that is simply too hard to overcome.[45] Another paper discusses how persons with dyslexia struggle with both

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[42] Mariger, H., 2006. 'Cognitive Disabilities and the Web: Where Accessibility and Usability Meet?', National Center on Disability and Access to Education (NCDAE) Resources. Available from: https://ncdae.org/resources/articles/cognitive/

[43] Lussier-Desrochers, D. et al., 2017, 'Bridging the digital divide for people with intellectual disability', Cyberpsychology, Journal of Psychosocial Research on Cyberspace vol 11, no 1. Available from: https://cyberpsychology.eu/article/view/6738/6204

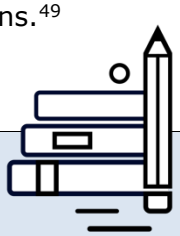
[44] De Los Rios Perez, C., 2020. 'Integrated Web Accessibility Guidelines for Users on the Autism Spectrum – from Specification to Implementation', PhD thesis, Curtin University

[45] Johansson, S., 2016. 'Towards a framework to understand mental and cognitive accessibility in a digital context', Doctoral dissertation, KTH Royal Institute of Technology. Available from: https://www.diva-portal.org/smash/record.jsf?pid=diva2:908641

remembering and inputting passwords. In particular, the paper highlights the potential tensions between security requirements and accessibility. The security requirements of passwords often impose on the user the need to create complicated passwords. However, the more complex passwords are, with elaborate combinations of letters and numbers, the more difficult they are to manage for persons with dyslexia.[46] Another issue related to authentication are provisions around consent and how users can feel safe about providing their information online. A paper reviewing academic literature on cognitive accessibility noted that there are several studies on consent, privacy and log-in procedures where participants struggle with issues of trust and understanding concerning online services and authentication.[47]

Authentication was also mentioned as an area where there is a need for more research and attention to accessibility aspects, by stakeholders in the open public consultation on the review of the Web Accessibility Directive[48].

There are fewer studies focusing on particular barriers that derive from the design and development of one particular digital interface. A Spanish research study that conducted user tests of touchscreen, including persons with mild cognitive impairments, showed that the size and activation of clickable areas could pose a barrier for these users. If the user misses the clickable area or presses the area too long, other functions than those intended are activated. The speed of audio instructions was another barrier raised in the study. An audio that is too fast can make it difficult to understand instructions.[49]



Education and training

Another barrier is the lack of understanding among professionals working with websites. Correct use of the W3C Web Content Accessibility Guidelines (WCAG) may improve access for all users, including people with cognitive disabilities. However, the particular obstacles faced by these individuals and appropriate resolutions are not well understood

[46] Renaud, K., Johnson, G., Ophoff, J., 2020. 'Dyslexia and password usage: accessibility in authentication design', In: N. Clarke, & S. Furnell (eds.), Human Aspects of Information Security and Assurance: 14th IFIP WG 11.12 International Symposium, HAISA 2020, Mytilene, Lesbos, Greece, July 8–10, 2020, Proceedings. Springer. https://doi.org/10.1007/978-3-030-57404-8_20

[47] Kärpinen, T (2019) ´A literature review on cognitive accessibility´ in Universal Design 2021: From special to mainstream solutions, Studies in Health Technology and Informatics 2021. Available from: https://ebooks.iospress.nl/volume/universal-design-2021-from-special-to-mainstream-solutions

[48] European Commission public consultation ´Accessible web & digital content for people with disabilities – review of EU rules´. Consultation period: 19 July 2021 - 25 October 2021. Available at: https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12537-Accessible-web-&-digital-content-for-people-with-disabilities-review-of-EU-rules/public-consultation_en

[49] Castilla, D., Suso-Ribera, C., Zaragoza, I., Garcia-Palacios, A. and Botella, C., 2020. 'Designing ICTs for users with mild cognitive impairment: a usability study', International Journal of Environmental Research and Public Health, 17(14), p.5153. Available from: https://roderic.uv.es/bitstream/handle/10550/77742/143292.pdf?sequence=1

by developers or designers of technology.[50] In addition, adaptation requirements to facilitate accessibility for people with cognitive impairments are not well known, which leads to a lack of alternatives as mentioned above. This lack of knowledge was also raised by both respondents to the survey and interviewees. One suggestion made by stakeholders is to make web accessibility knowledge compulsory for ICT students.

A study in the UK investigated reasons that impact the ability of web designers to implement guidelines on web accessibility for persons with intellectual disabilities. Some of the important factors were a lack of awareness and experience of intellectual disability. Most of the web professionals interviewed in the study had not come across persons with intellectual disabilities previously and were unaware of what it means in terms of user needs.[51] The web professionals in the study also pointed out that this lack of knowledge is equally widespread among website owners and decision makers, and that the lack of support on the issues from the top also hampers the ability of web designers to implement cognitively accessible websites. The study concludes that it is essential for web designers, developers and other stakeholders to engage with people with intellectual disabilities in order to increase the levels of understanding of the user needs.[52]

Conclusions

The evidence found in the literature points to barriers at several levels, including the ICT environment (design issues, content that is difficult to understand as well as lack of appropriate infrastructure and tools), and the social environment (lack of support, lack of knowledge among support staff, discriminatory attitudes, social stigma).

Tackling these barriers therefore seems to require an effort not only to solve the technical issues regarding the accessibility and availability of adequate infrastructure, but also very much an effort of work on the social situation: changing attitudes in the general population, awareness-raising and educating about the needs, providing support and combating discrimination.

It can be noted that the academic studies found concentrate on barriers on a broader technological or societal level. There are very few academic studies on the topic of specific cognitive barriers concerning the design and development of websites. These kinds of barriers are more extensively covered in the standardisation literature, and they tie more closely to the legislative approach to web accessibility in the EU which is built on providing requirements to avoid barriers in digital interfaces.

When it comes to the coverage of different mental functions, a brief overview of the non-normative standards conducted in this first stage of the literature review shows that there are at least some recommendations for all the mental functions including attention, reading, writing, tasks, calculating, choices, time, memory, and understanding. Many requirements cover several mental functions at the same time. For example: providing support to knowing where the user is in a form they are completing will help with

[50] Abou-Zahra, S., Lee, S., 2019. 'Cognitive and Learning Disabilities work at W3C and for the Easy Reading Project', (S7-8), Technology and Disability 31 (2019) S7–S107, IOS Press. Available from: https://www.academia.edu/40096719/2019_Waking_up_in_the_Morning_A_Gamified_Simulation_in_the_Context_of_Learning_Activities_of_Daily_Living

[51] Kennedy, H., Evans, S., Thomas, S., 2011. 'Can the web be made accessible for people with intellectual disabilities', The information society. Vol 27, 2011 Issue 1. Available from https://www.tandfonline.com/doi/abs/10.1080/01972243.2011.534365

[52] ibid

sustaining attention, managing a task, making choices (to continue or not), managing time, supporting memory, calculating (how many steps are there), and understanding information.

An initial analysis of how the requirements included in the standards that the European legislation points to relate to the common themes in non-normative standards shows that the former broadly touch upon the same areas of need in terms of supporting mental functions, such as attention. One key difference is that the minimum requirements of the legislation, where the EN 301 549 standard acts as presumed conformance, generally focus on specific functionality like headings or labels, whereas many of the non-normative requirements focus on general aspects, such as the layout or structure of all elements. Another important aspect is that, although many of the minimum requirements of the EN indirectly do support cognitive aspects as well, they are foremost created with other user groups in mind. Requirements that specifically target cognitive challenges are scarce in the normative part of the standard (Annex A).

A brief review of the non-normative standards and guidelines show that requirements frequently deal with the following barriers:

- finding the most important information on a webpage,
- understanding and using controls,
- staying focused on your purpose for visiting the website,
- managing time constraints (time-outs),
- comprehending content,
- inputting information,
- navigating between or within websites.

The surveys and interviews conducted in the study largely confirmed this list of barriers as being key issues that users with and without cognitive impairments are struggling with on the web.

Three of the barriers stood out in particular:

1) Navigation

Finding your way on websites was one of the issues that was highlighted as difficult by stakeholders both from an end-user perspective (persons with and without cognitive impairments), and from a perspective of website owners, especially within the public sector. Navigation was the primary obstacle mentioned by persons without disabilities in the survey, and one of the top three obstacles mentioned by persons self-identifying as having a cognitive impairment. Interviewees in all the stakeholder groups also highlighted navigation as a key issue. In addition, it was one of the main issues raised by respondents to the open public consultation on the Web Accessibility Directive.

The reasons behind navigational difficulties can be traced both to the complexity of the information structure of a website, but also to the complexity of the information and content itself. This seems to be the case in many public sector websites. One of the public sector respondents to the survey noted that many users do not understand the structure of the national public services, and nor should they have to in order to be able to find what they need. Another public sector respondent noted that one frequent feedback from users was that they did not understand when they were redirected to a different part of the public service website and had to login again. One of the interviewees also noted that one additional difficulty is that different public services have

their own way of structuring the information and that similar services look different, depending on who has ownership of the website and service.

2) Filling in forms and managing input mechanisms such as drop-down lists

Filling in forms was spontaneously mentioned as specific difficulties by both survey respondents with and without cognitive disabilities. For example, this was mentioned in the context of official public services, such as tax declarations. In this context as well, the issue is more complex than simply the design of the form itself. It has both to do with the language used in the forms, that is understanding the terms used and what information is asked for, and then how to manipulate the form and provide the input needed. Drop-down menus were highlighted by survey respondents and interviewees as a major difficulty for both persons with and without cognitive impairments.

3) Passwords and logins

In the first workshop of the study, it became apparent that many have an issue with passwords and login procedures. This was singled out by participants as the most difficult barrier to handle from a cognitive point of view. This is another example of a procedure that requires different cognitive skills at the same time. The reasons for problems with passwords can therefore vary between different groups of users. Researchers looking at dyslexia and the web highlight the fact that a long string of letters and numbers are difficult for persons with dyslexia to read and input – the input could be different at each attempt. For others, it is more about remembering the passwords and the procedure of logging in. Another difficulty is captchas that are difficult to understand and cannot be captured by assistive technology. In some instances, captchas are transformed to problem solving (like a mathematical calculation), to make it possible to handle using assistive technology, which may cause trouble for users with cognitive impairments (and others). Related to the issues around passwords and logins, is the wider concern about data privacy issues and consent procedures.

Another general barrier that was mentioned by interviewees and survey respondents alike, is language complexity. This is related to understanding web content, but it is also a broader issue than just accessibility related to the web. In section 5.1 there are some examples of actions that public authorities in EU Member States have taken with regards to plain language and easy-to-read.

4.3 What are the consequences of accessibility obstacles to persons with cognitive disabilities?

This section looks at the consequences of accessibility obstacles. The consequences found in the literature are related to the areas of inclusion and participation, education and training, and quality of life. These research areas are in no way an extensive list of areas where consequences of cognitive accessibility barriers can occur and be experienced. Rather, the areas covered in this section reflect the state of research as identified in the literature review. The team has noticed a research gap regarding the consequences of barriers, which is further discussed in section 6.

Inclusion and participation

Barriers faced by individuals with cognitive disabilities negatively impact their possibility to access services in transportation, healthcare, social and recreational activities, and housing.[53] Particularly, without access to the web, these individuals experience a "digital divide"[54], which is not limited to computers, but manifests itself as a lack of access to web content across multiple devices, platforms, and browsers. Also, due to the lack of acceptance of individuals with cognitive impairments, tolerance for their individual differences as well as appropriate accommodation, they are unable to fully participate as users of the digital environment. For instance, persons with limitation in attention capacities may experience that e-commerce websites are inaccessible if these websites lack suitable alternatives to web content containing time-limited actions that, for example, involve the use of "add to cart" purchase features.[55]

Other studies point to direct consequences in specific situations. In a study of cognitive accessibility for persons with mental disabilities, it emerged that in many cases public health service appointments could only be made through digital services requiring logins. Since the participants in the study often had severe difficulties using services with login, this barrier in practice hinders some users from accessing public health services.[56]

In the above-mentioned example, it is one specific barrier that leads to exclusion. In other examples, it may be a series of barriers or the complexity of the overall design of the service. One of the study interviewees that is involved in user testing also described how complex interfaces leads to fatigue for persons with cognitive disabilities, and that this increased fatigue may lead to failure to conclude the tasks that they set out to do on the website. This exclusion has concrete consequences for the individuals, as exemplified in a few of the interviews conducted in the study. One national organisation working with persons with cognitive impairments in an EU member state mentioned that certain public authorities only provide the services in a digital form, so not being able to use the service leads to complete exclusion. In other cases, it could lead to additional costs. An organisation representing senior citizens in another EU member state mentioned that making payments through your bank on paper is associated with extra fees, which can be difficult to afford especially for seniors living on smaller pensions.

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[53] Lazar, J., Stein, M.A. eds., 2017. 'Disability, human rights, and information technology', University of Pennsylvania Press. Available from: https://books.google.com/books?hl=en&lr=&id=UMXWDgAAQBAJ&oi=fnd&pg=PP1&ots=XKDColvCP8&sig=K18RqlfUc-8qJWDivyDmx3Y-lEA

[54] Blanck, P., 2014. 'eQuality: the struggle for web accessibility by persons with cognitive disabilities', Cambridge university, pp.23-31. Available from: https://onlinelibrary.wiley.com/doi/abs/10.1002/bsl.2101

[55] ibid

[56] Johansson, S., 2016. 'Towards a framework to understand mental and cognitive accessibility in a digital context', Doctoral dissertation, KTH Royal Institute of Technology. Available from: https://www.diva-portal.org/smash/record.jsf?pid=diva2:908641

Education and training

A research study focused on the use of information and communication technologies (ICTs) in a special educational needs (SEN) environment[57] found several negative consequences of barriers to accessibility of ICT. Particularly, staff of several SEN schools pointed to equipment failure, problems with printer, and inconsistent internet connections as several factors discouraging both staff and students from utilising ICT in the future. Consequently, a digital divide is created, whereby individuals with cognitive disability remain far removed from the digital environment. Another study[58] pointed to the fact that assistive technology does have the potential to remove barriers that make it difficult for learners with cognitive impairments to complete their education, but that unfortunately there is often both a lack of access to and availability of assistive technology in educational settings.

Quality of life

Nowadays, the Internet is the main place to efficiently look for and find employment, quality healthcare and education, and to interact with others. At the same time, government reports show that persons with cognitive disabilities have limited or no access to understandable information and usable ICT.[59]

The consequences of these accessibility obstacles have been found to affect the independence and quality of life of persons with cognitive disabilities on a broad scale. For example, the WHO's list of the disadvantages caused by the different barriers persons with disabilities face is also entirely relevant for the digital domain. The list of negative effects includes poorer health outcomes (due to untreated secondary conditions), lower educational achievements, decreased economic activity and earnings, resulting in higher rates of poverty, as well as limitations to live independently or

[57] Williams, P., 2005. 'Using information and communication technology with special educational needs students: The views of frontline professionals', In Aslib Proceedings. Emerald Group Publishing Limited. Available from: https://www.researchgate.net/profile/Peter-Williams-27/publication/241880906_Using_information_and_communication_technology_with_special_educational_needs_students_The_views_of_frontline_professionals/links/0deec5313201495686000000/Using-information-and-communication-technology-with-special-educational-needs-students-The-views-of-frontline-professionals.pdf

[58] Hersh, M., 2014. 'Evaluation framework for ICT-based learning technologies for disabled people', Computers & Education, 78, pp.30-47. Available from: https://www.sciencedirect.com/science/article/abs/pii/S0360131514001146

[59] Consumer and Governmental Affairs Bureau, 2016. Report: White Paper on Individuals with Cognitive Disabilities: Barriers to and Solutions for Accessible Information and Communication Technologies. Federal Communications Commission, p.1. Available from: https://www.fcc.gov/document/white-paper-ict-access-people-cognitive-disabilities/

participate fully in community activities.[60] Many of the barriers could be avoided and these disadvantages could be overcome.

In relation to care facilities for older adults, the review of literature indicates that individuals with mild to moderate cognitive impairments are even further removed from accessing technology, particularly technology developed for communication. This further increased the risk of social isolation, physical and mental deterioration and even mortality.[61] One of the reviewed articles points out that there is evidence showing that isolation, depression, and loneliness can increase cognitive impairments, but also that studies have shown that use of ICT in therapy can have a positive impact on both depression and to train cognitive functions among elderly.[62]

There is a large set of literature considering the use of ICT to promote improved cognitive abilities among elderly and in particular persons with dementia. One study has for example concluded that the use of internet and email can help to reduce cognitive decline among persons between 50 and 89 years of age[63].

Research has also shown that concrete barriers in a digital interface can lead to further psychological barriers that hamper inclusion and independence. For example, a study involving children with autism has shown that failure to achieve a goal when using digital technology can have a disabling effect.[64] One of the interviewees in the study that works with persons with cognitive disabilities describes that a person with cognitive disabilities that encounters barriers will first be disoriented and confused and then give up on the interface if the problem persists.

Another study confirms that access to remote communications through ICT that persons with cognitive impairments can use themselves has an important role to play to enable individuals to have increased control in their lives, promoting participation and empowerment. Access to remote communication also has a dual effect on safety, as it makes it possible for both the users and the caretakers and relatives to stay in contact.[65] Interviewees in the study that work with older adults in care homes also confirm the

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[60] World Health Organization and the World Bank Group, 2011. World report on Disability, p.262-263. Available from: https://www.who.int/teams/noncommunicable-diseases/sensory-functions-disability-and-rehabilitation/world-report-on-disability

[61] Vainstein, G., Adamit, T., Chaimov, N. and Idar, D., 2017. 'Digital Environment for Cognitive Impairment (DECI) Clinical Study-A Multi-Centre, Prospective, Randomized Study Funded by the European Union', In: The Practice of Patient Centered Care: Empowering and Engaging Patients in the Digital Era, p.89. Available from: https://ebooks.iospress.nl/pdf/doi/10.3233/978-1-61499-824-2-89

[62] Castilla, D., Suso-Ribera, C., Zaragoza, I., Garcia-Palacios, A. and Botella, C., 2020. 'Designing ICTs for users with mild cognitive impairment: a usability study', International Journal of Environmental Research and Public Health, 17(14), p.5153. Available from: https://roderic.uv.es/bitstream/handle/10550/77742/143292.pdf?sequence=1

[63] Xavier, A., d'Orsi, E., de Oliveira, C M., 2014. 'English Longitudinal Study of Aging: Can Internet/E-mail Use Reduce Cognitive Decline?', The Journals of Gerontology Series A, 69(9), 1117-1121 – August 2014

[64] Davis, M. et al., 2010. 'Guidelines for researchers and practitioners designing software and software trials for children with autism', Journal of Assistive technologies 4(1) pp. 38-48

[65] Buchholz, M., Ferm, U. and Holmgren, K., 2020. 'Support persons' views on remote communication and social media for people with communicative and cognitive disabilities', Disability and rehabilitation, 42(10), pp.1439-1447. Available from: https://www.tandfonline.com/doi/pdf/10.1080/09638288.2018.1529827

importance of the persons being able to stay connected to family and friends in terms of mental health and wellbeing.

