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"Warm Robots" for Children with Autism Spectrum Disorder? The Thermodynamics of Human Sociality and the Technology of Inclusion in South Korea

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Abstract

Over the past several years, robots that help children with autism spectrum disorder (ASD) to develop social skills have emerged as an archetype of "warm robots" in South Korea's public science and technology discourses. This paper critically examines the socio-historical and conceptual meanings of this phenomenon. First, it traces how these robots have come to bear the "warmth" imaginary of new techno-society at the juncture of two national trends: the promotion of humanist pursuits of new technologies since the 2010s, and the Fourth Industrial Revolution initiated by the 2016 Davos Forum. Second, it analyzes the thermodynamics entailed by the current idea of therapy robots—that these robots bear the warmth of an imaginary techno-society, while the human warmth of autistic children remains bracketed and their mothers' caregiving serves to insulate these human-robot interactions from broader sociality. By illuminating the complex social implications of such thermodynamics, this paper aims to move beyond the liberal humanist critique of machinic dehumanization of people with autism by criticizing its undergirding scheme of robots as surrogates for devalued gendered, racialized, and colonial labor. In doing so, this paper opens space for re-envisioning a more inclusive and diverse techno-society in South Korea and elsewhere.

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Introduction
In 2020 the Korea Evaluation Institute of Industrial Technology (KEIT) held an open idea competition called Warm (*tattŭt'an*) R&D in Robots. As of September 15, 2020, KEIT's website explains that this title refers to "robotic technologies that might offer new and improved education, care, and public services for the socially disadvantaged such as people with disability, the elderly, and children." The accompanying application guidelines for the competition offer as an example the development of CARO, the autism spectrum disorder (ASD) therapy robot. KEIT's competition illustrates how in recent years robots designed to help autistic children to develop social skills have become an archetype of "warm robots" in South Korean policy and public communication. However, there is little discussion about the cultural and ethical implications of this kind of robot for these children. This lack of social deliberation is concerning, considering the dehumanizing potential raised about similar therapy robots over the past several years, such as the EU-funded Development of Robot-Enhanced Therapy for Children with Autism (DREAM) project (Richardson et al. 2018; McBride 2020).

This paper is located at the fissure between the prominence of therapy robots for autism in policies and public communications and the lack of social deliberation about this prominence. It takes as its point of departure a critical reflection on the idea undergirding this phenomenon: robots designed for helping autistic children are "warm" because they allow "robot-like" autistic children to be included in natural human sociality. Challenging this taken-for-granted idea, this paper examines the affective-discursive matrix in contemporary South Korea wherein these robots bear the warmth of an imaginary techno-society while the autistic children's own human warmth remains bracketed and their mothers' intense caregiving is mobilized to insulate the human-robot thermodynamics from the broader social fabrics. In doing so, the analysis here engages with three questions.

First, in what socio-historical context have these robots emerged as an archetype of "warm" technology in South Korea? This paper traces the emergence of these robots as a key figure in Korean policies from the Intelligent Robot Development and Promotion Act (henceforth the Robot Act) in 2008 to the Presidential Committee on the Fourth Industrial Revolution (henceforth 4IR Committee) launched in 2017. In this, the paper attends to how two senses of "warm"—humanist and affective—undergird the development of these policies. It highlights the emerging status of such "warm" robots at the juncture of the growing emphasis on humanist science and technology over the previous decade

and the appeal of affective AI for psychological support with the rise of discourse on the Fourth Industrial Revolution in South Korea.

Second, if the affective-discursive matrix of warmth endows these robots with human virtues, what happens to the children in this exchange of temperature? To address the question, this paper then analyzes an exemplary clinical trial of robot-assisted therapy for autistic children performed in South Korea, to examine how the assumed and encouraged idea of normal social interaction reiterates what AI ethicist Kathleen Richardson calls the "machine model of autism" in this therapeutic setting (2018, 4). Through the example of the clinical trial, this paper proposes to re-evaluate the evoked warmth of technology in the broader context of what can be called "human-robot thermodynamics": "Warm robots" are instituted as an inclusive technology while ironically obscuring the human warmth of "robot-like" autistic children and naturalizing the existing human sociality that renders these children exterior in the first place—and thereby necessitating its own invention to facilitate their inclusion.

Third, how do feminist critiques on the intense caregiving expected from and performed by the mothers of children with autism in South Korea compound the dehumanizing potential of human-robot thermodynamics? Considering these mothers' caregiving demands more than reiterating the double task of redistributing and revalidating caregiving at the intersections of gender, disability, and global division of labor. It also opens a conversation with critical discourses on the gendered, racialized, and geopolitical contours of robots as the proxy for degraded human labor (Rhee 2016; Atanasoski and Vora 2019)—exploring the conditions and possibilities of re-envisioning a human-machine sociality alternative to reclaiming an unexamined human essence built on the extraction of infra-humanity's labor from machinic dehumanization and to reducing autistic children's sociality to the matter of unilateral care labor.

This paper does not oppose using robots to support autistic children. It, however, does call for a critical reflection on some of the assumptions underlying the endorsement of therapy robots for these children—ideas that undermine the rising orientation toward a "warm" techno-society—to illuminate the complex social implications of therapy robots for autism. As such, it aspires to open a space for re-envisioning a techno-society that is more inclusive and respectful of autistic sociality beyond the model of robots as the proxies for devalued human care work in South Korea and elsewhere.

