Are Robots Ready to Deliver Autism Inclusion?: A Critical Review

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ABSTRACT

The marginalization of autistic people in our society today is multifaceted as it includes violence that is both physical and ideological in nature. It is rooted in the dehumanization, infantilization, and masculinization of autistic people and pervasive even in contemporary research studies that continue to echo ableist ideologies from the past. In this work, we identify how HRI research reproduces systemic social inequalities and explain how they align with historical misrepresentations, and other systemic barriers. We analyzed 142 papers focusing on HRI and autism published between 2016 and 2022. We critique these studies through a mixed-methods analysis of their definition of autism, study designs, participant recruitment, and results. Our findings indicate that HRI research stigmatizes autism in three dimensions - 1) the pathologization of autism, 2) gender and age-based essentialism, and 3) power imbalances. Our work uncovered that about 90% of HRI research during the timeline explored excluded the perspectives of autistic people, particularly those from understudied groups. We recommend broadening the inclusion of autistic people, considering research objectives beyond clinical use, and diversifying collaborations, foundational works considered, & participant demographics for more inclusive future work.

CCS CONCEPTS

• **Human-centered computing → Accessibility theory, concepts and paradigms**.

KEYWORDS

human-computer interaction, robotics, autism

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1 INTRODUCTION

In 2022, the Disability Day of Mourning recorded at least eighteen autistic people around the world who were murdered by their caregivers. One of them was a young girl murdered by her mother who claimed she was "stressed" that her daughter might be autistic.[1] These acts of anti-autistic violence mirror the experiences of nearly 800 children who were killed by Nazi Germany under the supervision of Hans Asperger [33]. Asperger was the first to designate a group of children as "autistic psychopaths" and his work legitimized policies such as forced sterilization and child euthanasia [33]. His work on pathologizing autism was so influential that he became the namesake of Asperger's Syndrome, now controversially referred to as "high-functioning autism" [47, 85].

The beliefs that autistic people were "deficient" and needed to be "cured" were further entrenched in autism research when Baron-Cohen described autistic children as lacking the "quintessential human trait" of Theory of Mind [8, 53]. Although this deficit-based view of autism has been linked to other concerns such as an increased risk of suicidal ideation and social isolation in autistic individuals, it continues to be pervasive in autism research even today [25, 26]. Traditionally, studies in human-robot interaction (HRI) research are centered around the **medical model** view of autism which treats autism as a disorder that needs to be cured so that a person can be made "normal" [66, 105, 129]. This approach has been criticized by scholars for: 1) failing to center the perspectives of the autistic community and 2) applying a deficit-based understanding which has been linked to worrying social concerns such as negatively impacting the identity-building process, and an increase in suicidal ideation among autistic people [2, 13, 25, 26, 117, 136]. Furthermore, the medical model promotes the idea that a formal diagnosis is necessary to validate the experiences of autistic people, which introduces a power imbalance between medical professionals such as psychiatrists and the community [13]. Despite this, it continues to be pervasive in research.

Critical Analysis of Disability Research in Computer Science. In recent years, researchers in other areas of computer science have critically analyzed and applied different approaches to define and understand autism beyond deficit-based theories in efforts to be more inclusive [67, 97, 115, 116, 138, 139]. These approaches include using applied critical disability studies and crip technoscience.

[1]https://disability-memorial.org/arya-smith

As an interdisciplinary study of disability and society, **critical disability studies** attempts to incorporate the perspectives of disabled individuals in research concerning their communities [82]. In other words, it promotes the idea that research should be done *with* disabled individuals and not just *about* them [82, 117]. Prior work applying this approach has suggested building technologies that support both autistic and neurotypical people in communicating with each other to help broaden the scope of assistive technologies [82] among other proposed work. Prior work also suggests that, while participatory approaches may already be applied in the research process, they can be made more inclusive by including the collaboration of participants in all aspects of the research including the study design, data collection, analysis, and dissemination of results [82].

Similarly, **crip technoscience** particularly centers access, interdependence, and disability justice, and has been applied by researchers to examine how the medical model has shaped the status quo for technology research focusing on other neurodivergent populations [118]. Prior work uncovered how the medical model may marginalize neurodivergent end-users by focusing on outcomes that mitigate their experiences, thus privileging neuro-normative outcomes [118] by positioning neurotypicality as the 'norm' and neurodivergence as a deviation that can be 'diagnosed' or 'treated' [59]. For example, the belief that autistic people are 'deficient' in communication, can lead to dehumanizing assumptions about their agency and personhood [67]. For autistic children, the use of the medical model in research embodies societal expectations that marginalize autistic children while treating them as a secondary audience to purposes not defined by them [115]. Researchers have been encouraged to acknowledge that the emotional experiences of autistic adults are uniquely influenced by their social interactions and processing of sensory outputs, as they work towards creating more inclusive human-like AI technologies [139].

A prior literature review also found that similar to Autism research, ADHD research excludes the perspectives of end-users with ADHD, even in technologies that are about/for them [118]. To assist, researchers have developed the social-emotional-sensory design map to create more effective affective computing interfaces accounting for neurodivergent users [139]. However, recognizing that it will take time for research to move in a more inclusive direction that views autism as a difference and not a deficiency, AI ethicists have been encouraged to analyze the consequences of work that relies heavily on the medical model [67].

Thus, in this work, we examine anti-autistic ableism in HRI research as a case study of the broader marginalization of neurodivergent end-users in technology research. We focus on this area since the marginalization of autistic people in other areas of computer science such as human-computer interaction research [51, 115, 117, 136], gaming [116], design [114], AI ethics [13, 67], and affective computing [139] have been explored in prior work.

Robots and Ableism. Prior work has uncovered how our perceptions of robots and the resulting user experiences are shaped by ableism, while calling into question the effectiveness of developing clinical robots for autistic end-users. In "All Robots are Disabled", the author explores how our sociality with robots is largely shaped by disability stigma [130]. For example, the author discusses an incident where students were reprimanded for "harassing" the robots while studying them on a university campus [130]. This insinuates that there are social protocols of respect afforded to robots that their disabled end-users are expected to adhere to which may not be reciprocated, thus highlighting the power imbalances that exist between them. Other work critically examines the power imbalances that arise between robots and autistic end-users when such systems are used to provide therapy, diagnosis, and other forms of rehabilitation [129]. Research suggests that such objectives relegate robots to a mentorship role in efforts to help autistic end-users emulate "humanness" thereby supporting the idea that autistic people are deficient in their humanity by associating neurotypical behaviors to being human [67, 129]. It is important to note that prior work has also called into question the effectiveness of developing robots to provide therapy to autistic end-users as even clinicians are not convinced of their effectiveness and minimal progress has been made in making such robots clinically useful [12]. In fact, research even suggests that this use of robots may be counterproductive and negatively impact the skills they are designed to hone in autistic end-users [38].

Following the principles of critical disability studies and crip technoscience which center the inclusion of disabled individuals in research for/about them, we apply the theories of intersectionality [28], participatory design [103], and design justice [60] to quantify and critically analyze the inclusiveness of the objectives, designs, and results of HRI studies for autism, and the systemic barriers that may shape them. As **critical autism studies** promotes critically evaluating the power dynamics arising in discourses concerning autism [134], our work also focuses on untangling these dynamics in HRI research. Using these theories, we define autism inclusion as the application of theories beyond the medical model to understand autism, the involvement of autistic participants as key stakeholders in the design process, and the inclusion of participants from understudied minority groups. We highlight how a deficit-based understanding of autism, an underrepresentation of autistic adults and gender minorities, and power imbalances present in the research study designs and user interactions with robots are pervasive in this work. Our purpose is not to criticize the authors of these studies in any way but to highlight how the studies reflect systemic ableist beliefs.

This leads us to our research question.

Research Question: What is the state of autism inclusion in HRI studies?

Our work is novel in applying a mixed methods approach to critically examine the inclusiveness of HRI studies for autism based on their research study designs. We qualitatively and quantitatively analyze 142 papers published between 2016 to 2022. We contribute and provide 1) a critical analysis of the three dimensions in which autism is stigmatized in HRI research; 2) a contextualization of the results in foundational work shaping autism research; 3) characterization of the three dimensions through measurement; 4) systemic barriers; and 5) considerations for future work to help avoid the issues identified.

