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LITERATURE REVIEW

A Social Approach to Artificial Intelligence Systems for People with Down Syndrome: A Qualitative Systematic Review.

Pilar Dellunde ^a and Joan Moyà-Köhler^b

^aArtificial Intelligence Research Institute, Universitat Autònoma de Barcelona

^bBarcelona Science and Technology Studies Group (STS-b), Universitat Autònoma de Barcelona

A Social Approach to Artificial Intelligence Systems for People with Down Syndrome: A Qualitative Systematic Review.

Abstract

Objectives: This review was conducted by an interdisciplinary team with the aim of producing insights that are relevant to researchers, practitioners, and organizations supporting individuals with Down Syndrome.

Methods: A qualitative systematic review was conducted following PRISMA 2020 guidelines. 47 peer-reviewed studies (2014–2024) were selected from four major databases, focusing on implementations of Artificial Intelligence (AI) systems involving individuals with Down Syndrome.

Results: Findings show that AI applications targeted mainly the areas of education, communication, emotional regulation, mobility, and employment. Most systems used deep learning or intelligent robots. However, participatory design approaches were not widely adopted, and real-world deployment remained limited.

Conclusions: A shift toward more participatory, rights-based approaches is essential to ensure these technologies support autonomy and inclusion.

Keywords: artificial intelligence, Down Syndrome, inclusion, participatory design, systematic review

Introduction

For years, technology has held the promise of enhancing the lives of people with disabilities, a process significantly accelerated by the Covid-19 pandemic (Moyà-Köhler et al., 2023). This trend is expected to continue as AI opens new possibilities and imaginaries for future care and inclusion (Richter, et al., 2025). As noted in recent reports by the UN Human Rights Council and the European Network on Independent Living (Valle Escolano, 2023; Shah, 2024), AI can profoundly shape access to education, employment, communication, and autonomy, while also introducing serious risks, such as algorithmic discrimination, surveillance, and the entrenchment of ableist assumptions.

Within this context, the field of intellectual disability presents a particularly complex case. While many services are increasingly deploying technologies to support daily life (Zaagsma et al., 2020), dominant discourses continue to infantilize individuals with intellectual disabilities, presenting them as lacking autonomy (Björnsdóttir et al., 2015) and as unable to make decisions about their own lives (Mogensen et al., 2023). This, in turn, results in their exclusion from decision-making, both in design processes and in the use of technology (Hodson et al., 2022), thereby challenging alignment with rights-based frameworks such as the Independent Living Movement (Moyà-Köhler, 2024). These tensions make it crucial to investigate how AI has been conceptualized—framed and embedded within sociotechnical imaginaries (Jasanoff, 2015)—and implemented, particularly in populations such as individuals with Down Syndrome, who face different socio-technical barriers.

Several literature reviews have begun to chart the intersection between AI and intellectual disability: Almufareh et al. (2023), Díaz-Boladeras et al. (2023), and Zdravkova et al. (2022) present applications in the educational domain; Rojas et al. (2024) in professional and workplace settings; and Kharbat et al. (2020) examine the potential of AI to support learning, adaptation, and social development. Some other reviews target specific subgroups such as individuals with autism or emphasize medical and clinical applications (e.g., Adako et al., 2024), while literature on the use of AI for people with Down Syndrome remains scarce. Recently, Shafi et al. (2024) offered a quantitative bibliometric analysis of this research. The authors analyzed research trends by examining contributions from various countries, collaborative networks, and influential sources. Their trend analysis and keyword tree map revealed that the majority of research is concentrated on improving diagnostic and therapeutic procedures.

This paper contributes to addressing this gap through a qualitative review of AI technologies, aimed at enhancing the quality of life for individuals with Down Syndrome. The review is systematic in terms of the literature search and the formulation and addressing of research questions. However, we could not include a comparative or quantitative analysis of the selected works due to the heterogeneity of objectives, methodologies, and participant groups across the studies. Instead, we adopted a qualitative approach to synthesize and interpret the findings, aiming to identify patterns, gaps, and implications rather than focusing on statistical outcomes.