Social Contexts and Conceptual Frames of Analysis

This section establishes the approaches through which I engage with the socio-historical and the conceptual constitution of therapy robots for autistic children as "warm robots." First, I situate the emphasis on warmth as an affective infrastructure indicating the shifting paradigm of science and technology

following immediate reactions to the 1997 Asian financial crisis. Second, I draw from critiques on the machinic model of autism that permeates both robotics and clinical autism therapy to delineate the social and ethical stakes in the thermodynamics among autistic children, therapy robots, and society. Third, instead of following some critiques of the machinic model of autism that return to human essentialism, I invite critical race and femi-queer scholars to reassess human-robot affinities. In particular, their attention to robots as proxies for gendered, enslaved, and colonized workers helps me address the intense care work performed by the mothers of children with autism in South Korea as an invitation to re-envision human-robot sociality beyond robots as surrogate workers (wherein these children are always perceived as the recipient of medical, pedagogical, and reproductive care work).

Rearticulating Science and Technology, Society, and Policy in South Korea

Since the late 2000s, South Korea has seen significant efforts from governments, industries, and researchers in the development of service robots, moving away from its global prominence in industrial robots.[1] This shift occurred during recovery from the 1997 Asian financial crisis, which wounded the mega-corporations that had driven industrial robotics in South Korea. These efforts backdrop the trends in developing and employing robots for clinical and educational intervention in children with ASD, such as iRobiQ, developed by Yujin Robot Co., and CARO, developed by the Center for Robotic Research at the Korea Institute for Science and Technology. Naturally, there are dozens of scholarly articles on the development and application of animal-robot toys and humanoids for children with ASD in South Korea from the perspectives of medicine, behavioral psychology, special education, engineering, and design (see, for example, Kim and Song 2012; Ku and Lee 2012; Lee et al. 2016; Yun et al. 2016). However, social and historical accounts of this kind of robot or of the cultural and philosophical implications of its use are rare (e.g., M. Choi 2017), and none focuses on robots for supporting people with ASD in South Korea.

The necessity of addressing this lacuna is even more urgent given that such robots have been evoked for the good of techno-society in recent South Korean science and technology policies and public communications. Thus, this paper situates the centralization of these therapy robots as warm robots in the context of a shifting paradigm of science and technology—from an emphasis on national economic development to social welfare and other inclusive values. The focus on inclusive and humanistic values of technology has been palpable since the early 2010s in South Korean society in the appropriate technology (often called warm technology) movement under the slogan "the other 90 percent" (Anh and Song 2010; Jeon 2014). This article examines the social construal of these robots' warmth at the intersection of the development of a humanist approach to technology—promoted as a *saram-chungshim* (human-centric) philosophy—and

the appeal to affective technologies in the discourse of the Fourth Industrial Revolution during (and especially at the beginning of) the Moon Jae-in administration from 2017 to 2022.[2] My focus here is to foreground what the discourse of affective technology tells us about the social construal of warm technology, rather than to relegate the inclusive and humanist paradigm of technology to the Moon administration's relatively progressive political orientation.

The policies and public communications surrounding robots are important sites for examining and rearticulating the changing relationships among science, technology, and society. In particular, policies concerning robots have emerged alongside the shifting paradigm of science and technology governance, resonating with what Youngrak Choi identifies as "the new features of science and technology" that have appeared in twenty-first-century South Korea (2018, 23). These features include the incorporation of new fields of technology and a shift from a monolithic focus on economic effects to social values such as purposeful life and the welfare of citizens. Choi argues that these features demand "a new paradigm and approaches" in the country's science and technology policy that incorporate economic, social, cultural, and lifestyle perspectives as well as historical, philosophical, and ethical considerations, and that move beyond government-centered guidance toward civil discussion and consensus and an autonomous research community (24–26).

In this context, policies concerning research and development of robots for socially disadvantaged people illustrate the dynamic emergence of a new mode of science and technology governance, as the field relies largely on public funding due to its still-frail status in the market economy but promises to support social values that have gained renewed importance in the relevant industrial and research fields (and in general society). In this vein, this paper looks back to the establishment of the Robot Act in 2008, itself a consequence of the inclusion of smart robots as one of the Top Ten Future Growth Power Industries designated for economic development in 2003.[3] Even though there are strong continuities with the Growth Power Industries, the emphasis on developing technologies for the socially disadvantaged in the Robot Act points to a notable shift from the previous neoliberal nationalist-developmentalist paradigm of science and technology after the 1997 Asian financial crisis. This historical shift in the governance mode of science is an essential frame for understanding policy concerning robots since the Robot Act.

