

CO-DESIGN WITH PERSONS WITH DISABILITIES AS AN INNOVATIVE RESOURCE SET FREE BY AI

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ABSTRACT

UN's Convention on the Rights of Persons with Disabilities (CRPD) states that persons with disabilities should be allowed to develop their creative and intellectual potential, not only for their own benefit but for the enrichment of society. It means the right not to consume what others have created but to share one's own ideas, aesthetic expression, and intellectual work. Our thesis is that there is an unused potential in persons with disabilities. What if designers saw the world of a person with disabilities as a resource of diversity rather than a lack of normality? What if designers would tap into this resource of perspectives on everyday life to the innovation of technology? We would like to understand if AI could unleash the potential of persons with disabilities, by visualising and translating between people and technology. We discuss conversational and multimodal AI used for persons with learning and language disabilities, including AI visualization techniques. We aim to prepare for software re-design, translating between text-based services and symbolic language, the so-called Augmentative and Alternative Communication (AAC). Our case is a family with a young adult with learning and intellectual disabilities using AAC for social activities such as hiking. We find both barriers and potential. Barriers to harnessing the unused resources are due to traditional Co-Design methods, excluding persons with other languages than verbal and text. It is weighed up by the potential of AI to democratize through a certain lack of prejudice and norms, which make it easier to interpret, create, visualise, and share.

Keywords: Inclusive design, AI, co-design, alternative and augmented communication, innovation

1 INTRODUCTION

1.1 "For the enrichment of society"

The right to share with others what you have created, is written into the UN Convention on the Rights of Persons with Disabilities [1]. The rights to share have two benefits:

- 1) For the individual, the benefit of sharing is increased Health Promotion [2] and wellbeing through increased self-efficacy expressing yourself creatively and in a social group [3].
- 2) It benefits the community to recognise everybody's work, ideas and expressions as valuable resources, "for the enrichment of society" [1]. When designed thoughtfully, design for one particular user in mind, can be turned into commercially successful Universal Design, reaching a diversity of persons in different groups [4]. An example is the magnifying glass, made for a visually impaired person, that is used by elderly persons and at night with poor lighting by everybody. That is an innovation process of expanding design for an individual's needs to a universal design for the many.

1.2 Co-Design and Innovation through Diversity

Participatory Design and today's development into Co-Design has since the 1970s been part of a Scandinavian design tradition [5] to develop a democratic and socially sustainable technology. The traditional design process of products and services is often linear and divided into phases of insight, defining and development. It is led by professional designers and engineers and tested with users. A Co-Design process, with focus on democratic values and social sustainability, is much more fuzzy. In Co-Design tools and methods are available to everybody, including expert, designers and users. Co-Design uses: 1. *probes* to involve users early on in pre-design phase, 2. *toolkits* involving all in generative processes of making and relating, 3. *prototypes* in an evaluative phase to create and test concepts in real

life settings [6]. There is, however, a gap between vision and reality. Many persons with limited abilities to communicate verbally and to read and write are not included in traditional Co-Design and brainstorming sessions. It is because most Co-Design work is based on text on post-it notes and verbal discussions in groups or online [7]. However, based on research findings in the prototyping of multisensory Co-Design projects, we know that it is possible for persons with learning and language disabilities to share their creative and intellectual work with others in a design session [8]. The consequence of exclusion from sharing ideas, intellectual work, and expression is the individual's loss of power over the own life situation. It is also the loss of a diverse resource and to learn from people that experience the world differently and that could benefit many others. The "Co" of the Co-Design is reduced to empty words.

1.3 Case: Co-Design Use-stories with Family and Young Adult with Disabilities

"Linda" is a young adult with learning and intellectual disabilities, with limited verbal language and reading and writing skills. We have been following Linda and her family, her mother and father, for a year, and helped facilitate two Co-Design workshops and participated in outdoor hiking activities with the family and their community in Norway. We have also developed new Co-Design methods with Linda and her family. Throughout these activities, we have investigated how we can learn from Linda and her family's experiences. The work has resulted in Co-Design method development, presented earlier in a master thesis in Interaction Design by one of the authors of this paper [8], also as part of the EU-project RurAllure report [9].

