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Raised by Robots: Imagining Posthuman "Maternal" Touch

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Abstract: Posthuman parenting is fast becoming a reality with the development of technologies such as artificial wombs and childcare robots. Debates and concerns about these technologies often centre around questions of the risks and benefits of increased technological intervention into pregnancy and child rearing, while also circling around enduring feminist concerns regarding whether these technologies herald the liberation of women from biologically-determined motherhood, or whether they herald a dystopian age of patriarchal reproductive control. Our chapter seeks to move beyond practical ethical estimations to consider the potential significance of the experiential dimensions of ectogenesis and robot childcare as imagined in a range of media. We take a phenomenological approach that considers the particular, material implications of such technologies and the complex relational networks they are designed to replace and/or augment. We will do this by focusing on the phenomenon of machine/human touch as speculated in depictions of technological gestation and robot childcare. Examining news reports, press releases, as well as science fiction literature and film, we suggest that these technologies, as projected, predicted and imagined, assume a biocentric model of the human that overlooks the relationality of being, treating humans animals (even in infancy) as autonomous, hyper-individual cognitive subjects. In doing so, we question just how far technology can intercede for 'maternal' touch.

Introduction

In April 2017 researchers at the Children's Hospital of Philadelphia (CHOP) published a report detailing the creation of an extra-uterine device, or "Biobag," which successfully gestated a lamb for 4 weeks. CHOP's goal is to develop the 'Biobag' for human use, artificially extending gestation in cases of extreme prematurity in human fetuses, a leading cause of neonatal mortality in the Global North. As the research team explains in their *Nature Communications* article on the project, the "extracorporeal system incorporates a pumpless oxygenator circuit connected to the fetus of a lamb via an umbilical cord interface that is maintained within a closed 'amniotic fluid' circuit that closely reproduces the environment of the womb" (Partridge et al 1). The article includes several diagrams and illustrations, including two photos of the extra-uterine system in use (at day 4 and day 28 of support), which show a fetal lamb, lying on its side, encased in what looks like an especially sturdy Ziploc bag surrounded by medical tubing. A similar "extracorporeal system" is being developed for human use by researchers at Eindhoven University, with project leaders Frans van de Vosse and Guid Oei predicting a working prototype by 2024 (Muller). While van de Vosse and Oei's project is aimed at creating artificial wombs for the treatment of

significantly premature babies, many speculate that it is only a matter of time before full ectogenesis--reproduction and gestation, from conception to birth, outside the human body--becomes a reality (Smajdor).

Perhaps unsurprisingly, reporting of the CHOP and Eindhoven extra-uterine systems frequently invoke science and speculative fiction, particularly dystopic narratives, like Aldous Huxley's *A Brave New World*, that imagine human ectogenesis as part of a larger project of fascistic bioengineering.[1] However, in images of the Biobag, the gestating lamb looks vaguely vacuum packed, evoking the storage habits of the meat industry as much as, or perhaps even more than, the high-tech fantasies of science fiction. Indeed, the Biobag is distinctly low-tech and unglamorous in comparison to its sci-fi antecedents. The published Biobag images offer a hygienic, sanitized version of reproduction that erases the visceral muck and mess of human animal incubation, artificial or otherwise.[2] The images illustrate artificial gestation's effacement not only of *maternal* participation in gestation, but of any human interaction or interference in fetal development. The Biobag images rely on a vision of gestation as an orderly instrumental operation in which biological and mechanical functions are equivalent and interchangeable. As a result, the Biobag and its affiliated technologies conjure reproductive futures marked by mechanization and transhuman opportunity, in which technologies neatly and efficiently supplement or replace human conception and reproduction. In short, in these ecotogenetic imaginaries, biological mothers will no longer be necessary for the gestation of human infants.