However, the centralization of therapy robots for autistic children in the relevant policy during the Moon Jae-in government—which came to power in 2017 after former president Park Geun-hye was brought down by protests against the partisan politics and corruption of her administration—indicates a subtler shift than simply from economic to humanist values. One critic even argues that

Moon's more liberal science and technology policy is as subordinated to the logic of economy as Park's conservative-neoliberal policies (Kim 2022). To better understand the significance of policy regarding therapy robots during this period, I suggest attention to another factor: emphasis on the affective-interactive potential of technology with the rise of the Fourth Industrial Revolution as a key agenda after the 2016 World Economic Forum. Discourse surrounding 4IR deeply impacted South Korean society, already shocked by legendary Go player Sedol Lee's defeat by Alpha Go at Google DeepMind's challenge match in Seoul. Every presidential candidate since has claimed to be the leader best prepared for the 4IR era. Thus, this article analyzes relevant policies to examine how affective interactions with robots substantialize the warmth of appropriate technology for the disadvantaged.

Challenging the Association between Autistic People and Machines

This paper draws from critiques on the association between autistic people and robots, prevalent both in scientific discourses on robotics and cybernetics and in medical and psychological discourses on autism. Scientists researching cybernetics and robots have often used autism as a metaphor or figure for understanding various kinds of deficiencies and problems in thinking machines. Predicting disruptive behaviors that match diagnostic criteria from the *Diagnostic and Statistical Manual of Mental Disorders*, fifth edition (*DSM-V*), among AIs and robots,[4] digital design and development scholar Gregory P. Garvey warns that "humanoid robots will betray serious limitations especially in social situations" such as "inappropriate verbal responses, abnormal eye contact and repetitive actions," despite the rapid advance in social robots and affective computing (2015, 525). Garvey particularly points to how robots designed for social and emotional interactions, such as Cynthia Breazeal's Kismet and David Hansen's Sophia, display "communication deficits" that induce the uncanny valley—describing them as "similar to a range of *autistic behaviors*" (525).[5] In *How We Become Posthuman*, N. Katherine Hayles similarly describes how second-order cybernetics theorist Humberto Maturana's account of autopoiesis fails to recognize the active nature of interaction in social systems. In particular, Hayles draws from Simon Baron-Cohen's proposition that autistic children "suffer from 'mindblindness,' an inability to imagine for others the emotions and feelings they themselves have" (1999, 148).

This kind of trope requires critical reflection given the highly influential yet controversial nature of Baron-Cohen's theory, which argues that autism is a manifestation of extreme-male brain—that autistic people are hyper-systemizers who lack capacity to empathize with others' feelings and intensions (1995, 2002). As technology critic Os Keyes notes, this medical model and its consequential understanding of autistic people as "asocial and overly rational" resonates with representations of autistic people—as "computer geeks" and as "computers; as robotic, machine-like 'others'" (2020, 2). Thus, reflection on this kind of trope also

calls for examination of the medical model of autism. Keyes's charting of three different models of disability and their positioning offers a useful reference in this light. Under a medical model of disability, "autistic people (autists) are individuals suffering from a *disorder*, one characterized by stunted or absent social skills and emotional awareness." In contrast, the "neurodiversity" movement "seeks to portray autism and autists in a more positive light." And there are perspectives "floating between these two points" (including Keyes's), which "seek to contextualise and historicise the construction of 'autism' as a concept and the already-political nature of diagnostic procedures" and "trace the (often racialized and gendered) variations in autistic experiences of the world" (2). In line with Keyes, I suggest that the prevalent associations between machines and autistic people are less objective descriptions than a biopolitical dispositive for approaching and governing autistic people.

Autism studies scholars have already criticized such associations between machines and autistic people and their bearing on the violent and dehumanizing effects of medical "treatment" of autistic people. In her book *Challenging Sociality*, Richardson questions the role of robots designed "to therapeutically help children with autism develop social skills" and refers to ethnographic and experimental data gathered over ten years (2018, 1). Concluding that robot therapy for children with autism makes sense only "within a machinic model of autism," Richardson traces this problematic position back to 1940s psychiatry that persists among medical and psychological discourses on autism. Richardson criticizes the logic underlying robot therapy as something that "flattens out distinctions between humans and machines" and thereby justifies the replacement of human caregivers with robots (4). From this perspective, Richardson is skeptical of how "autism and robots" has become the epitome of a new mode of sociality in the digitally connected world, in line with the current scholarly trend that rejects "human essentialism" in favor of "poly-perverse monsters, cyborgs, and ontologies that equate persons and things" (15). Richardson therefore objects to the idea of therapy robots based on "dehumanizing descriptions of autistic persons" and instead calls for a more relational approach (that focuses on "a humanistic I-you interrelatedness") to autistic people and their sociality (15).

Given the problematic association between people with ASD and robots, this paper also aims to critically examine the status of children with ASD in imaginary and actual therapy using robots as co-constituting the ableist techno-futurist imagination of inclusive society. However, it also does not dismiss potential posthumanist or cyborgian approaches for re-envisioning an inclusive techno-society that is more open to autistic (and other non-normative) personhood and sociality. These approaches offer better tools than human essentialism does for scrutinizing the liberal notions of "human" and "sociality," wherein humanness is

historically and conceptually buttressed by drudgeries performed by infra-humans.