Up to the age of 18, all Norwegians have access to learning technologies, tools, and leisure activities, sports and cultural events, through their local schools. When leaving school, many persons with disabilities lose connection with friends and social life and are not anymore included in processes where they are asked to participate, also outside of school. Only a select few are offered jobs and gain entry into new networks in society. This is the case for "Linda", who still lives with her parents and is dependent on their goodwill to meet with people and get involved in activities. Linda uses Augmentative and Alternative Communication (AAC), symbol language, both physical talking cards (fig. 1) and an interactive tablet, TD Snap [10]. With the tablet and the way the symbols are built up as a natural language with the possibility to choose verbs, nouns, adjectives, etc., Linda speaks in full sentences, expresses herself and her opinions, creates new concepts and ideas, and shares those with her family. To be able to connect with the world around her and to be able to choose what activities to do, she needs to know about the activities and be able to express what she wants. Linda's parents have founded a software company called SmartCognition [11], with the purpose of translating text to other multimodal outputs such as sound and symbols. So far, the texts about activities Linda and her peers can access have been manually typed into the application by personnel working at the local municipality and by Linda's mother, resulting in delays due to lack of time. The parents expressed that they wanted more involvement from Linda and that she needed to be able to make decisions concerning her own life and how she spent her leisure time. We explored various options and recommended that Linda plan a hike along lake Mjøsa, heading to a location she wanted to visit, engaging in activities she enjoyed, such as having picnics, and more. Based on the principles of participation and Co-Design, we suggested arranging Co-Design workshops accessible to Linda and the whole family.

In a physical workshop with the parents, we tried out Co-Design and how to replace and complement some methods. We brainstormed and prototyped how a narrative would look based on the talking cards (fig. 1) made in a series of two workshops with Linda, her parents, and design researchers [7].



Figure 1. Talking cards are used in hiking situations to express meaning and communicate what you want in full sentences. From workshop with experts, parents, and designers, created by Cecilie Eide [7] based on the TD snap software[10]

Linda used the talking cards, combined them with hand-drawn pictures, and played out scenarios as a role play with all of us as her actors. Linda even put on music and staged a dance with all of us. Linda ended with a picnic and a snack together at one of the tables full of drawings, symbols, and talking cards.

1.4 Augmented and Alternative Communication and Artificial Intelligence

Artificial Intelligence AI has long been integral to AAC systems, enhancing communication for individuals with disabilities. Evangeline et al. [12] underscores the impact of AI-driven AAC tools through their systematic literature review. They point out a notable gap, highlighting the lack of AAC solutions that seamlessly combine speech recognition and reconstruction within a single device, catering to partially and fully speech-disabled users. This gap, however, is not a barrier but an opportunity for inclusivity. Complementing this, Valencia et al. [13] suggest that AI technologies, specifically large language models (LLMs), can significantly enrich AAC by improving the quality and diversity of textual suggestions provided to users. These concepts align with the potential of generative AI to empower people with disabilities, enabling their active participation in co-creative activities.

2 METHODS

We searched for relevant literature and built further on the case based on workshops with a family with a young adult with learning and intellectual disabilities. Finally, in Table 1, we compared the different technologies' innovative potential qualities to be health-promoting for individuals, enriching for others and society and their individual degree of diversity, and based on culture and social values.

2.1 Literature Describing AI with Persons with Disabilities

The last time AI was popular in 1986, Dreyfus and Dreyfus wrote about how computers «...radically have increased the abilities of seriously disabled children to function in normal school environments, by allowing, for example, students to work on microcomputers equipped with special input devices. Reading machines for the blind are already available, as are machines that help the deaf learn to speak, and artificial vision systems which translate TV signal into tactile images on the user's back, are in development.» [14] We believe that AI, 38 years later, could be used to empower persons with disabilities to communicate and taking part in planning, expressing ideas, and all the Co-Design processes of pre-design in *probes* with users, *toolkits* for generative processes and *prototypes* in real life testing [6].

We made a search in the databases ACM and PubMed for the combination of the terms Artificial Intelligence AND Disability (OR Accessible) AND learning (OR intellectual) for the years 2019-2023. We did another search, also including AAC. We found eight relevant papers and articles describing the innovative uses of AI together with the target group. Three of the papers are described in Table 1 and

the main concepts in each lifted up and compared with the concepts of the physical card and the SmartCognition software.

3 RESULTS

3.1 AI-fying Language Models and Multimodal Interaction for Diversity

The innovative concepts for AI-based large language models (LLMs) and conversational agents in the papers were mapped and compared to the existing software and the physical Talking cards used in the two workshops with the family and the young adult Linda (see Table 1).

In describing the different innovations in Table 1, we include both technologies and theoretical concepts. We have rated *Diversity*, *Health Promotion*, and *Enriching Society* from 1 to 5, where 5 is the highest rating. Cecilie Eide’s [8] physical Talking card (fig. 1), used in workshop one and developed further in workshop two, is in its simple form, easy to understand and view as long as it is relevant to the situation and task you will perform. The fact that the card is printed on paper and not possible to change makes it static and eventually obsolete as the situation changes. On the card in Figure 1, the symbols are all to be used in a hiking situation out in nature. Some may be relevant in a walking situation in the city, but much will be irrelevant in, let’s say, a choir practice situation. It is easy to master the talking card and therefore Health Promoting for an individual as it promotes self-efficacy and the feeling of accomplishment and mastery [2, 3]. In its physical form, it is slow to use and distribute and is not enriching for many more than the person using it.