The main goal of the article is to present the different types of AI systems applied, the life domains they target, and the extent of user participation. Our study is grounded in a

social model of disability, highlighting both promising practices and structural limitations that influence the development and use of these technologies.

Methodology

Our methodology adheres to the PRISMA 2020 guidelines¹ for systematic reviews and meta-analyses.

Eligibility Criteria

Publication Year

We included studies published between 2014 and 2024. This time frame was selected to capture a decade of rapid evolution in AI techniques and the introduction of a new paradigm in AI, as well as the growing emphasis on social and inclusive approaches to disability research during this period. Our aim was to focus on recent applications of AI technologies that could be useful for professionals working with individuals with Down Syndrome.

Document Type

We focused on peer-reviewed original research articles written in English, including both journal and conference papers. We excluded non-peer-reviewed materials and

¹ These guidelines are publicly available at <http://www.prisma-statement.org> and are distributed under the Creative Commons Attribution License (CC BY 4.0). For a reference see (Page et al., 2021).

abstracts, posters, newsletters, and editorials. We excluded studies for which the full-text was not accessible.

Type of Participants

We considered papers that presented empirical data involving Down Syndrome participants of any age or gender.

Type of Technology

We included studies that implemented AI systems, whether symbolic, connectionist, or neuro-symbolic. In the case of robotics, we limited inclusion to intelligent robots and excluded educational robotics kits that do not incorporate AI. Additionally, we excluded studies that referenced potentially AI-enabled technologies but did not actually apply any AI techniques.

Subject Area

We excluded studies that focused exclusively on medical, clinical or rehabilitation applications, such as brain imaging and neurological data analysis, genetic studies and prenatal screening or risk assessment tools for congenital conditions.

Information Sources and Search Strategy

We conducted electronic searches for eligible studies using the following databases: Scopus, Web of Science (WoS), ACM Digital Library, and IEEE Xplore. These databases were selected for their comprehensive coverage of research in Computer

Science, as well as their inclusion of studies from related fields such as AI, Human-Computer Interaction (HCI), and the Social Sciences. This selection enabled a broad and interdisciplinary review of the literature relevant to our research questions:

Q1. Which aspects of the lives of individuals with Down Syndrome do the AI systems presented in the reviewed articles aim to enhance?

Q2. What type of AI system is described in the article? Is the system currently being used by individuals with Down Syndrome in their daily lives?

Q3. Are individuals with Down Syndrome or other key stakeholders (e.g., parents, caregivers, psychologists) involved in the design process of the AI system? Which specific demographic within the Down Syndrome community (e.g., children, adolescents, adults) is the research primarily targeting?

On January 11, 2025, we performed advanced searches using the built-in tools provided by each digital database. Our search query included multiple terms applied to the title, abstract, and author keywords. The following string was used in Scopus:

(TITLE-ABS-KEY ("artificial intelligence" OR "machine learning" OR "deep learning" OR "artificial neural network" OR "optimization" OR logic* OR "natural language processing" OR "large language model" OR "expert system" OR "computer vision" OR "ChatGPT" OR "recommender system" OR "robot*")) AND TITLE-ABS-KEY ("Intellect* disab*" OR "differently-abled" OR "handicapped" OR "discapacit*")) AND PUBYEAR > 2013 AND PUBYEAR < 2025 AND (LIMIT-TO (LANGUAGE, "English"))

This initial search in Scopus yielded 1,138 entries. After refining the results by limiting them to the keyword ‘Down Syndrome’, we obtained 34 entries, which were then collated and de-duplicated using Microsoft Excel. We used word stems and a variety of historical and contemporary terms referring to individuals with intellectual disabilities, such as handicapped, differently-abled, people with disabilities, and people with intellectual disabilities. Using the same query in the other databases, we obtained the following results: Web of Science (WoS): 721 entries (177 after refining); ACM Digital Library: 431 entries (200 after refining) and IEEE Xplore: 830 entries (96 after refining)