A Critical Race and Feminist Remapping of Human-Robot Affinities

Richardson's criticism of posthumanist theories such as those of Bruno Latour and Donna Haraway as anti-humanism that "equates persons and things" is reasonable, considering how the association between autistic children and robots and the replaceability between human interlocuters and therapy robots have shaped the potentially dehumanizing scheme of therapy robots for autistic children (2018, 15). However, critics who have engaged with the gendered, racialized, geopolitical, and ableist contours of human-machine relationships have shown the necessity for critically questioning the hegemonic notion of the (white male) human and its distinction from machines in Western political and philosophical tradition (Chun 2009; Kafer 2013, esp. Chapter 5; Rhee 2016; Atanasoski and Vora 2019). These critics demonstrate that, although association with machines and robots (alongside animals) has been a frequent method of dehumanization, dissociation *from* robots won't ultimately resolve the issues. Thus, criticism of power relations that dehumanize autistic people and other marginal groups should go hand in hand with reworking the hegemonic notion of the human and its relationship to others within and outside the human species. This task entails reassessing the mechanical within humans, recognizing both the role of technology as an important constituent of social fabrics, and seeking to go beyond the modern Western imaginary of robots as replacements for the human labor force (which also frames Richardson's criticism of human-robot equivalence).

In such a light, this paper extends critical examination of the thermodynamics between therapy robots and children with autism—attending to the care work disproportionally imposed on the mothers of children with autism in South Korea in conversation with critical race and feminist discussions of human-robot affinities. On the one hand, I draw on Neda Atanasoski and Kalindi Vora's theorization of the "technoliberalism" in US imperial and racial capitalism, which reiterates the fantasy of the human subject "freed for creative capacities" when "machines, algorithms, and artificial intelligence take over the dull, dirty, repetitive, and even reproductive labor performed by racialized, gendered, and colonized workers of the past" (2019, 4). Atanasoski and Vora excavates how the architecture of the free human subject as an effect of "the violent process of extraction and exploitation" of labor performed by those at the margin of humanity is built into the imaginaries and designs of specific technologies (11). On the other, I'm inspired by Margaret Rhee (2016) taking the cultural associations between Asian women/immigrants and robots as "second-class laborers" to be a cue for an intersectional recalibration of posthuman cyborg feminism. As far as such associations speak to the historical racialization of Asians in US neocolonial capitalism as cheap alien laborers with "great productivity" yet lacking proper

emotions and creativity (Rhee 2016), they also call for an affirmative revalidation of robotic inhumanity and labor for a geopolitically situated analysis of the human-robot relationship.

Dialoguing with these critiques guides my approach to the extensive caregiving offered largely by the mothers of autistic children. First, the taken-for-granted mothers' care work buttressing the discourse of warm technology problematizes whose repetitive labor is considered worth saving by robots (in this case, medical doctors and therapists). Second, looking at how these women's caregiving insulates the thermodynamics between therapy robots and autistic children from the broader social context, I also call for re-envisioning techno-human sociality beyond the frame of robotic labor as surrogate for (medical, educational, and reproductive) care work, to which autistic children's sociality is reduced.

How CARO and iRobiQ Became Warm Robots

Two Senses of "Warmth": Affective Infrastructure

How have robots designed for helping children with ASD become archetypically "warm robots" in contemporary South Korea's public discourse, especially during the Moon administration? Alongside the Moon administration's promises for a more inclusive and democratic society, I attend to how "warmth" has established an affective infrastructure through the confluence of two trends regarding the two senses of the word *warm* (*ttattŭt'an*). First, *warm* has become a trope for promoting the *humanist* aspects of new technologies in South Korea since the 2010s. However, this term also refers to the *affective* nature of new technology with the advance of the Fourth Industrial Revolution, which became a key agenda after the 2016 Davos Forum. Jeong-mo Lee, director of the Gwacheon National Science Museum, asked a question that is still pertinent: "Would there have been the Fourth Industrial Revolution wave in South Korea, had it not been for the Alpha Go shock in March 2016 and the presidential election in May 2017?" (2017, 134). However, even the politically driven (and government-led) wave of 4IR is nonetheless symptomatic of something beyond the narrowly defined realm of the political. As such, I approach the two senses of "warm" (humanist and affective) as threads for tracing something that has been happening for longer and with a broader scope but catalyzed in the second half of the past decade, constituting an affective infrastructure for the rise of therapy robots for children with ASD in the policies I analyze below. In delineating this affective infrastructure, I invite us to critically reflect on (and go beyond) the depoliticized vision of an inclusive techno-society that professes to benefit the socially disadvantaged.

The Robot Act and Its Three Basic Plans: Service Robots for the Socially Disadvantaged

South Korea was one of the first countries to propose a national roadmap for robotics. In 2003 the government designated intelligent robots as one of the

Growth Power Industries. However, the paradigm shift I detail above becomes more noticeable with the Robot Act in 2008. At the end of the initial period of ten years, the act was extended until 2028 with partial amendment.[6] The act's stated purpose is to "enhance[e] the quality of life of citizens and the national economy by establishing and promoting a policy on the sustainable development of the intelligent robot industry" (Article 1). Although the Robot Act still revolves around an economic and industrial agenda, its current commitment to other social values is also notable. The act establishes government responsibility to socially disadvantaged people "such as disabled, the elderly, and low-income earners" (Article 17), and official support for the charter on intelligent robot ethics (Article 18). The act also requires the government to establish a basic plan every five years "to achieve the purpose of this act…in an efficient manner" (Article 5). As a result, the first, second, and third *Basic Plan(s) for Development of Intelligent Robots* were installed during the periods of 2009–2013, 2014–2018, and 2019–2023. Per the Robot Act, these plans include concrete measures for supporting socially disadvantaged people (Article 17).