It is not only in the realm of gestation that "maternal" bodies are being supplanted by technology (the term "maternal" is being used here as a shorthand to encompass a variety of possibilities, such as cis-gendered and genetically-related mothers, surrogates, recipients of donor wombs, or non-binary or trans individuals). Once infants leave the womb, technological innovation is being harnessed to assist and augment childrearing and childcare. Recently developed care robots, such as iPal, Care Bear and Kuri, propose to entertain, motivate and comfort their human

child companions, and while their abilities remain limited, roboticists and robot ethicists alike predict increased robotic intervention in childhood, intervention aimed at alleviating the burdens of care on parents, particularly mothers.[3] Like artificial wombs, these artificial caregivers, or "robot nannies" as they are frequently referred to in the media, provoke a great deal of curiosity and concern. Noel Sharkey, a professor emeritus of robotics and artificial intelligence at the University of Sheffield, argues that there are "significant dangers" in using robots for childcare: "They do not have the sensitivity or understanding needed for childcare," and using robots to raise or look after children, he argues, might result in "a number of severe attachment disorders that could reap havoc in our society" (qtd. in Wong). At present, there is insufficient evidence to determine whether so-called nanny robots do (or might) pose a threat to infant and child development and well being. However, in the realm of science fiction, the trope of the "mother robot" has been well-developed, where human infants are raised by robots, often seemingly without any detriment to their psycho-social or emotional development. Indeed, mother robots, as we shall see, are often imagined to have no notable developmental effects whatsoever on the children they rear.

The promises and perils of what we are terming, with considerable qualifications and critique, "maternal" technologies, such as artificial wombs and nanny robots, have been explored at length in popular media, bioethical debates and science fiction. Debates surrounding these technologies often focus on the physical and psychological risks and benefits of increased technological intervention into gestation and child rearing. Feminist critics have been particularly vocal in these debates, questioning whether such technologies herald the liberation of women from biologically-determined motherhood, with the potential to dismantle hetero-patriarchal gender roles, or a dystopian age of patriarchal reproductive control, through technologies that have been designed not with the interests of women as their primary concern.[4] While these debates are of central importance in framing the development and implementation of these technologies, our analysis in this Chapter deviates from these well-worn paths of critique and debate. In what follows,

we explore the phenomenology of "maternal" technologies and "maternal" touch alongside analyses of contemporary speculative and science fiction texts which imagine near-future realities where ectogenesis and mother robots are commonplace.

Our phenomenological approach will explore the potential material, intercorporeal and experiential consequences of existing and imagined ectogenesis and "mother" robot technologies. We are concerned with how these technologies might transform, augment or diminish the complex intercorporeal, relational enmeshments that produce and sustain early human life. To what degree, we ask, might such technologies produce novel forms of relating and being? We turn to science and speculative fiction to examine fictional accounts which attempt to flesh out the biotechnological possibilities of ectogenesis and mother robots, while interrogating present-day social conventions regarding gender roles, reproduction and the body. Through exploring existing social conventions through hyperbolic, apocalyptic, or futuristic settings, science fiction is an effective cultural tool for elucidating the impact of present social trends (Dolezal 95). Nancy Kress suggests that "abstract debate about'' science and technology fails to grasp fully how it affects people; by telling its materially-situated stories, science fiction can serve as a necessary supplement to the public culture of technoscience; as Kress puts it, “In the world's laboratories, science rehearses advances in theory and application. In fiction, SF writers rehearse the human implications of those advances.” In her view, “science fiction is the dress rehearsal for social change” (207). Through examining how ectogenesis and mother robot technologies are imagined in cultural texts, with a particular focus on imaginaries of "maternal" touch, we elucidate some of the physical, social and political implications of adopting these technologies for widespread use.