Selection Process

Titles and abstracts of the retrieved studies were independently reviewed. Any discrepancies were discussed until a consensus was reached. Subsequently, full-text articles were screened for inclusion based on the predefined eligibility criteria. After removing duplicates across databases and applying the inclusion criteria, we finalized a dataset comprising 29 journal articles and 18 conference papers, totaling 47 unique entries. The authors thoroughly read the final set of papers and extracted data to address each of the research questions. For every paper, responses to all research questions were documented.

Generative AI tools

Microsoft Copilot (based on the GPT-4 architecture, as of June 2025) was used solely for language refinement and did not assist in any stage of the PRISMA review process.

Limitations

One of the primary limitations of our study is the inability to conduct a comparative analysis, due to the heterogeneity of the experiments and AI systems reviewed. This diversity does not allow for direct comparisons across studies, which led us to adopt a purely qualitative approach for synthesizing and interpreting the findings.

While our review captures a representative sample of academic contributions, it is important to note that many AI implementations occur within local institutions. These often involve innovative and promising initiatives, yet their outcomes are rarely published or disseminated in academic forums. We also excluded interesting and valuable conceptual and theoretical proposals that did not present a clear design of a technology, as we wanted to focus on the process of implementation and use of these systems.

Results

Q1. Which aspects of the lives of individuals with Down Syndrome do the AI systems presented in the reviewed articles aim to enhance?

The Convention on the Rights of Persons with Disabilities (CRPD) identifies several key domains in which the rights and fundamental freedoms of persons with disabilities must be upheld. The reviewed articles address several domains identified in the CRPD: Accessibility (Art. 9), Liberty and Security of the Person (Art. 14), Living

Independently and Being Included in the Community (Art. 19), Personal Mobility (Art. 20), Education (Art. 24), and Work and Employment (Art. 27).

While some of the reviewed articles focus specifically on one of these core areas, many contribute to several simultaneously, aligning with the framework provided by the United Nations Human Rights Council in its report Artificial Intelligence and the Rights of Persons with Disabilities (A/HRC/49/52, 2021), which highlights how AI technologies intersect with and impact the rights of individuals with disabilities across multiple life domains. For example, AI systems designed to support communication or emotional regulation may enhance both educational outcomes and social inclusion.

Table 1 presents the main findings in response to our first research question.

AREAS	REPRESENTATIVE ARTICLES	AI APPLICATIONS

EDUCATION	Andrade-Altamirano et al. (2021); Caro et al. (2020); Chauca et al. (2023); Escudero-Mancebo et al. (2021); Galindo-López et al. (2022); Hernández-Lara et al. (2019–2023); Jiménez et al. (2019); Joypriyanka et al. (2024); Landuran et al. (2023); Macias et al. (2023); Panceri et al. (2021–2024); Sampath et al. (2022–2024)	Cognitive skill development, autonomous learning, serious games, virtual reality (VR) environments, gesture-based learning, and educational robotics.
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COMMUNICATION	<p> Alemi & Bahramipour (2019); Araujo et al. (2019); Corrales-Astorgano et al. (2018–2024); Costanzo et al. (2023); Escudero-Mancebo et al. (2021); González-Ferreras et al. (2017); Hernández- Lara et al. (2019–2023); Hervás et al. (2016); Jiménez et al. (2019); Landuran & N’Kaoua (2023); Mariselvam et al. (2023); Oyuela et al. (2023); Pereira et al. (2022– 2024); Silva et al. (2023); Szturm et al. (2018) </p>	<p> Speech recognition, prosody training, Augmentative and Alternative Communication systems, robot-assisted language learning, VR- based communication practice, and affective avatars. </p>
EMOTIONAL UNDERSTANDING AND ADAPTATIVE BEHAVIOUR	<p> Costanzo et al. (2023); Hernández-Lara et al. (2019–2023); Panceri et al. (2021–2024); Paredes et al. (2022–2023); Szturm et al. (2018–2021) </p>	<p> Emotion tracking, empathy development, behavioral monitoring, and adaptive interaction through robotics. </p>