Conclusions

The findings show that obstacles to accessibility have consequences for persons with cognitive impairments both in the day-to-day life, as well as on their longer-term opportunities to participate in society and on their quality of life. The academic and grey literature includes only a few studies showing a direct link between a particular obstacle in the interface and the ensuing consequences, as far as can be seen. However, from the examples identified, it can be noted that single web design obstacles, such as complex password systems or "add to cart" features have far-reaching consequences that make it impossible for the persons to continue using the service, and therefore excludes certain people from important parts of the digital society.

The fact that these barriers have real consequences is also confirmed by the responses in the stakeholder consultation. In addition to the more general information provided by the interviewees, several respondents to the survey reported being unable to complete a purchase or booking because of accessibility obstacles in the booking or payment process. Other respondents reported having missed appointments or even having missed out on employment opportunities since they were not able to complete the online application process. Another interviewee that works in the private sector testified of situations where persons with dyslexia have been unable to get or keep an employment opportunity since the employers were not aware of existing possibilities of support that would help the employee in their job. Indications from the employment sector seem to be mostly anecdotal as all in all, there is very little literature looking at either barriers or consequences in terms of employment opportunities.

Another area of consequences that is reported by stakeholders, but is largely absent in the literature, concerns the consequences for the society. Several interviewees mention that inaccessible websites lead to fewer customers for private organisations and higher costs in terms of having to provide additional services for persons that are not able to access the information online. Other interviewees point to the general need for increasing the number of persons active in the workforce and that excluding persons with disabilities has economic consequences for both the individual and the society.

However, the research team has not been able to identify any substantial studies that investigate the relationship between barriers and consequences at a societal level.

4.4 Analysis of the connection between barriers and consequences

In a given user scenario, the barrier to the user and the consequence are very concrete. The user is unable to perform a certain task online (barrier), which means that the task does not get done (consequence), at least not immediately or without help.

However, looking at the bigger picture, the mechanics behind the scenario are much more complex. On the one hand, there are many factors that lead up to the barrier.

In the broad perspective, there is a general lack of awareness of user needs related to mental functions in the wider society, including among people involved in designing and developing digital interfaces, as well as those commissioning and selecting the interfaces. This general lack of knowledge leads to a more specific lack of training on how to ensure that digital interfaces are accessible from a cognitive point of view. In addition, as pointed out by stakeholders in this study, there are issues around stigmatisation that keeps web professionals from learning more about cognitive user needs. Researchers in

the stakeholder consultation pointed to preconceptions among both people working with persons with cognitive disabilities and persons working with ICT that persons with intellectual disabilities do not need ICT solutions and that it is too difficult or even dangerous for them to access ICT. Added to that is the lack of involvement of users with a higher need for cognitive accessibility in the design processes.

The result of these gaps is that the interfaces become inaccessible not by intention, but by lack of attention to the user needs.

On the other hand, the consequences of these barriers also go beyond the specific situation. In the short term, the user may either give up on the task they set out to do or ask for assistance. In either way, there are consequences not only for completing the task, but also in terms of independence and participation.

There are therefore both practical short-term effects of the barrier, as well as longer term effects related to the specific service, as well as to the use of digital services in general. If, for example, the digital service with the barrier was a public service to access health services or employment services, the barrier will have a real impact on equal access to public services and the ability of the user to participate in society. Examples of these impacts can be found in section 4.3.

However, there is also a wider implication regarding the empowerment of the user. In the stakeholder consultation, several respondents have pointed out that not being able to complete a task also has a psychological effect on the digital confidence of persons with cognitive disabilities, which is a direct effect of stigmatisation. For the user, it is difficult to know whether failing at a task is caused by the inaccessibility of the service, or by their own shortcomings. This can lead to a withdrawal from digital services and hence further exclusion. A weakened digital confidence also leaves persons open to further vulnerabilities. For example, recent research has shown that persons with lower digital confidence have had more difficulties in taking in and understanding information about COVID and have experienced higher anxiety levels in relation to the pandemic.[66] In addition, another study points to the therapeutic effect of ICT and digital activities to combat cognitive decline. The study showed that regular use of the internet led to a reduced rate of cognitive decline among people in retirement.[67] In this context, it is important to build and keep digital confidence to be able to reap the benefits of ICT use.

The question of digital confidence and empowerment also leads to a broader discussion on the way user needs related to mental functions are perceived and accepted in the wider society. In the stakeholder consultation, responses both from the survey and from interviews show that there is still stigmatisation around cognitive needs in society in general. Examples of stigmatisation include stereotyping. One stakeholder specifically mentioned that some people expect all persons with autism to behave in a specific way or hold specific types of interests. Another example pointed out by stakeholders is where employers avoid hiring persons with dyslexia because of a lack of awareness of what this means in practice. Therefore, persons with a need for cognitive accessibility will often hide the needs and not openly display what they need help with, to avoid feeling ashamed. This effect is both a result of a societal environment where cognitive needs are

[66] Robinson, L., Schulz, J., Wiborg, Ø. 2021. 'The COVID Connection: Pandemic Anxiety, COVID-19 Comprehension, and Digital Confidence', American Behavioural Scientist, 65(12) 1721-1746 – April 2021

[67] Green C.P., Mao L, O'Sullivan V, 2021 'Internet usage and the cognitive function of retirees', Journal of Economic Behaviour & Organization, Vol. 190 p.747-767, October 2021

hidden away, and at the same time it contributes to perpetualising a situation where cognitive needs are not openly discussed and accepted. One of the stakeholders interviewed in the study also pointed out that, in many cases, persons with cognitive disabilities are not able to formulate feedback on what it is that does not work when they encounter a barrier. This means that the designers and developers do not even realise that some people are being excluded. The persons with cognitive disabilities therefore become invisible.

The below figure illustrates how a lack of awareness in society leads to a lack of knowledge among decision makers and web professionals. This lack of knowledge in turn leads to inaccessible websites and services which leads to an inability to participate. These barriers lead to further invisibility which perpetuates the cycle of exclusion.

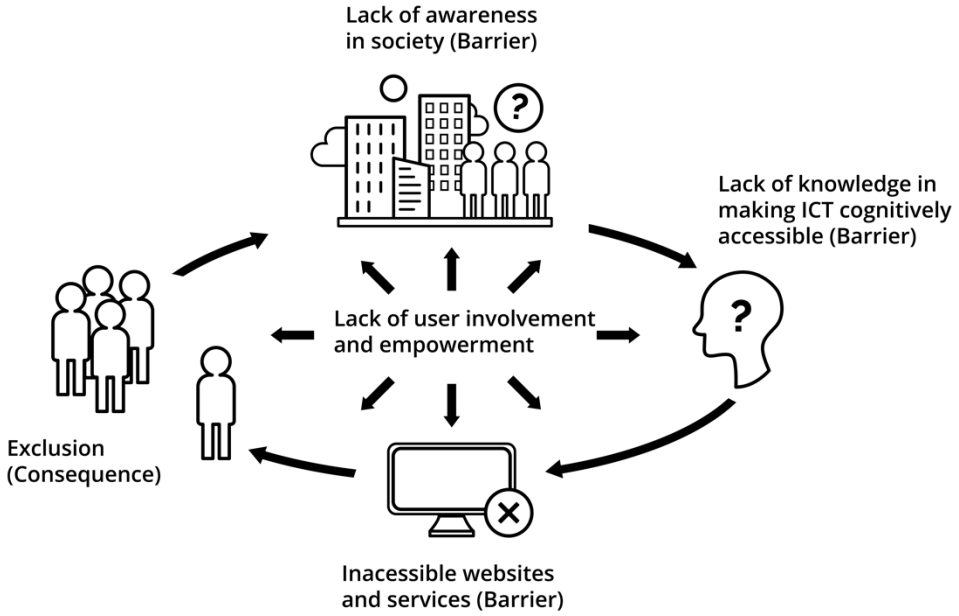


Illustration 2: Cycle of cognitive barriers and consequences

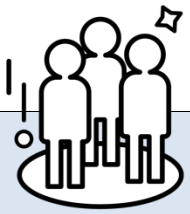
In addition to the aforementioned consequences on an individual level, there are also important societal consequences of the exclusion. It leaves people out in education and work which means that organisations and also society at large are missing out on useful human resources, both in terms of higher productivity and the individual qualities of the persons left out. The exclusion also leads to extra costs on several levels: for support measures due to dependence, for work arounds when digital potentials are not used (prolonging outdated traditional services such as printing services, personal services), as well as higher costs in health services due to low prevention levels and barriers in health care.

5. Actions to remove accessibility barriers

This section presents the findings from the literature review and stakeholder consultation on the research questions relating to what actions have been taken to remove accessibility obstacles for persons with cognitive disabilities, and the results of these actions.

5.1 What actions have been taken to remove accessibility obstacles for persons with cognitive disabilities?

In this section we look at actions related to legal frameworks and public sector initiatives, web accessibility requirements and standardisation, inclusion and participation, design considerations, technology, personal support, and education and training.



Inclusion and participation

User participation in the design process is the key common success factor in examples of good practices that were mentioned both in the literature and by stakeholders in the study survey and interviews. The ambition and methods vary from consultation and user testing to more advanced methods of persons with cognitive impairments as co-researchers, but there is a broad understanding among researchers, Disabled Persons' Organisations (DPOs) and also website owners consulted in the study that user participation is instrumental to ensuring that products are relevant, useful and accessible to everyone, and especially persons with cognitive disabilities. All researchers interviewed, all companies interviewed, and more than half of the public organisations interviewed specifically mentioned participation of users in different ways as an important means to increasing accessibility.

One important aspect raised by some of the interviewed researchers is that the user participation must be respectful of the persons with cognitive impairments that participate. Users need to understand the purpose of the research and be able to participate under their own conditions. Another success factor raised by researchers working with senior citizens is that the user participation needs to take place early on in the design process and conceptualisation of the product or service. If the user testing is only done in the final stages of the product or service development, there may be accessibility and usability issues that have been built in earlier on and that are difficult to change.

Another researcher interviewed mentioned that it is also important to not only look at accessibility and usability in user testing, but that the overall user experience should also be considered since users will abandon services and products that they do not enjoy using.

Web accessibility requirements and standardisation

The main reference for web accessibility requirements in the EU today is the standard (H)EN 301 549 "Accessibility requirements for ICT products and services"[68]. Annex A of this standard contains the requirements that the current web accessibility legislation points to. For the moment, the (H)EN 301 549 standard refers to the requirements of the WCAG 2.1 standard, level AA.

The Web Content Accessibility Guidelines (WCAG) are developed by the World Wide Web Consortium (W3C), under the Web Accessibility Initiative (WAI). W3C is a member organisation that develops protocols and guidelines to ensure long-term growth for the web. W3C standards and technical documents are developed by W3C members, staff and invited experts.

The WCAG is built upon the 4 principles also referred to in Article 4 of the Web Accessibility Directive: perceivable, operable, understandable and robust. Each principle (or chapter) has 12-13 guidelines, and each guideline has testable success criteria. The success criteria contain the actual requirements, which are referred to in the (H)EN 301 549 standard. The WCAG success criteria are divided into three levels, A, AA and AAA. In the (H)EN 301 549, level A and AA are normative and listed in Annex A, whereas level AAA is informative and listed in clause 9.5.

It is important to note, that presumed conformance of the Web Accessibility Directive includes more than the WCAG criteria. Therefore, Annex A of the latest (H)EN301549 (currently v 3.2.1) should always be used.

In the EN 301 549 standard, user needs are formulated as functional performance statements. One of these statements include usage with limited cognition. The standard does not go into detail on the different kinds of cognitive user needs within this broad area. It does however provide an overview of which of the web accessibility requirements stated in the standard that relates to cognition as a functional performance statement (i.e., somewhat simplified cognition as a user need).

This is presented in Annex B of the EN301549, where the relationship between the technical requirements and the functional performance statements are listed as "primary" or "secondary". Primary relationship means that the requirement supports the user need of a specific performance statement (in this case Usage with limited cognition). Secondary relationship means that the requirement provides partial support for the functional performance statement, for some users and/or in specific situations.

Thus, to some extent, the standards that the web accessibility legislation points to do include actions to eliminate barriers of cognitive accessibility.

Currently, the requirements in the EN standard point to WCAG 2.1. These guidelines have been developed primarily for persons with physical impairments and include only

[68] Harmonised European Standard EN 301 549 V3.2.1 (2021-03). Available from: https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf

some accommodations for cognition.[69] The implication is that the requirements that are included in the standard do not necessarily reflect the needs as prioritised by persons with cognitive impairments.

Annex D of the EN 301 549, specifically addresses the need for, and current lack of, requirements on cognitive accessibility, and refers to ongoing research in the area. Whereas the standard EN 301 549 does not focus on cognitive accessibility, there are many non-normative standards and guidelines[70] issued by standardisation organisations that do focus on requirements developed specifically to support cognitive needs and needs relating to mental functions.

The criteria presented in these non-normative standards and guidelines differ from the requirements in the EN standard and WCAG in that they are not meant to be formal requirements that can be monitored for compliance. To be able to enforce a requirement, it needs to be measurable. Because of this, web accessibility requirements in legally enforced standards tend to be stated in a binary way, making it possible for the monitoring agency to determine whether the requirement tested is a pass or a fail (or not applicable). However, many recommendations on how to reduce or eliminate barriers are stated in more broad terms. For example, one recommendation that was often cited in the sources of the literature review is to not include texts that are too long and complicated. The question then becomes how to measure what is too long and complicated. As international standards are meant to be useful globally, it is often difficult to find a formulation that is widely accepted.

This lack of precision has previously been seen as an important obstacle to include requirements on cognitive accessibility in standards, the argument being that requirements must be testable.[71] New research and developments suggest that this does not need to be the case. On the one hand, a recent research project has shown that it is possible to transform the guidelines into measurable criteria that can be evaluated in a standardised way. The project formulated five criteria based on pre-existing guidelines in the areas of focus, navigation, memory, and orientation. The project then developed and tested methods of evaluation for each of them to ensure that independent reviewers can assess whether or not the requirement has been met. The study report concludes that this process is feasible for other guidelines as well.[72]

In addition, standardisation organisations are opening up to more flexibility in the evaluation of requirements. For example, W3C is currently working towards a WCAG 3.0 with more flexible levels of measurement and several levels of conformance.[73] This approach would require considerations to be made when it comes to testing and monitoring, should they be used in legal settings.

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[69] https://www.w3.org/TR/WCAG21/

[70] See sources no 3-12 under the heading "Sources in standardisation" in Annex 1

[71] Johansson, S., 2016. 'Towards a framework to understand mental and cognitive accessibility in a digital context', Doctoral dissertation, KTH Royal Institute of Technology. Available from: https://www.diva-portal.org/smash/record.jsf?pid=diva2:908641

[72] Kjellstrand, S., Laurin, S., 2021. Final report of research project" Criteria for cognitive web accessibility", funded by Swedish Innovation agency Vinnova. Project results are available at: www.cogreq.eu

[73] Spellman, J., Lauriat, S., Cooper, M. et al., 2021. Requirements for WCAG 3.0. "W3C First Public Working Draft". Available from: https://www.w3.org/TR/wcag-3.0-requirements/

Web accessibility recommendations on cognition can be found in a range of non-normative standards and guidelines, both those dealing with accessibility in general, and those targeting cognition.

Some of the application areas of the non-normative standards and guidelines include:

- Mobile ICT devices,
- Design for all in ICT products,
- Multimedia communications,
- General guidelines on cognitive accessibility,
- Guidelines for assistive products – daily time management,
- General accessibility guidelines for software.

It should also be noted that the standard WCAG 2.1 includes 19 success criteria that, to varying degrees, support cognitive accessibility at level AAA which are non-normative.

Some of these, like for example success criterion 3.1.3 Unusual words, are specifically targeting persons with cognitive disabilities. The success criterion reads: "A mechanism is available for identifying specific definitions of words or phrases used in an unusual or restricted way, including idioms and jargon." Others, like for example success criterion 2.4.9 Link Purpose (Link Only), is primary beneficial for blind, visually impaired or motor impaired users of assistive technology. The success criterion reads: "A mechanism is available to allow the purpose of each link to be identified from link text alone, except where the purpose of the link would be ambiguous to users in general." The focus here is to make sure that users of assistive technology like screen readers can navigate more efficiently by using internal link lists and short cuts in their tools. Better link texts are beneficial to all users, but for the success criterion to be primarily supporting people with cognitive disabilities, it would also need to contain aspects of understandability.

The WCAG level AAA success criteria that include cognitive aspects in some way are found under the following guidelines:

- 1.3 Adaptable: Create content that can be presented in different ways (for example, a simpler layout) without losing information or structure.
- 1.4 Distinguishable: Make it easier for users to see and hear content including separating foreground from background.
- 2.2 Enough Time: Provide users enough time to read and use content.
- 2.4 Navigable: Provide ways to help users navigate, find content, and determine where they are.
- 3.1 Readable: Make text content readable and understandable.
- 3.2 Predictable: Make Web pages appear and operate in predictable ways.
- 3.3 Input Assistance: Help users avoid and correct mistakes.

WCAG level AAA is recommended as a general policy, while it is not possible to meet all AAA-success criteria for some content. For example, success criterion 3.1.5 Reading Level reads: "When text requires reading ability more advanced than the lower secondary education level after removal of proper names and titles, supplemental content, or a version that does not require reading ability more advanced than the lower secondary education level, is available." This would not be feasible to apply to "all" web content, as it would require even expert-to-expert content to be provided in a simplified version.

Therefore, these success criteria are not included in the requirements that any legislation points to.

