

# Trustworthy Autonomous Systems and Disabled Young People: A Critical Literature Review

## Authors

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## Abstract

Autonomous robotic and AI assistive systems are becoming increasingly prevalent in public and private spheres—often heralded as having the potential to revolutionise the everyday lives of disabled people. The reality could not be more different: disabled young people are routinely excluded from such spheres and, significantly, from the recent efforts to ensure that autonomous systems are trustworthy. Our critical literature review explores how trustworthy autonomous systems (TAS) can be framed within a critical disability studies perspective. We introduce the field of TAS and explore the interdisciplinary field of critical disability studies. This brings us to a key question: how is disability conceptualised, methodologically explored and represented in the TAS literature? We address this question by considering the ways in which disability and TAS have hitherto connected in the literature. We conclude with suggestions for future research and innovation that place disabled young people at the core of research and innovation in TAS.

## Keywords

Trustworthy Autonomous Systems; Disability; Trust; Critical Disability Studies; Co-production; Equality, diversity and Inclusion.

## Introduction

In a generalised sense, autonomous systems are software applications and machines capable of independently making decisions and performing actions previously reserved to humans.

Contemporary examples of autonomous systems within our homes include robot vacuum cleaners,

lawn mowers, artificial intelligence (AI) applications such as voice assistants (Alexa, Siri, Google Assistant), and social robots. Autonomous systems are associated with an enhancement of human experience through the use of artificial intelligence and, more often than not, machine learning. They are accompanied with a promissory dimension in that they claim to be concerned with the making of new ways of navigating and being in the world (Macrorie et al, 2012). As Stanford Online (2022:1) observes, *‘everywhere you look, autonomous systems permeate our everyday lives, from self-driving cars to robotic vacuum cleaners...new applications are emerging in every industry and walk of life.’* The Stanford document elaborates on a number of case studies including driverless cars, automated systems in the factory, hospital care, and space exploration. Harel et al. (2022: 17491) note that autonomous systems are already able to replace humans in carrying out a variety of functions such as medical diagnoses, medical treatments, industrial manufacturing, agriculture, traffic management and urban security. However, while it is clear that autonomous systems development and deployment are driven by technological innovation, it is equally clear that questions regarding autonomy and the removal of human control raise important questions when considering what it means to be human and the assumptions of human ability embedded within such narratives.

The introduction of autonomous systems raises numerous ethical and practical issues including the need for justified trust by those people who are impacted directly, or indirectly, by the decisions made, and actions undertaken, by such systems. For the UKRI Trustworthy Autonomous Systems Hub programme (2020) systems are deemed ‘trustworthy’ when their goals, design, engineering and operation ensure positive outcomes, avoid harm for its users and so on. Further to this, what makes an autonomous system ‘trustworthy’ is its assurance of reliability, safety, security, privacy, availability and usability (Wing, 2021). When autonomous systems enter spaces of human activity then they may raise anxiety, concern and uncertainty. People may worry that robots are taking their jobs, for example healthcare professionals may feel that their expertise and skills are being replaced by non-human systems. And in each of these contexts, human beings often express concerns related to safety, privacy, dignity, autonomy and other such human values. As such, autonomous systems are deemed trustworthy when human values and ethics align with their development and their use. This assertion is especially important when one recognises the ways in which the creep of autonomous systems into workspaces demands an urgent reskilling of the UK workforce at large (UK-RAS 2021).

An exploration of autonomous systems perhaps inevitably brings in a consideration of Industry 4.0 (Deloitte, 2017). It is envisaged that two thirds of children in primary school today will work in jobs

that currently do not exist (NESTA, 2017) and early adopters of new technologies will reap the greatest employment/revenue rewards (Royal Society, 2017). Much is made of autonomous systems to assist disabled (and in our case, young) people in their personal and public lives (e.g. Buhler 1995, Foresi 2018, Ajani 2021, Ajani 2020, Chivarov 2020). While disabled young people are categorised as key users of autonomous systems, they rarely are invited as co-designers. While increasing diversity and engagement is central to Responsible Research and Innovation (RRI), the reality is that disabled young people are less likely to take a Science, Technology, Engineering or Medical (STEM) degree and those who do are more likely to be unemployed after graduation than their non-disabled counterparts (UK-RAS 2021). Disabled people are often only seen as passive recipients of autonomous technologies (Monteleone 2020) and research often considers the needs of disabled and older people as synonymous, proposing a single solution to cover all categories of need. By focusing on trustworthy autonomous systems (TAS), we consider key practical and ethical issues, particularly in relation to the lives and aspirations of disabled young people.