2 METHODOLOGY

Following similar data collection and analysis techniques as other critical literature reviews [118], we systematically searched through

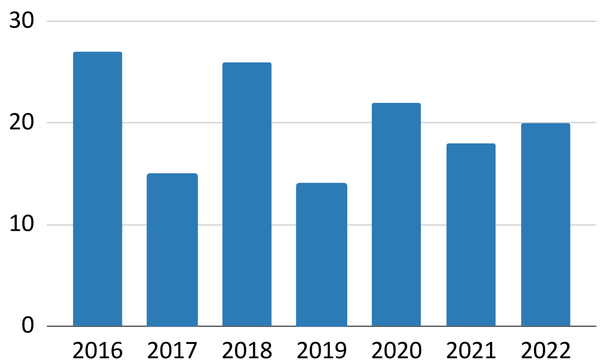

Figure 1: Distribution of publication years of the papers included in our main corpus.

literature using the Google Scholar search engine. Through three iterations of data collection, our main corpus included 142 papers. Our referenced works corpus comprised of all the works referenced by our main corpus. We conducted both inductive & deductive qualitative thematic analysis and used descriptive statistics to analyze the data.

2.1 Positionality Statement

Following recommendations from feminist methodologies [54], we position ourselves to contextualize our study design, methodologies, data collection process, results, and analysis. The research team is neurodiverse and includes women and men-identifying researchers who have a strong interest in improving inclusivity in Human-Centered Computing studies.

The authors of this paper believe in community-oriented design practices such as participatory design [55] and design justice [60] to address power imbalances in traditional HCI research practices between participants and researchers. We understand that certain methodologies may require adjustments based on the access needs of the participant communities [83].

Due to the international scope of our literature review, we focused on gender and age solely for our intersectional analysis. The first author of this paper has lived in five countries, and recognizes the limitations of the US-centric perceptions of race, religion, and other identities which may not translate to other cultures. The exclusion of other identities is not reflective of their perceived importance by the authors. We acknowledge the difficulties researchers may have with recruiting diverse participants for their study, and want to note that we are not criticizing the individual authors of any of the works critiqued in this paper.

2.2 Main Corpus Selection

Our corpus selection was carried out in multiple iterations. We obtained full papers, short papers, survey papers, and editorials from the fifty most relevant results using the criteria detailed in Sections 2.2.2 and 2.2.3 from the Google Scholar search engine, the ACM Digital Library, IEEE Xplore, Springer, and Science Robotics. Our search criteria specified the publication years ranging from 2016 to 2022. The distribution of the publication years of our main corpus are detailed in Figure 1. For searches that revealed more than 50 results, we filtered our results based on relevancy and reviewed the first 50 papers.

We selected 142 papers [2] for our final analysis. Table 1 summarizes the venues and papers selected for our analysis.

2.2.1 Venue Selection. We chose our venues based on Google Scholar's h5-index ranking in robotics[3] and HCI.[4] These venues were: IEEE International Conference on Robotics and Automation (ICRA), IEEE Robotics and Automation Letters (RAL), Computer Human Interaction (CHI), IEEE Transactions on Affective Computing (TAC). While RAL and TAC had no relevant corpus, we were able to obtain 16 papers from CHI and ICRA. We added the International ACM SIGACCESS Conference on Computers and Accessibility (ASSETS) and the ACM Conference on Computer-Supported Cooperative Work (CSCW) due to their focus on accessibility and human-centered technologies. We found two papers from CSCW and four from ASSETS fitting our selection criteria which we included in our main corpus.

Next, we consulted an expert in human-robot interaction to identify the top HRI venues and added the following to our venue list: International Journal of Social Robotics (JSR), ACM/IEEE International Conference on Human-Robot Interaction (HRI), IEEE International Workshop on Robot and Human Communication (RO-MAN), and the ACM Transactions on Human-Robot Interaction (THRI). In contrast to our first search iteration, 60%of the literature obtained through this search fit our selection criteria and they comprised the majority of the papers included in our study.

In total, we obtained 142 papers from more than 10 venues, detailed in Table 1. Unsurprisingly, the majority of the papers were published in three HRI venues: HRI, RO-MAN and JSR.

2.2.2 Search Criteria. We searched for papers published between 2016 and 2022. For venues focusing on robotics or HRI, our Google scholar search string included the conference or journal name and *autism OR autistic OR ASD*. For other venues such as CHI, we added *AND (robots OR robotics)* to the search string. While searching through the ACM Digital Library, IEEE Xplore, Springer, and Science Robotics, we also specified the conference or journal name. For our search, we looked for papers with the key words in the title, abstract or paper text. In addition to full papers, we included short papers, survey papers, and editorials to broaden the scope of papers considered to include future work and works in progress.

2.2.3 Inclusion Criteria. Table 1 details the total number of papers found through each search in the '# Results' column and the final number of papers included in our main corpus in the '# Selected' column. We began our selection process by excluding any papers that were published outside of the venues and years specified in the sections above. For example, while searching for CHI papers on the ACM Digital Library, we encountered works that were published in TOCHI which we excluded from our corpus. We obtained the

[2]https://figshare.com/s/576daf217af2178026a1
[3]https://scholar.google.com/citations?view_op=top_venues&hl=en&vq=eng_robotics
[4]https://scholar.google.com/citations?view_op=top_venues&hl=en&vq=eng_humancomputerinteraction

Venue	# Results	# Selected
ACM/IEEE International Conference on Human-Robot Interaction (HRI)*	50	36
IEEE Intl. Symp. on Robot & Human Interactive Communication (RO-MAN)*	48	36
International Journal of Social Robotics (JSR)*	50	26
IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*	33	3
ACM SIGACCESS Conference on Computers and Accessibility (ASSETS)	50	4
ACM Conference on Computer Supported Cooperative Work (CSCW)	11	2
Science Robotics (SR)*	19	5
ACM Transactions on Human-Robot Interaction (THRI)*	50	9
IEEE International Conference on Robotics and Automation (ICRA)*	37	4
The ACM Conference on Human Factors in Computing Systems (CHI)	50	12
IEEE Robotics and Automation Letters*	1	0

Table 1: Selected conferences and journals and the number of papers included in our main corpus.

abstracts for all the remaining papers found in our search results using the Semantic Scholar API. We analyzed these abstracts to only include papers that: i) focused on robotics, and ii) explicitly identified autistic people as the end-users for their work. If the API was unable to find the abstract, we manually obtained it and analyzed the full papers. For papers that used other terms to define their target users that may include autistic people, such as 'neurodivergent', we also read other sections of the paper for clarification to determine whether autistic people were their target end-users. Our main corpus contains the papers filtered using these inclusion criteria from each venue.

2.3 Referenced Works Selection

These works were selected through the automated analysis of all the references from our main corpus. We built a web crawler that obtains the Digital Object Identifier (DOI) of each paper as a unique ID. Using these DOIs, we found matching works cited in each paper and obtained a total of 6,611 papers. In order to gain a better understanding of trends in the most frequently referenced works in HRI research for autism, we analyzed the publication years and fields of all of these papers. We selected the 100 works most frequently referenced by our main corpus and conducted a deductive qualitative thematic analysis to identify the model used to define autism in their work.

2.4 Data Analysis

Our data analysis consisted of two parts: a manual coding of the corpora and an automated analysis of the metadata obtained from the Semantic Scholar API.

2.4.1 Manual Analysis. A thematic analysis was carried out in several iterations described in Table 2 by three authors of this paper. This analysis was both deductive and inductive in nature as we referenced HRI literature to code the robot automation levels and roles [7, 11], but generated our own codes for other data such as the proposed use of robots. In order to determine the model used in each study, we first identified the proposed use of robots in each paper. The criteria for determining the usage of robots in the studies are detailed in Table 3. Using Braun and Clarke's six-step method [30, 81], we generated several pertinent themes in each iteration detailed in the results section and provided some exemplary works in Table 2. To generate these themes, we first familiarized ourselves with the data by reading the papers and identifying their research objectives. For example, we collected data on the proposed use of robots by looking at the objective of their interactions with autistic end-users, such as providing dance therapy, detection of autism-related aggressive behavior, or support in the ER. Through discussion, we narrowed these to codes such as therapy, behavior detection, skills training, and medical support and synthesized them into the themes detailed in Table 3. The coding for all of the themes in the proposed use were exclusive. However, the classification of the models applied in some of the themes detailed in Table 3 were non-exclusive. For example, while the support theme exclusively included the self-care, and medical, social, general, & educational support codes, these codes were not exclusively considered medical or social model codes as they did not necessarily pathologize autism. In contrast, the codes for the treatment theme were also exclusively placed in the medical model theme due to their clinical approach to understanding autism.