In addition, newly developed resources provided by the W3C Cognitive and Learning Disabilities Accessibility Task Force[74] has partly been included in the recently published working draft of the WCAG 2.2. Provided the test implementation and candidate recommendation procedures are successful, these requirements may be integrated into the stable standard when published, which may in turn have an impact on the next version(s) of the EN standards supporting the EU directives on accessibility.

In addition to the guidelines issued by standardisation organisations, there are also a host of requirements and recommendations issued by different actors, ranging from standardisation experts at W3C and web accessibility experts contributing to their work, to subject matter experts, such as the National Center on Disability and Education, Funka and tech providers like Mozilla.

Many of the requirements on cognition overlap in the different guidelines. For example, the requirement to provide summaries of large texts and prepare the user of its content is included in an ISO standard on the ergonomics of human computer interaction[75], in a guide for addressing accessibility in standards[76], as well as a more specific guideline for the design of mobile ICT devices[77]. A recent Swedish research project proposes a classification of the requirements included in current standards and guidelines relating to cognition and ICT according to the following themes[78]:

- Order and logic. For example: consistent location and layout of content and controls.
- Focus. For example: using spacing and visual design to help the user find and focus on important information.
- Providing help and assistance.
- Time management. For example: avoiding time-outs.
- Helping the user to orient themselves on a website or in a process.
- Multimodality. For example, using images to support text messages.
- Individual settings.
- Handling interruptions. For example, being able to continue after an interruption without loss of data.
- Vocabulary. For example, support to understand difficult words and concepts.

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[74] Abou-Zahra, S., Lee, S., 2019. 'Cognitive and Learning Disabilities work at W3C and for the Easy Reading Project', (S7-8), Technology and Disability 31 (2019) S7–S107, IOS Press. Available from: https://www.academia.edu/40096719/2019_Waking_up_in_the_Morning_A_Gamified_Simulation_in_the_Context_of_Learning_Activities_of_Daily_Living

[75] ISO 2008, Ergonomics of human-system interaction – Part 20: Accessibility guidelines for information/communication technology (ICT) equipment and services, ISO 9241-20:2008

[76] ISO/IEC 2014, Guide for addressing accessibility in standards, ISO/IEC Guide 71 (confirmed in 2021)

[77] ETSI 2016, Guidelines for the design of mobile ICT devices and their related applications for people with cognitive disabilities, ETSI EG 203 350 v.1.1.1

[78] Kjellstrand, S., Laurin, S., 2021. Final report of research project" Criteria for cognitive web accessibility", funded by Swedish Innovation agency Vinnova. Project results are available at: www.cogreq.eu

- Easy to read. For example, provide an easy-to-read summary of longer texts.

Relevant research projects have also been identified across the EU to promote web accessibility for people with cognitive disabilities. In Sweden, the Cognitive Criteria Project was launched in 2019, with funding from the Swedish Innovation Agency Vinnova.[79] The two-year project was led by Funka and aimed to develop and test criteria for cognitive accessibility that could be used for legislation and standardisation across the EU and beyond. The research project strengthened partnerships between organisations specialising in cognitive accessibility and standardisation, end users with cognitive disabilities, ICT suppliers and website owners.

Technology

Much of the research on technological solutions for cognitive accessibility can be found in research on ageing and age-related cognitive decline. Addressing the organisation of health care, a project funded under the Horizon 2020 initiative, the EU Framework Programme for Research and Innovation proposed a digital environment model targeting older adults with cognitive impairments. This model highlights the potential of ICT in order to provide ad hoc healthcare services and monitoring health to manage patients' cognitive functioning, integrate relevant support services, and manage and exploit resulting information flows.[80] This project explores the design of a digital environment for cognitive inclusion. It proposes to merge digital technologies and digital environments within the patients' home to improve the sustainability of integrated social-care services and remotely provide patient-specific services by detecting trends in personalised data.

Technical recommendations were also provided for persons with memory impairments.[81] Particularly, one study recommended the use of social media to document their day, to keep track of their daily interactions with other individuals and the daily events. The compiled data from their social media is then made accessible to designated persons that can them to remember, for example, events and names.

Another study concludes that (cognitively accessible) ICT tools can be very beneficial in facilitating contact with public authorities of persons with mental illness. For example, sending notes on appointments in messages that can be kept in the telephone is much

[79] ibid

[80] Vainstein, G., Adamit, T., Chaimov, N. and Idar, D., 2017. 'Digital Environment for Cognitive Impairment (DECI) Clinical Study-A Multi-Centre, Prospective, Randomized Study Funded by the European Union', The Practice of Patient Centered Care: Empowering and Engaging Patients in the Digital Era, p.89. Available from: https://ebooks.iospress.nl/pdf/doi/10.3233/978-1-61499-824-2-89

[81] Karlsson, T., Classon, E., Rönnberg, J., 2014. 'The brain-friendly workplace - cognition, cognitive disabilities, and work environment', Arbetsmiljöverket.pp.1-89. Available from: https://www.av.se/arbetsmiljoarbete-och-inspektioner/kunskapssammanstallningar/den-hjarnvanliga-arbetsplatsen-rap-20142-kunskapssammanstallning/

easier to remember and keep track of than formal letters arriving in the physical mailbox.[82]

Personal support

In addition to general guidelines, for some persons and in some instances, it can be useful to focus on comprehension of the content by adopting an approach with individual adaptations rather than general solutions that are more or less suitable for everyone.[83]

Both sources in the literature and persons interviewed for the study have drawn attention to the need to go beyond web accessibility requirements and design guidelines to be able to provide accessibility for certain groups. For example, one study recommended repurposing existing web content or design for display in different formats, other website or on different devices.[84]

Several studies have put forward personalisation as a way forward to deal with the diversity of user needs among persons with cognitive disabilities.

One review of guidelines for accessible interface design notes that customisation is one way to deal with the variations of characteristics and needs among persons within the autism spectrum.[85]

Another study concludes that customisation can be used to enhance website usability for persons with dyslexia. The study investigated the user experience of persons with dyslexia on a default website compared with a website where parameters such as font size, font type and contrast between the text and the background could be changed by the users. The results show that participants reported much less issues regarding, for example, navigation and how the information was presented in the customisable version of the website.[86]

Another recommended approach is to make room for innovative technologies such as cloud driven web services focused on comprehension and semantics. These solutions are individualised, in that they are influenced by and affect individual preferences and differences. Particularly, the personalisation of approach to web accessibility will work as an enabler of human rights envisioned by the UN Convention on the Rights of Persons

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[82] Johansson, S., 2016. 'Towards a framework to understand mental and cognitive accessibility in a digital context', Doctoral dissertation, KTH Royal Institute of Technology. Available from: https://www.diva-portal.org/smash/record.jsf?pid=diva2:908641

[83] Blanck, P., 2014. 'eQuality: the struggle for web accessibility by persons with cognitive disabilities', Cambridge university, pp.23-31. Available from: https://onlinelibrary.wiley.com/doi/abs/10.1002/bsl.2101

[84] Pouncey, I.,2010. 'Web Accessibility for Cognitive Disabilities and Learning Difficulties', Available from: https://dev.opera.com/articles/cognitive-disability-learning-difficulty/

[85] Pagani Britto, T.C., Brigante Pizzolato, E., 2016. 'Towards Web Accessibility Guidelines of Interaction and Interface Design for People with Autism Spectrum Disorder', ACHI 2016 : The Ninth International Conference on Advances in Computer-Human Interactions

[86] Kous, K., Polancic, G., 2019. 'Empirical Insights of Individual Website Adjustments for People with Dyslexia', Sensors, Basel 2019 May; 19(10):2235

with Disabilities. At the same time, technological innovation will allow for the personalisation of various components of the web, which will initiate meaningful legal and policy changes to remain up to date with these advances.[87]

There are a handful of EU-funded projects and studies that use personalisation as the starting point for tackling barriers related to cognitive accessibility. One such project is Easy Reading, a Research and Innovation Action project, co-funded by the European Commission under the Horizon 2020 programme.[88] Easy Reading aims to help people with cognitive disabilities to read, understand, and use web pages more effectively and efficiently. The project has developed software tools that support people with cognitive disabilities to personalise online content, simplifying the text and adjusting the presentation of text.

In terms of on-going EU-Funded initiatives, the Buddy project was launched in 2021 to enable people with cognitive disabilities to interact with digital services.[89] The 12-month project is a collaboration between Johannes Kepler University, Austria, and Funka, Sweden. The objectives of the project are to create an online repository of digital assistive technologies for people with cognitive disabilities, to enable tool producers to include their assistive technologies into the repository, to use artificial intelligence (AI) to create recommendations on the most suitable tools for users with cognitive disabilities, and to raise awareness about the service among users of the repository.

Another example of how AI can be used for providing intelligent accessibility on a personal level is the KI-Assist project funded by the German federal government. In this project AI solutions are explored for different groups including persons with intellectual disabilities. The project is focusing on vocational rehabilitation and how AI solutions can be used in the teaching of digital skills.[90]

An earlier initiative is the Literacy project, an Online Portal for E-Learning and Supporting Social Inclusion of People with Dyslexia that was co-funded by Commission under the FP7 Programme 2012-2015.[91] The project operated in Spain, Austria, Czech Republic and Hungary and aimed to create advanced online portals, which aided both dyslexic youths and adults through personalised e-learning programmes, useful tools and methods for helping people with dyslexia to improve their abilities in reading, writing and then function in society.

Studies also acknowledge that personal support cannot always be automated. For example, persons with severe intellectual disabilities may need assistance from a supporter to, for example, fill in a shopping basket online[92], but can then themselves do a review of the content before the purchase is made. In some cases, therefore, human support is needed to overcome certain barriers.

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[87] ibid

[88] Presentation of project Easy Reading, available from https://www.easyreading.eu/

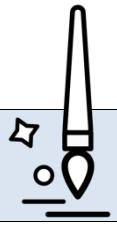
[89] Buddy Project EU (2021). Available from: http://www.buddyproject.eu/

[90] KI.ASSIST (2021) Presentation of project KI-Assist, available from: https://www.kiassist.de/wissen/kuenstliche-intelligenz/ki-basierte-assistenztechnologien

[91] Cordis (2021). Literacy Project. Available from: https://cordis.europa.eu/project/id/288596

[92] Kennedy, H., Evans, S., Thomas, S., 2011. 'Can the web be made accessible for people with intellectual disabilities?', The information society. Vol 27, 2011 Issue 1. Available from https://www.tandfonline.com/doi/abs/10.1080/01972243.2011.534365

Design considerations



In broader terms, the literature on user centred design underlines that besides accessibility in the classical sense (as the possibility to get to the information, from the perspective of the four accessibility principles in WCAG: perceivable, operable, understandable and robust) the usability perspective (that is how easy a website or online service is to use) is also important when aiming to create websites with manageable cognitive load. User centred design should consider aspects of navigation, functionality, context and text, layout and how multimedia is used; finally, user participation is crucial in order to achieve the desired outcome.[93]

There are also studies that focus on only one group of users. For example, one study used eye-tracking techniques together with people with autism to empirically evaluate a few WCAG guidelines related to the visual complexity of web page and understandability of different features on webpages. The study recommended simple design principles and distinguishable elements to facilitate access for users with autism.[94]

One of the sources found included an extensive literature review to identify the best practices of web access, and to determine if there is consensus on what features might improve the accessibility and usability of the web for users with cognitive disabilities. Within this exercise, twenty web design guidelines that addressed some form of cognitive disability and included specific design recommendations were compared and evaluated to find the recommendations with the highest consensus among the experts in the reviewed studies.[95] A similar concept is also explored in another source that goes beyond accessibility to look at the usability of web content. The source looks at providing non-technical recommendations that can be easily understood by service providers and users.[96]

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[93] Mariger, H., 2006. 'Cognitive Disabilities and the Web: Where Accessibility and Usability Meet?', National Center on Disability and Access to Education (NCDAE) Resources. Available from: https://ncdae.org/resources/articles/cognitive/

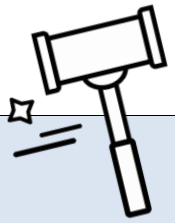
[94] Eraslan, S., Yesilada, Y. and Yaneva, V., 2021. 'Keep it simple!: an eye-tracking study for exploring complexity and distinguishability of web pages for people with autism', Universal Access in the Information Society, 20(1), pp.69-84. Available from: https://wlv.openrepository.com/bitstream/handle/2436/623056/Eraslan_et_al_Keep_it_simple_2020.pdf?sequence=3&isAllowed=y

[95] Friedman, M.G. and Bryen, D.N., 2007. 'Web accessibility design recommendations for people with cognitive disabilities', Technology and disability, 19(4), pp.205-212. Available from: https://www.researchgate.net/profile/Mark-Friedman-2/publication/284481795_Web_accessibility_design_recommendations_for_people_with_cognitive_disabilities/links/5653fa6e08aeafc2aabb63be/Web-accessibility-design-recommendations-for-people-with-cognitive-disabilities.pdf

[96] James, A., Draffan, E.A. and Wald, M., 2017. 'Designing Web-Apps for all: how do we include those with cognitive disabilities?', Studies in health technology and informatics, 242, pp.665-668. Available from: https://www.researchgate.net/profile/Abi-James-4/publication/324729223_Designing_Web-Apps_for_All_How_Do_We_Include_Those_with_Cognitive_Disabilities/links/5c9e26b7a6fdccd460438314/Designing-Web-Apps-for-All-How-Do-We-Include-Those-with-Cognitive-Disabilities.pdf

Other studies on requirements have highlighted the needs of persons with specific cognitive impairments. The user research conducted by the W3C COGA group specifically addresses the needs of user groups in the following categories: Ageing-Related Cognitive Decline, Aphasia, Attention Deficit Hyperactivity Disorder, Autism, Intellectual Disability, Dyscalculia, Dyslexia, and Non-Verbal. The user research proposes a list of web accessibility requirements for each of the groups proposed for inclusion in standards.[97]

On a more general level, broader design guidelines may also be helpful for providing basic support. In France, the private company Groupe SEB and APF France Handicap collaborated to develop a best design practices guide for universally accessible objects and services, with the support of the French national funding agency for the preservation of autonomy (CNSA).[98] The "Good Design Playbook", is available as a resource for all stakeholders aiming to bolster their approach to inclusive design.



Legal frameworks and public sector initiatives

Review of relevant academic literature identified several legislative instruments in countries around the world aimed at removing accessibility obstacles for persons with disabilities. In most of these instances, cognitive disabilities are not specifically mentioned, but are included in the general provisions. Americans with Disabilities Act (ADA), which became law in 1990 prohibits discrimination against persons with disabilities in places of employment, schools, transportation, and all public and private places which are open to the general public. The ADA, which has been amended in 2008 as the Americans with Disabilities Act Amendments Act (ADAAA) specifically mandates the right to equal access, formulated in terms of anti-discrimination legislation"[99]. ADAAA Title II addresses public bodies on state and federal level, whereas Title III covers commercial services, including content provide online. In addition, the obligations of public bodies to make reasonable modifications to ensure equal access are also applicable to online content.[100] The ADAAA does not specifically mention web and online services, since the law was originally written before internet took on the proportions it has today. Over time, an understanding has been developed within the Department of Justice and among courts that online services are covered by the existing provisions.[101]

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[97] Seeman, L., Cooper, M., 2021. 'Cognitive Accessibility User Research W3C Editor's Draft 10 May 2021', Available from: https://w3c.github.io/coga/user-research/

[98] Groupe SEB, 2021 (FR). 'Good design playbook', Available from: https://www.groupeseb.com/en/news/inclusive-design-groupe-seb-and-apf-france-handicap-join-forces-develop-best-practices-guide

[99] Lazar, J. and Stein, M.A. eds., 2017. 'Disability, human rights, and information technology', University of Pennsylvania Press. Available from: https://books.google.com/books?hl=en&lr=&id=UMXWDgAAQBAJ&oi=fnd&pg=PP1&ots=XKDColvCP8&sig=K18RqlfUc-8qJWDivyDmx3Y-lEA

[100] ibid

[101] Blanck, P., 2014. 'eQuality: the struggle for web accessibility by persons with cognitive disabilities', Cambirdge university, pp.23-31. Available from: https://onlinelibrary.wiley.com/doi/abs/10.1002/bsl.2101

In the United Kingdom, several Acts have been adopted over the years to realise this objective including the Disability Discrimination Act of (DDA) 1995. The provisions of the DDA have been merged into the current Equality ACT of 2010 which obliges services providers to ensure reasonable adjustments to enable persons with disability to access their services.[102] The Disability Discrimination Act 1992 (DDA) in Australia also uses the WCAG 2.0 as a standard for ensuring web accessibility. Keeping in mind the needs of consumers with a cognitive or intellectual disability, Australia implemented measures under this Act to ensure information and transaction processes are accessible to persons with cognitive disabilities. Means to ensure accessibility can include, for example, providing essential information in multiple formats, such as easy-to-read or audio-visual versions of sales material and contracts.[103]

There is legislation at both the EU and Member State level to promote web accessibility for people with disabilities more broadly. However, neither at EU-level nor in the Member States does legislation, specifically aimed at improving web accessibility for people with cognitive disabilities, exist.

As the recent EU-level directives related to web accessibility refer to the same minimum requirements (EN 301 549 v 2.1.2), they all share the same gap when it comes to requirements for cognitive impairments. The recently published draft standardisation request/mandate for harmonised standards in support of the European Accessibility Act[104] covers the EN 301 549 as well as the EN 17161:2019 Design for All - Accessibility following a Design for All approach in products, goods, and services - Extending the range of users and the EN 17210 Accessibility and usability of the built environment - Functional requirements. It is premature to conclude any detailed information about what updates or additions, when it comes to requirements on cognitive accessibility, may be the result of these efforts.