PERSONAL MOBILITY AND INDEPENDENT LIVING	Landuran & N’Kaoua (2021); Ochoa-Zezzatti et al. (2021); Szturm et al. (2021)	Real-time location tracking, life planning assistants, and mobility training using robots.
WORK AND EMPLOYMENT	Hong & Kim (2024); Maheut (2024)	AI-based career education, skill development, and support for workplace integration.
QUALITY OF LIFE	Costa et al. (2024); Dellunde et al. (2024); Fraile Parra et al. (2024); Yadav et al. (2022)	AI analysis of quality-of- life dimensions indicators using GENCAT questionnaire data.

Table 1. Key areas of AI applications for individuals with Down Syndrome

Q2. What type of AI system is described in the article? Is the system currently being used by individuals with Down Syndrome in their daily lives?

A variety of AI systems are described in the reviewed articles, with most utilizing Machine Learning (ML). These techniques span from classical methods like Support Vector Machines (SVM) or Decision Trees (DT) to more recent Deep Learning (DL) implementations such as Computer Vision (CV). The literature includes examples of both Supervised and Unsupervised ML, as well as some instances of Reinforcement Learning (RL) primarily used for personalization. Below is a classification of the reviewed contributions based on the AI techniques employed:

Natural Language Processing (NLP)

Corrales-Astorgano et al. (2018–2024) and Escudero-Mancebo et al. (2021) used SVM and Random Forests to analyze prosodic speech and assess oral production. Costanzo et al. (2023) developed a real-time speech recognition system that translates unintelligible sounds using a personalized speech bank. González-Ferreras et al. (2017) created a video game to train speech prosody. Landuran & N’Kaoua (2021–2023) combined CNNs, RNNs, and reinforcement learning for sentiment analysis and personalized life planning. Sampath et al. (2022) enhanced voice recognition with RNNs, and Vaz et al. (2020) used the Google Speech API to convert Portuguese speech into text. These approaches are particularly relevant for individuals with Down Syndrome, as they address key barriers faced by this population—such as atypical prosody, unintelligible speech, and limited access to augmentative and alternative communication tools.

Computer Vision

Caro et al. (2020) and González-Ferreras et al. (2017) integrated gesture recognition into educational games. Emotion4Down, developed by Hernández-Lara et al. (2019–2023), uses CNNs and RNNs for real-time facial emotion detection. Paredes et al. (2022, 2023) built a CNN-based model to recognize five primary emotions. Szturm et al. (2018–2021) created DownTracker using Microsoft’s Cognitive Services for emotion recognition. Galindo-López et al. (2022) implemented a 3D CNN for human activity recognition from video. All of these approaches aim to address challenges related to socio-emotional expression and daily autonomy for individuals with Down Syndrome.

Intelligent Robotics (IR)

Contributions to IR systems include Araújo et al.’s (2019) storytelling robot, Alemi et al.’s (2019) and Jiménez et al.’s (2019) NAO-based language learning robots, and Panceri et al.’s (2021–2024) MARIA T21, a socially assistive robot with CV and LiDAR. Andrade-Altamirano et al. (2021) introduced AsiRo-μ, a 3D-printed robot with gesture and speech recognition. Ochoa-Zezzatti et al. (2021) used NAO robots to enhance cognitive and motor skills in a zoo setting. Oyuela et al. (2023) developed a robot for language training through interactive games. This line of work is aimed at fostering motivation and engagement in individuals with Down Syndrome, while simultaneously serving as a facilitator of learning.