2.4.2 Theoretical Analysis. Once the themes were identified, we then categorized papers from the corpus using theories from Critical Autism Studies and neurodiversity (pathologizing) [66, 134], intersectionality (essentialism) [23], and Feminist HCI (power imbalance) [131]. For example, the medical model views autism as a medical condition that needs treatment [2] so that autistic people can move toward 'humanness' [129]. This promotes neuronormativity as it positions the social and communicational preferences of neurotypicals as the 'norm' that autistic individuals deviate from and must adhere to [59]. This approach to understanding autism has been linked to worrying social concerns detailed in section 1. Thus, we coded papers proposing the usage of robots for diagnosis, treatment, or therapy as medical model papers as they focused on making autistic people adapt to neurotypical norms. Due to the prevalence of clinical collaborations in HRI research for autism and its emphasis on **Evidence-Based Practices (EBP)** [12], we have two separate codes for 'therapy' and 'skills training' papers. The 'therapy' code included only the studies employing a close collaboration with therapists to develop specialized 'treatments', while the 'skills training' code included studies taking a less therapeutically centered approach. The typical robot-assisted therapy sessions employed

Reading Iteration	Objective	Information Collected	Qualitative Analysis Methods
First*	Model Identification	Model applied to understand autism in the study (e.g. the deficit-based medical model) [65], the proposed use of robots, the inclusion of autistic individuals in the study design	Thematic analysis (both inductive and deductive) [81]
Second*	Intersectionality Considerations	Age of participants, representation of gender minorities (i.e. women, and girls, as the papers did not report other genders)	Thematic analysis (inductive)
Third*	Analyzing Robot Characteristics	User data collected, automation level [11], interaction type, robot name, robot characteristics, robot roles [7]	Thematic analysis (both inductive and deductive)
Fourth	Analysis of Frequently Referenced Works	Model applied in study [65], proposed application of research	Thematic analysis (deductive)

Table 2: For our manual data collection, we carried out several reading iterations to identify and collect the information from the corpus detailed in this table. *The first, second, and third reading iterations were carried out for our main corpus only.

Theme	Criteria and Codes	Examples
Treatment	Robots used for therapy, skills training, or other forms of treatment. These technologies may be co-designed with professionals such as therapists and usually focus on a specific set of skills which autistic people are "deficient" in according to the medical model. **Codes:** *therapy, skills training, symptom management, treatment*	Eye contact training, responding to interruptions, and other body movements [75, 106].
Diagnosis	Robots used to diagnose or identify certain behaviors **Codes:** *diagnosis, behavior detection, quantifying harmful behavior*	Detecting autism-related headbanging, analyzing imitation deficits for autism assessment [125, 127].
Support	Robots developed to provide recreational support to autistic end-users. **Codes:** *medical support, general support, self-care, educational support, social support*	Robot companions, toys [36, 49].
Assisting Specialists	Robots designed to assist certain specialists (excluding therapists) **Codes:** *teachers, ER workers, caretakers*	Assisting special education teachers, caregivers, and other medical professionals [70, 107].
Awareness[5]	Robots that center the perspectives of non-autistic people, spread disinformation, outdated perspectives, and harmful myths [40]. **Codes:** *autism awareness*	Robots to make non-autistic people aware of what it is like to be autistic [77]

Table 3: Through a qualitative thematic analysis, we categorized the proposed use of the robots in each study into one of five categories.

Applied Behavior Analysis techniques to provide skills training such as emotion recognition [29, 37, 72, 75, 100, 113, 120, 123, 124].

2.4.3 Automated Analysis. Using the Semantic Scholar API, we obtained the abstracts and bibliographic information such as the title, research field, and publication year of all the papers in our references corpus. These papers were included in the fourth iteration of our manual analysis described in Table 2.

Variance in Literature Surveyed. While all of the papers in our main corpus provided enough information to categorize the proposed usage of robots and the model applied to understand autism in their work, some papers omitted the information needed for our other analysis. For example, we discovered that the usage of robots is difficult to analyze and categorize in survey papers. Additionally, not all the papers reported the gender ratio and ages

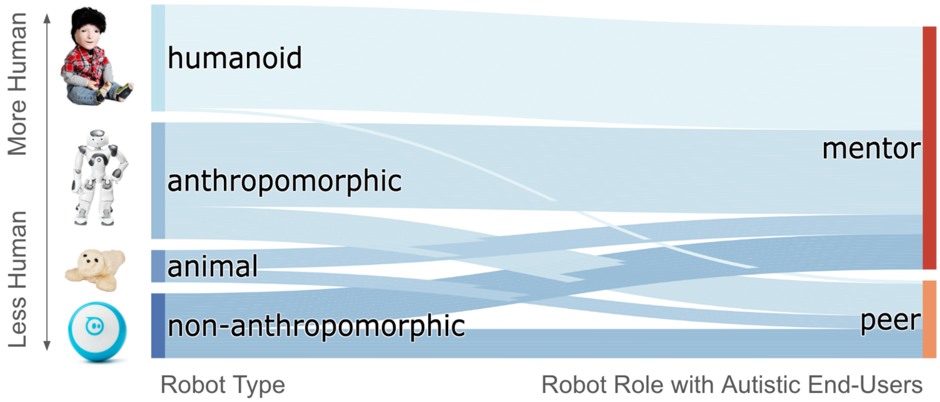

Figure 2: There is a notable correlation between the "humanness" of robots and a power imbalance in user interactions with autistic people in our main corpus. More human-like robots were placed in mentor roles for diagnosis or helping autistic people move toward 'humanness' [129]. Although autistic children prefer engaging with non-anthropomorphic robots [95], only 13.9% of HRI studies utilized them.

of their participants, or detailed information on the user interactions. Thus, the sample size of each visualization is included to contextualize the results.

3 RESULTS

We analyzed the objectives, research study designs, and findings of all the works in our main corpus. Through an inductive thematic analysis, we uncovered three dimensions of stigmatization in HRI research for autism: pathologization, essentialism, and power imbalances. These dimensions encompass the theoretical understanding of autism applied in the research objectives, the inclusion of autistic people in the study design, and how power imbalances have shaped their methods and results.

3.1 Pathologizing

Our foundational knowledge and understanding of autism has been shaped by researchers who adapted dehumanizing language through the **"Theory of Mind"** [8, 53]. They expanded on prior work analyzing whether chimpanzees have a theory of mind and concluded that autistic children lack the "quintessential" human trait [65]. This deficit-based understanding is central to the **medical model**, which focuses mainly on the causation or cure of autism as a disorder [65]. This dehumanization of autistic end-users is replicated in human-robot interactions. Traditionally, robotics research has pathologized the communication behaviors preferred by autistic people and introduced technologies that encourage them to adopt neurotypical social norms [15, 34, 126, 129]. Figure 2 illustrates how 15 of the studies in our corpus used robots that looked like animals to play a "mentor" role focused on providing social skills training to autistic end-users. By placing animalistic robots in this role, such studies inadvertently perpetuate the findings of the dehumanizing foundational work in autism research that concluded certain animals have stronger social skills and are thus "more human" than autistic children [8, 53]. Additionally, the majority of the 76 studies utilizing anthropomorphic and humanoid robots had the robots adapt a mentor role with autistic users, which perpetuates the belief that autistic people are deficient in their humanity and robots can help them move toward "humanness" [129].

A deficit-based understanding of autism has been pervasive even in computer science and robotics research [22, 34, 63, 68, 78, 98, 129, 132] even though prior work has suggested it contributes to the ostracism and discrimination autistic individuals face in our society [5, 65, 97]. The ostracism of autistic people in studies that use this definition can be quite explicit. For example, one paper studied the use of robots to:

> "diagnose abnormal social interactions within autistic children" [6].