Apart from the transposition of EU legislation, few Member States have developed legislative measures at the national level to promote web accessibility for people with cognitive disabilities. Recent progress has been made in Germany, however, through amendments to the Regulation on the creation of barrier-free information technology according to the Disability Equality Act (BITV 2.0). Section 3 of the Regulation enforces the use of easy language and facilitates communication for people with cognitive disabilities. The legislation establishes that public authorities should communicate with

[102] UK Government (2013) "Equality Act 2010: Guidance" Available from: https://www.gov.uk/guidance/equality-act-2010-guidance

[103] Maker, Y., Arstein-Kerslake, A., McSherry, B., Paterson, J.M. and Brophy, L., 2018. 'Ensuring equality for persons with cognitive disabilities in consumer contracting: An international human rights law perspective', Melbourne Journal of International Law, 19, p.178. Available from: https://minerva-access.unimelb.edu.au/bitstream/handle/11343/221757/Maker-et-al-Advance-Copy.pdf

[104] Draft standardisation request to the European standardisation organisations as regards harmonised standards in support of Directive (EU) 2019/882 – Notification under Article 12 of Regulation (EU) No 1025/2012 on possible future standardisation requests to the European standardisation organisations. Available from: https://ec.europa.eu/growth/system/files/2021-11/Draft%20standardisation%20request%20to%20the%20European%20standardisation%20organisations%20as%20regards%20harmonised%20standards%20in%20support%20of%20Directive%20%28EU%29%202019_882.pdf

people with intellectual disabilities and people with mental disabilities in simple and understandable language.[105]

In addition to the legal measures, there are also other public sector initiatives in the Member States that, more or less directly, promote cognitive accessibility. In Italy, the Agency for Digital Italy (AGID) has issued Guidelines on the Accessibility of IT tools in 2020, enabling Public Administrations to provide increasingly accessible services.[106] These guidelines explicitly mention the involvement of people with cognitive disabilities in the evaluation team of the verification of web pages.

At the regional level, the Office of Cognitive Accessibility and Easy Reading (OACEX) was launched in the Extremadura region of Spain, in collaboration with Plena Inclusión Extremadura (Full Inclusion Extremadura).[107] Since its launch, the OACEX has worked with people with cognitive disabilities to verify the accessibility of official documents in the region. The office regularly adapts documents into easy-to-read formats, evaluates the cognitive accessibility of public spaces, provides training on web accessibility and cognition, and promotes awareness raising and research on cognitive accessibility.

Several EU member states have guidelines related to writing content in plain language and providing easy-to-read versions of public content. For example, Sweden has a language act that includes requirements for plain language provision[108], and the Netherlands has a plain language brigade that support civil servants on clear communication[109]. These initiatives are important since complicated language is one of the accessibility barriers that cuts across different user groups and impacts a large number or persons with and without cognitive impairments.

In the context of language and content, the EU Publications Office have also conducted a proof-of-concept project on how to produce documents that are accessible to persons with reading disabilities. The main target group of the initiative are persons with dyslexia. The initiative identified several solutions to improve accessibility including guidelines for authors, text to speech solutions and possibilities to customise fonts and layout.[110]

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[105] Federal Ministry of Justice and Consumer Protection of Germany (DE). Regulation on the creation of barrier-free information technology according to the Disability Equality Act. Available from: https://www.gesetze-im-internet.de/bitv_2_0/BJNR184300011.html

[106] Agency for Digital Italy (AGID), 2021 (IT). Accessibility of IT tools. Available from: https://www.agid.gov.it/it/design-servizi/accessibilita

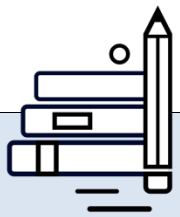
[107] Plena Inclusión, 2021 (ES). Office of Cognitive Accessibility and Easy Reading of Extremadura (OACEX). Available from: https://plenainclusionextremadura.org/plenainclusion/que-ofrecemos/accesibilidad/oacex

[108] Ministry of Culture, Sweden, 2009 (SE) Language Act (2009 :600). Available from: https://www.regeringen.se/49bb9d/contentassets/9e56b0c78cb5447b968a29dd14a68358/spraklag-pa-engelska

[109] Ministry of the Interior and Kingdom Relations, the Netherlands, 2020 (NL). Open Government Action Plan 2020-2022. Available from: https://www.opengovpartnership.org/documents/netherlands-action-plan-2020-2022/

[110] Publications Office of the European Union (2020) 'Reading disability and document access – a possible approach'. Available from: http://pocrdda.publications.europa.eu/documents-reports-phase1.html

Education and training



ICT can help inclusive education and making the learning environment more accessible for students with cognitive disabilities. Best practices in education include both providing a learning environment that is adapted to various learning needs and approaches through universal design principles and providing concrete tools, methods and materials that are adapted to specific needs.

On the more general side, one source cited an overall recommendation on ensuring web accessibility for people with cognitive disability that was issued to different groups involved in the implementation of structured technology training[111] to service providers as well as the users.

There are also good examples of how to provide digital learning materials that support cognitive needs. The Swedish Agency for Special Needs Education has, for example, developed a method for marking up properties of educational material for primary and secondary schools, according to which cognitive needs they provide accommodation for. The list of educational material and properties are used both for communicating with publishers about what kind of adaptations are requested by teachers and students, and for informing teachers about the availability of accessible educational material. Examples of properties related to cognitive user needs include easy-to-read versions, material with slow progression.[112]

Another study involved the production of a multimedia learning environment (LE) that can allow users to access multimedia content and learning materials that suit their personal level of ability.[113] The LE included the setting up of user profiles with information about individual abilities, preferences, and access needs. Based on the profile, a personalised set of learning materials was filtered out and sent to the users in the form of a series of links to different learning activities.

Another aspect of education and training is to offer a safe space for training to persons that are unsure of or not used to digital interfaces. A DPO in Germany, PIKSL provides training for persons with cognitive disabilities in a safe environment where they can learn and try out different digital skills and solutions without worrying about something going wrong. In a similar vein, a recent research and innovation project in Sweden has built a training platform for senior citizens and persons with cognitive disabilities where they can

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[111] Lazar, J. and Stein, M.A. eds., 2017. 'Disability, human rights, and information technology', University of Pennsylvania Press. Available from: https://books.google.com/books?hl=en&lr=&id=UMXWDgAAQBAJ&oi=fnd&pg=PP1&ots=XKDColvCP8&sig=K18RqlfUc-8qJWDivyDmx3Y-lEA

[112] Specialpedagogiska skolmyndigheten (SPSM) 2021, https://hittalaromedel.spsm.se

[113] Williams, P., 2005. 'Using information and communication technology with special educational needs students: The views of frontline professionals', In Aslib Proceedings. Emerald Group Publishing Limited. Available from: https://www.researchgate.net/profile/Peter-Williams-27/publication/241880906_Using_information_and_communication_technology_with_special_educational_needs_students_The_views_of_frontline_professionals/links/0deec5313201495686000000/Using-information-and-communication-technology-with-special-educational-needs-students-The-views-of-frontline-professionals.pdf

learn and train on how to make payments and do online shopping without making purchases in real life. The platform will be managed in collaboration between Funka and the county administrative board in Skåne as part of their government assignment to supervise access to payment services for all.[114]

Conclusions

The study has identified a range of actions to remove obstacles for cognitive accessibility that go from generic initiatives, that refer to persons with cognitive disabilities but do not specify particular barriers or cognitive needs, to particular requirements and tools that tackle specific issues. The most generic initiatives include anti-discrimination legislation and general guidelines in different domains. It can be noted that the literature points to a two-way approach to initiatives – either one can develop separate initiatives, requirements and guidelines that specifically address cognitive disabilities, or these can be integrated into broader actions striving for increased accessibility or combating discrimination and other barriers.

Another noteworthy observation is that many of the initiatives, both regarding the design of web accessibility requirements, the development of tools, such as assistive technology, and the evaluation of websites, make a point of involving persons with cognitive disabilities in the implementation. This is indeed a key success criterion for ensuring that the initiatives are in fact useful and relevant to the target group.

Concerning web accessibility requirements, the review shows that although the current standards supporting the legislation in the EU are weak when it comes to requirements that are specific to cognitive needs, there are recommendations developed in non-normative standards and guidelines and in the research community that do target explicit cognitive barriers. So far, none of these non-normative requirements have been deemed suitable for legalisation purposes.

The EU mandate for the development of accessibility standards supporting the European Accessibility Act may contain opportunities to further explore new or updated requirements for cognitive accessibility. This could mean that more requirements are eligible for inclusion in the standards.

Another kind of gap between needs and solutions can be found in education and training. The section on barriers identified training and education needs for several target groups. On the one hand, persons with cognitive impairments need inclusive access to ICT training. On the other hand, ICT professionals working with digital interfaces need training on web accessibility and on how to implement accessibility in their work. However, the solutions we have found in this area solely focus on education and training for persons with cognitive impairments. This is another area where there are gaps both in research and in practical measures.

5.2 What were the results of actions to remove accessibility obstacles for persons with cognitive disabilities?

In this section we look at the results of actions related to the research themes mentioned in section 5., that is inclusion and participation, technology, personal support, design considerations, legal frameworks and public sector initiatives and education and training. For all of the themes, it has been difficult to find evaluations of initiatives that have taken

[114] Training platform available at: www.funkabutiken.se

place in real life, outside of research environments. Therefore, most of the results refer to solutions that have been tried out on a small scale, mostly in studies and research projects. Within these contexts, the solutions have shown a proven effect to promote cognitive accessibility to varying degrees, but most often the value on a large-scale has not been tested. It should be noted that the list of research areas dealt with in this section are purely defined from the results of the literature review and stakeholder consultation. It is not in any way exclusive, nor is it a prioritised list.

Inclusion and participation

One of the identified studies compiles knowledge related to cognitive processes and the work environment. The study discusses problems and solutions regarding the work environment from a cognitive perspective and it describes a number of measures that have proven effective to support cognitive accessibility in the workplace, in particular for persons with cognitive impairments.[115] The solutions are categorised into nine themes that each relate to mental functions. Some examples include:

Language (solutions include AI to provide simplified summaries of texts to easier find the most important information).

Executive functions (solutions include using calendars for planning and cognitive training for how to tackle tasks with several steps).

Memory (solutions include using social media to document and share important events)[116]. Compilation of such practical knowledge serves as a starting point for a practical work environment that is equally accessible for people with cognitive disability.

Web accessibility requirements and standardisation

The literature from standardisation bodies does not include evidence of the results of the implemented web accessibility requirements. There are, however, research studies showing that web accessibility requirements for cognitive accessibility emanating from standards, have a positive impact on improving the ability of persons with cognitive impairments to use the web independently. For example, a study focused on developing and testing measurable criteria for cognitive accessibility to be used in standardisation and legislation across the EU and beyond, developed and tested five such criteria on over 30 users in Sweden and across the EU. The five criteria were developed based on a review of recommendations in existing non-normative standards and included: focus on

[115] Karlsson, T., Classon, E., Rönnberg, J., 2014. 'The brain-friendly workplace - cognition, cognitive disabilities, and work environment', Arbetsmiljöverket.pp.1-89. Available from: https://www.av.se/arbetsmiljoarbete-och-inspektioner/kunskapssammanstallningar/den-hjarnvanliga-arbetsplatsen-rap-20142-kunskapssammanstallning/

[116] ibid

important information, indication of progress in a process, showing users location in a set of webpages, clickable objects are clearly distinguishable, interactive elements to have similar behaviour and patterns of activation. The user tests involving persons with and without cognitive impairments show that all five criteria make it easier for users to complete tasks on a website. The study also showed that the developers and designers perceived the changes imposed by the requirements as subtle and not so difficult to implement.[117]

Furthermore, one academic study tested how implementing web accessibility guidelines affected users without disabilities. The study showed that websites where WCAG 2.0 had been implemented led to higher task completion time and rate for persons without disabilities. In addition, these websites were also rated higher by users in terms of usability and trustworthiness.[118]

Technology

While studies that try out specific technical solutions often include some sort of user evaluation on the efficiency of the solution, it has been difficult to find evidence of large-scale use of technology. In this particular study, many of the technical solutions that were found are also oriented towards personalised use. See for example the information on the Easy Reading project in the paragraph on personalisation.

Personal support

The Horizon 2020 project, Easy Reading, as described above, focused on individual support needs of the users with cognitive disabilities. The project used a participatory research methodology where the people with cognitive disability are actively participating in the projects as they are experts on their own needs.[119] As part of the Easy Reading project, the accessibility techniques in W3C are being evaluated in real life situations, allowing the opportunity for further improvement user tests that were conducted already

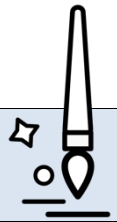
[117] Kjellstrand, S., Laurin, S., 2021. Criteria for cognitive accessibility in the digital environment. Funka, Swedish Institute for Standards, National Agency for Special Needs Education and Schools, Eskilstuna Skoldatatek, Lingio, Studentlitteratur, Gleerups, Försäkringskassan and IAAP Nordic. Available from: www.cogreq.eu

[118] Schmutz, S., Sonderegger, A., Sauer, J., 2016. 'Implementing Recommendations from Web Accessibility Guidelines', Human Factors, The Journal of the Human Factors and Ergonomics Society

[119] Zaynel, N., Bieker, K., and Edler, K., 2019. 'Inclusive Participatory Evaluation and Analysis with Peer-Researchers with Cognitive Disabilities – an Innovative Approach', (S9), Technology and Disability 31 (2019) S7–S107, IOS Press. Available from: https://www.academia.edu/40096719/2019_Waking_up_in_the_Morning_A_Gamified_Simulation_in_the_Context_of_Learning_Activities_of_Daily_Living

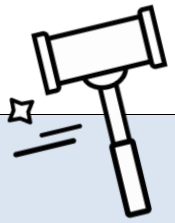
in the early stages of the project indicated that the target group had a strong need for adaptations.[120]

Design considerations



When it comes to design considerations, many of the studies cited in the above section do include evidence on the effect of the design, without explicitly publishing formal evaluation results. In many cases, user testing has been done to some extent. It is difficult to comment on the effect of the design guidelines in the cases where there is no explicit framework of evaluation. However, there are several examples of where guidelines have been tested with users. For example, one study presented recommendations on web design to increase accessibility and usability of websites for persons with Downs syndrome. One of the key recommendations was to minimise the number of elements on a webpage to only include the menu, the toolbar and the content. In this study, a comparison was made between a webpage with and without guidelines applied. The evaluation showed that lowering the number of elements on the webpage helped more participants to understand and use the webpage independently. One third of the participants in the study did not finish the usability tests in webpages with more than five elements.[121]

Legal frameworks and public sector initiatives



Despite the many challenges presented in the available literature, access to the web and ICT in general can potentially foster social inclusion for people with cognitive impairments. In this regard, legislative action through the implementation of the UN Convention on the Rights of Persons with Disabilities (UNCRPD) can highlight the role of technology to promote human rights of people with disabilities. The UNCRPD also highlighted the role of ICT accessibility as a key enabling factor for full and equal enjoyment of rights, globally.[122]

The review of relevant literature also included examples of the positive impact of national legislations on rights of people with cognitive disability. In Australia, measures to ensure that information and transaction processes are accessible for consumers with cognitive

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[120] Heumader, P., Miesenberger, K., Morales, T.M., Parker, S., Wakolbinger, B., 2019. 'Adaptive User Interface Concepts Supporting People with Cognitive Disabilities', (S10-S11), Technology and Disability 31 (2019) S7–S107, IOS Press. Available from: https://www.academia.edu/40096719/2019_Waking_up_in_the_Morning_A_Gamified_Simulation_in_the_Context_of_Learning_Activities_of_Daily_Living

[121] Alonso-Virgós, L. et al., 2018. ´Web page design recommendations for people with Downs syndrom based on user experience´, Sensors (Basel). 2018 Nov; 18(11): 4047.

[122] Ferri, D. and Favalli, S., 2018. 'Web accessibility for people with disabilities in the European Union: Paving the road to social inclusion', Societies, 8(2), p.40. Available from: https://www.mdpi.com/2075-4698/8/2/40/pdf

disabilities can potentially make such processes more accessible to all consumers, including those with and without disabilities.[123] Also, in the United States, the provisions of the ADA relating to reasonable modification attempts to mitigate unfair restrictions placed upon persons with cognitive disability[124], particularly the provisions of ADA and the UN CRPD, were affirmed in a Supreme Court case, Olmstead v L.C., regarding discrimination against people with cognitive and intellectual disability. The verdict of the case indicated that individuals with cognitive disability have the right to live in the community rather than be segregated in institutions. The decision of this case reflects a change in attitude towards disability rights and highlights the need to ensure full and equal opportunity for people with disabilities to use web content.

Also, in the United Kingdom, adoption of the more ambitious disability discrimination Act over the years has led to more formal learning support for people with various types of cognitive disabilities.[125]

Gaps in available policy documents of relevance have limited our analysis of the effects of policy measures for people with cognitive disabilities in the field of web accessibility. Most Member States have not implemented legislation or policies at the national level to improve web accessibility for people with cognitive disabilities, beyond transposing and implementing the Web Accessibility Directive (WAD). While online accessibility measures mention people with disabilities more broadly, a specific focus on cognitive disabilities was largely absent from the policies identified. Furthermore, limited information was available on EU-funded policy initiatives and programmes which expand web accessibility for people with cognitive disabilities.

However, while few EU Member States have adopted relevant policies to enhance web accessibility beyond the WAD, EU educational and research programmes have resulted in concrete projects aimed at supporting cognitive accessibility. The previous EU framework programme on research and innovation, Horizon 2020, included calls for proposals specifically targeting the development of digital interfaces designed to support persons with cognitive disabilities. Projects funded under these calls – in particular the Easy Reading Project (2018-2020)[126], and Insension (2018-2021)[127], are aiming to remove barriers to digital applications and interfaces. These initiatives are contributing to helping people with cognitive disabilities to benefit from online education, participate in political processes, and lead more independent lives.