Our aim for this critical literature review is as follows. In introducing trustworthy autonomous systems and the contemporary debates around them, we sit with these key questions and themes of what it means to be trustworthy, reliable and safe whilst also in alignment with human values, dignity and ethics (Townsend et al, 2022). We frame these considerations in dialogue with critical disability studies. The latter approach allows us to unpack what it means to be human and indeed disabled; prioritising disability as the way of approaching, disrupting and envisaged a future world of TAS as more inclusive. With this in mind, we review studies into TAS by considering how disability is considered, conceptualised and researched. We conclude with an invitation to researchers across autonomous systems and critical disability studies to enter into dialogue with one another: to consider the promissory TAS landscape as inclusive, socially just and accessible to all.

## Critical Disability Studies

Disability has traditionally been conceptualised as a flaw, deficit or failing of an individual's body or mind. This philosophy considers disability as a problem in need of a solution (Mitchell and Snyder, 2006) and psychology and medicine have been called upon to offer curative or rehabilitative responses to the problem of disability. The first Professor of Disability Studies in the UK, Mike Oliver (1990), conceptualised this dominant discourse of 'disability-as-problem' in terms of what he termed the *individual model of disability*. This pervasive model of disability focuses on the functional limitations caused by the presence of a physical, sensory and cognitive impairment.

Disability is understood as a tragedy, a deficit and a lack within an individual as a consequence of a person's impairment. Critical disability studies propose different models. The *social model of disability* is a dominant approach in British disability studies. This model addresses the social and economic barriers that people with impairments face in their day to day lives which lead to experiences of exclusion and discrimination (Oliver, 1990). The social model considers disability not as an individual problem but a *societal* problem. Therefore, people are disabled by their environments; excluded by physical environments and attitudinal barriers that are not fit for people with impairments. This shift of perspective has been key to the development of critical disability studies. Disability is a complex mix of biological, psychological, relational, social, historical, cultural, political, institutional, systemic, material, ecological and economic factors (Shakespeare, 2013). Disability is contextualised in its social and cultural context. Henceforth, distinct perspectives on disability have emerged, in various national contexts, emphasising disability's minority status (North America), socio-economic foundation (United Kingdom), cultural location (Australia and North America), relational constitution (Nordic countries), bio-psycho-social character (supranational perspectives such as World Health Organisation and United Nations) and colonial imprints (including Africa, Asia and South America) (for an overview see Goodley, 2016). What all of these perspectives have in common is the assumption that disability is never solely the consequence of an individual problem: disability is always a phenomenon created at the complex interface of the body, mind and society.

Disability, for us, is a complex phenomenon: capturing an axis of inequality, a cultural category, a personal and therefore often political identity, an embodied experience and a disruptive phenomenon to the normative order of things (Ghai, 2003; Scully, 2008; Goodley et al, 2019; Wong and Lim, 2021). According to the World Health Organisation and World Bank (2011) there are over one billion disabled people in the world: constituting the globe's biggest minority group and a community that has expanded during the pandemic. Where there is poverty, war or conflict then one will often find disability: reminding us that the most profound inequalities are to be found when these different conditions intersect. The Global Disability Summit held in Norway in 2022 brought together disabled people's organisations, funders, donors, global leaders and disability rights activists. Their message was very clear - disabled people continue to experience discrimination and exclusion in all areas of life across education, employment, healthcare and community participation - and these experiences have been magnified by the recent Covid-19 pandemic (Global Disability Summit, 2022).