Hybrid architectures

These systems include Macias et al.'s (2023) mobile sensing system for analyzing parental behavior, and Hong & Kim (2024) Entry, a block-based programming tool supporting supervised and unsupervised learning. Silva et al. (2023) combined CNN, DT, and image processing in educational tools. Joypriyanka et al. (2024) used Proximal Policy Optimization in a VR Air Hockey game. Chauca et al. (2023) and Mariselvam et al. (2023) developed immersive VR environments and AI-driven virtual assistants that adapt to user interactions using RL. Hybrid systems are primarily applied in educational and training contexts, where the combination of multiple AI techniques allows for adaptation to the diverse learning profiles of individuals with Down Syndrome.

Other techniques

- **Planning and Optimization.** Maheut et al. (2024) propose a Mixed-Integer Linear Programming model for staff scheduling in sheltered employment contexts.
- **Data Analysis and Classification.** Yadav et al. (2022) apply multiple ML algorithms to analyze responses from the GENCAT questionnaire (see Verdugo et al., 2010).
- **Explainable AI.** Costa et al. (2024), Fraile Parra et al. (2024), and Dellunde et al. (2024) use logic explained networks to generate global explanations of the correlations between quality of life dimensions from the GENCAT questionnaire.
- **Empathy Detection.** Hervás et al. (2016) develop a logistic regression model to identify empathic behavior during interactions.
- **Adaptive Learning Algorithms.** González-Ferreras et al. (2017) design a game that dynamically adjusts difficulty based on user performance using ML.

Prototype Availability

Most of the reviewed articles have developed a prototype² of their AI system and have presented experimental results. However, the authors rarely specify whether these systems are fully functional or in active daily use by individuals.

Q3. Are individuals with Down Syndrome or other key stakeholders (e.g., parents, caregivers, psychologists) involved in the design process of the AI system? Which specific demographic within the Down Syndrome community (e.g., children, adolescents, adults) is the research primarily targeting?

Most projects mention the involvement of caregivers, educators, or institutions in data collection or system testing, but few- especially recent studies- explain in detail that they have adopted co-design or participatory design methodologies (Hodson et al., 2023). Now we highlight the articles that have presented this detailed information:

² Some demo videos and downloads of these prototypes can be found here: Talkitt (Costanzo et al., 2023) is a mobile application designed to assist individuals with speech impairments. The project was developed in collaboration with the company Voiceitt <https://www.voiceitt.com/PictoBERT> (Pereira et al., 2022–2024) assists in next pictogram prediction <https://colab.research.google.com/drive/1miMZIrm5zKWuZDAXDeEsWLmNYbxgosfr> The authors have also developed Reaact, a freely accessible augmentative and alternative communication tool <https://reaact.com.br/>. Silva et al. (2023) developed a mobile application prototype to support communication https://youtu.be/lZHn_1F9GnY?feature=shared.

Szturm et al. (2018, 2021) actively involved individuals with Down Syndrome, their parents, and professionals through workshops, interviews, and feedback sessions. According to the authors, participants' contributions influenced both interface design and system functionalities. Similarly, Landuran and N'Kaoua (2021) collected feedback from 37 adults with Down Syndrome over several iterations of a life-planning assistant.

The series of studies by Panceri et al. (2021–2024) detail the structured involvement of three stakeholders with mild to borderline intellectual disabilities during the development of the serious game *You & I*. These participants were integrated as co-researchers, gradually taking on more active roles, from listeners and co-thinkers to advisors, partners, and ultimately final decision-makers. Their input had a clear influence on various design decisions, such as the thematic focus of the game and the features of its user interface. The study presents this process not simply as desirable, but as necessary to translate abstract theoretical recommendations into concrete design choices, offering a clear example of meaningful inclusion.

In Talkitt (Costanzo et al., 2023), users with Down Syndrome and their caregivers contributed to the system's calibration and provided feedback on how to use it. While the reported results suggest a form of practical engagement, specifically through successful daily use over a period of six months, the study concentrates primarily on functional outcomes (e.g., improved speech intelligibility), offering limited reflection on the transformative or empowering potential such involvement might have had for participants themselves.