To address our concerns about the prevailing cultural imaginaries regarding “maternal” technologies, our essay turns to the “posthuman” as a means to conceptualise the complex, formative embodied entanglements responsible for human animal being. Our use of posthuman builds on new materialist-inflected posthumanist scholarship by Rosi Braidotti, Karen Barad, Maria

Puig de la Bellacasa and others who theorize "the human" as a relational ontology that is "always already," in the parlance of posthumanist theory, embedded in dense more-than-human networks. Like Braidotti, we interpret the "critical posthuman subject . . . [as] a relational subject constituted in and by multiplicity" (49), as "materialist and vitalist, embodied and embedded, firmly located somewhere, according to the feminist "politics of location" (51). This relational, entangled, embodied ontology means that contact *matters*, not only for survival and flourishing, but for the very ontological shape of human being. Different relations, different assemblages produce different organisms.

1. "Maternal" touch and the posthuman

In her essay "Maternal touch and the developing infant," psychologist and neuroscientist Ruth Feldman describes touch as the primary conduit for life-sustaining care in early human life: "Maternal touch," Feldman explains, "is not just one more thing mothers do. It is the basic channel for the expression of parenting and serves as the bedrock of the individual's future capacity to provide love and nourishment to future attachment relationships. Attachment relationships, in turn—at least according to some perspectives—provide the motivating force that guides human development and defines the apex of the human condition" (373-374). Touch is the fundamental sense in early (and often later) life: it is the first sense to develop in utero and remains the dominant, "most mature sensory system for the first several months of postnatal human life" (Holler 15; see also: Field 8; Benthien); it "accounts for as much as 80 percent of infant communication" (Holler 15) and remains the dominant sense for children exploring the physical world throughout the first year of life (Field 8).

Experiences of touch in infancy and childhood not only shape a person's lifelong affective capacities and preferences, they are responsible for organism survival and development. Like most altricial species, humans require significant care to survive and this care is largely facilitated by,

and often delivered through, haptic modalities. Touch receptors in infant lips allow them to nurse (Holler 15) and there is evidence that tactile stimulation encourages premature infants to increase caloric intake and weight gain (Stack 354; Holler 2). Touch's formative role has been further demonstrated by the devastating effects of its denial. The deprivation of tactile contact in early infancy has been shown to have catastrophic effects on psycho-social development, physical well-being and even survival (Stack 353). Studies of institutionalized babies and children denied touch have shown devastating developmental and emotional impairments resulting from lack of contact, further demonstrating the degree to which human animal capacities are intercorporeally produced (and nourished) during early life through embodied contact. Infants and children denied the affective touch of caregivers are permanently affected by this absence. Indeed, touch is so important for human animal development and wellbeing that religious philosopher Christina Traina makes a case for physical affection as an ethical obligation, describing affective touch as "a condition of human flourishing . . . not only permitted but required" (Traina 116). Across neurobiology, medicine, psychology and sensory studies, it remains undisputed that young infants require regular tactile contact from caregivers for their sustenance, development and socialization (Stack 2001). One finds clear consensus that touch is a crucial, formative means of communication and care from the earliest stages of human life, contributing to physical well-being along with "the infant's neurobehavioral, cognitive, and social–emotional growth" (Field 376).

When thinking about the importance of touch for human infants, it is important to note that touch is not something that begins outside of the womb and, therefore, is important only in early infancy. The somesthetic system, including kinesthesis and cutaneous sensations, is the first sensory system to develop *in utero* (around week 8) (Stack 352). In other words, touch is our first sense; it is operative and affecting from the very early stages of foetal being. The rich phenomenological scholarship on pregnancy and gestation[5] argues that intercorporeal relations--that is relations of touch, movement and affect between sensing bodies--begins within the womb,