Critical disability studies is an interdisciplinary field of research that starts with but never ends with disability (Goodley, 2012): recognising that disability always intersects with matters of race, gender,

sexuality, class and place (Meekosha and Shuttleworth, 2009). Accordingly, scholarship in contemporary critical disability studies is increasingly nuanced; spanning black, working class, indigenous, feminist, LGBTQ+ and Global Southern perspectives (Durst et al, 2006; Dunham et al, 2015; Grech and Soldatic, 2016; Van Trigt et al, 2016). Critical research approaches to disability assume that many disabled people are excluded from mainstream society - online and offline - and propose that research should address this exclusion by centering disabled people as expert-by-experience in their own lives. To understand disability it is important too to recognise the existence of two key practices: ableism and disablism.

Key to contemporary theorisation is the proposition that research should attend to the distinct though complementary practices of *ableism* and *disablism* (Wolbring, 2008; Goodley, 2014). Disablism occurs when people with physical, sensory or cognitive impairments are excluded from mainstream society. The social model of disability is particularly engaged with disablism. When a wheelchair user is unable to enter an inaccessible building or a student with learning disabilities cannot access a curriculum then we can understand these events as examples of disablism. This is an exclusion endured specifically by disabled people. Ableism occurs when able-bodied-and-mindedness is presumed and idealised. Hence, when buildings or curricula are designed with only able-bodied-and-minded participants in mind then we can describe these assumptions and practices as ableist. This state of affairs is endured by everyone; intimately tied to other ideologies such as neoliberalism and individualism. Ableism assumes ability and assumes the presence of a standard citizen: ready, willing and able. Critical disability studies researchers seek to expose and eradicate the distinct though often complementary processes of ableism and disablism. Too often disablism and ableism are not given the same kind of attention as processes such as heterosexism and racism.

In seeking to foreground the lives of disabled people, some scholars have argued for the need to *desire disability* (McRuer, 2006; Kafer, 2013). This literature has been defined as ‘crip scholarship’; a reappropriation of the traditionally derogatory term ‘cripple’ and reframed in more positive ways as identity (crip) and practice (cripping). Hence, were we to crip buildings and curricula we would draw on disability as an opportunity to make our public spaces and educational contexts more inclusive and welcoming. Critical disability studies researchers cast disability as an object of research (worthy of researching in its own right) but also a driving subject of inquiry (the entry point into conversations around research and innovation). We therefore position disability front and centre: as *the* conversation starter. We adhere to the leitmotif of the disabled people’s movement - ‘nothing about us without us’ (Charlton, 2000; Wellcome Collection, 2021). This mantra demands that research should not only be accountable to disabled people but should deploy research methods

that truly include disabled people as the co-producers of knowledge. Critical disability studies recognises the importance and impact of working with disabled people as *co-researchers* and *experts-by-experience*. Centralising disabled young people's experiences in our research is important because, far too often, their experiences and expertise are conspicuously absent. For example, across the social sciences and humanities, researchers have investigated the complex impacts of technology on the human condition. This work has led to the emergence of the field of Critical Posthumanities (Braidotti, 2013, 2018); an interdisciplinary community that acknowledges the blurred wetware of bodies with the hardware of machines. Critical posthumanities also draws on developments in Science and Technology Studies (STS); appraising technological interventions of their inclusive potential for human enhancement (Latour, 1988; Haraway, 1991; Fukuyma, 2002, Meloni and Testa, 2014). While this work is welcome, the absence of disability (as an object of inquiry) and disabled people (as co-researchers of knowledge) renders this work not only incomplete but also potentially ableist and by extension disablist. When disability is absent in research and scholarship then this might be read as ableist (assuming that the human condition is typically an able-bodied-and-minded one) and disablist (excluding disabled people from knowledge production). By centering disabled young people as co-researchers and experts-by-experience we respond to the aspirations of critical disability studies to make disability front and centre in research. In a recent paper it was argued that:

Any contemplation of new tech must place disability front and centre. Moreover, disability should be the guiding subject through which to critically evaluate the impact of new tech on people's lives. This means ensuring the research is co-produced with disabled people as equal partners as well as ensuring that the theoretical contributions from critical disability studies are used as the key conceptual and analytical makers for any radical analysis of Industry 4.0 (Goodley, 2020; Mosco, 2017). We need to always attend to the possibilities of new technologies; but we also should remain critical of the ways in which inequalities might be reaffirmed and reconstituted in our digital lives (Goodley et al, 2022: 535 - 536).