Finally, the Emotion4Down project by Hernandez-Lara et al. (2023) included psychologists, special education teachers, parents, and students with Down Syndrome or intellectual disabilities across several design and evaluation stages. While this reflects an effort toward inclusive design, the authors themselves acknowledge methodological challenges—particularly regarding the involvement of people with Down Syndrome in low-fidelity prototyping phases. Tools such as the FunToolKit proved only partially effective, indicating the need for more adapted participatory methods suited to the cognitive and communicative profiles of this population.

Target populations

Many AI systems are developed primarily for children with Down Syndrome (e.g., Hervás et al., 2016; Silva et al., 2023; Sampath et al., 2022), while others, such as (Hernandez-Lara et al., 2023) and (Landuran & N’Kaoua, 2021), focus on adolescents and young adults, often highlighting areas such as cognitive development or emotional regulation. A smaller subset of studies explicitly targets adult users (e.g., Alemi & Bahramipour, 2019; Vaz et al., 2020), whereas only a few (e.g. Costanzo et al., 2023) work with heterogeneous age groups. Despite this apparent diversity in age targeting, many studies lack an explicit stance on which group they aim to address and why. In several cases, Down Syndrome is mentioned alongside other disabilities without further clarification. In others, and this is significant, the participant group includes individuals with intellectual disability and those on the autism spectrum, again without clearly stating the rationale behind this grouping, thereby presupposing a commonality of communicative or relational difficulties that may not hold upon closer scrutiny.

Discussion

In our review, we have identified key areas where AI and automated decision-making technologies can significantly impact the rights of persons with disabilities, as outlined in the Convention on the Rights of Persons with Disabilities (CRPD). However, there are several areas where the articles we reviewed offer minimal contributions. While there are theoretical articles on these subjects, mainly from the Humanities and Social Sciences disciplines, the literature on AI systems implemented for these purposes is scarce. Here are some of these areas:

- Equality and Non-Discrimination (CRPD, art.5): AI systems must be developed to respect the privacy and data protection rights of persons with disabilities and implement mechanisms to prevent bias, as people with disabilities are often excluded from training data sets.
- Situations of Risk and Humanitarian Emergencies (CRPD, art.11): AI can support persons with disabilities in emergencies. More attention should be paid to prohibiting autonomous weapons systems, which might misidentify assistive devices as weapons and classify persons with disabilities as threats.
- Freedom from Exploitation, Violence, and Abuse (CRPD, art. 16): AI must ensure accessible information and not be used to censor, monitor, or harass persons with disabilities, for instance, via online bots.
- Living Independently and Being Included in the Community (CRPD, art. 19), Participation in Political and Public Life (CRPD, art. 29), and Participation in Cultural Life, Recreation, Leisure, and Sport (CRPD, art. 30): AI tools can enhance access to political processes and facilitate information acquisition but also pose risks if used for surveillance or to restrict participation.

- Adequate Standard of Living and Social Protection (CRPD, art. 28): When AI is used to determine eligibility for social services, it is crucial to implement mechanisms to identify and prevent discrimination in the allocation of these services.

Regarding AI technologies, one important obstacle to the use of AI systems is the limited amount of data available from these studies, which constitutes a significant restriction for training AI systems. In general, researchers tend to work with small sample sizes. Noteworthy contributions addressing this limitation include a large dataset presented by Sampath et al. (2022) and the development of an artificial dataset by Hervás et al. (2016). The latter employs synthetic data generated by shuffling sequences of interactions, preserving the intrinsic characteristics of the original data. This approach appears to be a promising solution when real-world datasets are insufficiently large.