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[123] Maker, Y., Paterson, J.M., Arstein-Kerslake, A., McSherry, B.M. and Brophy, L., 2018. 'From Safety Nets to Support Networks: Beyond 'Vulnerability' in Protection for Consumers with Cognitive Disabilities', University of New South Wales Law Journal, 41(2). Available from: https://www.unswlawjournal.unsw.edu.au/wp-content/uploads/2018/09/Maker-et-al.pdf

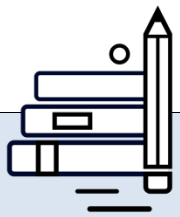
[124] Blanck, P., 2014. 'eQuality: the struggle for web accessibility by persons with cognitive disabilities', Cambirdge university, pp.23-31. Available from: https://onlinelibrary.wiley.com/doi/abs/10.1002/bsl.2101

[125] Williams, P., 2005. 'Using information and communication technology with special educational needs students: The views of frontline professionals', In Aslib Proceedings. Emerald Group Publishing Limited. Available from: https://www.researchgate.net/profile/Peter-Williams-27/publication/241880906_Using_information_and_communication_technology_with_special_educational_needs_students_The_views_of_frontline_professionals/links/0deec5313201495686000000/Using-information-and-communication-technology-with-special-educational-needs-students-The-views-of-frontline-professionals.pdf

[126] Presentation of project Easy Reading, available at https://www.easyreading.eu/

[127] Presentation of project Insension, available at https://www.insension.eu/

Education and training



ICT can help inclusive education and making the learning environment more accessible for students with cognitive disabilities. A research study has found that the use of assistive technology (AT) can, however, be hindered by external factors. A study found, for example, that its use might be restricted during tests, as it could provide undue advantage in relation to the other students, who are not allowed to use ICT. Another finding was that scanning all the printed material to use them with the ICT AT could take too much extra time, and therefore some students preferred not to use AT.[128]

One difficulty when it comes to selecting ICT-based support for persons with cognitive disabilities is the lack of evaluation frameworks. What works for one set of users in one setting may not be appropriate for other learners. In this context, one study focused on creating a framework for evaluating ICT-based learning technologies for disabled learners and inclusive ICT-based learning technologies.[129] This study aimed to support learners in making informed choices about appropriate learning technologies. In addition, this type of evaluation can allow learners with cognitive disability to try out and compare features of different ICT systems with similar applications.

Conclusions

In this section we have strived to find evidence of impact regarding initiatives to remove barriers to cognitive accessibility in all the research themes. One observation from the literature is that the evidence of impact that we have found almost exclusively refers to results of limited research studies, most often involving some kind of user testing. There are several studies that do test actions that are relevant for concrete situations of participation and inclusion, for example in the workplace or in education, but few studies, if any, look at large-scale implementation of actions or policies. However, there are a large number of studies with clear results from user testing, both for actions that help a majority of users and for actions that are targeted to specific groups. Within this literature there are many results that do point out solutions with a potential to make a difference at a large scale. One such example is the study on tools and methods in the workplace that is mentioned under the theme of inclusion and participation.

Regarding web accessibility requirements, there are few studies on how the recommendations and web accessibility requirements that are integrated in existing standards have helped users in practice. User research tends to be oriented towards proving the need for specific recommendations in the development phase, rather than testing whether existing standards and recommendations have been helpful. The Swedish

[128] Diraä, N., Engelen, J., Ghesquière, P. and Neyens, K., 2009, November. 'The use of ICT to support students with dyslexia', In Symposium of the Austrian HCI and Usability Engineering Group (pp. 457-462). Springer, Berlin, Heidelberg. Available from: https://www.researchgate.net/publication/221217749_The_Use_of_ICT_to_Support_Students_with_Dyslexia/

[129] Hersh, M., 2014. 'Evaluation framework for ICT-based learning technologies for disabled people', Computers & Education, 78, pp.30-47. Available from: https://www.sciencedirect.com/science/article/abs/pii/S0360131514001146

research study developing requirements out of existing standardisation guidelines does however provide some interesting evidence. This evidence can be seen both in the positive impact of the requirements for users with and without cognitive impairments, and also in the fact that these requirements were not too difficult for developers and web designers to understand and implement.

This study is also the only one identified that contains measurable conclusions on specific web accessibility requirements for cognitive accessibility. However, in other research studies, there are often user tests that show what difference the solution developed makes for users with cognitive impairments in a given situation. These tests have measurable conclusions even though they may be limited in their extent since they test one solution or feature for one specific group of users. From the studies identified in the literature, there is therefore some validated information about specific solutions that do work, such as larger clickable areas in interfaces for older adults in a Spanish study, or the different features of the Easy Reading framework developed in an EU-financed project. These kinds of studies and reports provide some evidence on what solutions work.

The stakeholder consultation did not result in further substantial information about what public or private initiatives work.

A few stakeholders in the private sector and in DPOs mentioned initiatives that they have taken and that these are successful in training professionals, training persons with cognitive impairments or raising awareness. However, there is no firm quantitative data confirming the results of these initiatives. Furthermore, there is a general lack of information on initiatives and actions that specifically concern cognitive accessibility in both the public and private sectors. Neither the survey respondents nor the interviewees had much information about the results of specific initiatives. The most frequent answer across all stakeholder groups on the question of what public initiatives they were aware of is that they knew about the European legislation on web accessibility, or the adoption in public policy of the WCAG standard or similar. One survey respondent that worked in the public sector replied that they thought that the adoption of WAD also covered the cognitive user needs, and that this area therefore already was covered by existing legislation. This seems to be indicative to the state of discussion on cognitive web accessibility in the public sector in Europe – there is an assumption that since cognition is mentioned in the EN standard, which the legislation points to, the topic is already covered. This seems to indicate a need for raising awareness of what the current legislation does and does not include.

6. Gaps identified in research and the web accessibility requirements

6.1 Research

During the literature review it quickly became apparent that there is much less research on cognitive accessibility than on web accessibility in general. This situation persists even though cognition has received more attention in research on ICT and digital interfaces in the last few years.

In addition, most literature on the use of the web or ICT in general focus on physical rather than cognitive disabilities. This is for example evident in the Special Educational Needs (SEN) setting. To date, literary work has paid very little attention to the views and needs of SEN staff[130], who bear the responsibility of educating pupils with various types of cognitive disabilities.

The overall picture coming from the literature review and stakeholder consultation points to 5 areas where there are specific research gaps to be filled:

- **Studies comparing and differentiating various degrees of user needs in terms of cognitive accessibility, looking at a diversity of user groups**

One study notes that there is a limited availability of research to identify the barriers experienced by people with different types of cognitive disabilities and how these can be resolved. Hence, there is a specific need for further research which measures the impact of different design recommendation on improving accessibility, the condition for utilisation of that design and the type of cognitive disability being addressed[131].

Similarly, the World Wide Web Consortium (W3C) responsible for developing Web Content Accessibility Guidelines (WCAG), in a recent report on how to improve web accessibility for people with cognitive disabilities, identified several research challenges they were faced with whilst producing the report.[132] These include the lack of existing

[130] Williams, P., 2005. 'Using information and communication technology with special educational needs students: The views of frontline professionals', In Aslib Proceedings. Emerald Group Publishing Limited. Available from: https://www.researchgate.net/profile/Peter-Williams-27/publication/241880906_Using_information_and_communication_technology_with_special_educational_needs_students_The_views_of_frontline_professionals/links/0deec5313201495686000000/Using-information-and-communication-technology-with-special-educational-needs-students-The-views-of-frontline-professionals.pdf

[131] Friedman, M.G. and Bryen, D.N., 2007. 'Web accessibility design recommendations for people with cognitive disabilities', Technology and disability, 19(4), pp.205-212. Available from: https://www.researchgate.net/profile/Mark-Friedman-2/publication/284481795_Web_accessibility_design_recommendations_for_people_with_cognitive_disabilities/links/5653fa6e08aeafc2aabb63be/Web-accessibility-design-recommendations-for-people-with-cognitive-disabilities.pdf

[132] The information access group (2021) Finding solutions to improve web accessibility for people with cognitive disabilities. Available from: https://www.informationaccessgroup.com/news/cognitive_disabilities.html

research on different aspects of cognition, the variation in the type and levels of cognitive impairment as well as the persisting need for simplification of web content.

Where available, research conducted on technology development for learners with cognitive disabilities often have a singular focus, rather than addressing barriers due to multiple impairments. For instance, online tests required for the completion of vocational training programmes in Lithuania[133] are suitable for disabled adults with learning difficulties, however, they do not take into consideration other physical impairments. While having such facilities for people with intellectual disabilities positively affects their educational aspirations, the gap in provision may still prevent some learners from attaining such qualifications.

- **Studies evaluating measures for cognitive accessibility**

In the survey and interviews, a small minority of the respondents in both the private and public sector mentioned that there was no need for further research since all solutions are already there, it is just a matter of applying them. While it can be debated whether the necessary solutions already exist, there is a larger consensus around the fact that there are still many obstacles regarding how to apply the insights from existing research. This is not only an issue of lack of awareness around previous studies. The literature review also shows that there is a lack of studies that provide evidence on the overall effectiveness of solutions, whether it concerns web accessibility requirements or technical solutions. In research projects, the solutions are tested with user groups, but there are very few studies focusing on evaluating solutions in real-life environments or scenarios. It is therefore difficult to draw firm conclusions on which types of solutions that most benefit a specific target group in a given situation.

A related gap that was mentioned by the researchers interviewed is that there are hardly any studies on how cognitive accessibility measures benefit persons without cognitive impairments. There is general literature backing up the fact that persons without cognitive impairments also experience, for example, cognitive overload. There are also a few studies where user testing has shown that everyone can benefit from a specific solution. However, the study could not find any systematic studies in this area.

- **Cross-disciplinary research**

One striking observation that the study team has made when going through the literature is that research into cognition and more generally into web accessibility is highly compartmentalised. In most studies, the research question and approach comes from a single discipline and often concerns a single target group with specific needs. Since it has been established that user needs are often common for persons with different cognitive disabilities, and also for persons without cognitive disabilities, it could be beneficial to conduct more studies into how research results regarding solutions developed for a specific group of users can be transferred to broader user groups. Furthermore, because of the complexity of the issues involved, more cross-disciplinary research should be encouraged to ensure that all relevant aspects have been taken into account when examining a barrier or developing and testing new solutions. Several stakeholders

[133] Hersh, M., 2014. 'Evaluation framework for ICT-based learning technologies for disabled people', Computers & Education, 78, pp.30-47. Available from: https://www.sciencedirect.com/science/article/abs/pii/S0360131514001146

interviewed, in both industry and academia, also raised the need for broader perspectives to tackle common challenges.

- **Cognitive user needs over the lifecycle**

Another gap that is apparent in the literature concerns how user needs, and users are perceived. This question is also related to the academic compartmentalisation and silos. There are many studies focusing on cognitive support for school children in educational settings and for older adults and age-related cognitive decline. In between, the studies are much fewer and far between. In particular, studies related to employment focus more on rehabilitation than on general conditions that would help persons with varying types and degrees of cognitive impairments to come into and stay in employment.

From the interviews and the workshop, it became apparent that this gap is also a factor when it comes to policy and support actions. Several persons that were consulted in the study testified that the support structures that exist for children with cognitive disabilities disintegrate when the children graduate from school. There is a need for more research and more support for cognitive accessibility for adults with and without cognitive disabilities, in particular in the workplace.

- **Research into the consequences of barriers**

Very few studies found in the literature are concerned about the practical consequences of barriers in the longer term. There are reports from stakeholders that inaccessible web services do lead to exclusion, and anecdotal evidence from the literature is also pointing in this direction. However, exactly how the mechanisms of exclusion work are difficult to pinpoint. It should be noted in this context that the consequences of barriers not only affect persons with cognitive impairments. As pointed out by stakeholders interviewed in this study, society as a whole is impacted in multiple ways when online services are difficult to use. This is therefore an area where additional research is needed to support further initiatives in both the public and the private sectors.

In addition to these more general research gaps, the stakeholders who took part in the survey and interviews mentioned a number of areas where they would welcome more research:

- Research into how far cognitive accessibility can be provided through general requirements and design and at which point personalised assistance is required for deeper needs for specific individuals and groups. (2 researchers, 1 industry representative).

- How to use possibilities of AI and automatization to provide solutions for accessibility (automatic easy-to-read versions, automated annotation tools, personalisation driven by AI) (7 stakeholders in research, public and private sector, DPOs).

- Investigate the potential of standardising apps and functionalities that are used often. Many public services and also apps, such as word processors and communication platforms, look different which means additional learning processes. It is also difficult for users to keep up with new features and changes. (3 – researchers and DPOs).

- More tools to support developers and designers (e.g., tools for web developers and designers to automatically produce accessible interfaces, plug-ins to analyse

level of difficulty of language, content and interfaces) (2 researchers, 2 industry representatives).

- Business case and incentives for companies to invest in implementing cognitively accessible digital interfaces (1 researcher, 2 industry representatives).

6.2 Web accessibility requirements

As noted in section 5.1 above, the standard (EN 301 549) that the current web accessibility legislation points to only has a partial coverage of cognitive user needs. The EN 301 549 and WCAG 2.1 standards includes additional cognitive user needs at (non-normative) AAA level, but these are not included in legal requirements in Europe or elsewhere. The W3C is aware of this lack of focus on cognition and has a specific group, the COGA Task Force, working on user requirements for persons with cognitive disabilities. In addition to this, other standardisation organisations have developed requirements to be used as general non-normative guidelines or in specific contexts.

There is, however, no consensus around exactly what cognitive user needs can be covered in a meaningful way through web accessibility requirements. Several stakeholders interviewed in this study mention that more research is needed on the extent to which user needs can be met by general requirements, and where additional support is required.

It is therefore not possible to provide a definite list of what requirements are missing in the current normative standards, since there is no clear view of the target.

Nevertheless, a comparison of the requirements in EN 301 549 with non-normative standards can illustrate a few areas where requirements could be strengthened:

1) Visual support for orientation, navigation, operability and understanding

One of the most frequently cited barriers on cognitive accessibility has to do with being able to navigate and find your way on websites and between websites. The interfaces are reported to be complex, with menus and organisation of elements that are difficult to understand.

Users report that they:

- Do not know where they are on a page and do not know how to find the information they are looking for.
- Do not understand from looking at an element (such as a button for example), whether it is clickable or not.

In the standard EN 301 549, navigation and orientation are mainly dealt with in terms of predictability and understandability of individual elements and support is provided with mainly text-based information. For example, the page should be titled, headings and labels should be clear and structured. This does not provide support for persons needing help with visual orientation and interpretation and sorting of elements that are presented visually.

Example of guidelines outside the normative standard that provide support for this need:

- Interactive elements should be visually indicated as clickable (ISO/IEC_TR_29138-1).

- Information about the user's location within a set of Web pages is available. (WCAG 2.1 AAA Success Criterion 2.4.8 Location).
- The interface should, where task progress can be measured, show a visible indication of the progress towards the completion of a task (ETSI EG 203 350).

2) Requirements that consider the relationship between several elements on the same page or in a process

As mentioned above, most requirements in the EN 301 549 deal with specific elements of an interface, one at the time. However, the by far most frequent barrier mentioned in the literature and the stakeholder consultation concerns the complexity of interfaces, that is, the adding up and relations between many elements on a single page or in the same system. Barriers reported by users include difficulties finding and focusing on the most important information and distractions caused by an overload of visual information on the same page.

Examples of guidelines outside the normative standard that provide support for this need:

- The [interface/system] should set the focus of attention on important information; (ETSI EG 203 350).
- The [interface/system] should present the most important information (including critical elements) to stand out from other presented items of information. (ISO/FDIS 9241-112).
- Organise content into well-defined groups or chunks, using headings, lists, and other visual mechanisms (WebAIM guidelines).
- Section headings are used to organise the content (WCAG 2.1 Success Criterion 2.4.10).

3) Support for individual options

One way to accommodate individual needs via general requirements is to include requirements for providing options to the user. The EN 301 549 does take into account the need for different ways to access information in the context of providing support for persons with physical impairments. Indirectly, this also provides support to persons with cognitive impairments who use assistive technology for accessing information. However, support is limited when it comes to understanding and processing information.

Examples of guidelines outside the normative standard that provide support for this need:

- The [system] should enable the user to have information repeated (ETSI EG 203 350).
- The [system] should enable users to access different amounts of information in order to meet their individual needs (ETSI EG 203 350, ISO/FDIS 9241-112).
- The [system] should enable the user to select one or more modalities in which feedback and prompts should be provided (ETSI EG 203 350; ETSI EG 202 325 [i.5], ETSI ES 202 746 [i.7] and ETSI TS 102 747 [i.9]).

The overall lack of sufficient attention to cognitive user needs in normative standards is connected to two underlying gaps. Firstly, there is no substantive overview of what legal

requirements and non-normative recommendations and techniques exist for cognitive user needs, what barriers they address, in which situations they can be used and what groups of users are helped by these requirements. In other words, there is a lack of a standardised approach to making websites more suitable and/or adaptable to users with different types of cognitive disability. The W3C COGA Task Forces, for example, notes that different techniques used for cognitive accessibility of the web should be gathered in one place and investigated for their potential for adaptation.[134] This will facilitate the identification and implementation of a standard set of techniques to enable adaptation for specific learning and cognitive disabilities.

Secondly, there is a lack of measurable requirements. In this first part of the review, the main recommendations and guidelines issued by standardisation organisations, such as ISO and ETSI, were briefly looked at. Upon review, few of them are actionable in terms of being measurable and accompanied by evaluation methods. In this context, there is a gap of knowledge on why the recommendations that exist have not been turned into firm requirements with measurement methods, and which recommendations that are eligible for becoming measurable. One recent study has attempted to transform general recommendations into measurable requirements. It has done this by using a hybrid method of literature review and extensive user testing with website owners, developers and designers, as well as persons with cognitive impairments to ensure such requirements are both relevant and helpful for the users as well as possible for web professionals to implement.[135]

[134] Seeman, L., Cooper, M., 2021. 'Cognitive Accessibility User Research W3C Editor's Draft 10 May 2021', Available from: https://w3c.github.io/coga/user-research/

[135] Kjellstrand, S., Laurin, S., 2021. Criteria for cognitive accessibility in the digital environment. Funka, Swedish Institute for Standards, National Agency for Special Needs Education and Schools, Eskilstuna Skoldatatek, Lingio, Studentlitteratur, Gleerups, Försäkringskassan and IAAP Nordic. Available from: www.cogreq.eu

7. Practical proposals for actions to improve independent and inclusive access

7.1 Introduction

This section summarises the insights from the study research into a list of 17 practical proposals for actions to improve cognitive accessibility and promote independent and inclusive access to online services.

The 17 proposals are structured in two complementary segments with three categories of proposals in each segment:

General: Accessibility measures that benefit all and tackle common needs	Personal: Add-ons and extra support beyond general measures. Targets individual needs
Web accessibility requirements (4 proposals)	Educational initiatives (3 proposals)
Design-oriented guidelines (3 proposals)	Technical solutions (4 proposals)
Awareness-raising and training (2 proposals)	Personalised approach (2 proposals)

It should be noted that in reality, the general and personal accessibility measures are very much interrelated: both are necessary and in each situation it is just a question of where one of them is enough and where the other type of measures need to be added to provide the best accessibility.