The *First Basic Plan* asserts that "robots are the best resolution for meeting the megatrends," such as population-aging and increasing interest in well-being (2009, 1). The plan supports personal service-robot projects affiliated with other programs for socially disadvantaged groups as one way to preempt the global market by expanding demand through consumer-centered pilot projects. More specifically, the plan proposes to support the commercialization of "welfare robots" that offer disability and nursing assistance in connection with public-health centers and nursing homes, and to establish a business model for English-teaching assistant robots targeting low-income groups as a replacement for native-English speakers (31). It doesn't specify what these "welfare robots" might be, but the list of tasks for the initial year of the Basic Plan includes housework-support robots for seniors living alone and robots for rehabilitation and care of people with a physical disability (51–52).

These two kinds of robots for the socially disadvantaged continually appear in the subsequent plans, each of which offers a slightly revised focus in the field of service robots. The *Second Basic Plan* (2014) emphasizes the areas of disaster-response robots, robot health towns, human-robot collaborative manufacturing, and housework robots. The *Third Basic Plan* (2019) proposes revised foci on care, medicine, logistics, and wearables. In the development of the three Basic Plans, people with disabilities and the elderly (especially those living alone) became the iconic socially disadvantaged groups that would benefit from the development of service robots, even though their strategic importance as users is still explained in economic terms. Importantly, the specific functions of robots addressed for both groups largely concern physical assistance.

However, an exception appears in the *Third Basic Plan* (2019). In addition to care robots for assisting with eating (for people with hand paralysis), transporting critical patients, and toilet care, the plan also includes testing "care robots for dementia prevention" (26–27). The plan does not explain what dementia-prevention robots are, but lists functions such as "speaking to the elderly, phone calling, and AI speakers" in bullet points with a picture of a humanoid robot surrounded by a few elderly people (27). Thus, even though it isn't clear what kind of communication these robots are expected to have with the elderly, it does show an emerging orientation toward therapeutic-care robots with affective and social functions. The addition of this new type of robot for the elderly is accompanied by a taxonomic change. The first two basic plans use both *toumi* (literally "helper" but also used to refer to a caregiver) and *tolbom* (care) to refer to physical assistance for the elderly and people with disability and to housework support for seniors living alone. However, the third plan uses *kae-ŏ*—a phonetic reading of the English word *care*—to refer to all these and to dementia-prevention robots, which evokes a more emotionally and socially supportive meaning than *toumi* does. These changes echo "the changing concepts of robots" introduced in the *Third Basic Plan* "from working robots to robots that empathize and connect with humans." This shift follows the two other shifts already introduced in previous basic plans—"from the replacement of labor force to collaboration with workers" and "from the improvement of productivity to the improvement of the quality of life" (2019, 3).

Overall, then, the Robot Act and the corresponding three basic plans newly emphasize warm (humanist) values, alongside the earlier emphasis on economic values, in science and technology policies. Service robots that offer physical assistance to the elderly and people with disabilities are the most representative of this humanist orientation, while an ambiguous type of care robot for "preventing dementia" appears with attention to affective interactions between humans and robots in the more recent Basic Plan.

The 4IR Committee: Social Robots for the Elderly with Dementia and for Autistic Children

Attention to human-robot affective interactions was also prominent in discussions of the 4IR Committee, launched in September 2017 shortly after the inauguration of the Moon government. In 2018, the final year of the *Second Basic Plan*, certain priority tasks were forwarded to the committee (*Third Basic Plan* 2019, 1). These tasks include developing technologies for service robots and expanding the supply of robot products to the socially disadvantaged. At the end of the year, the committee's agenda for its future direction and plans included the robot industry, which is globally expanding thanks to its incorporation of AI technologies. Resolutions at the meeting included "developing social robots that support dementia patients and autistic children" and "developing care robots to support the socially disadvantaged" (Ministry of Trade, Industry, and Energy 2018, 9).

These resolutions also specifically refer to the development of "conversation robots" that recognize emotions and voices of patients with mild cognitive impairment and dementia, and autistic-children-friendly robot systems that provide diagnosis and education programs for improving sociality (9). In the 2019 4IR Committee progression report, robots for people with dementia and for children with autism are categorized as "social robots" (*sosyŏl robot*), which is distinguished from "care robots" (*tolbom robot*) whose primary functions are physical assistance such as transportation, eating support, and toilet care (4IR Committee 2019, 90).