and that the "container metaphor" for pregnancy that dominates discussions of reproductive technologies, does not do justice to this experiential reality (Dolezal 2018). As Jane Lymer points out, the "intrauterine world" is not merely a passive receptacle which happens to provide nourishment, instead it is a dynamic, communicative and constitutive medium "not only moving but also rhythmic, regulated and animate" (Lymer 138). There is evidence that from 22 weeks, through movement and touch, the maternal-foetal connection begins to "manifest as *a relationship or communication*, as reciprocity…" (Lymer 138). This communication between the "maternal" body and the foetus happens both explicitly and episodically, for instance, through a "maternal" figure deliberately responding to a foetal kick through touch, and also implicitly and continuously through prereflective bodily processes. Lymer summarizes the research, explaining: "mothers' bodies respond to foetal movement … unconsciously. A mother does not need to consciously feel her baby move in order for her body to respond ... Should a foetus experience anxiety it will move more and thus … stimulate the maternal sympathetic nervous system to tighten the uterine contraction and thus restrict the foetal movement which consequently calms the foetus in much the same way as swaddling an infant can sooth distress" (Lymer 139). As such, even *in utero*, touch is a means to communicate affectively, setting the foundations for the postnatal intercorporeal relations which, as discussed above, are crucial for and constitutive of an infant's physical and psycho-social development.

However, when thinking through "maternal" touch in gestation and childrearing, it must be remembered that reproduction has never been a wholly "natural" matter whereby "bodies might enact some natural biological destiny" (Neimanis 109). Instead conception, pregnancy, birth and childrearing are necessarily what Donna Haraway terms "naturalcutural" (Haraway 2), entangled with cultures and institutions, along with "ecologies of human and more-than-human bodies and technologies" (Neimanis 109). During gestation, birth and infancy we are touched not only by caregivers, but also by the technologies and artefacts of caregiving. Hence, human bodies are not

just intercorporeally related to other human bodies, but also radically and necessarily relational with non-human entities. As the feminist phenomenologist Gail Weiss notes, "the experience of being embodied is never a private affair, but is always already mediated by our continual interactions with other human and non-human bodies" (5). Hence, while we can posit an experiential primacy to 'maternal' touch, it must be remembered that this touch is accompanied and scaffolded by a range of touches and technologies within which we are entangled in complex and constitutive manners.

Acknowledging the complex entanglements of human subjects with other human and non-human entities, we propose a posthumanist framework for understanding "maternal" touch. As discussed in our introduction, posthumanism disrupts the proposed unity of the humanist subject, conceived as a discrete, self-contained entity, in its attention to the fundamental inter-relatedness between humans and their "others" (Braidotti). A posthuman understanding of touch acknowledges the dense formative intercorporeal entanglement of human bodies, even during gestation, and rejects the humanist frameworks that interpret humans as atomized, self-contained, mechanistic organisms that can be substituted and relocated without consequences. "Posthuman touch" refers to the tactile aspects of our formative entanglements, the cutaneous, affective dimensions of our relationality that create and shape more-than-human being. Our point is that touch is always already posthuman because intercorporeal entanglement produces being and because all bodily processes related to reproduction are naturalcultural: embodied, embedded and entangled**.** In fact, studies of touch suggest that complex posthuman relations are foundational to existence with myriad material/intercorporeal interactions that blur distinctions between maternal and fetal/infant bodies.[6] As a result, "maternal" touch, as we discuss it here, is always already "posthuman touch."

2. Imagining Maternal Technologies

Though ectogenesis and "mother" robot technologies are nascent, their existence, operation and potential effects and affects have been imagined in a range of speculative fictions, including literature, film and television. The intimacy between technological innovation and fictional representation is well documented; indeed, many roboticists have cited the formative influence of science fiction on their sense of what robots are and might be.[7] Images and narratives shape the cultural imaginary, influencing technological designers and users alike. The aforementioned ubiquity of references to *Brave New World* in ectogenesis reporting is a reminder of the role that fiction plays in anticipating, shaping, challenging, even prohibiting the development and reception of biotechnologies. As Douglas Kellner asserts, science fiction "often illuminates aspects of reality frequently overlooked by utilizing the vantage point of a further intensification of present social trends … [a good science fiction writer] takes current trends to possible conclusions and provides instructive warnings about certain social tendencies and phenomena" (Kellner 203). In this way, speculative and science fiction act as testing grounds,[8] allowing creators and audiences alike to experiment with prediction and critique. These texts facilitate, as we have discovered in our reading and watching, detailed scenarios of posthuman biotechnological phenomena engaged in more-than-human becoming, as well as premonitions of technological substitutions that simultaneously maintain humanist imaginaries, of autonomous self-contained subjects, as underpinning the socio-political status quo. In the next sections we turn to examine a range of contemporary speculative fiction that imagine both ectogenesis and "mother" robot technologies, examining, in particular, the presence and absence of posthuman maternal touch in these imaginaries.