The categorisation of the proposals corresponds to the research areas that provide the basis for the findings and suggestions.

For every proposal there is an explanation of:

Level of intervention: societal level (solutions that benefit all), group level (solutions for identified coherent groups with specific needs), individual level (additional support to persons on their own terms).

Type of intervention: e.g., what will be produced, for example a provision of guidelines, process improvement, public policy, provision of training or education, awareness-raising.

Expected results: e.g., what will be achieved, for example more inclusive interfaces, higher awareness, improved understanding, better knowledge and training.

Intended audience: e.g., the professionals or sector that should implement the proposal, for example web professionals, website owners, public policymakers, standardisation organisations, user organisations, educational institutions.

Description of the intervention: Short description of the intervention, including rationale behind the proposal.

Implementation/ feasibility: Short description of conditions for implementing the proposal, including information on costs and benefits where available. It should however be noted that there is very little substantiated data regarding costs and benefits. In most cases, the discussion on feasibility therefore focuses on factors that can affect the implementation and success of the proposals.

7.2 Web accessibility requirements

This section contains four proposals:

- Study whether cognitive accessibility requirements can be added to standards that the European legislation is pointing to.
- Study whether existing cognitive accessibility guidelines can be converted into measurable requirements.
- Develop common understanding of user needs related to cognitive accessibility for the purpose of standardisation.
- Involve end users with cognitive disabilities in standardisation.

Proposal: Study whether cognitive accessibility requirements can be added to standards that the European legislation is pointing to

Level of intervention: Society.

Type of intervention: Public policy development.

Expected results: Requirements for all organisations in the EU that are subject to the Web Accessibility Directive and the European Accessibility Act and thereby also the Procurement Directive to take into account user needs related to cognitive accessibility in in the design and development of ICT.

Intended audience: European Commission, European standardisation organisations

Description:

The minimum accessibility requirements of the European legislation are key to ensure that basic user needs are considered by organisations that do impact the daily lives of European citizens. In addition, the legislation does send a strong signal that the user needs are important and it therefore also carries much weight in terms of awareness-raising on top of the concrete usefulness of the requirements.

The minimum requirements also indirectly affect parts of society that are not covered by the legislation, for example ICT-suppliers who want to sell to public sector bodies, who require accessibility in their procurements. Furthermore, as accessibility becomes the norm, even more organisations start regarding it as a regular practice.

Currently, the impact of the legislation is limited when it comes to user needs related to cognition and mental functions. This is because the requirements in the current harmonised standard (EN 301 549) serving as presumed conformance to the Web

Accessibility Directive has been developed from a perspective of physical user needs and does not explicitly refer to needs related to specified mental functions.

The research literature and stakeholder consultation show that many of the user needs related to cognition and mental functions are common to persons with and without cognitive disabilities. Older adults and individuals that are new to technology are often mentioned as examples of user groups that share these needs. Including requirements specifically designed to improve interfaces by supporting mental functions, such as memory and organisation, would have highly beneficial consequences both directly for persons with and without cognitive disabilities, and indirectly to increase awareness and acceptance of cognitive user needs and reduce stigmatisation.

Implementation/feasibility:

The standardisation request connected to the presumed conformance of the European Accessibility Act is not yet formalised, but the draft covers EN 301 549, EN 17161 and EN 17210 as well as two technical reports. EN 17161 and EN 17210 are based on universal design principles. However, EN 17161 covers organisational processes and doesn't contain specific requirements, whereas EN 17210 does contain design considerations based on cognitive abilities.

The updates that will be the result of the new mandate provide a perfect opportunity to add requirements on cognitive accessibility to the harmonised standards. Research projects, preparations, testing and piloting of several possible cognitive criteria have already been carried out among various stakeholder groups and there is a common understanding about the fact that it is necessary to include more specific requirements to support better cognitive accessibility.

Including new requirements to the standard(s) will require collaboration with ETSI, CEN and CENELEC already established in the Joint Working Group.

Key aspects to consider for the implementation:

- The definition of user needs related to cognition should be precise, easy to understand and put into practice and avoid stigmatisation. It is recommended that the requirements should be related to mental functions, following the direction of recent research and guidelines issued by European standardisation organisations. Broad categories to be used without value laden words (e.g., Use executive functions, not ability to make decisions).
- One of the reasons WCAG success criteria on cognition is placed in level AAA, is that they are not considered possible to implement in all sorts of interfaces. As many other requirements are indeed also conditional under WAD, this argument should not be a barrier for a broader uptake of cognitive criteria as part of the minimum requirements of WAD and EAA.
- Another aspect is the need for measurability. This has proven possible to achieve in a national research project called Cognitive Criteria.

Proposal: Study whether existing cognitive accessibility guidelines can be converted into measurable requirements

Level of intervention: Society.

Type of intervention: Standardisation.

Expected results: A wider range of proven requirements that can be included in standards for web accessibility and that are feasible for web professionals to implement and evaluate.

Intended audience: European standardisation organisations (European Commission, researchers, persons with disabilities, accessibility experts).

Description:

Current standards that legislation points to in Europe and other parts of the world is limited when it comes to user needs related to cognition and mental function. There are, however, a wide range of non-normative standards that do include requirements for cognitive accessibility. In addition, there are a number of guidelines that have been produced by researchers, private and non-profit organisations. These guidelines have been developed to be a guidance rather than normative and are therefore not formulated in a way that makes them appropriate for evaluations in the context of enforcement.

Investigating how and whether existing guidelines can be reformulated to become appropriate for enforcement and evaluation would:

- Provide a firmer basis of requirements that can potentially be included in standards that legislation in the EU points to.
- Facilitate the application of the requirements for web professionals that are not familiar with web accessibility and be able to ensure that their implementation has been done correctly.
- Raise the profile of cognitive accessibility requirements as firm requirements rather than optional guidelines.

Implementation/feasibility:

A proof of concept has been conducted within a research project, showing that the endeavour is feasible. The endeavour could be conceived as a centralised approach managed by a standardisation organisation, but it could also take place within decentralised research projects. In either scenario, the transformation will have to pay attention to the selection of guidelines to avoid bias to certain types of user needs, and to the conceptualisation of measurability and evaluation requirements in order to facilitate the implementation of the requirements by web professionals.

Key aspects to consider for the implementation:

- The requirements must be useful for users with cognitive impairments. User participation and testing of the requirements is therefore essential.
- The requirements must be measurable for the industry and monitoring agencies.
- The requirements must be feasible for PSB when procuring digital interfaces.

Proposal: Develop common understanding of user needs related to cognitive accessibility for the purpose of standardisation

Level of intervention: Society.

Type of intervention: Research, standardisation.

Expected results: Improved understanding of how user needs related to cognitive accessibility can be conceptualised and implemented in standards. This will lead to better conditions for including requirements related to cognitive accessibility in ICT standards in the EU and beyond.

Intended audience: Research and innovation actors, standardisation organisations, public and private stakeholders involved in standardisation.

Description:

The current standard that the European legislation points to does not include a definition of what user needs are referred to under the broad umbrella term cognition. Non-normative standards from European and international standardisation organisations take different approaches to defining user needs. This contributes to a dilution of the concept of cognition and to parallel and potentially conflicting definitions of what cognitive user needs consist of. A common terminology and conceptualisation of user needs would facilitate both a harmonisation of existing guidelines wherever feasible, as well as provide a common and more solid ground for developing new guidelines and standards.

Implementation/feasibility:

Content-wise, there is already much information available that could support the development of a common approach. The key aspects in terms of feasibility concerns the organisational and technical aspects such as who would be responsible for the undertaking, which stakeholders would be involved, and which collaboration and decision-making mechanisms are needed.

The European Commission could, for example, issue a standardisation request to the ESOs, potentially adding a new initiative in connection with the new mandate of the ETSI STF 536 and the Accessibility Joint Working Group (JWG) handling the EN 301 549.

Key aspects to consider for the implementation:

- The JWG, representing the whole value chain of digital accessibility, should be involved and possibly lead the work.
- Funding would be needed to ensure participation from leading experts.
- There is much existing information regarding definitions, from standardisation organisations as well as from research projects, to be taken into account.
- User consultation and participation is needed to ensure that the chosen approach corresponds to real user needs.
- The definition of user needs related to cognition should be precise, easy to understand and put in practice and avoid stigmatisation. It is recommended that the joint definitions are structured according to mental functions and not diagnosis.

Proposal: Involve end users with cognitive disabilities in standardisation

Level of intervention: Society, group.

Type of intervention: Improvement of standardisation processes.

Expected results: Improved inclusion of end-users in standardisation, leading to a better understanding and consideration of user needs in the development of new ICT standards. Another expected result is the increased empowerment of persons with cognitive limitations. As a bonus, standardisation work may be made more understandable and transparent to the general public.

Intended audience: Standardisation organisations, public and private stakeholders involved in standardisation, end users with cognitive disabilities and their support staff.

Description:

Standards are key to improve inclusion, especially now that EU has legislation on web accessibility. One reason behind the fact that cognitive aspects are often omitted in standards is that the target audience is very rarely involved in standardisation work. The overall participation of representatives of Disabled Persons Organisations (DPOs) and individuals with physical disabilities is arguably too low, but people with cognitive impairments are even less represented.

By making it possible for the target audiences to participate in standardisation, first-hand expert knowledge would be automatically included, cognitive issues would be more in focus and other stakeholders would learn about the topic.

Implementation/feasibility:

Participation could be made possible using various methods, which should be further researched. Involvement of end users with cognitive disabilities would require some flexibility and interest from the standardisation organisations.

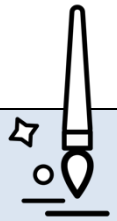
The involvement of end users with cognitive impairments in product development as well as research has been well documented. Research projects and standardisation initiatives at EU- and national levels have paved the way for increased end user involvement, developing toolkits, providing guidance and testing different actions. Combining results from these fields, as well as ensuring accessibility of the tools and systems used, would make it possible to better cater for end user participation of people with cognitive impairments.

Key aspects to consider for the implementation:

- The participation needs to take place on the terms of the users, making sure that their individual needs and requirements are met.
- Standardisation processes are quite complex, so implementation would require training and assistance of individuals and their support staff.
- Standardisation staff and invited experts will need guidance and manuals on how to make sure meetings and communication are carried out in a manner suitable for users with cognitive impairments, without creating barriers for other participants.
- Documentation and ICT-systems must be accessible and possible to use by the target group, either independently or with support.

The target audience would also most probably need financial support when it comes to travel, interpreters etc.

7.3 Design-oriented guidelines



This section includes three proposals:

- Increase user participation in the design of user interfaces, ICT products and services.
- Develop and spread nuanced personas that illustrate needs for cognitive accessibility.
- Raise awareness of existing universal design and accessibility guidelines and spread good practices.

Proposal: Increase user participation in the design of user interfaces, ICT products and services

Level of intervention: Society.

Type of intervention: Improvement of design process.

Expected results: Products and services that integrate user needs related to cognitive accessibility from the beginning.

Intended audience: Companies and organisations that commission, own, design and develop user interfaces for the web or ICT products and services. I.e. both supply and demand side of the eco-system.

Description:

User participation in the design and development process has been identified as the most widespread recommendation for improving accessibility and usability of ICT products and services, both in the literature and among the stakeholders consulted in this study. There are benefits on several levels:

- Improved accessibility, usability and relevance to users of different abilities.
- Better uptake and interest to buy.
- Decreasing costs by avoiding issues with accessibility and usability later.
- Increasing awareness and knowledge.
- Empowerment and inclusion.

Implementation/feasibility:

The participation can take different forms. More ambitious schemes involve co-creation with users participating in the conceptualisation of the product / service and all through the design and development. A more standard approach includes user testing and consultation on concepts, designs and prototypes developed by the research or development team. It is therefore possible to adapt the participation to the size and budget of the development project.

Costs involved in setting up user participation are mitigated by benefits in terms of higher uptake / sales potential and reduced costs in having to redeem accessibility and usability errors at a later stage.

Key aspects to consider for the implementation:

- The participation should take place in the early stages of conceptualisation to make sure the product/service meets actual demands from users. When user testing only comes in after the product has been developed, too many decisions have already been taken and it may be more or less impossible to re-start.
- When users are not involved in the design process, the risk is that changes have to be done after the launch, which significantly increases total costs. User participation has a potential of saving costs.
- It is important that the user participation is designed to include and empower the participants. The participation needs to take place on the terms of the users, valuing their contributions and respecting their needs in terms of consent, preparation, support and compensation.
- Not all organisations have the necessary knowledge and experience to involve users in a reasonable way, so manuals, training and sharing best practices are needed.

Proposal: Develop and spread nuanced personas illustrating needs for cognitive accessibility

Level of intervention: Society and group.

Type of intervention: Research and innovation funding.

Expected results: Improved understanding of cognitive user needs for all professionals working with ICT that will be used by persons with cognitive impairments. Increased awareness of the diversity of ICT usage situations where cognitive accessibility is needed and a more nuanced and less stigmatising representation of cognitive user needs.

Intended audience: Web professionals designing and developing ICT products and services, teachers, researchers, web accessibility specialists.

Description:

Personas are used in UX design processes as a fictional representation of the potential users of the product or service to be developed. They can also be used in other settings, such as training, to highlight and raise awareness of user needs in relation to accessibility. Personas can help web professionals get insights into how users of different abilities will interact with the product or service. It does not replace user participation, but it is an additional tool to integrate user needs into the design and development process at an early stage. A key aspect of the personas is that they describe the user need in relation to a specific situation where the product or service developed will be used. In this sense, they can illustrate the relationship between personal abilities and the influence of the environment when it comes to defining what support or accommodations are needed.

In the stakeholder consultation for the present study, it was pointed out that personas are especially useful for illustrating how needs for cognitive accessibility are common

to persons of different abilities depending on the situation and circumstances in which the service or product will be used. For example, persons without cognitive disabilities, but that are stressed, may have the same needs regarding time management as persons with concentration impairments.

Implementation/feasibility:

First of all, personas are not a replacement for user involvement. In the development of the personas it should therefore be clear when and where these can be used as a tool to complement user testing.

Many organisations use and develop personas. The feasibility is already proven, and the threshold of starting to create personas is relatively low given that there is a lot of information to use as inspiration and that the level of ambition can easily be adapted according to the budget and time available.

However, there are several factors hampering their use:

- Lack of overview of existing personas to use.
- Lack of knowledge on how to produce and use personas.
- Lack of evaluation data to assess the quality of existing personas. Anecdotal data suggests that personas often are developed from the basis of a person with a certain diagnosis rather than departing from broader and more nuanced user needs.

Key aspects to consider for the implementation:

- User consultation is important to minimise the risk of misrepresentation.
- Keep in mind that there is no straight correlation between user needs related to mental functions and different cognitive disabilities conceptualised in terms of diagnosis. Personas need to be nuanced to provide realistic representations of user needs.
- Do not forget that representing persons with varying abilities also means including persons without cognitive impairments that are facing situations with particular barriers.

Proposal: Raise awareness of existing guidelines and spread good practices

Level of intervention: Society.

Type of intervention: Research, communication.

Expected results: Wider awareness and uptake of universal design and accessibility guidelines and good practices for improved cognitive accessibility.

Intended audience: Web professionals, researchers, website and app owners.

Description:

For overall web accessibility, there are centralised guidelines, such as the EN 301 549 and WCAG but also national guidelines, that are generally well known and widespread references. However, when it comes to cognitive accessibility, the existing guidelines are fewer and less well-known outside specialist circles. In the stakeholder

consultation it became apparent that professionals and researchers alike were unaware of guidelines for cognitive web accessibility developed in different sectors.

To overcome this lack of awareness, there is a need to:

- provide an overview of existing guidelines and good practices.
- promote these across disciplines and to all professionals working with digital interfaces.

Implementation/feasibility:

Funding for awareness raising is usually connected to the specific projects where guidelines are being developed. It can therefore be difficult to find the resources to collect and promote guidelines that are already out in the open but are difficult to find. Another issue may be that the organisations developing the guidelines do not have the means or knowledge to do awareness-raising. One way of getting around this might be to allocate public awareness-raising funds specifically for guidelines and to provide funds for coalitions between stakeholders that are used to organising awareness-raising initiatives, such as branch organisations or disabled person's organisations and stakeholders that provide the guidelines.

7.4 Awareness-raising and training

This section includes two proposals:

- Ensure future web professionals get training in cognitive accessibility.
- Raise awareness of the diversity of cognitive accessibility needs to increase knowledge and reduce stigma.

Proposal: Integrate training in cognitive accessibility in the education of future web professionals (e.g., designers, web authors, developers)

Level of intervention: Society.

Type of intervention: Education.

Expected results: Increased knowledge and know-how of web professionals involved in designing, developing and creating content for online services and websites. This will in turn lead to the design and development of more accessible user interfaces.

Intended audience: Higher education, as well as vocational education and training (VET) institutions, national public bodies responsible for higher and VET education.

Description:

The lack of cognitively accessible online services and content is in general not a conscious choice but rather the result of a lack of knowledge. Studies and projects on web accessibility in the broader sense confirm that most universities in Europe do not systematically teach future web professionals about accessibility or how to create accessible content and websites. The minority that does provide courses on web accessibility focus on physical impairments This lack of attention to the subject is

something that the students carry with them from their education into the working life.

A key principle when it comes to designing and developing accessible products and services is that the earlier one starts integrating accessibility principles in the process, the easier and less costly it is to achieve accessibility. It is easier to make it accessible from the start than to fix issues later.

Similarly, it is easier to learn about accessibility during the basic training when the students develop their overall skills rather than having to relearn and rethink their habits at a later stage.

Implementation/feasibility:

Studies on the integration of accessibility in higher education courses show that the main barriers for implementation are a lack of awareness and knowledge of teachers compounded by competing imperatives and lack of time and, on the other hand, a lack of incentives from decision-makers in higher education. At the same time, the interviews conducted in this study, as well as in other studies on higher education, show that there is an interest and willingness among teachers, if they had the time, knowledge and means to work on this.

European projects funded by Erasmus+ have developed freely available resources for teachers on web accessibility that partially cover cognitive user needs as well. There are also many other openly available resources that are not specifically targeted to teachers but that can be used in teaching. The challenge for feasibility of integrating cognitive accessibility in courses is to first raise awareness of the importance of the topic, and then make sure that available sources are widely known and made use of.