TAS offers the promise of revolutionising the everyday lives of disabled people. However, despite such promissory and anticipated futures, disabled people are frequently excluded from these imagined futures. We agree with Goggin (2018: 87) when he writes that 'critical work is crucial to opening up the shaping of new technology systems, values and imaginaries'. We wonder to what extent disability is an integral part of the imaginations of designers and developers of TAS? When autonomous systems work in ways that fail to include disabled people then they are at risk of being disablist. And if the imaginations of TAS designers only have in mind standard users with requisite abilities to participate then this risks recreating ableism.

These critical questions foreground disability as the entry point into appraisals of the TAS and the related literature. And yet, at the same time, we are concerned with understanding the ways in which research, innovation, design and practice conceptualise and envisage TAS. Moreover, the critical work that Goggin (2018) calls for demands to challenge assumptions that we might hold about the use value of autonomous systems. Too often, Cowan et al (2015) note, disability equates with assistive technologies. And while this area of TAS is crucially important we are mindful that disabled young people - like all young people - might well utilise autonomous systems to enhance other areas of their life including education, work and leisure. Further to our critical disability studies perspective, inviting disabled young people as co-researchers is another necessary step in studies of TAS. With co-producing, collaboration is key; and here the relationship between TAS and Makerspaces (in our broader empirical research project, see link [here](#)) offers very real opportunities for democratising the co-design of TAS (Brady et al, 2014). One consequence of bringing critical disability studies to bear upon the field of TAS is the creation of what the disability theorist Carol Thomas (2017) describes as transdisciplinarity: the breaking of boundaries between fields of inquiry and the constitution of new knowledge and methodologies. We are motivated by extending the state-of-the-art relating to TAS: to deploy critical disability studies as a foundational discipline that underpins an inquiry of trust and autonomous systems with a focus on the engagement of disabled young people. We therefore ask: how is disability conceptualised, methodologically approached and finally, represented in the TAS literature?

## **Disability and autonomous systems research**

In this section we review how disabled young people are represented within the body of autonomous systems research. We started our review by considering the range of applications for which autonomous systems have been proposed for use with disabled people. We found that there was a focus on the development of systems to support individuals in everyday tasks in their own home. Moreover, a large number of the papers considered autonomous systems which enhanced the functionality of wheelchairs.

In much of the work there was a focus on everyday tasks carried out in users' homes. The primary was to enable people, with severe and complex disabilities, to live independently (Bühler et al., 1995; Kim et al., 2012; Chen et al., 2013; Hawkins et al., 2014; Schröer et al., 2015; Chance et al., 2016; Tan et al., 2016; Candeias et al., 2018; Jevtić et al., 2018; Canal, Alenyà and Torras, 2019, Ajani and Assal, 2020). Indeed, everyday tasks were considered by a number of papers: Hawkins et al. (2014) focused on shaving; Schröer et al. (2015) considered drinking; Candeias et al. (2018) developed robotic feeding assistants; and Ajani and Assal (2020) focused on tooth brushing. One set

of tasks which was considered by a number of papers was that of assisted dressing (Chance et al. 2016, Canal, Alenyà and Torras. 2019, Jevtić et al. 2018). Since the autonomous systems suggested for these activities typically involve vision based perception, and the activities themselves may be inherently private, we must consider the need for privacy and security in systems design, something that is rarely mentioned in the literature.

Work by Rani and Sarkar (2005) considered the mechanisms for control of such systems allowing users to provide instructions through muscle stimulation (electromyographic signals). Kim et al. (2012) recognise the high cognitive load required for controlling a robotic arm mounted on a wheelchair and describe the use of sensors, including vision, to aid the user. Each of these papers considers a single control case rather than addressing the need for systems which can be used by a range of users with differing physical and mental support needs.

We note that research is often iterative, with new works often addressing problems identified in the earlier research. In 2013, Chen et al. (2013) discussed the topic of “detecting inappropriate forces for a (shaving) task” and reported that the participant was able to perform the task with limited success, i.e. it resulted in some abrasions. In 2014, Hawkins et al. (2014) reported that they solved this problem, and improved safety, by withdrawing the tool when the robot detected forces inappropriate for shaving. In 2018, Jevtić et al. (2018) showed that, through robot personalization, a system for assistive shoe dressing was able to shorten dressing times, reduce the number of user commands required, and reduced the workload for the user. In 2019, Canal, Alenyà and Torras (2019) took one step further and reported quick behaviour adaptation to user preferences, using symbolic task planning.