a. Imagining ectogenesis

Artificial wombs and ectogenesis have long been a theme of speculative fiction. Perhaps most notably in Aldous Huxley's *A Brave New World* (1932 [2007]), artificial wombs are used to

enable the mass production of human beings as part of a project of fascistic bioengineering. Huxley's dystopic fantasy is often invoked in discussions of ectogenesis by researchers and cultural scholars as representing all that can easily go awry with technologies that aim to render artificial the "natural" functions of maternal reproduction. Almost a century after Huxley, anxieties about ectogenesis are still prominent in a range of contemporary science fiction texts. For instance, Anne Charnock's *Dreams Before the Start of Time* (2017) and Helen Sedgwick's *The Growing Season* (2017) both centre on near-future realities where using ectogenesis for the creation of human babies is a predominant social norm. Both texts celebrate the possibilities of ectogenesis technologies, where women are in effect liberated from some, if not most, aspects of reproductive "labour," creating opportunities for men to be equal caregivers in prenatal life and early infancy. However, tempering the liberatory promises of ectogenesis futures are narratives which focus on the social ills that may arise when tampering with "natural" reproduction. What is predictable, but interesting, in both novels, is the unproblematized assumption that the human womb can be simply replaced by a technological surrogate.

Anne Charnock's *Dreams Before the Start of Time* offers a series of interconnected vignettes which are explicit in their exploration of the anxieties that arise when considering the physical, social and psychological ramifications of near-future reproductive technologies, such as artificial wombs and genetic manipulation. In the vignette, "The Adoption," Rudy and Simone visit the clinic where "bottle babies" are gestated (77). They are considering adopting a baby that has been orphaned; its genetic mother has been killed in a bicycle accident. The foetus has been rendered motherless, suspended in a clear vessel on the "third-trimester ward" (83). While Dr Christophe insists "It's safer than a natural pregnancy once the fertilized egg has bonded with the womb lining", the narrative emphasises the social risks of these potential technologies--a child so easily rendered an orphan before birth. The foetuses are suspended in "tear-shaped bottles" (80) set out in repeating rows in darkened wards. However, this ostensible "production line" (79) is tempered

by a repeated emphasis on reproducing the conditions of human wombs. Dr Christphe explains: "as it's dark in a mother's womb, we try and create similar conditions" (79).

Interestingly, touch is acknowledged as a key developmental marker: "Once the embryonic period is complete, and when most of the foetal body surface responds to touch, we transfer it to the second-trimester ward" (79). However, this acknowledgement of the centrality of touch in neonatal development quickly falls out of this technological imaginary. Although Dr Christophe notes that parents, "can place their palms on the vessel. They can see and feel the baby moving" (83), this opportunity for a haptic connection is not emphasised as central to "bonding." It is mentioned instead as something that parents simply enjoy "if they visit during their baby's active time" (83). However, "bonding" *is* encouraged, but achieved through sound rather than touch: "We record the mothers' and fathers' voices and feed the sound into the foetus flasks during gestation. We follow a natural daily rhythm--no voices during the night, just the sound of a parental heartbeat" (78, 80). When Rudy and Simone ask if parents' voices are switched off if a baby is orphaned, Dr Christophe replies: "I try to dissuade the adopting parents from deleting the source-parent voices. We have concerns about continuity … We feel some aspects of brain development might falter" (80). Hence, the emphasis on maternal/caregiver involvement needed to ensure successful development is auditory, rather than haptic. It is the *sound*, rather than the *movement* of the heartbeat, that is highlighted as significant. And likewise, it is the voices of mothers/caregivers, rather than their touch or movement, that is emphasised as necessary for development.