Labeling these robots as social robots separate from care robots is an interesting change from the basic plans. However, this isn't indicative of a linear evolution over time, as the 4IR Committee agenda and its progression report mentioned above and the *Third Basic Plan* are concurrent. Also published in the same year as the launch of the 4IR Committee, the *Technological Roadmap for Small and Medium Businesses: Robots* lists psychological-support robots as one of three kinds of care (*kae-ŏ*) robot (alongside physical-support robots and life-support robots), which is itself a subdivision of social robots (Small and Medium Businesses Administration 2017). This roadmap defines psychological-support robots as "robots that help the users to avoid loneliness or depression and to live an emotionally healthy life" (82). The roadmap suggests that robots can prevent emotional isolation through affective communication (such as reading the user's emotions and responding accordingly), referring to various projects in the European Union that address loneliness among the elderly (82). Interestingly, the roadmap's section on domestic trends in social robots reports that dementia-prevention Silbots (*Silbŏt* in Korean, combining *sil* from *silver* and *bŏt*, meaning friend or companion) are already used for treating mild-dementia patients in a retirement town and children with autism at a medical university (102).

What is suggested by the ambiguous, changing, and conflicting systems of labeling and the appearance of robots for children with ASD in these reports written between 2017 and 2019? Among other possible answers, I think the appearance of robots, alongside the mutating systems of labeling, shows a growing emphasis on emotional and psychological interaction between humans and robots, which circulates between and across the categories of social and care robots with the rise of the discourse of the Fourth Industrial Revolution. As the focus of robots for the elderly evolved from housework help (*toumi*) to dementia-prevention (*kae-ŏ*) to psychological support (*sosyŏl*), children with ASD emerged as another important group of users who share the same category of social robots (or even the same models). Thus, on one hand, robots designed for autistic children have become a vital figure in Korean policies, intersecting the two genealogies of "warm" robots—"[humanist] robotics that may offer education, care, and public services for the socially disadvantaged such as people with disability, the elderly, and children" (as in the KEIT's 2020 competition) and

"[affective] robots that empathize and connect with humans" (*Third Basic Plan* 2019). On the other hand, this intersection backdrops the emergence of robots for children with autism as a kind of social robot in Korean science and technology policy, even though these robots' functions are officially diagnosis and special education.

This genealogy of policy supporting therapy robots for autistic children thus shows that the perception of these robots as "warm" is a cultural and historical construct. As such, while this trend hailing "warm robots" signals a more humanist paradigm of science and technology in South Korea, it also invites another line of critical inquiry. The emphasis on affective human-robot interactions partly explains the policy focus on robots for children with autism and the elderly with dementia (populations often considered to have difficulty being involved in meaningful affective sociality) rather than for people with alcohol addiction, anxiety, or depression—the major drivers of poor mental health in South Korea. Yet, while these "warm" robots aim to address social isolation, the suggested human-robot affective interactions are based on normalizing discourses in psychology, psychiatry, and special education. Critical autism scholars have noted the violent and dehumanizing consequences of such normalization practices, including the applied behavioral analysis (ABA) that is often considered standard treatment in the US (Yergeau 2018, esp. Chapter 2; Keyes 2020). Furthermore, compared with dynamic debates around and criticism of social robots for the elderly either with dementia or who live alone (Bołtuć 2017; Jenkins 2017), those for autistic children are rarely seen as problematic—which itself calls for critical reflection.

The Thermodynamics between Therapy Robots and Children with Autism

An important question therefore arises: If robots designed to help autistic children in developing social skills are endowed with human warmth at the intersection of humanist and affective orientations in science and technology governance, what happens to the children in this exchange of temperature? In search of answers, let me revisit the presupposition that robots for autistic children are warm because *they allow robot-like autistic children to be included in natural human sociality*. This presupposition is in turn reiterated by two co-constituting assumptions. First, there is natural human sociality that autistic children are exterior to and thus must be incorporated into. Second, such an injunction for "incorporation" is in turn taken for granted, because this kind of robot therapy not only relies on but also naturalizes the assumption that autistic children are like robots (and therefore outside human sociality*)* and prefer robots to humans (and therefore robots are legitimate channels of social incorporation). This kind of assumed association with robots is a prevalent scientific-clinical dispositive for approaching autistic children, and more fundamental than cultural representations or stereotypes.

It's worth examining how therapy robots for autistic children are designed and used in light of these presuppositions. One clinical trial of "a robot-assisted behavioral intervention system for children with autism spectrum disorders" using CARO and iRobiQ draws sample subjects from the Child and Adolescent Psychiatry Clinic at Seoul National University Bundang Hospital in South Korea (Yun et al. 2017). The trial does not explicitly associate autistic children with robots; however, it illuminates how the current scheme of robot-assisted therapy focuses on the clinical method, which is embedded in prevalent presuppositions about autistic children's proximity to machines. Notably, the system designed by scientists at Korea Institute for Science and Technology (Yun et al. 2016) draws on research co-authored by Baron-Cohen that approaches ASD in terms of "abnormal development" in abilities of empathy, pretend play, joint attention, and imitation, which is linked to "impaired social communication" (Charman et al. 1997, 781). The intervention system thus provides "social skills" training in basic eye contact and reading facial emotions (Yun et al. 2017). A robot-assisted clinical trial session begins with a child-resembling humanoid robot verbally greeting and attempting to establish eye contact with the subject (an autistic child) sitting next to the therapist, to which the child is trained to make "appropriate eye contact" in return (Yun et al. 2017, 1308). The robot then makes facial expressions and asks the child to read its emotions (such as happiness, sadness, anger, or fear). Here, let me add that I—who is not considered autistic—nonetheless find the photographs of digital facial expressions made by iRobiQ (with its eyes and mouth) and CARO (with its eyes) quite challenging to read. If the child shows the desired response (such as making eye contact with the robot or identifying the correct emotion), the robot offers a reward (such as blinking its LED face, singing a song with a dance routine, or raising its hands); if the child does not, the robot provides "encouragement" (such as calling the subject's name, speaking the correct answer, or shaking its head) or pauses (Yun et al. 2017, 1308). This intervention system is based on the discrete trial teaching protocol, a structured ABA technique (Yun et al. 2017, 1307).