Raising demand derived from the EU directives is pushing for accessibility to be part of the regular curricula. However, this need is based on the minimum requirements, and therefore mostly physical access.

Key aspect to consider for the implementation:

- User participation is equally important in the courses as in the design process. The best way to understand user needs is for the students to engage with the users themselves.
- Member states are, under WAD Article 7, required to promote and facilitate training programmes on web accessibility. Based on initial results of the stakeholder consultation of the WAD-review, this doesn’t seem to be happening much.
- A professional certification scheme should be considered to facilitate for public sector bodies when recruiting or procuring web services. This would be rather easy to set up, for example in collaboration with the International Association of Accessibility Professionals (IAAP).

Proposal: Raise awareness of the diversity of needs in terms of cognitive accessibility to increase knowledge and reduce stigma

Level of intervention: Society.

Type of intervention: Awareness-raising campaigns, research and innovation projects and funding, training and education initiatives.

Expected results: Better understanding of decision makers, web professionals, and the general public of what it means in practice to have a higher need for cognitive accessibility and of the diversity of user stories and needs of persons with cognitive impairments. Increased acceptance of user needs related to cognitive accessibility as a normal part of the human experience that needs to be considered in all products and services directed to citizens.

Intended audience: Web professionals designing and developing ICT products and services, teachers, researchers, web accessibility specialists.

Description:

Throughout the literature review and the stakeholder consultation it has become evident that there is a complexity surrounding the word cognitive. While some have not given any thought about cognitive user needs at all, others have a very specific idea of which user groups are affected by cognitive needs or not. Studies and stakeholders consulted also confirm that the term cognitive, as well as the more concrete user needs, carry with them stigma in different shapes and sizes. This stigma both hampers the ability for individuals to obtain the support needed, and it also obscures the wider picture where cognition is part of human characteristics that need to be taken into account in all services designed for people of all abilities.

Awareness and knowledge of cognitive user needs is a pre-condition for the design, development and implementation of any measures to improve cognitive accessibility, whether it concerns support actions for individuals or society-wide initiatives, such as standards and policies.

Implementation/feasibility:

Awareness-raising initiatives can take many different shapes, and therefore the feasibility of the design and implementation of such initiatives will depend on the different contexts.

The European Commission could lead by example:

- requiring framework contractors and research projects to take cognitive accessibility into account.
- making sure persons with cognitive disabilities are represented in committees/groups that are NOT focusing on disability issues.
- making sure meetings and information are cognitively accessible and not just captioned and sign language interpreted.

7.5 Educational initiatives

This section includes three proposals:

- Study possibility of developing training platforms where persons with cognitive disabilities can learn technology skills without stress.

- Ensure that guidance and support to digital apps, tools and interfaces is provided in plain language.
- Improve conditions for ICT training and education for persons with cognitive disabilities.

Proposal: Study possibility of developing training platforms where persons with cognitive impairments can learn technology skills without stress

Level of intervention: Group.

Type of intervention: Research and innovation (R&I) funding.

Expected results: Empowerment of persons with cognitive impairments to increase skills and confidence to be able to access and use online services and content. Increased participation and inclusion.

Intended audience: Public R&I funders, private R&I funders, innovators.

Description:

In the stakeholder consultation, users with and without cognitive disabilities responded that using services online is difficult in a situation where there are stakes involved, such as the need to access a public service for administrative reasons or the wish or need to accomplish a task within a certain timeframe. The stress induced by the pressing situation adds on to the stress created by specific barriers on websites. Feeling confident about how specific services, such as booking services or online banking, usually work can make it easier for users to manage the services in a given situation, despite external and internal stress factors.

The literature points to training platforms on generic online services as a way for users to gain more knowledge and skills in a safe environment where there are no stakes involved. One such platform that has been successfully developed and tested lets the users do shopping and payments online in scenarios with various degrees of complexity.

Implementation/feasibility:

Before such training platforms can be implemented at a larger scale, more research is needed into which types of online services or content are best suited for this kind of training. The feasibility in terms of a cost/benefit calculation also requires investigation. It will depend on the ownership of the platforms. It is conceivable that companies develop versions of training platforms to attract more customers for their solution. However, this would limit the versatility of the platform and therefore the usefulness for the users. Generic platforms for training on different variants of the same type of service have a broader application field, however, there needs to be a sustainable ownership for the platform to be a lasting solution.

Key aspects to consider for the implementation:

- There needs to be some form of user participation in the conceptualisation and development of the platform so that it becomes accessible, relevant and usable for persons with and without cognitive disabilities.
- Gamification should be considered since it is a proven method for engagement in web-based training.

- Language – automatic translation at its current state would not be good enough for these user groups. Also, websites differ quite significantly between member states.
- The platforms need to be available over time so that the learners can go back to the material and brush up the knowledge when they need to. If it is a one-off opportunity there is a risk that the user forgets what they have learned by the time they need to use their knowledge.
- For additional support, it is also recommended that the platforms include provisions for peer-to-peer learning or support by family members or caregivers. For many persons it is easier to become motivated and stay in the training if it is done together with other people.

Proposal: Ensure that guidance documents and support to digital apps, tools and interfaces is provided in plain language and easy to understand

Level of intervention: Society.

Type of intervention: Guidelines and best practice models.

Expected results: Improved independence for users of digital apps and services as it becomes easier for the user to learn how to interact with the digital interfaces without assistance.

Intended audience: Web professionals, owners of digital apps and services.

Description:

The stakeholder consultation and information from research consulted in the study show that persons with and without cognitive impairments struggle to understand instructions and manuals on software and services. Issues that are mentioned include long and complicated texts and a lack of images or examples to support the text.

The study also shows that users first and foremost try to solve issues themselves, by searching for the answer on the internet or reading the manual or other guidance documents. It is therefore important that the guidance is clear and easy to understand for everyone. This is especially the case since many apps and services used on a daily basis often tend to be updated on a regular basis, which means that the users are expected to re-learn how to use the app or service.

Standardised instructions with plain language and multimodal support would be helpful to support independent and inclusive use of online services by everyone.

Implementation/feasibility:

Since most companies already issue guidelines and manuals, the procedures and resources exist. The key issue here is rather to have the knowledge and know-how on how to develop guidelines that are accessible from a perspective of cognitive user needs. The feasibility of implementing accessible guidelines therefore depends on the existing knowledge and level of awareness within each company or organisation that is responsible for an app.

One possibility that was raised in the stakeholder consultation is that the development of a standardised model for cognitively accessible guidance, manuals and instructions

could be helpful for increasing knowledge among owners of apps and services and for making accessible guidelines available at a larger scale.

Apart from plain language, a multimodal approach to information is key to increase understandability.

As the EAA covers the accessibility of labelling, instructions and warnings as well as documentation and support measures of certain products and services, efforts on defining the minimum requirements for these to include cognitive user needs should be intensified.

Proposal: Improve conditions for ICT training and education for persons with cognitive disabilities

Level of intervention: Group and individual.

Type of intervention: Guidelines for training and education, awareness-raising.

Expected results: Improved ability of persons with cognitive disabilities to be more confident with ICT and to independently use online services.

Intended audience: Teachers, trainers, educational support staff, decision-makers in educational environments.

Description:

Both sources in the literature included in the study and stakeholders consulted highlight that there is a lack of appropriate education and training on ICT that is specifically adapted for persons with cognitive impairments. This lack does not only concern children in schools, but also persons in all ages that would like to learn how to use digital technology. The research in the study shows that persons with cognitive impairments use online services and information to a large extent in their daily activities both privately and in settings of work or other occupations. To ensure inclusive and independent participation, all users should have the opportunity to learn how to use ICT on their own terms and conditions.

Implementation/feasibility:

There are several elements involved in ensuring that the learning environment is adapted to the needs of persons with cognitive impairments:

- Accessibility of the learning platforms and interfaces. The accessibility of learning platforms vary, but there are examples of good practice that can be used. In this context, it is also important to consider varying degrees of accessibility needs for different learners.

- Universal design for learning. The teaching methods also need to take into account different needs in terms of styles of taking in and processing knowledge. The guidelines on universal design are a good start for teachers, trainers and assistants to see how the teaching methods can be adapted.

- Both the adoption of accessible learning tools and teaching methods depend on teachers, trainers and assistants having the sufficient knowledge and awareness to be able to make the choices that are most appropriate for the level of support needed by each individual student.

- The platforms need to be available over time so that the learners can go back to the material and brush up the knowledge when they need to. If it is a one-off opportunity there is a risk that the user forgets what they have learned by the time they need to use their knowledge.
- For additional support, it is also recommended that the platforms include provisions for peer-to-peer learning or support by family members or caregivers. For many persons it is easier to become motivated and stay in the training if it is done together with other people.

7.6 Technical solutions

This section includes four proposals:

- Take stock of and evaluate existing and publicly available technical solutions.
- Raise awareness of existing and publicly available technical solutions.
- Ensure access to assistive technology throughout the life journey
- Provide training on assistive technology to increase independence of end users

Proposal: Take stock of and evaluate existing and publicly available technical solutions

Level of intervention: Individual.

Type of intervention: Awareness-raising and education.

Expected results: Increased quality assurance and better efficiency and effectiveness in the spread and use of technical tools for individuals that already exist on the market.

Intended audience: Developers of AT solutions, public authorities and organisations involved in the assessment and provision of AT solutions, end user organisations and organisers of ICT courses for end users.

Description:

The stakeholder consultation indicates that on the one hand there is an abundance of technical solutions to support users with cognitive impairments in various degrees, and on the other hand there is sometimes a gap between the availability and the actual use of these solutions. There is a component of the gap that concerns the lack of information on existing tools, this is connected to awareness-raising.

However, there is another issue at play, it is also difficult for users and supporting staff to know which solutions are best suited for their specific situation. At the other end, stakeholders working with older adults express that they get many offers of new technical solutions to try but that the usability and usefulness of the solutions are not always clear.

There is therefore a need for a comprehensive overview of existing tools and for a mechanism that supports the users in choosing suitable tools. This mechanism should

also provide information of the quality of the tools in terms of accessibility, usability and effectiveness. Important quality aspects here include, for example, the flexibility when it comes to personalisation, the need for introduction/training as opposed to self-instructing solutions and the level of support provided by the manufacturer/distributor/provider.

Implementation/feasibility:

As many users in the target audience find it hard to express their exact needs, the search for solutions becomes very difficult. AI can support the process of matching existing solutions with specific user needs, as is shown in the EU-funded Buddy project.

The categorisation of tools and solutions is creating problems, not least because the unclarities when it comes to terminology, but also because of the different models of AT provision in the member states. An easy to use and well explained repository of tools and solutions for cognitive support available in the European market should be created to help AT-assessors, care givers, end users and market players. National and sector-based databases exist, but they are not comprehensive and most often developed to support the professionals, rather than the users.

Language support (what language the solution is available in) is arguably even more important when it comes to AT providing cognitive support, as automatic translated tools may be very confusing. The possibility to receive training and support in the mother tongue of the end user is also key.

Interoperability and specific requirements when it comes to device, browser and versions, need to be clearly defined and a minimum requirement for basic coverage could be considered.

Proposal: Raise awareness of existing and publicly available technical solutions

Level of intervention: Individual.

Type of intervention: Awareness-raising and education.

Expected results: Increased spread and use of technical tools for individuals that already exist on the market but where many are unaware of their availability and potential.

Intended audience: Developers of AT solutions, public authorities and organisations involved in provision of AT solutions, end user organisations and organisers of ICT courses for end users.

Description:

There is a variety of assistive technology solutions available to support cognitive user needs, but many of these solutions are unknown to persons who could benefit from using them in their daily activities. In this context, assistive technology does not necessarily refer to software that is provided through official procedures for persons with identified disabilities. There are many free and simple solutions that can be of use for persons that do not consider themselves disabled, but may have a need for support in specific areas. One such example can be seen with memory aids or text to speech solutions that are versatile and useful for many groups.

Implementation/feasibility:

- The lack of information is multi-layered which suggests that information need to get through on different levels, both to individuals, but also to employers, teachers, support staff, and others working with persons with cognitive impairments.
- There is a need for an overview of tools that provide support in varying degrees since some user groups may need more help than others. For this, some kind of common categorisation of tools could be envisaged.

Proposal: Ensure access to assistive technology throughout the life journey

Level of intervention: Individual.

Type of intervention: Research and re-structure the AT-provision systems.

Expected results: As digital products and services are important for all parts of life, better support for end users with cognitive disabilities throughout education, work and leisure would increase independence and participation in society.

Intended audience: Governments, policy makers, public sector agencies and NGOs involved in AT provision. Indirectly, the AT industry as a whole.

Description:

Most, if not all AT-provision systems in EU tend to divide user needs according to the structure of the ministries in public sector (education, higher education, labour market, culture etc.). This means that one individual will need to apply for and get a new assessment with every new phase of life. It is of course important to keep track of and re-assess the user needs as life evolves, but as the process around AT-provision is usually both exhausting and stigmatising, the system should follow the user in a much more efficient and human way. This would save money and make sure solutions and end user needs are a better fit.

Implementation/feasibility:

Changing AT provision systems is not a small task, but lessons could be learned by comparing systems across the EU and sharing best practices. Focusing more on the needs of a specific individual rather than the part of the system the user is currently involved in, would also make it easier to follow up on costs and benefits.

Key aspects to consider for the implementation:

- AT is a broad topic, and there is a need for both generic and specific knowledge among assessment staff to cover all aspects of cognitive needs.
- Instructions, training and support are important parts of AT-provision that are not always working well. Follow-up measures should be built into the system.
- AT is part of a technical environment including hardware, software, browsers, internet connection and various tools – as well as regular updates. All of this need to work properly for the AT-use to be efficient.

Proposal: Provide training on assistive technology to increase independence of end users

Level of intervention: Individual.

Type of intervention: Training and education.

Expected results: End-users are better equipped and feel more confident in using AT independently.

Intended audience: Actors in the national system of AT provision.

Description:

Research shows that end users find it difficult to use their AT once it has been assessed and provided to them. This situation includes prescribed AT provided through the government paid system for AT provision as well as commercial tools bought our downloaded for free.

Making sure instructions, training and support are included in the process of providing AT to people with disabilities would increase independence of end users and reduce the need for individual support in everyday use of digital products and services.

Implementation/feasibility:

The preferred process for providing instructions, training and support for end users will depend on the national system of AT provision. Where government agencies handle the provision and market players are taking care of support, responsibilities must be clear to all players involved, not least the end users. A common, single-entry point would probably be most suitable.

7.7 Personalised approaches

This section includes two proposals:

- Study feasibility of developing personalisation solutions that are freely provided through browser extensions or in-built features
- Provide more R&D funding for developing AI-based solutions on cognitive accessibility

Proposal: Study feasibility of developing personalisation solutions that are freely provided through browser extensions or in-built features

Level of intervention: Individual.

Type of intervention: Development of technological solution.

Expected results: Increased availability and use of tools that permit users to select and implement personalised support for a basic set of specific needs related to cognitive accessibility.

Intended audience: Research and innovation organisations, companies developing AT solutions, tech companies developing browsers.

Description:

There is a variety of assistive technology solutions available to support cognitive user needs, but many of these solutions are unknown to persons who could benefit from their use. To make it easier for the user to select and apply supportive solutions, it is suggested that personalisation options be made available through interfaces that users already have access to. This could for example be through browser extensions or solutions added on to websites by the website owners.

In recent years, browsers themselves have started to provide more cognitive support to a higher or lower extent. The study has brought up some examples of existing web-based tools related to text to speech or screen masks. However, most assistive technologies are still client-based or require download.

Implementation/feasibility:

The technical feasibility of the existing assistive technology tools and solutions have been proved and tested, either commercially or in research projects. What needs to be investigated for this personalised support to work and be useful are questions such as What kind of tools are both suited for integration in browsers or on websites? or What solutions are sought after by the end users? There is therefore some research both on the technical and the user side to be conducted before developing and promoting these kinds of solutions.

An important aspect of the personalisation tools is that they should not be confused with overlays. Overlays are a category of services that just recently entered the European market, after stirring up hot feelings in North America during quite some time. The main problem with these services is the marketing message: "Let our service wipe out all your accessibility problems." The overlay providers have so far not been able to prove that they do remediate accessibility issues. On the contrary, some overlays create additional accessibility barriers for users and some even break the expected behaviour of the interface, making it even harder to use.

Proposal: Provide more R&D funding for developing AI-based tools for cognitive accessibility

Level of intervention: Society.

Type of intervention: Development of technological solution.

Expected results: Increased availability and use of AI-based tools that can help developers and designers build in support for cognitive accessibility in general solutions

Intended audience: Research and innovation funding agencies, research and innovation organisations, tech companies.

Description:

There is a lot of research going on in the field of artificial intelligence, and many of the concepts and tools currently developed could be harnessed and built upon to increase cognitive accessibility in everyday ICT solutions. Whereas the previous proposal focused on assistive technology, this recommendation acknowledges that AI has a

potential to provide individualised support for cognitive accessibility in general web-based services and apps used by everyone on a daily basis. For example, AI can make it possible to provide simplified texts to complement longer and complicated texts on public websites. It is then up to the user to decide which version they would like to access.

Implementation/feasibility:

Since the focus of this proposal is on research and innovation, the question of implementation and feasibility of the solutions in real life settings is for a later stage. There are however some aspects that should be considered when setting up new research projects in this area:

- It is important to take stock of and build on existing initiatives and solutions. There are a few on-going initiatives in different sectors and countries, and these can be quite difficult to find if one is not specifically looking for them
- Research teams should be interdisciplinary to include knowledge of cognitive user needs, as well as aspects such as ethical issues related to privacy and the collection of data
- Persons with cognitive disabilities should be involved in the development process from the beginning to ensure that the solutions are designed to respond to real user needs.

8. Concluding remarks

This study has looked at cognitive accessibility in the digital world, in as broad sense as possible, including a wide diversity of user needs.

While the study shows that there are still many knowledge gaps to be filled, it also outlines a picture of a very diverse and vibrant research community working on issues related to digital inclusion from a cognitive perspective.

Actions and initiatives from the public and private sectors are currently lagging behind. One thing to bear in mind here is that the web accessibility directive is still quite new, and many public actors are in a learning process when it comes to implementing web accessibility. In this sense, it would be a good opportunity now to use the momentum around the Directive and upcoming legislation to also expand the notion of web accessibility to include cognitive user needs.