Another significant limitation is the high cost associated with implementing AI systems, both in terms of financial investment and the required human resources. As a general trend, we have observed that applications for people with intellectual disabilities are introduced later than, for example, in economic domains where there is more investment. This issue is particularly significant when it comes to generative AI which involves high training costs. We have found these systems to be largely absent from the literature we have reviewed, except for a few studies (Pereira et al., 2022–2024) that used transformers.

An economic consideration of a different nature is introduced by Panceri et al. (2022), where the authors highlight the potential economic advantages of adopting these technologies, particularly when compared to the high costs of traditional therapeutic interventions. A deeper reflection is needed on the implications of such a shift, especially regarding the quality of care and the human aspects of therapeutic relationships.

With respect to the target populations, we would also like to mention that studies generally do not differentiate between the various levels of Down Syndrome—mild, moderate, severe, and profound—with Hernández-Lara et al. (2023) being an exception. Moreover, gender representation in experimental samples tends to be unbalanced, and socio-economic differences are rarely considered, with a few exceptions such as Panceri et al. (2021).

Some of the studies lack continuity, both in terms of advancing existing technologies and in conducting follow-up assessments of the populations involved. A common theme across the sources we reviewed is the motivational potential of AI systems. These technologies are generally user-friendly, incorporate repetitive patterns, and offer progressively challenging tasks, which can support sustained engagement and learning. However, the absence of long-term or follow-up studies presents significant limitations. Without longitudinal data, it is difficult to assess potential negative effects—such as increased aggression, addiction, or social isolation—or to determine whether the benefits achieved during training are maintained over time. In addition to these considerations, it is important to distinguish between in-game performance and the

transfer of acquired skills to real-world contexts—an aspect that is often overlooked in existing studies.

Linguistic considerations also play a significant role, as highlighted by González-Ferreras et al. (2017). Although the search was restricted to English, some articles describe applications in other languages (e.g., Portuguese and Spanish). However, in general, systems in English or other languages are available exclusively in one language, which limits their accessibility and effectiveness across diverse linguistic communities. To address this, it is essential to promote the sharing of resources among institutions and to ensure that systems are made available in multiple languages. Beyond straightforward translation, cultural adaptation may also be necessary to align the content with the specific social and cultural context of the target audience. Generative AI offers promising possibilities in this regard, potentially streamlining both translation and cultural customization processes.

Finally, there is a need for more participatory design approaches that engage individuals across all stages—from ideation and prototyping to deployment and evaluation. The active involvement of the people who will use these systems is not merely desirable—it is necessary to ensure that technologies respond to real needs, foster autonomy, and avoid paternalistic or exclusionary outcomes. In summary, some of our findings highlight the need for more demographically representative samples, and a shift toward a social model of disability—which emphasizes the role of environmental, attitudinal, and systemic barriers. Such a shift is essential for AI to align with the rights-based

approach enshrined in the CRPD and the principles of the Independent Living movement.

Conclusions and Future Work

At this moment, it is important to develop common methodological frameworks and benchmarks that would enable the collection of data suitable for robust multivariable analysis and other quantitative analysis, including new AI techniques. Such frameworks would also support the presentation of experimental designs in a unified format.

Most studies still rely on top-down development models, where users with Down Syndrome are treated more as testers than as co-creators. Future research should systematically embrace participatory design, adapting methods to different support needs and assessing not only system effectiveness but also how such participation enhances users' agency and empowerment.

The European Network on Independent Living (Shah, 2024) highlights AI's transformative potential by boosting autonomy, communication, and access to information. Yet, it also raises alarms about algorithmic discrimination, surveillance, and ableist biases that threaten self-determination and inclusion. To realize AI's promise without amplifying its risks, the Down Syndrome research community must take a more active role. This means fostering collaborative networks, sharing data, scaling up promising practices, securing funding for large-scale initiatives, and developing robust evaluation frameworks through co-design processes grounded in the

lived experiences of individuals with Down Syndrome. A central challenge—and opportunity—is to ensure that AI systems not only function well, but also support meaningful, dignified, and inclusive lives for people with Down syndrome.

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