Such language is rooted in ableism as historically the word "abnormal" has been used to describe things that are unhealthy or unnatural [27, 61, 88]. Yet, an automated analysis uncovered words such as 'typically develop*' and 'abnormal' which explicitly posit non-autistic people as the norm and their autistic peers as a deviation from the norm were prevalent in 27 papers, while deficit-based language appeared in 11 papers as shown in Appendix 1a [6]. This led us to uncover the prevalence of the medical model that applies a deficit-based understanding of autism and promotes diagnosis and treatment through therapy and skills training [66], as shown in Figures 3 and 4.

3.1.1 Deficit-Based Studies. A deficit-based understanding of autism was prevalent in our main corpus. The majority of the studies in our corpus (93.5%, n=129) applied the medical model in their work as shown in Figure 3. Out of those studies, the majority (85.92%, n=122) focused on diagnosis and treatment as shown in Figure 4. Although the papers focusing on treatment, diagnosis, awareness, and assisting specialists in our main corpus always applied a medical model understanding of autism in their work, the papers using robots for support applied various models. The support category includes robots that provide companionship, entertainment, or other

[6]https://figshare.com/s/576daf217af2178026a1

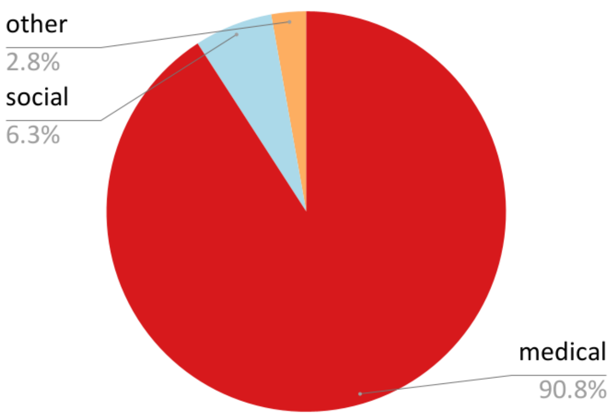

Figure 3: An overview of the disability models applied in our main corpus reveals the medical model is the most commonly used model in HRI research. Papers were categorized as 'other' if they did not exclusively fall under the medical or social model.

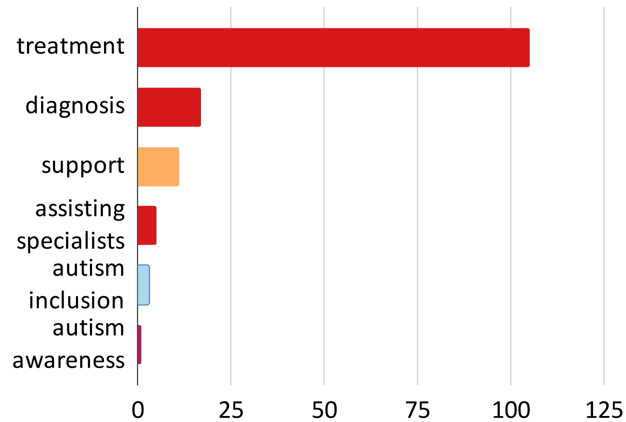

Figure 4: The majority of papers in our main corpus focused on providing treatment to the end-users. Support is shown in orange as the codes for this theme are not exclusive to a particular disability model, while the codes for autism inclusion (light blue) exclusively do not apply the medical model.

kinds of support to autistic end-users who are usually children. An example of a paper applying the medical model in such robots included providing behavioral assistance to children [36], while an example of a paper applying other models used robots to provide more affordable educational support to children in underserved rural schools [21].

Our findings suggest that the deficit-based understanding of autism may be reflective of the foundational work HRI researchers are building upon. Through a deductive qualitative analysis of the 138 works most referenced by the papers in our main corpus, we uncovered a similar understanding of autism was applied by 129 papers, the overwhelming majority, as shown in Figure 7. Interestingly, the majority of the works referenced by our main corpus were published in only 3 fields: psychology, computer science, and medicine, as shown in Figure 5. It is important to note both psychology and medicine have studied autism using a clinical approach. Figure 6 illustrates how the majority of these works were also published before more inclusive theories were introduced in the 2010s.

3.1.2 Diversify Autism Definition. As we continue to make improvements in our understanding of autism, these changes are reflected in the diverse theories of autism that exist today [7]. In recent years, there has been a growing interest in human-computer interaction research applying identity or difference-based understandings of autism in their work [97, 115, 116, 138, 139]. The **neurodiversity** movement promotes this difference-based definition of autism [66]. Neurodiversity is heavily influenced by the Mad Pride movement of the 1960s, which denounced psychiatric labeling and promoted embracing "madness" as a unique identity to be celebrated [42]. Critical Disability Studies applies a difference-based approach by promoting accommodations and equality over the pathologization of disabilities [94]. It examines disability as both the lived experiences and realities of a disabled individual, and the existing social and political power imbalances in our society [94]. In contrast to the medical model, the **social model** defines disabilities as a social construct that emerged due to a lack of accessibility [133]. According to this model, autism is a difference and not a deficit in communication behaviors. Figure 3 shows that 6.3% of HRI research for autism applied this definition in their work, which may indicate such research is moving toward a more inclusive direction.

The cross-neurological theory of mind also applies a difference-based approach by stating that there is no universally "correct" way to represent one's thoughts and feelings [10]. This theory suggests that miscommunications arise due to lack of accommodations and acceptance of neurodiversity. Other researchers studying cross-neurological social interactions have identified barriers to effective communication that may arise due to neurotypical individuals misunderstanding, responding improperly to communication preferences, and misinterpreting the non-verbal communication behaviors of autistic individuals [20, 44, 58, 97, 109]. Similarly, the **double empathy problem** extends a difference-based understanding to the communicational difficulties experienced by people with different conceptual understandings and outlooks [86]. For example, when an autistic person converses with an allistic (i.e. non-autistic) person, both of them may experience difficulties in understanding each other due to their different neurotypes. In order to communicate more effectively, researchers have suggested autistic and allistic individuals may benefit from creating a shared communication system [14] or learning about each other's communication styles and preferences [97]. This challenges existing social inequalities which place the burden only on autistic people to adapt to neurotypical social norms [97]. The double empathy problem has also been proposed as a guiding framework for a more autism-inclusive approach to design research [87].

[7]https://www.bps.org.uk/psychologist/me-and-monotropism-unified-theory-autism

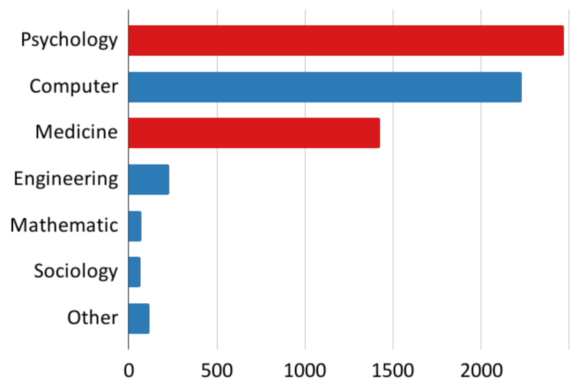

Figure 5: Psychology, medicine, and computer science are the most frequently referenced fields by our main corpus. Pyschology and medicine are shown in red as they have historically applied a medical model approach by viewing autism as a disorder [50]. The following fields were grouped together in the "Other" category as they individually comprise less than 2% of the works referenced: Physics, Biology, Political Science, Economics, Art, Business, Materials Science, Geography, History, Geology, Chemistry, Philosophy, and Environmental Science.

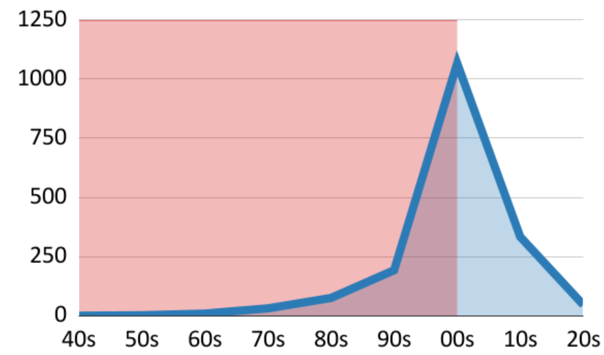

Figure 6: The majority of our referenced works corpus was published when deficit-based theories dominated autism research. The red area represents the papers that were published before the introduction of Critical Autism Studies which seeks to challenge dominant misunderstandings of autism and have a positive impact on the lives of autistic people [89]. This data has been annualized to allow for a fair comparison.