A number of papers addressed issues arising when using wheelchairs in challenging environments with early works by Madarasz et al. (1986) demonstrating a self-navigating wheelchair within an office building. Later works mounted sensors on the chair to automatically stop the chair when physical obstacles were detected (Patel and Prakash 2015) and provide obstacle detection and avoidance (Mohanraj and Siddharth 2017). The problem of navigating wheelchairs autonomously was considered using ‘low cost’ navigation systems (Des Handicaps 2016) and more recently ‘smart wheelchairs’ were developed (Gomez Torres et al. 2019). While early works considered the specific needs of a group of disabled users, namely those with cerebral palsy (Parikh et al. 2007) we have, more recently seen attempts to build architectures for the development of robotic wheelchairs designed for a range of users with different needs (Karpov et al. 2019). When handing over the control of a wheelchair to a system, safety should be considered and works by Vanualailai and



Prasad (2021) reported a nonholonomic rear-wheel drive wheelchair that navigates in an obstacle-ridden environment to maintain a robust obstacle avoidance scheme.

Whilst the majority of papers reviewed considered the support of users in a home setting a small number of papers also considered how such systems could enhance employability including one application which considered a factory environment (Noritsugu and Tsuji, 2000; Gelin et al., 2001; Kang, Kim and Chung, 2008; Graser et al., 2013). We note that the majority of the papers that worked with disabled people considered adults and older people, often as a single category or impairment specific with only a small number of the studies considering disabled young people specifically. This pattern shows that most of the studies consider TAS as physical support for adults with physical impairment indicating that disabled young people are potentially underrepresented in the current literature.

The majority of the applications we encountered in our review were concerned with supporting users with physical tasks. However we found that when we focused specifically on young people the focus was more likely to be on cognitive development, education, therapy and improving social skills (Esubalew et al., 2012; Shamsuddin et al., 2012; Chuah et al., 2014; Goulart et al., 2014; Wainer et al., 2014; Barakova et al., 2015; Costa et al., 2015; Reardon et al., 2015; Shukla et al., 2015; Beer, Boren and Liles, 2016; Yun et al., 2016; Conti et al., 2017; Esteban et al., 2017; Conti et al., 2018; Silvera-Tawil, Bradford and Roberts-Yates, 2018; Cao et al., 2019; Clark et al., 2019; Koumpouros, 2021; Panceri et al., 2021). Specifically, we found that many of these studies consider children labelled with autism. Approximately half of the systems we encountered used the NAO robot with the others developing bespoke platforms.

We found very few papers addressing multiple impairments for disabled young people although Conti et al. (2017) supported intellectual difficulties (ID) and learning difficulties (LD) that could be related clinically. In addition, Conti et al. (2018) and Silvera-Tawil, Bradford and Roberts-Yates (2018) provided support to both ASD and ID together that could be further to each other clinically.

When considering the development of the technology or research process itself we found that more than half of the studies did not report any involvement of people with severe and complex needs in the development of their robotic or autonomous systems. Among the studies that reported some involvement of disabled people, we found that disabled participants were mainly involved in the evaluation or 'end user' stage, rather than the whole development life cycle or research design. We only observed two studies reportedly involving disabled people in multiple stages of the development. Gomez Torres et al. (2019) reported their reliance on the participatory design (PD)

methodology when developing an affordable smart wheelchair while Koumpouros (2021) reported that children were involved in both design and evaluation stages.

We will now turn to the key ethical debates around TAS and look to situate disability within this as a commitment to centring equality, diversity and inclusion as part of this research agenda.