Let me first acknowledge that ABA is currently the most established evidence-based practice, especially in the US—affirmed by organizations such as the American Psychiatric Association, the American Psychological Association, and the US Surgeon General. Nonetheless, it is important to note that concerns have been raised about this method, characterized by up to thirty-six hours of weekly intensive and repetitive interventions to normalize ("correct") children. Henny Kupferstein (2018), a psychologist who is also autistic, concludes that ABA treatment of autistic children potentially heightens the risk of posttraumatic stress disorder (PTSD). Some psychologists argue that the method is not effective, or is even abusive (Sandoval-Norton, Shkedy, and Shkedy 2019; Shkedy, Shekedy, and Sandoval-Norton 2021). Others argue conversely that "there is lack of reliable data and research that ABA-based interventions have

resulted in a diagnosis of PTSD, anxiety, or depression" (Leaf et al. 2022). There is little criticism of ABA treatment in South Korea, and South Korean experts also follow US standards of diagnosis (the *DSM-V*) and treatment guidelines (focusing on ABA), but the prescriptions and treatments are often modified due to the relative institutional lack of proper ABA and other service providers (Chang 2020, 201–4).[7]

While it is true about ABA that "the structure and demand for documentation lends itself to automated process," the content of the robot-assisted technology is also "driven by the perceived functional deficits that comprise a diagnosis of autism and the particular social expressiveness of the condition" (Spiel et al. 2019, 18). These children are thus framed as the target of intensive corrective clinical intervention, expected to learn what are supposed to be normal ways of interaction for the non-autistic population. Within this kind of medicalized framework, the eye contact with and face reading of iRobiQ and CARO are considered helpful social-skills training—despite complaints among autistic people that eye contact can be distressing and even physically painful (McGlensey 2016) and the lack of efforts among non-autistic people to learn how to better communicate and interact with autistic children. In this light, it's worth attending to criticism that human-robot interaction technologies focusing on autistic children often become extensions of a normativizing environment that aims to change and teach autistic children without asking about their needs and wellness on their own terms.

The discourse on "warm robots" is then ironic in its appeal to humanist technology. This discourse overshadows the human-robot thermodynamics—wherein autistic children's supposed proximity to machines is taken for granted and the repetitive and mechanical interventions for these children are legitimized—only to highlight the supposed affective functions of the robots. There is no record on how the children in the research trials with iRobiQ and CARO felt about the repetitive and mechanized routine. However, a study of discrete-trial-teaching-based treatment for autistic children using a similar humanoid robot (Nao) at a university based in the US offers an interesting insight (Louie, Korneder, and Abbas 2021). A child didn't respond to the robot's prompt, so the researchers modified the delivery of the prompt to use a prerecorded human voice, to which he immediately responded. Still, the intervention with this child was discontinued due to "lack of progress." Another child requested that he no longer participate in the study, so the intervention was discontinued—which means that only one of the original three participants could complete the designed intervention. Although the researchers recognize that one participant preferred a human voice to a robot's and that the intervention was frustrating to two of three participants, this nonetheless didn't lead to re-examination of their assessment that "all the children participating…enjoyed interacting with the robot" or of their proposal to use robots "in place of human therapists" (31).

Although the design of the intervention systems using iRobiQ and CARO does not aim to replace human therapists with robots, it does aims to address a therapist's request to make the technology capable of performing "repetitive training routines" and thereby promise "the possibility of a labor-saving effect" (Yun et al. 2016, 59). In this sense, the approach to therapy robots as "warm" operates through and reproduces the dehumanizing effects that Richardson (2018) has criticized—namely, depriving children of human interaction on the assumptions that they are similar to and prefer machines over humans. Existing human sociality is also naturalized within these thermodynamics, and the artificial incorporation of autistic children (who are exterior to it) into the existing sociality is envisioned as inclusive. The technology—and the society that supports this technology—is intended to be "warm," but the warmth of autistic children (their humanity and sociality) remains uncertain at best.

So, what does the thermodynamics of temperature between robots and children tell us? It tells us that society's engagement with autistic people concerns no less than how we think of human sociality and where we draw boundaries of the human as a social community. Critics have already noted that the challenges in communication between autistic people and neurotypical people are mutual (that is, the latter also don't understand or communicate well with the former) and that neurotypical peers are less willing to communicate with those with autism (Sasson et al. 2017; My Planet Neurodivergent Admin 2021). In this light, the thermodynamics points to the need to shift focus from robots as futuristic subject-objects that stand for inclusive techno-society to the techno-social context wherein certain human-robot interactions occur—in which concerns about prevalent clinical-pedagogical approaches to autistic children are eclipsed by abstract aspirations for a warm techno-society projected onto robots. A critical analysis of the thermodynamics thus urges redirecting our focus from rewiring autistic children to rewiring the social fabrics of human-technology (into which autistic sociality is embedded) to be truly inclusive of autistic people.