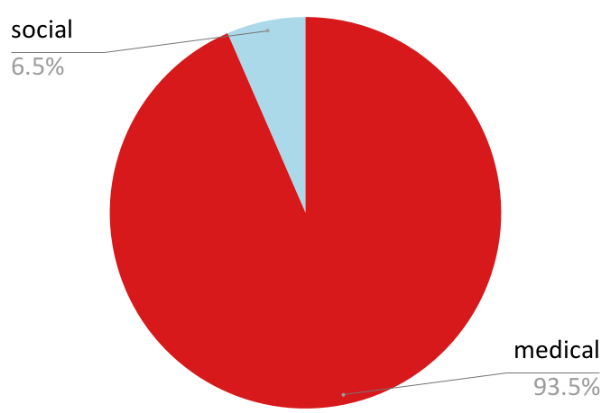

Figure 7: An overview of the models applied in our referenced works corpus reveals that the medical model of autism is the most pervasive in these works.

Even though expecting autistic people to adapt to neurotypical social norms contributes to anti-autistic discrimination in our society [5, 65, 97], the majority (85.92%, n = 122) of papers placed the burden of overcoming the double empathy problem entirely on autistic people. Prior work has pathologized autistic people's unique communication styles by, for example, focusing on correcting the ways in which people with autism use eye contact in communication, as shown in Figures 4 and 10. Since autistic adults have expressed interest in developing social skills [32], HRI researchers should work towards designing, developing, and testing solutions that support autistic adults in their learning and encourage the acceptance of various communication styles.

> **Autism-Inclusion Tips to Avoid Pathologization**
> - Consider that humans communicate and perceive the world in diverse ways, and those differences are not deficits
> - Diversify the foundational work for your research studies by citing newer research published in fields beyond medicine and psychology, such as Critical Autism Studies
> - Consider research directions promoting communication between different neurotypes in a balanced manner instead of placing the burden entirely on autistic people to adapt to different communication styles such as the works of Morris and Rizvi et al. [87, 97].

3.2 Essentialism

Essentialism, in the context of Autism, is the idea that people with autism have common characteristics that are "inherent, innate and unchanging" [101]. Historically, the **extreme male brain theory** has identified autism as an extreme presentation of a "normal" male profile [9]. This theory has been criticized for its gender essentialism and pervasive influence [73]. For example, the belief that autism is a "masculine" disorder has led to the underrepresentation of women and girls in autism research; due to misconceptions among researchers and the general population, people are more likely to recognize autism in males [1, 128]. Foundational research also **infantilizes** autistic adults by characterizing them as "children" [17], and viewing autistic bodies as being "frozen" in childhood [16]. This infantilization has led to widespread misbeliefs that autistic

Figure 8: The majority of studies in our main corpus (shown in orange) did not report their gender data. Among the papers that did report, only 12 studies had a gender ratio that is representative of the autistic population (shown in blue) [80].

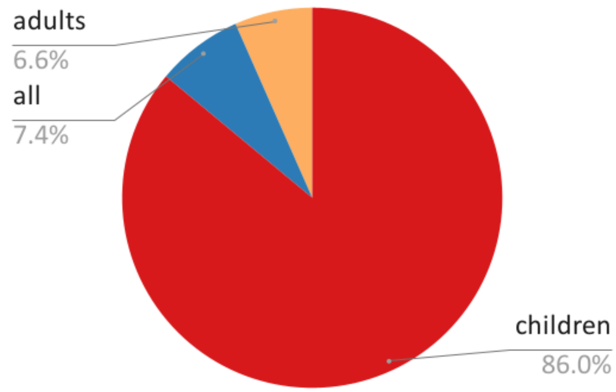

Figure 9: An overview of the ages of the participants reported in our main corpus. The participant ages were reported in n=139 of the papers in our main corpus.

people are dependent and lack autonomy [16]. Even in HCI and HRI, prior work on autism research has mainly focused on children [22, 31, 46, 62, 96, 114, 115]. Additionally, the concept that an autistic person's "mental age" is different from their physical age is rooted in ableism and specifically pervasive in autism research [39].

3.2.1 Essentialism in the Main Corpus. Through an analysis of the participant demographics and study objectives, we investigated how the historical masculinization and infantilization may be perpetuated by these studies, through an underrepresentation of adults and gender minorities, as shown in Figures 8 and 9. Due to the masculinization of autism, many gender minorities may not learn about their neurodivergence until later in life and may face additional barriers due to the intersections of their gender with autism [1]. An example of such gender-based stereotypes is linking traits like "aggression" to autism, which is more socially acceptable for boys and men than people of any other gender, and thus uncommon in gender minorities with autism [48]. Yet, one of the papers we surveyed linked this trait to autism, and did not take gender into consideration:

> "Issues with [...] aggression [...] are common in children with autism" [108].

This paper investigates the usage of smart technologies, such as robots for many purposes, including diagnosis. However, it links aggressive behavior to autism, which has historically contributed to the underidentification of women and girls with autism [48]. Currently, there is a well-known gender gap in the autism community, with a ratio of 3 males to every female [80]. As this gender gap has been widely studied in other fields, researchers have argued for adapting an intersectional and gender-aware approach to autism research [104], which some information technology researchers have started applying in their work [3, 4]. Yet, the average representation of gender minorities such as women, girls, and other marginalized genders in the participant populations was only disclosed in n=55 papers applying a binary definition of gender. The majority of these studies did not have a representation of gender minority participants that was proportionate to their population ratio [80], as shown in Figure 8.

The infantilization of autistic people is pervasive as researchers focus mainly on children and neglect the needs of autistic adults [69]. One study exploring the impact of age on robot learning notably excluded autistic adults and compared the results of autistic children to non-autistic children and adults [52]. While the differences between non-autistic adults and children were considered in the study, the results of autistic children were considered sufficient to represent autistic people as a whole. Thus, even in a study focusing on the intersections of autism and age, autistic adults were left out.

There are known differences in the experiences of older adults with autism [19]. Yet, they remain an understudied demographic in HCI research, as Figure 9 shows that 86% (n=117) of the studies did not include adults. Age remains a pertinent aspect of participant identities as researchers have highlighted the unique biases autistic adults may face in data collection due to the intersection of their age and neurotype [99]. For example, autistic adults may be stereotyped as unable to achieve autonomy, and therefore require more support [16]. Such infantilization was explicit in one paper asserting that:

> Autistic people "need someone to help stop them [...]" [77]

from engaging in what the authors described as stereotypical behaviors [77]. Such language perpetuates beliefs that autistic people lack control over their own actions and need assistance. Providing support to autistic people was the third most common usage of robots in the studies we analyzed, as shown in Figure 4. The premise of this work may inadvertently infantilize autistic people by making assumptions about their autonomy and support needs [16].

3.2.2 Understanding the Importance of Diversity. Autistic people are often broadly masculinized and infantilized in our society. For example, there is a well-documented gender bias in the medical field in diagnosis and treatment of autism [73], and an underrepresentation of women and girls with autism in the media [121]. As well, infantilization is pervasive in portrayals of autistic people. For example, in support organizations and media: children make up 95% of the autistic people featured in the homepages of regional and local support organizations, and 90% of autistic characters in fictional books [119]. Even media that focuses on autistic adults, such as the Netflix TV Series Love on the Spectrum, has been criticized for infantilizing its adult characters [79].

Intersectionality is a framework originally used to study the gender and race-based marginalization Black women experienced in anti-discrimination law and politics [28]. This theory has been widely applied to study how social identities intersect to create unique experiences for marginalized populations [28]. In studies focused on human experiences, intersectionality encourages researchers to consider various aspects of one's identity and investigate the experiences of diverse groups. For studies focused on people with autism, this would include participants of various ages and genders as autistic adults have diverse needs and may experience unique biases [19, 99], and autistic gender minorities may have experiences and needs that are different from their cis-male counterparts [1, 104]. While we acknowledge the challenges and difficulties in recruiting diverse participants, our analysis uncovered that the majority of the studies did not even report demographic information such as the participant genders, as shown in Figure 8. Future work should consider reporting this data to contextualize their results without promoting gender or age based essentialism. This will ensure the needs of diverse autistic people are represented fairly and more accurately in such studies.