## Key ethical debates and TAS

The design, development, and deployment of TAS cannot be divorced from important legal, ethical, socio-political, and philosophical considerations. We have described elsewhere how the establishment of trust in autonomous systems (AS) is imperative to its adoption. Guiding trust are core identified themes and principles predicated on an emergent corpus of ethical and legal AI-relevant instruments and regulations (Jobin et al, 2019). Whether the impact and uptake of TAS will result in better futures for those living with disability is largely dependent upon the extent to which those who have been silenced or marginalised within this space are encouraged to be heard. A critical part of these conversations is not only to establish the nature and scope of the ethical or rights-based principles at stake (that is, *what* an ethical principle means for the individual person within a context), but also *how* an ethical principle can be framed, find relevance, and be embedded within the TAS so that the principle can be effectively and appropriately realised (Townsend et al, 2022; Weng & Hirata, 2018).

Much has been published on the legal and ethical challenges in the adoption of AI and AS more generally (Floridi et al, 2018; Jobin et al, 2019; Fjeld et al, 2020; Dignum, 2018; European Commission, 2019; OECD, 2019). Amongst the many ethics-related issues cited in the literature with regard to AS adoption are: privacy (both spatial and informational privacy) including the collection and use of personal and often ‘sensitive’ or ‘special category’ information, such as medical and health status data (Price & Cohen, 2019); reliability, responsibility, accountability, and safety (Habli et al, 2020; Yeung, 2019; Dixon-Woods & Pronovost, 2016; Van de Poel et al, 2015; Coeckelbergh, 2020); bias and algorithmic injustice (Whittaker et al, 2019; Price, 2019; Cirillo, 2020); the ethics of algorithmic decision-making and notions of an ‘ethical algorithm’ and an ‘ethical black box’ (Kearns & Roth, 2020; Winfield & Jirotko, 2017); equity and non-discrimination (Toronto Declaration, 2018); explainability and transparency (London, 2019); autonomy and informed consent (Cohen, 2020); and inclusivity, diversity, and fairness (Buolamwini & Gebru, 2018).

While many of these concerns will apply, more generally, to disabled young people, few (if any) papers speak to the specific ethical and legal implications of TAS applications with regard to disability, and to disabled young people, in particular. Disabled young people have unique requirements and are often presented as vulnerable or at ‘high risk’ for rights infringements, the amelioration of which calls for strengthened ethics and rights-based protection. Pressing concerns for disabled young people centre on notions of equity, fairness, diversity and inclusivity, dignity, social justice, and non-discrimination. A right to non-discrimination - or not to be discriminated against on the basis of one’s disabilities (in the form of disablism) - as described above - either overtly or tacitly is of particular relevance and significance to disabled young people within the field of technological development and adoption.

Drawing on disability studies, Bennet & Keyes argue that researchers into artificial intelligence ethics and disability should move beyond simplistic notions of fairness towards broader ideas of justice (Bennett & Keyes, 2020). Pfeifer-Chomiczewska describes the impact of autonomous systems on human dignity, for example, in the care for people described as ‘vulnerable’, including older people and disabled people. Personal data protection, informational self-determination, and privacy are cited as of additional concern (Pfeifer-Chomiczewska, 2022). Along a not dissimilar vein, Bradshaw-Martin & Easton highlight the importance of travel in leading an independent life and the legal and political issues regarding self-driving cars and disability. Importantly, they posit that technology should be developed with inclusion, participation, and broader access at its heart (rather than considering disability requirements and the input of those with disability merely as an afterthought) (Bradshaw-Martin & Easton, 2014). Although speaking directly to elderly care and robots, Sharkey & Sharkey identify, amongst other things, concerns around the potential reduction in the amount and level of human contact experienced by the disabled individual and of the loss of dignity, personal liberty, and control. This being said, these are challenges which, if overcome, can enable TAS to improve the lives of the older people and, we would suggest, of disabled young persons, by creating opportunities for independence and increased social integration (Sharkey & Sharkey, 2010).