Going forward, one of the challenges that has been raised by stakeholders in various ways is how to combine the diversity of approaches regarding user needs and research directions with a need for a common terminology and approach to conceptualising cognitive accessibility across user groups and situational settings.

Another challenge that hampers research and actions is that unfortunately there is still a lot of stigma around cognitive accessibility and cognitive user needs, in whichever way these have been formulated. In addition to concrete measures to deal with barriers for inclusion, the study team would also like to highlight that there is a need of accompanying measures to de-dramatise cognitive accessibility and reduce stigma.

In addition to the list of proposals, the study team would like to conclude with a few general observations from the study to be considered in any initiative aiming at improving inclusive and independent access to online services.

1) General web accessibility requirements supporting mental functions such as memory or attention, can be of help to many different users, regardless of their abilities. Conceptualising needs in terms of support to mental functions rather than labelling of user groups helps to avoid pointing out individuals and makes common needs and solutions more visible.

2) There is a need for both broader measures aiming at a general level of cognitive accessibility and for more personal and tailored solutions on top of this basic framework of protection so that additional needs can also be accommodated. There is no conflict between these approaches, both are needed so as to include everyone.

3) Measures to improve cognitive accessibility benefit everyone, with and without cognitive impairments. To get the most out of digitalisation as a society, we need to make sure that the ICT we use on a daily basis is easy to understand and handle.

Annex 1 Sources for the literature review

Academic literature

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Mapping of sources against the research themes[136]	
Inclusion and participation	
Academic	Blanck P (2014), Buchholz, M., Ferm, U. and Holmgren, K.(2020) Friedman, M.G. and Bryen, D.N. (2007), Johansson, S., Gulliksen, J. and Gustavsson, C. (2020), Shpigelman C.-N., Gill C.J. (2014), Zaynel, N., Bieker, K., and Edler, K. (2019)
Grey literature	Gaber s (2020), WHO (2011)
Public and private initiatives	Sources primarily relate to other themes
Web accessibility requirements and standardisation	
Academic	Abou-Zahra S., Lee S. (2019), Schmutz S, Sonderegger A, Sauer J (2016)
Grey literature	The information access group (2021), Kjellstrand S., Laurin S (2021), Pagani Britto T.C, Brigante Pizzolato, E. (2016), Seeman L, Cooper M (2021)
Public and private initiatives	Sources primarily relate to other themes
Standards	ETSI (2007), ETSI (2009), ETSI (2016), ETSI (2018), ISO/IEC (2008), ISO/IEC (2014), ISO/IEC (2018a), ISO/IEC (2018b), ISO/IEC (2019), ISO/IEC (2020), ISO/IEC (2021), W3C (2021)
Technology	
Academic	Bartfai, A. and Boman, I.L. (2011), Vainstein, G., Adamit, T., Chaimov, N. and Idar, D (2017)
Grey literature	Insension project consortium (2021), Johansson, S. (2016), Karlsson T, Classon E, Rönnberg J. (2014), Olson, N. (2021)
Public and private initiatives	Sources primarily relate to other themes
Personalisation	
Academic	Heumader, P., Miesenberger, K., Morales, T.M., Parker, S., Wakolbinger, B. (2019), Kous K, Polancic G (2019)
Grey literature	Buddy project consortium (2021), Easy Reading project consortium (2020), KI-Assist project consortium (2021), Pouncey, I (2010)

[136] As standardisation literature is focused on requirements, this category of literature has only been included for the theme of web accessibility requirements.

Mapping of sources against the research themes[136]	
Public and private initiatives	Sources primarily relate to other themes
	Design
Academic	Alonso-Virgós, L et al (2018), Castilla, D., Suso-Ribera, C., Zaragoza, I., Garcia-Palacios, A. and Botella, C. (2020), Davis M, Dautenhahn, K., Powell, S. and Nehaniv, C. (2010), Kärpinen T (2019), Renaud K., Johnson G, Ophoff J, (2020)
Grey literature	De Los Rios Perez, C (2020), Mariger, H. (2006)
Public and private initiatives	Groupe SEB (2021)
	Legal frameworks and initiatives
Academic	Ferri, D. and Favalli, S. (2018), Lazar, J. and Stein, M.A. eds (2017), Maker, Y., Arstein-Kerslake, A., McSherry, B., Paterson, J.M. and Brophy, L. (2018), Maker, Y., Paterson, J.M., Arstein-Kerslake, A., McSherry, B.M. and Brophy, L. (2018)
Grey literature	Sources primarily relate to other themes
Public and private initiatives	Plena Inclusión (2021), Agency for Digital Italy (AGID) (2021), EU (2016), Federal Ministry of Justice and Consumer Protection of Germany (2011), Publications Office of the European Union (2020), UK Government (2013)
	Education
Academic	Hersh, M. (2014), Kennedy H, Evans S, Thomas S (2011), Williams, P. (2005)
Grey literature	Diraä, N., Engelen, J., Ghesquière, P. and Neyens, K. (2009), Funka, Länsstyrelsen (2021)
Public and private initiatives	Specialpedagogiska skolmyndigheten (SPSM) (2021)
	Quality of life
Academic	Xavier A, d'Orsi E, de Oliveira C M (2014)
Grey literature	Sources primarily relate to other themes
Public and private initiatives	Consumer and Governmental Affairs Bureau (2016)

Annex 2 Study approach and methodology

This section provides a description of the study methodology, outlining the key features of each research task. The study methodology has been refined through discussion with the European Commission. A full description of the method is outlined in the Study Plan finalised in May 2021.

The following sub-sections describe the main tasks related to research included in the study methodology (Desk research, stakeholder consultation, triangulation of data).

Desk research

The desk research focused on the following two areas:

- A review of academic and grey literature including an overview of cognitive accessibility in the context of the web, and the state of research on cognitive user needs.
- A review and analysis of legislative actions and standardisation and other measures that aim to remove obstacles to web accessibility for persons with cognitive disabilities, and the outcome of those measures.

The desk research covered all EU Member States, as well as some relevant literature from outside the EU.

The desk research entails data collection on the following topics:

- Existing research/studies in Europe on web accessibility for persons with cognitive disabilities (RQs 1-4).
- Actions and policies established in relation to web accessibility for persons with cognitive disabilities, and the results of these actions (RQs 5-6).
- Gaps in research and web accessibility requirements for persons with cognitive disabilities and potential solutions to combat barriers that persons with cognitive disabilities face (RQ 7-8).

To identify relevant literature, a combination of three series of keywords were used:

Cognitive user profile:

Disability, attention deficit, adhd, alzheimer*, aphasia, asperger*, autism, cognitiv* disab*, cognitiv* impair*, communicat*, dementia, development* delay*, delay* development*, dyslexia, dyslex*, dyscalc*, dysgraph*, dysprax*, intellectual impair*, intellec- tual* disab*, language disorder*, language impairment*, learning disab*, learning disorder*, mental* disab*, men- tal* ill*, mental* impair*, mental* retard*, neuropsychia* disab*, neuropsychia* disorder*, neuropsychia* impair*, psych* disab*, psych* impair*, read* difficult*, slow learner*, slow reader*, elderly, mental function, cognitive function, attenti*, reading, writ*, tasks, executive, calculate*, time, memor*, underst*, choice, focus, perception, perceive, comprehend*, understand, listen, speak*

Keywords relating to the application area:

ICT, computer*, digital*, digital environment, ICT environment, app*, application*, device* information system*, information tech*, information and communication tech*, interface*, internet, ipad*, ipod*, laptop*, on-line*, pad*, palmtop*, pc, phone*,

player*, portable*, reader*, smartphone*, social media*, social medium*, surfpad*, web*, learning systems, LMS, digital service, online service, IoT, AI, AR, VR.

Outcomes and gaps:

accessib* inclusi*, user experience, user, usefulness, user needs, usab*, understandable, user friendl*, user satisfaction, comprehen*, effectiv*, effic*, interaction, solution*, tool, method, policy, standard*, impact, recommendation, support, effect, initiative, barrier, obstacles, difficult*, exclus*, issues, hindrance, problem, lack, gap, participat*, independent*.

A template to capture literature review findings was also developed. This enabled the study team to collect a range of factual information in relation to each source and also specific information in relation to research questions.

Stakeholder consultation

The stakeholder consultation complemented the desk research by collecting specific information not available in the literature on the autonomy and participation of persons with cognitive disabilities in the digital environment, and related barriers. In addition, the consultation was used to gather insights and suggestions from stakeholders with specific knowledge from an inside perspective. This information was used to inform practical proposals to improve independent and inclusive access to online content and services for persons with cognitive disabilities.

The consultation covered all perspectives that are relevant for the practical proposals to improve cognitive digital accessibility in Europe. The consultation involved:

a) End-users: persons with cognitive disabilities and organisations representing them.

b) Public sector bodies, distinguishing between:

- Policymakers at EU-level: relevant EU institutions involved in the design or review of the web accessibility policies, including the EU Web Accessibility Expert Group (WADex), the Disability Intergroup of the European Parliament, and the EU High Level Group (HLG) on Disability.
- Policymakers at national level: ministries responsible for designing and implementing web accessibility policies and related monitoring agencies.
- Implementing bodies: representatives of national/regional/local bodies subjected to web accessibility regulation policy.

c) ICT Industry players, distinguishing between:

- Specialists defining web accessibility practice in the field: web accessibility experts, AT producers, such as providers of speech to text solutions and suppliers, which may be public bodies or private companies depending on the market in different Member States.
- ICT suppliers that are selling to bodies in scope of the Web Accessibility Directive.

d) Industries in scope of the European Accessibility Act:

- Consumer banking services.
- Computers and operating systems.
- ATMs, ticketing, and check-in machines.

- Smartphones.
- TV equipment related to digital television services.
- Telephony services and related equipment.
- Access to audio-visual media services such as television broadcast and related consumer equipment.
- Services related to air, bus, rail, and waterborne passenger transport.
- Banking services.
- E-books.
- E-commerce.

e) Subject matter experts (academia).

The consultation consisted of an online survey, in-depth interviews, and two online workshops. These methods were used to gather information from all groups on the RQs 3-8.

Online Survey

The online survey was used as the first step in the consultation, to gather basic data on the approach and position of the stakeholders with regards to the research questions, and to point in the direction to stakeholders to interview. In addition, the data in the survey was also used to illustrate and enrichen information gathered in the literature review and the interviews. To a minor extent, the online surveys also resulted in identifying additional sources to be included in the literature review.

The online surveys were tailored to the main stakeholder groups based on their user needs and perspective. The tailoring of the surveys was based on previous experience in reaching out to particular target group. The respondents were recruited through a multiplier approach, where we reached out to both stakeholder contacts identified in the offer, and the broader network of Inclusion Europe and Funka, as well as key contacts identified in the initial desk research and literature review.

Statistics on survey respondents

The majority of the respondents replied as citizens representing themselves. Some of the respondents working in the academic, public or private sector also chose to respond as citizens rather than representing the organisation they work for.

'I am responding as:'

Value	Percent	Count
A citizen representing myself	52.2%	36
A carer for or relative of a person with a cognitive disability	2.9%	2
A public body	17.4%	12

An organization representing persons with disabilities	8.7%	6
A university or other research institute	1.4%	1
A private company	4.3%	3
Other (please explain):	13.0%	9
	Totals	69

The survey respondents came from 19 Member States in the EU. Among respondents outside the EU, a majority came from the United States, Australia and Canada.

'In which country do you live?'

Value	Percent	Count
Austria	5.9%	4
Belgium	2.9%	2
Estonia	1.5%	1
France	1.5%	1
Germany	14.7%	10
Iceland	2.9%	2
Ireland	1.5%	1
Italy	1.5%	1
Latvia	1.5%	1
Lithuania	1.5%	1
Luxembourg	7.4%	5
Malta	2.9%	2

Netherlands	2.9%	2
Norway	10.3%	7
Poland	1.5%	1
Portugal	1.5%	1
Slovakia	1.5%	1
Spain	1.5%	1
Sweden	5.9%	4
United Kingdom	7.4%	5
Other	22.1%	15
	Totals	68

In-depth interviews

The in-depth interviews followed the desk research and the online survey. The interviewed qualitative information that served to deepen the understanding of questions raised in the literature review. The interviews also provided complementary perspectives from stakeholders in each of the targeted groups.

The interviews were semi-structured and tailored to the different target groups. The main focus of the interviews was to gather qualitative information on the barriers for cognitive accessibility, consequences of barriers and actions to prevent and combat barriers and promote inclusion. The questions therefore mostly related to RQs 3-8.

In addition, the interviews provided information on the kind of research and solutions that stakeholders perceived as most useful and important to promote inclusion. The team conducted a total of 40 interviews, 10 each in the stakeholder groups of academia, end-users, industry and public sector. The interviews were conducted in English, Swedish, Spanish and German, with stakeholders from 13 countries, in the EU and beyond.

List of interviewees for the Pilot Project Study: Inclusive Web-Accessibility for Persons with Cognitive Disabilities

Type of organisation	**Name of organisation**	**Country**
Academic	Johannes Kepler University	AT
Academic	TU Dortmund University	DE

Type of organisation	Name of organisation	Country
Academic	University of Southern Denmark	DK
Academic	Rovira i Virgili University	ES
Academic	Sahlgrenska University Hospital	SE
Academic	Karolinska Institutet	SE
Academic	Laurea University of Applied Sciences	FI
Academic	University of Fribourg	CH
Academic	University of Strathclyde	UK
Academic	Independent academic expert	SE
Industry	Samsung	UK
Industry	ING	NL
Industry	Swedbank	SE
Industry	Beletrina	SI
Industry	Atos	UK
Industry	Frances West Co.	USA
Industry	Texthelp	UK
Industry	LifeTool	AT
Industry	Google	USA
Industry	Meta	USA
Industry	E-commerce Europe	EU
Public sector	LBB Bremen	DE
Public sector	Estonian Ministry of Social Affairs	EE
Public sector	Language Council of Sweden	SE
Public sector	Swedish Agency for Accessible Media	SE
Public sector	National Agency for Special Needs Education and Schools	SE
Public sector	UK Home Office	UK
Public sector	Andalucian Regional Council	ES
Public sector	Vilanova City Council	ES
Public sector	Norwegian Broadcasting Corporation	NO
End-user	Autism and Asperger association in Sweden	SE
End-user	Inclusion Czech Republic (SPMPCR)	CZ
End-user	PIKSL	DE
End-user	European Dyslexia Association	EU
End-user	National Pensioners' Organisation (PRO)	SE

Type of organisation	Name of organisation	Country
End-user	National Aphasia Association	SE
End-user	Papunet	FI
End-user	Inclusion Europe	EU
End-user	Attention	SE
End-user	Saint John of God Community Services	IRL
End-user	Autism Sevilla	ES

Workshops

To complement the data collection tools, and to make sure we cover a broad range of stakeholders, the offer foresaw the organisation of two digital workshops covering direct as well as indirect perspectives on the topic. The workshops aimed to gather stakeholders from all groups and across the EU. To allow for a broad range of views to be collected, the workshops included interactive elements where the participants were invited to contribute to the discussion through polls and word-clouds.

A first online workshop was held on 22 June 2021. The workshop had more than 350 registered participants from the EU and beyond. The overall purpose of the workshop was to present initial findings from the research, to ask the participants for the view on these topics, and to validate the direction of the research. The participants took part in two polls during the workshop: one regarding which situations on the web pose the most problems in terms of cognitive accessibility, and one concerning which barriers are most prevalent on the web in terms of cognitive accessibility.

The participants were also asked if there were any situations or barriers that were not mentioned, but that should be included in the study. The results of the polls have confirmed that all the situations and barriers mentioned are relevant. No further situations or barriers were mentioned. It was therefore suggested that the categories can be included in the survey to be sent out in the second phase of the study.

A second online workshop was held on 25 November 2021. The workshop had more than 230 registered participants from the EU and beyond. The overall purpose of the second workshop was to present the proposed solutions for actions to promote cognitive web accessibility, to ask the participants for the view on these solutions, and to validate the findings of the research. The participants took part in two polls during the workshop: one regarding which solutions they would like to see for increased cognitive accessibility, and one concerning what topics for research that they see as most needed in the near future.

The results of the polls have confirmed that the proposals are relevant both in terms of content and categorisation. Additional information on research and proposed solutions have been added to the report. The workshop resulted in one further proposal on measures, which has been added to the report.

The outcome of the workshops was also used for analysis and triangulation of data at the end of the consultation phase and in writing up the final report.

Synergies with the evaluation of the Web Accessibility Directive

As the present study was performed in parallel with the Web Accessibility Directive (WAD) evaluation[137], we have included some results from the public consultation and analysis of any early reporting from Member States, when relevant. Even though the WAD evaluation does not specifically cover cognitive accessibility, it has provided some data from the evaluation that was relevant for the current study. For the first time in an open public consultation, the public could also choose to respond to an easy-to-read version of the consultation. This version turned out to be highly popular, at least partly because for this version the public did not need to register an account with the European Commission Authentication Service to be able to respond.

Triangulation of data and gap analysis

The purpose of the triangulation was both to ensure that no important aspects of the study have been overlooked and to prevent and overcome any fundamental biases that can arise from the use of a single method. In this step, data from all sources were compared to ensure that all perspectives have been covered for the core questions, either through the desk research and literature review or via the stakeholder consultation including online surveys, interviews, and workshops.

In the final report, the study findings were framed through a stepwise approach where answers to the research question leads up to an analysis of gaps in web requirements and research.

The gap analysis builds on both findings from the desk research and from the stakeholder consultations. The findings are complemented by conclusions and suggestions from the study team. The main focus of the gap analysis is to assess what measures make a difference for the users. In particular, we assessed to what extent the user needs within the field of cognition are currently being met and to what extent specific behaviour and usage specificities of persons with cognitive disabilities are considered in research and web accessibility requirements. The gap analysis fed into both a list of additional research needs and a set of concrete proposals on practical measures to improve independent and inclusive access to online content and services for persons with cognitive disabilities.

To make the proposals for practical measures actionable, they identify the both the stakeholders that are relevant for the implementation of the measures as well as conditions impacting the feasibility of the measures in practice.

[137] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12537-Accessible-web-&-digital-content-for-people-with-disabilities-review-of-EU-rules_en

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