> **Autism-Inclusion Tips to Avoid Essentialism**
> - Prioritize intersectionality in participant recruitment, research objectives, and data analysis
> - Avoid ableist language and essentialist stereotypes such as the ones mentioned in Bottema-Beutel et al.'s paper [18]. For example, referring to non-autistic children as "typically developing".
> - Report participant demographics to help readers contextualize your findings

3.3 Power Imbalance

Many foundational works in autism research have applied social deficit theories; instead of studying the unique social behaviors preferred by autistic individuals, established research in developmental psychology highlights autistic people's "deficit" of neurotypical social norms such as the ability to "mind read" and make "appropriate" eye contact [8, 53, 65]. This phenomenon, known as **Neuronormativity**, promotes neurotypical behaviors as the "norm", thereby introducing a power imbalance in social interactions between individuals of different neurotypes [59].

As a solution to this "problem", researchers have attempted to use robots to train autistic people how to imitate these neurotypical behaviors. Systematic literature reviews and editorial works in HRI research have called for the usage of robots to provide therapy and skills training to autistic end-users [12, 22, 90, 102, 105]. This also includes the use of anthropomorphic and humanoid robots which are designed to be more human-like [91]. This is concerning as there is research suggesting such robotic systems may not be useful at all [12] and their designs directly contradict the known preferences of autistic children [38, 95]. There are additional concerns regarding the context of foundational research in autism which humanized a non-human entity over autistic children [8], as it makes assumptions about autistic people's skills deficits and promotes the belief that non-human entities may be more socially skilled than autistic people [129].

Additionally, autistic people have historically faced a lack of representation in both the research teams and the study participants. Critical Autism Studies (CAS) encourages broadening the participation of autistic scholars in autism research [134]. According to CAS, a lack of autistic authorship may impact the accuracy of such work and may fail to address power dynamics in the medical model understanding of autism [134]. While participatory design encouraged community involvement in the design process, researchers have highlighted such approaches may fail to focus on under-served communities if they do not take historical context into consideration, neglect community access and perceptions of the materials and activities, and cause unintentional harm [55]. Many disabled scholars have discussed the harms of excluding under-served disabled populations from the design process [136] and proposed alternative approaches [139]. Thus, in our work, we analyzed existing power imbalances in the studies on three levels: 1) autistic and non-autistic people in general, 2) the researcher and participants in the studies, 3) and the resulting human-robot interaction.

3.3.1 Promoting Neuronormitivity and Ignoring Neurodversity. In social interactions, autistic people are expected to "fix" their "deficit" of neurotypical social norms [59]. In particular, autistic people's different eye contact preferences are frequently pathologized by the medical model [8, 53, 65]. Yet, we found a correlation between the user's eye contact data collected and medical-model driven purposes, as shown in Figure 10. The majority of studies promoted the usage of robots to provide 'treatment' in the form of therapy or skills training to help autistic people adapt neurotypical social norms.

3.3.2 Participation of Autistic People. Autistic scholars have expressed concerns about 'tokenism' that arise when research teams fail to provide autistic people with decision-making power in research that impacts them [93]. Yet, despite being the target end-users for their product, the perspectives of autistic participants were not taken into consideration at all by17.7% of the papers that only included therapists, caretakers, or special educators as stakeholders in their studies as shown in Figure 11. Our results also uncovered that nearly 90% of the papers did not include the input of autistic people in the design process. This introduces a power imbalance as the design and research objectives are shaped only by the input of the researchers and other specialists (e.g. therapists, and special education teachers), and exclude the perspectives of autistic individuals.

3.3.3 Human-Robot Interactions. While scholars have encouraged HRI researchers to re-think social hierarchies in their work [131],

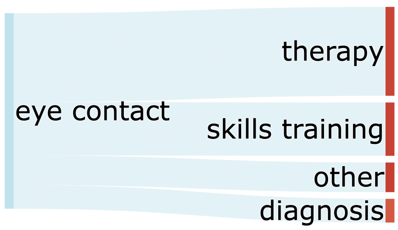

Figure 10: The majority of studies collecting eye contact data from the users focused on clinical applications such as therapy, skills training, or diagnosis.

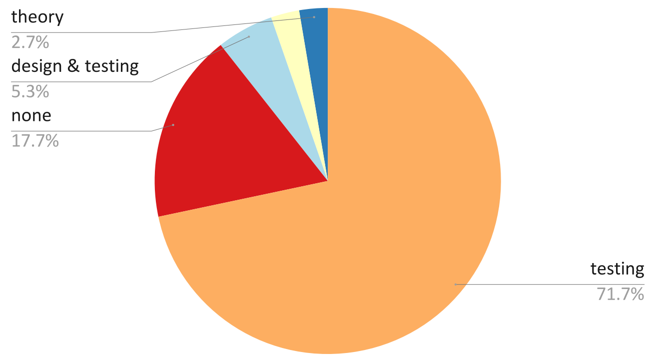

Figure 11: The majority of HRI studies did not include autistic people in the design stage, and nearly one-fifth of them did not include the perspectives of autistic people at any stage of their study.

malignant stereotypes and existing social inequalities are still enacted in HRI studies [60, 129]. Utilizing robots for therapy, skills training, and similar purposes can promote a power imbalance. As shown in Figure 2, the majority of robots with human-like traits are more likely to play a mentor role which introduces a power imbalance in their interactions with the users based on their humanization. In contrast, less human-like robots play a "peer" role in their interactions, which echoes foundational work in autism research questioning the humanity of autistic people [8, 53, 129].

Promoting Neurodiversity. Using robots as mentors to teach social skills to autistic people promotes the belief that autism is a deficiency of certain social norms [66]. It is important to note that little work has been done on developing robots that "flip the burden" [97] of understanding diverse communication behaviors on non-autistic users by teaching them how to interact with autistic individuals. Thus, while existing technologies may assist autistic individuals in understanding their allistic peers, they ultimately fail to address the double empathy problem [86]. Researchers should focus on developing solutions that train non-autistic users how to understand and adapt to neurodiverse social skills. This approach is more equitable as it validates the communication skills of autistic individuals instead of viewing them as having a "deficit" of neurotypical skills.

Autism-Inclusion Tips to Avoid Power Imbalances: Part 1- Social Norms

- Consider community-based research collaborations in lieu of clinical collaborations
- Reconsider diagnosis or treatment-based research directions that prioritize clinical outcomes
- Identify the needs of autistic end-users through more user-centered design approaches [118] instead of making assumptions based on clinical literature

3.3.4 Addressing Power Imbalances in Research Designs. Input from autistic people should be well-represented in the work by giving autistic people decision-making power as both participants and researchers, and the methodologies should take their accessibility needs into consideration [139]. Research teams should avoid tokenizing and making assumptions about autistic people, and instead promote broader inclusion of the perspectives of autistic people in their research as prior work has found such inclusion may help lower odds of ableism [17]. As researchers' identities also impact how they interact with participants and their perspectives on the world, **positionality statements** can help provide important context [76]. Such statements discuss how the authors' identities such as race, class, gender, and neurotype may have impacted their work. While these statements are largely absent in HRI research, future work should consider including them to contexualize the results.

Autism-Inclusion Tips to Avoid Power Imbalances: Part 2- Research Designs

- Avoid making assumptions about the abilities of autistic end-users in the study instruments
- Avoid the tokenization of autistic people by giving them decision-making power in the study design without pressuring them to accept clinical applications
- Increase collaborations with autistic researchers and include positionality statements to contexualize the objectives and findings of the study

Addressing Inequalities in Human-Robot Interactions. To promote more equitable user interactions, HRI researchers should consider centering the preferences of autistic individuals in their work. Although foundational work in HRI suggests that robots may reduce certain conversational inequalities [112], such work has usually excluded autistic people in various steps of the research process. Thus, researchers must challenge the historical exclusion of autistic people in studies defining "humanness" [8, 53, 65]. Prior work on participation equality in human-robot conversations has discovered that gender and age may impact conversational equality [112], which highlights the importance of intersectionality to ensure these technologies are designed to be inclusive for diverse groups of people. Therefore, it is imperative for researchers to study the conversational inequalities that may exist specifically between robots and autistic people in research studies, taking the historical marginalization of the autistic community into consideration.