Table 1. AI-fying Co-Design technology for sharing

| Technology (AI, Physical, SW) | Diversity (1-5) | Health Promotion Individual (1-5) | Enrich society by sharing (1-5) | Innovation (technology, theory) | Reference |
|-------------------------------|-------------------------|-----------------------------------|--------------------------------------|-------------------------------------|------------------------|
| Physical | 2 (static) | 3 (easy to master) | 3 (slow) | Talking card, mobile | Eide 2023 [8] |
| AI | 4 | 4 | 3 (individual focus) | HCAI – human computer AI | Shneidermann 2022 [15] |
| AI | 5 (social, prototyping) | 3 (master for limited group) | 5 (potential for social interaction) | Tinkerable AAC | Yang 2023 [16] |
| AI | 2 | 5 (master for limited group) | 3 (individual focus) | Speech recognition & reconstruction | Evangeline 2024 [12] |
| AI | 4 | 3 (master for dialogue) | 5 (potential for social interaction) | LLMs Speech Prompts AAC | Valencia 2023 [13] |
| Software | 3 | 2 (delay) | 3 (local, manual) | Database text, symbol, sound | SmartCognition [11] |

Ben Shneiderman’s [15] theoretical concept of Human-Computer AI (HCAI) wants to ground AI in Human values (rights, justice, dignity) and individual goals (self-efficacy, creativity) and threats for the individual. However, it is less focused on society and sharing with others. It would need to be tested further in the development of software for sharing to see if it works outside a single-user situation.

Boyin Yang’s [16] Tinkerable AAC is a concept that scores highest on Diversity and Enrich society because of the potential in Co-Designing and sharing during participatory workshops with users with diverse backgrounds [8]. The idea that prototyping is made social and that we open machine learning training for users to participate in is fundamentally democratic and based on the principles of Participation and Co-Design [5, 8]. To be truly participatory, the user should be offered to participate in rule-making and policy-making activities, as well as in the execution and playing out of the rules.

For individuals with speech deficiencies Evangeline [12] want to see more AI-based AAC solutions in speech recognition to speech reconstruction software. In their review 2017-2022 they lack AI-development of seamless integration of speech recognition and reconstruction with contextually relevant outputs in speech and pictograms. Valencia [13] successfully used AI to design and test Interactive

Speech Prompts to extend short conversation prompts, written by a person with disabilities, into full sentences, to add biographical data and to quest for more feedback. They also included Pictograms in combination with written text to speed up and motivate to a seamless and smooth conversation between persons with and without disabilities. Compared to the other options, Smart Cognition's traditional software without AI capabilities is a straightforward database with a rule-based system for selecting symbols, sounds, and texts [11]. Because it is manual labour, it is also vulnerable to delays based on the person who types the text and makes the connection. It is the least rewarding option.

4 DISCUSSION

We think that the future development of an AI-fyed SmartCognition software for translating between text and symbolic language and multimodal communication (AAC) should be Tinkerable [16]. Tinkerable in the *pre-design* and *generative* phases of Co-Design [6] in the sense that you are motivated to participate in Co-Designing the rules for how the AI should learn and operate. AI should also involve the individual mastery of physical and multimodal interaction, such as with the talking cards, expanded with sensory input, and also be flexible for social play, with possibilities to detect and include activities such as Linda's staged and improvised dance and role play from the workshops.

As our case was a family with a young adult with learning and intellectual disabilities using AAC for social activities such as hiking, we will still find both barriers and potentials. This will also be the case in future automated AI applications. We think the potential of AI is to democratize through a certain lack of prejudice and norms that make it easier to interpret, create, visualise, and share. What innovative resources could designers and engineers tap into if we invited persons with disabilities to Co-Design future machine learning algorithms for AI?

In all the Co-Design phases (*pre-design*, *generative* creative, *prototyping* and evaluating real life testing), we believe AI could help speed up dialogue, e.g. with Valencias [13] use of speech prompts and the possibility to speed up the response time for the person with disabilities.

The main take away is that AI-based Augmentative and Alternative Communication (AAC) is in an early stage of development, in need of more explorations, but with many promising possibilities. Possibilities for school, learning and other context sensitive use-situations. The main finding from the literature study is that the AI-technologies miss case studies in all areas, for all tasks, users and contexts. We suggest that these explorations and case studies involve users with disabilities in Co-Design processes, to get as much relevant knowledge as possible.

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