Rewiring: Thinking with Caregivers in South Korea

This final part of the paper explores one way of rewiring the social fabrics of human-technology to address these challenges. It reflects on the role of mothers of children with autism in insulating the human-robot thermodynamics, in conversation with Atanasoski and Vora's (2019) critique of the surrogate relations built into the technoliberal imagery of robots and other technologies.

South Korean scholars have attested to the intellectual, emotional, and managerial care work disproportionally provided by the mothers of children with autism and other disabilities (Chang 2020, 2021; D. Lee 2010). Hawon Chang observes that women raising young children with autism are expected to be sensitive and knowledgeable enough to notice their children's subtle health

problems quickly and provide appropriate interventions in South Korea, where clinical and educational services for autistic children are not as institutionalized as in the US (or other "advanced" societies)—placing an even stronger responsibility on mothers and requiring that they practice an intense scientific and self-sacrificing motherhood (2020, 2021). Chang's observation is in line with some feminist scholars' critiques of the notably high rate of mothers as the primary caretakers of children (Park 2022) and the intensification of the mother's role as a manager of children's education and development (J. Lee 1999) in the context of the 1997 financial crisis and ensuing neoliberalization in South Korea. It also underlines the feminist demand for socialization of care work (alongside the critique of Korean "military masculinity") (Ahn 2017) and attention to the intersections of class and race in "the global rearrangement of care" (Ahn 2012, 131).

Here, these existing feminist political perspectives merit revision, in order to account for how both current and envisioned care work for autistic children implicates surrogate relations among and between various human groups and robots. On the one hand, turning to these women-as-mothers' care work that evades the discourse of warm robots illuminates the hierarchical and complex distribution of humanness-mechanics among various actors. Whose work gets to be replaced by robot labor: the mother's or the doctor's? On the other, this kind of calibration stumbles if we ask why these mothers' care work is perceived as less replaceable even by other surrogates, when migrant workers and wives are doing care work for elders and adults (mostly men) with disabilities (Kim and Kim 2017; Shin 2019). Juxtaposing these two pictures demonstrates that redistribution and reassessment of care labor only partially improves our vision of an inclusive techno-society, falling short of reassessing autistic children's relational status (as the presumed object of intensive care) vis-à-vis both robots and fellow humans.

I take this limit as an invitation to reflect on how we might rewire our human-machine sociality, rather than rewiring children with autism. The existing feminist critiques' emphasis on these mothers' caregiving as labor (even though it well deserves attention) still marks the difficulty of considering the social ties of children with autism beyond the relations of care (in which autistic children are invariably the object of clinical, educational, and reproductive care). Then, such a difficulty also assures the urgency of an alternative to the problematic fantasy of surrogate labor built into the imaginations of the therapy robots for autistic children.

There are other efforts and experiments going on in the UK, Japan, Colombia, and elsewhere to redirect human-robot interaction in a direction more respectful of autistic people and people with dementia (McBride 2019; Wright 2019; Ramírez-Duque et al. 2021). And, despite the limitations I've discussed above, the phenomenon of warm robots in South Korea is nonetheless still promising in that

it's shaped less by the cultural imagery of robots as replacement for humans than by the desire for robots as co-habitants that enhance the warmth of society. In critically reflecting on the operations and the limits of thermodynamics among therapy robots, children with autism, and their mothers (as the threshold to broader society), I hope this paper offers a groundwork for critical and creative deliberation on a better way to acknowledge and support autistic sociality as an important part of our social fabric in order to envision a new kind of "warm" techno-society.

Notes

[1] According to the *World Robotics Report 2023* of the International Federation of Robotics, South Korea exhibits the highest global density of robots in the manufacturing industry (International Federation of Robotics 2024). Previously, South Korea topped the list for eight of the past nine years, except for 2019 when it was second to Singapore.

[2] President Moon's plenary speech at the first National Science and Technology Advisory Committee meeting captures this orientation. The speech is available on YouTube (KTV 2018).

[3] As Sanghyun Lee and Heesun Shin (2019) note, the Top Ten Future Growth Industries list played a part in establishing the Robot Acts and consequent policies. There are also institutional and personnel connections between these two schemes.

[4] The *DSM* is the standard classification of and diagnostic tools for mental disorders, published by the American Psychiatric Association and used by mental-health professionals in the United States.

[5] In addition to autism spectrum disorder, Garvey also suggests social communication disorder, Asperger syndrome (eliminated as a category and simplified as ASD in *DSM-V*), and anti-social personality disorder as potential issues among new artificially intelligent entities (2015, 525–27).

[6] The amendment offers a broader definition of "intelligent robot" to include "software necessary for operating the device," in addition to "a mechanical device that perceives the external environment for itself, discerns circumstances, and moves voluntarily" as defined by the original 2008 act.

[7] Determining the clinical efficacy of ABA treatment is beyond the capacity and scope of this article, in either the Korean or US context.

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