> **Autism-Inclusion Tips to Avoid Power Imbalances: Part 3- User Interactions**
> - Promote user participation and conversational equity in the human-robot interactions
> - Obtain feedback from autistic users on their preferences for different robot types and roles such as bystanders or information consumers
> - Avoid creating user interactions that may compare autistic people to animals or other non-human entities

4 LIMITATIONS

Due to time constraints, we had to filter out venues, publication years, and even papers published in our target venues and publication years if the search engines did not determine them to be relevant enough to be included in the first 50 results. We made the decision to only consider the first 50 results after our first two search iterations on the Google Scholar search engine revealed other papers were unlikely to fit our selection criteria. Through this, we may have excluded works offering different perspectives that were published in other venues or years. However, through analyzing just the first 50 papers, we were able to gain a better understanding of the papers that received the most citations and views that were published recently in the top venues.

5 DISCUSSION

Building upon prior works that investigated the marginalization of neurodivergent people in other areas of technological research, our work investigated autism research within HRI studies as a case study of this systemic marginalization [116, 118]. Through this, we uncovered that misconceptions of autistic people that are rooted in the historic dehumanizing, infantilizing, and masculinizing foundational work in fields such as psychology continue to be pervasive in HRI research for autism [9, 65, 119]. Here, we critically examine the inclusivity, effectiveness, and broader impact of such research and provide suggestions for improvements. While many of these suggestions can be broadened to fit HRI research and researchers as a whole, it is important to note that this analysis and resulting suggestions are geared towards autism-focused HRI research and researchers. As well, we note that researchers may face limitations related to their tools and experiences, and thus inclusion efforts should be a shared task within the research community.

5.1 Autism Exclusion in HRI Research: Do the Ends Justify the Means?

As clinical collaborations are pervasive in HRI research for autism, with 90.5% of the studies applying a medical model approach in their work, it is important to critically investigate them. Although prior work uncovered that autistic children prefer engaging with non-anthropomorphic robots [38, 95], the majority of HRI studies did not utilize these robots, as shown in Figure 2. Some researchers have justified this clear gap between autistic users' needs and the current research practices by arguing human-like systems may have a greater potential for generalizing skills [38].This is concerning as it shows the extent to which autistic people are excluded from research that focuses on them. Thus, more work is needed to determine autistic people's preferences for and the effectiveness of anthropomorphic robots [38, 95]. However, it is important to note here that prior work has shown the clinical use of robots may be ineffective or even counterproductive [12, 38]. In fact, some prior work demonstrated a decrease in social-communication skills in autistic participants who were communicating with robots [38].These results suggest that more qualitative and quantitative research is needed to determine how these interactions impact autistic people over time, and the perspective of autistic people about the clinical use of robots.

In our corpus, approximately 90% of HRI research also excluded autistic people as key stakeholders, with nearly 20% of the studies not taking their perspective(s) into consideration at all throughout the research process, despite them being the target end-users of such systems. In order to avoid such misrepresentations and adhere to the more inclusive design practices [55, 118], it is imperative for research focusing on autistic people to center them and consider perspectives beyond the medical model. This may highlight a broader pattern of exclusion of neurodivergent users in design research, as prior work has shown people with ADHD experience similar exclusion contradicting the principals of both Interaction Design and User-Centered Design [118], while the prevalence of the medical model has also caused HCI video games to fail to support the self-determination of neurodivergent populations [116]. Self-determination is an important objective for autistic people in particular, as their historical infantilization has caused misconceptions about their lack of autonomy to be pervasive in our society [16, 119], with even HRI research explicitly making such assumptions in published work [77]. We encourage researchers who employ robots to provide "support" and other forms of assistance to autistic people to consider the ethical aspects of that work.

5.2 Ethical Questions for HRI for Autism Researchers

The purpose of these questions is to help researchers avoid the most common harmful stereotypes and historical misrepresentations uncovered in our analysis. HRI researchers who focus on autism may consider this non-exhaustive list of questions to assess the inclusiveness of their work:

(1) *Are autistic people accurately represented in your research team?*
Critically examine your positionality. Do any autistic people have decision-making power in your study design? How

are you ensuring their perspectives are well-represented in your work? How may the identities represented on your team including neurotypes and areas of expertise impact or influence your work?

(2) *Were any assumptions made about the autistic users' autonomy that would not have been made for neurotypical users?* Critically examine the foundational works used to determine the objectives and use cases in your research study. Would these research studies be considered adequate if they were examining the needs of non-autistic end-users? Did the studies follow the principles of user-centered design [118] and other inclusive design practices [55]?

(3) *Is input from non-autistic third-parties given more weight than input from the autistic end-users in the design process?* Critically examine your data collection instruments and methodologies. Is your study design assuming non-autistic people such as therapists, clinicians, special education teachers, or caretakers will know more about the abilities and needs of autistic people than people who are actually autistic? Ensure your research design gives decision-making power to autistic people and adequately compensates them for their labor.

(4) *Were the needs of the participants taken into consideration in the research methodologies?* Critically examine your research methodologies. In recent years, researchers have studied more inclusive research practices such as adapting design activities to the needs of autistic participants [83]. What are some of the ways you are adapting your methodologies to ensure your activities are inclusive for people with diverse sensory needs? Are you giving back to the communities you are working with [55]? If your research activities may be triggering for the participants, are you providing them with any resources to manage the trauma or ending your sessions with activities that evoke more positive emotions?

(5) *Is your work inadvertently promoting harmful stereotypes?* Critically examine your study outcomes. Will your work negatively impact autistic people's self-perceptions? What kinds of beliefs about autistic people will your work disseminate to researchers and other non-autistic people? Do you use any ableist language, such as referring to non-autistic people as "typically developing" or saying someone is "at risk" for autism [18]? Is the language used in your study generalizing the abilities, experiences, and needs of all autistic people while only including participants that are overrepresented in autism research, such as children or cis-men?

5.3 Analyzing Broader Impacts

The clinical use of robots for autistic users mainly focuses on providing 'treatment' in the form of therapy or skills training, as shown in Figure 4. Even if we assume robots were effective in achieving these objectives, critically examining the broader impact they have on our society uncovers several ethical concerns. First, these systems promote the idea that autistic people are "deficient" in their humanness, and that robots can teach them how to be more human-like [13, 66, 129]. This echoes foundational work that has questioned the humanity of autistic people, and proposed non-human entities such as animals may be more human than them [65]. We see these views being inadvertently replicated in the assigned human and robot roles in HRI studies, as shown in Figure 2, as there is a notable correlation between the humanness of robots and their likehood of playing a mentor role. Second, such work may also promote age and gender-based essentialism, as our work uncovered adults and gender minorities are either underrepresented or misrepresented in the majority of these studies. For example, one study attempting to study the intersection of age and neurodivergence included only neurotypical adults, and compared them to autistic children and neurotypical children [52]. Such study designs contribute to the widescale erasure of autistic adults in our society [16], and fail to take their unique needs into consideration [19]. This widens our knowledge gap in understanding the role of intersectional identities such as age and gender on users' needs. As well, it leads to misrepresentations explicitly linking certain traits to autism, which may only be found within a particular group of autistic people, such as aggression which is uncommon in autistic gender minorities [48, 108]. Finally, as shown in Figure 5, there is a lack of diversity in the literature examined by HRI research, as the majority of works referenced were published in psychology, computer science, or medicine focused venues. As technology researchers are more likely to cite the works of other computer scientists even in human-centered research, it is imperative to shift to more inclusive research practices. This may lead to a positive domino effect in other areas of technological research.

5.4 Positive Trends

We also uncovered examples of more inclusive work which may be indicative of an imminent positive shift in HRI research for autism. For example, 5 papers had a representation of gender minorities larger than their actual population [71, 110, 111, 137], out of which one study even took gender into consideration in the study design [84]. Additionally, as shown in Figure 3, 9.1% explored perspectives beyond the medical model in their work, such as robots used as educational companions for autistic children in rural schools, which were well-received by autistic children [21]. These works may be reflective of changing attitudes within the research community, which may not be reflected in the existing research due to systemic and institutional barriers.