While *Dreams Before the Start of Time* presents a very traditional imaginary with respect to ectogenesis, where the "Bottling rooms" of Huxley's Central London Hatchery and Conditioning Centre (Huxley), are rendered into a modern-day benign baby "production line", we find a very different imaginary of ectogenesis in Helen Sedgwick's novel *The Growing Season.* In a near-future reality, human reproduction is entirely managed by FullLife, a corporate entity that has revolutionized gestation, rendering biological pregnancy almost obsolete, through the production

of "the pouch" (9). In this novel, ectogenesis doesn't take place in labs monitored by expert technicians, but instead has been democratized to the population at large. The pouch is a gestational sac that is strapped on over the shoulders and "snug on the belly" (10), worn throughout the day by parents/caregivers, and hung on a "pouch stand" at night, where it is attached to a nutrient bag that feeds both the foetus and the pouches live cells that sustain its "biological environment" (11). Told through a series of interlinking narratives the novel explicitly explores the ambivalences of the pouch with respect to its potential social and physical harms alongside its possibilities for positive social transformation. The novel centres around unexplained pouch-born stillbirths along with a fear that the human species has rendered itself genetically infertile through outsourcing reproduction to technology. However, the narrative also emphasises how the pouch's widespread implementation in society has been positive: reproduction and childrearing has been democratised with men and women, of all ages, sexualities and fertility-statuses, equally able to take on the responsibilities of gestation and parenting; women have been definitively liberated from the "pain of childbirth" and its other associated horrors: "women who had to be cut open, women whose bodies were so damaged they were left incontinent for life … women whose babies had died" (28).

The move away from bottles in labs, towards a vision of externalised biological wombs, strongly emphasises the caregiver/foetal relationship, with a particular focus on touch and movement. The pouch is effectively worn like a prosthetic belly, inviting the affectionate and responsive touching, cupping and stroking that is customary of external "maternal" touch during biological pregnancy. Rosie and Kaz, a young couple in the novel, are expecting to birth their baby Will in the FullLife clinic. They share wearing the pouch and their intimacy with it is described repeatedly, with a strong focus on affective touch: "She pressed Kaz's hand, still held in her own, gently onto the curve of the pouch he was wearing, then slid her palm further round so they could feel the warmth of it together. The texture had changed as it expanded over the months, as baby

Will grew and the pouch filled … In its squidgy early days she'd gently pressed her face onto the soft cover … The pressure of her touch passed through the cover and bio-membrane, just like through clothes and skin. In response she felt baby Will give a soft impatient kick" (29-30). While the ectogenetic imaginary in *The Growing Season* acknowledges, to a large extent, the centrality of affective touch in gestation, what is missing, of course, is the "maternal" touch of the intrauterine world. Indeed, any ecotogenesis technology, which positions the human womb as little more than "just a clever incubator" (Gosden 2000: 182), will necessarily fail to recognize the potential significance of the inner communication that happens between the biological "maternal" body and the womb-bound foetus, where a feotus's movements and affective states can stimulate the maternal sympathetic nervous system to "respond" through contractions and movements. Recalling Lymer's words above, the "intrauterine world" is a dynamic, communicative and constitutive medium "not only moving but also rhythmic, regulated and animate" (Lymer 138). Indeed, the imaginaries of ectogenesis presented in both Sedgwick and Charnock's novels fall into a biological abstraction that, at present, cannot stand in practice. As Aristarkova writes: "Ectogentic desire, thus, while trying to mimic the mother, often presents the maternal as a mere occasion for the exchange of "matter"--fats, amino acids, immune cells, and so on--through the maternal-fetal interface" (124). In rendering the "maternal" merely a complex container with the capacity for nourishment, that can be interacted with to varying degrees, the necessarily posthuman nature of our human being is overlooked. The fact is we are not atomized, self-contained, mechanistic organisms that can be substituted and relocated without consequences. Our existence is intercorporeally entangled with other human bodies in ways that subtend our conscious, deliberate engagement with other socially constituted subjects. In short, in imagining ectogenesis as merely a matter of replacing wombs with machines, however biologically complex, both novels are loaded with transhuman assumptions that occlude our posthuman realities.