One issue of immediate and significant concern to critical disability studies is the introduction of discriminatory bias and the rise of algorithmic injustice in TAS adoption (Hutchinson et al, 2019). While the focus in anti-bias in AI discussion has been primarily on gender discrimination and discrimination towards people of colour, disappointingly comparatively little on disability has been included in the AI-bias conversation (Whittaker et al, 2019). Aligned with the issue of

discrimination on the basis of disablism described above, Whittaker et al address how to go about protecting marginalised groupings and those who fall outside of the ‘norms’ reflected and constructed in society and mirrored by AI technologies (Ibid). Indeed, research has demonstrated how autonomous systems stand, not only to potentially produce biased and prejudicial outcomes, but to replicate, amplify, and perpetuate patterns of general systemic and structural undesirable social bias, such as race- and gender-discrimination, and by extension disablism (Angwin et al, 2016; Benjamin, 2019; Friedman and Nissenbaum, 1996; Hutchinson et al, 2019; Richardson et al, 2019; Sandvig et al, 2016; Schwemmer et al, 2020; Susskind, 2018). Algorithmic injustice arises when patterns of marginalisation, imprinted in the historical data that shape AI systems (be they training or test data) produce individual predictive anomalies that, if left unchecked, inform a feedback loop of further entrenching, perpetuating, and exacerbating future down-stream systemic and structural injustice within a larger category or grouping (Glickman & Sharot, 2022). Incidences of algorithmic injustice are aggravated in contexts where data are inaccurate, under-representative, or exclude certain categories of persons (such as those living with disability). Zimmermann et al argue that ‘algorithmic injustice is not only a technical problem, but also a moral and political one, and that addressing it requires deliberation by all of us as democratic citizens’. Importantly, responsibility and accountability for addressing this becomes shared, rather than the domain ‘offloaded and outsourced to tech developers and private corporations’ (Zimmermann et al, 2020).

Any notion of a TAS cannot be separated from important ethical and normative considerations (Townsend et al, 2022). While some work has been done in this regard, reasons of equity, justice, inclusivity, and diversity dictate that much more attention should be placed on the well-being, contribution, and perspectives of disabled young people who are well-positioned to act as critical stakeholders and active participants in establishing, addressing, and resolving key ethical issues. Accordingly, centering disability studies at the heart of the normative discourse ought to be prioritised and should continue throughout all stages of the TAS design, development, and deployment process.

## **Conclusions: Foregrounding disability in TAS research**

Our literature review has attended to the growing presence and promise of trustworthy autonomous systems (TAS) in society. In this literature review, we outlined the growing introduction of TAS and its promised possibilities and potential implications for society with a particular focus on disability. We then introduced the role of critical disability studies as a conceptual lens through which to see TAS and its application in the context of disability. Within this is a commitment to participatory and

equitable methodologies to ensure that disabled young people are involved in all aspects of the research process. Our review of TAS literature in doing this demonstrates the gaps in both how disability is conceptualised in the context of more traditional models but also the limits in which participatory methodologies are utilised in this context. Further to this, a focus on ethical debates further demonstrated the necessary emphasis and commitment to equality, diversity and inclusion in this developing research agenda.

It is clear, however, that disabled people (in general) and disabled young people (more specifically) have been side-lined in critical discussions and applications of TAS. The science, research and innovation sectors are not immune to the impacts of disablism (the exclusion of people with physical, sensory and cognitive impairments) and ableism (the preferential treatment of able-bodied-and-minded citizens). It is clear that we need to cultivate forms of research, design and innovation that include disabled people from the outset and in all stages of the development life cycle through methods of co-production. Moreover, in debating the ethics of TAS we must ensure that we contemplate the lives and aspirations of disabled people. Rather than bolting on disability considerations to existing TAS research we believe that disability should drive discussions and practices. Our ambition is that disability is a driving subject of TAS because in foreground disability this opens up huge possibilities for equality and equity, and diversity and inclusion. With this orientation in mind we outline a number of recommendations:

- Disability studies and studies of TAS should work in concert with one another from initial scoping and exploration through to design and application.
- Disabled young people - like all young people - are future users of TAS and therefore should be engaged with as key stakeholders.
- Considerations of TAS in relation to disability should not simply focus on assistive nor specialist technologies; we should also ensure disabled people are considered as key users of all forms of AS.
- Disabled young people should be engaged as co-producers and co-designers of AS and involved in all aspects of studies of TAS.
- Innovative methodologies should be embraced to ensure that disabled young people are included as key co-designers of TAS.
- When we include disabled people in the TAS field we are likely to increase the inclusivity and responsiveness of AS to a wider range of users and designers.

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