5.5 Systemic Limitations & Community-Generated Insights Addressing Them

There are several systemic limitations impacting autism research that may impact a shift toward research that approaches autism as a difference instead of a deficit. It is important to address these limitations as they may inadvertently impede research that does not focus on the medical model or clinical applications.

Funding. There is a known misalignment between the funding distribution for autism research and community priorities [45]. A 2019 investigation of US federal funding for autism research revealed that the majority of the grants awarded for research focused on the biological aspects, treatment, and interventions for autism and that these funding patterns remained constant [56]. Other studies have revealed similar funding priorities in nations including Canada, Aotearoa (New Zealand), and Australia, though a shift has been observed in Australia in the past decade [35, 43, 74]. Research suggests that funding can impact what researchers focus on and the methods they use [122], thus potentially increasing the number of opportunities that encourage more inclusive methodologies may improve the way autism research is conducted.

Publication Process. The publication processes of journals and conferences impact the type of research published. In recent years, journals such as "Autism" have prioritized inclusion in their leadership, editorial board, and pool of reviewers to ensure their processes are led by community members [45]. They have also highlighted how reconsidering the focus of the work published may contribute positively to changing the research landscape [45]. In contrast, two editorials published in the years and journals fitting the search criteria for our literature review focused exclusively on medical model papers, and did not include any researchers or editors who apply other approaches to defining autism in their work [57, 135], which may influence their publishing standards.

Autistic Autism Researchers Dwyer et. al published a paper in 2021 that focused on the concerns and insights from roundtables with autistic researchers who focus on autism [41]. They found that autistic autism researchers may face many tensions between the broader research community, institutions, and participants in the research process. Some of these tensions are related to language, as researchers may grapple with the pervasiveness of offensive language used by researchers, and trying not to make autistic participants or their families feel attacked for using such terminology [41]. Tensions may also arise due to differing perspectives and research agendas. Autistic researchers may feel torn between their sense of responsibility to their community and adhering to institutional requirements that may not align with the community needs (especially concerning the use of the medical model) [41]. Additionally, they may face infighting between members of the community with different perspectives [41], which may be difficult to incorporate [92]. Furthermore, researchers, in general, may struggle to meet the needs of diverse autistic participants as they are difficult to generalize and not addressed by best practices [24].

Community Insights. In a round-table discussion on their experiences with conducting autism research, autistic researchers generated recommendations to improve the challenges and tensions they face [41]. Several of them echoed the sentiments discussed in earlier sections of our paper: broadening the inclusion of autistic people (particularly those with intersectional identities), switching the focus of research to more strengths-based approaches, refraining from assuming autistic people need to be 'fixed', and recognizing the full diversity of autism (including understudied and marginalized populations) [41]. Autistic researchers also called for reforming academia to make institutions and practices more inclusive, and encouraged their colleagues to treat autistic people as peers and equals, be open and receptive to learning, and have empathy for and validate the diverse experiences of autistic people [41].

5.6 Recommendations for Future Work

While systemic changes such as addressing the misalignment between funding priorities and community needs, and diversifying reviewers and editorial boards to include more community members are important, making changes to traditional research practices may also help HRI research shift toward autism inclusion. These include diversifying research collaborations, foundational works considered, participant demographics, and objectives for research directions to explore perspectives promoting a more neurodiverse understanding of autism.

Diversifying Perspectives. Our work uncovered HRI research for autism continues exploring ways to diagnose or treat autism as shown in Figures 3 and 4 even though prior work has linked this perspective to anti-autistic ableism [5, 65, 97]. Despite the diversity of alternative viewpoints in autism research that emerged in other fields over the past decade, the majority of the HRI research in our corpus continued referencing works published in the 1990s and 2000s in the medical and psychology fields, which mainly apply a deficit-based medical model understanding of autism, as shown in Figures 7, 6, and 5. By including newer research published in other fields such as critical autism studies in their foundational work, HRI researchers who focus on autism may move toward more inclusive research directions that focus on promoting neurodiversity. By reviewing, reflecting on, and incorporating the diverse perspectives in autism research, particularly those of autistic researchers themselves, HRI researchers can move toward more inclusive research directions and practices. For example, future work may focus on resolving the double empathy problem by promoting conversational equality between different neurotypes instead of placing the burden solely on neurodivergent people to adapt to unique communication styles [87, 97].

Diversifying Collaborations. We found clinical collaborations dominate HRI research for autism in lieu of more community-based research collaborations. The majority of the papers did not include autistic people in the design process (90%, n=109) and pathologized their communication behaviors (93.75%, n=135) as shown in Figures 11 and 3. To address this power imbalance, HRI researchers who conduct this work should consider giving autistic people decision-making power in the design and objectives of the research study as prior work has found this may help lower anti-autistic ableism [17]. As researchers' identities may influence how comfortable the participants feel around them, it is important to consider more community-oriented approaches to ensure the results obtained are accurate and reflective of the users' needs [55, 76].

Diversifying Demographics. Our work also uncovered of the 144 papers reviewed, only 55 and 139 reported the participants' genders and ages respectively. Out of these papers, the majority overrepresented autistic participants that identified as male (78.18%, n=43), or only included participants under the age of 18 (82.64%, n=119) as shown in Figures 9 and 8. Examples of language promoting essentialist gender and age-based stereotypes such as linking a lack of agency [77] and aggression to autism were found even in highly cited works [108]. In order to avoid promoting essentialist stereotypes in their work, HRI researchers who focus on autism should prioritize intersectionality in their study design and recruitment and provide more information on their participants' demographics to help contextualize their results. Although other marginalized identities such as race and class go beyond the scope of our paper, we encourage researchers to also take them into consideration by familiarizing themselves with other works such as Annamma's DisCrit [5]. We note here that diversifying demographics and collaborations should also include respecting identity disclosure decisions and recognizing the ethical limitations of diversifying demographics.

Humanizing Participants. Finally, we found that HRI research reproduces dehumanizing foundational work through the robot types and roles in user-interactions. For example, Figure 2 shows how human and animal-like robots continue to be employed in mentor roles to provide autistic end-users with skills training and therapy for selected social "deficits". This reproduces dehumanizing foundational work in autism research [8] while promoting the ableist notion that robots may help autistic people move toward "humanness" [129]. HRI researchers may address this by obtaining input from autistic end-users on the traditional user and robot roles, especially with respect to the robot's anthropomorphism to avoid inadvertently dehumanizing autistic people. Exploring alternative research directions such as focusing on the double empathy problem [87] will also help promote more equitable user interactions.

Using Inclusive Language & Positionality Statements. Additionally, future work should reconsider language that promotes such stereotypes or anti-autistic ableism in general. We recommend referring to the works of Bottema-Beutel et al. to learn more about language that may be considered ableist against autistic people [18], the works of Stevenson et al. [119] and Krahn & Fenton [73] to learn about essentialist stereotypes, and autism research focusing on intersectionality such as the works of Kanfiszer et al. [64] for examples of more inclusive and intersectional research practices. While positionality statements are largely absent in HRI research, their inclusion can help provide information on the researchers' various identities and how they may have shaped the data collection and analysis.

6 CONCLUSION

Through a systematic critical review of 142 papers published between 2016 to 2022, we analyzed the inclusion of autistic people in HRI research. In particular, we focused on the study objectives, methodologies, and results to examine whether the perspectives of autistic individuals were taken into consideration, and whether historical and contemporary misrepresentations were replicated in their work. Additionally, we discuss systemic barriers researchers may face related to funding, publication standards, and interpersonal tensions. Through an inductive thematic analysis, we identified that autism is stigmatized in three dimensions in HRI research through: 1) the pathologization of autism, 2) gender and age-based essentialism, and 3) power imbalances. As these dimensions are rooted in the historical dehumanization, infantilization, and masculinization of autistic people, we argue that existing work may inadvertently reproduce harmful stereotypes and is not inclusive. Our findings reveal that autistic people are not accurately or adequately represented in about 90% of such work. Our suggestions for improving the inclusivity of HRI research for autism focus on diversifying research collaborations, foundational works considered, participant demographics, and objectives for research directions to explore perspectives beyond the medical model that promote a more neurodiverse understanding of autism. Additionally, we provide a non-exhaustive list of ethical questions based on our findings to guide HRI researchers critically examining the inclusivity of their work.

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