b. Imagining robots

In many ways, fictional robot mothers operate much like artificial wombs, functioning as machine substitutes designed to mimic the function and effects of their human counterparts. Caregiving companion robots, frequently termed "Mother," appear in a range of contemporary science fiction texts, including the novels *The Mother Code* (Stivers 2020), *A Closed and Common Orbit* (Chambers 2016), and television programs and films like *Raised by Wolves* (2019-) and *I Am Mother* (2019). In most cases, the robot mothers, whether benign or malignant, raise normative human children and the narrative hinges on whether these human offspring will opt to abandon (or escape, as the case may be) their machine "mother's" care in favour of more species appropriate companionship. In *I Am Mother* and *Raised by Wolves*, robots[9] gestate and rear humans who eventually discern the ethically dubious lengths their robot mothers will go to to ensure the survival of their human children. In both the film and television program, fetuses are gestated in artificial wombs, in glass tubes or plexiglass cubes, that produce healthy infants that the artificial mothers proceed to nurture and assist. The resulting children are normatively human in their appearance, habits, traits, postures and communicative styles. Indeed, despite its title, *Raised by Wolves* depicts artificial humans gestating and rearing normative human children who bear no apparent traces of their robot relations. As a result, the title takes on an ironic quality: being raised by robots is nothing like the legends and histories of humans "raised by wolves" whose intimacy with lupine primary caregivers results in "feral" children.[10] Quite the contrary, the children raised by artificial humans bear no traces of their machine intimacies.

In *I Am Mother*, the humanoid robot, "Mother," raises an infant, known as "Daughter," to young adulthood. Mother is a tall, industrial-style robot with a rectangular "head" featuring a single eye-like light that produces a Cyclops effect. There is some approximation of a face, but the overall form of the robot is aggressively mechanical -- Mother has no synthetic skin, no soft surfaces whatsoever. The robot's one concession to conventional mammalian tactility is a glowing,

presumably warm blanket it uses to hold the newborn Daughter. In the film's opening montage, the viewer sees Mother cradling and soothing the infant in its industrial arms and this provocatively incongruous image of robot maternity produces the central tension that propels much of what follows. The film is propelled by the narrative frisson of Mother's hard, mechanical materiality set against its gentle, soothing human female voice, implying that this human verbal communication provides the maternal care necessary to support Daughter's normative human development. The montage depicts the incredible "success" of this development, showing how Daughter has become an exceptional, ethical human being, at least according to the film's liberal humanist moral framework.[11] The film imagines ontogenesis as a mechanical process in which discrete human individuals develop with support from, but not in co-constitutive relation to, the material bodies around them. As a result, Daughter develops as a (cinematically) "normal" young woman: beautiful, elegant, graceful, thoughtful, loyal, moral, and so on. There are no corporeal signs of her robot parentage; watching videos of humans has apparently taught her ballet and comedy; listening to Mother's "maternal" voice has taught her kindness and concern. In these ways, the film prioritizes the formative role of non-tactile senses of sight and hearing -- even the role of taste is covered in scenes of Daughter eating. However, except for the early images of infant Daughter in the warming blanket, touch remains largely unconsidered.

Stivers' novel *The Mother Code* similarly proposes soft, human-like tactility as crucial to robotic maternity, a tactility limited to a single modality, in this case, the robot mothers' "soft inner hands" (86). The robot's designers acknowledge that "when interacting with their children, the Gen5 will require a gentle touch, a precise touch. But to deal with the outside world, they will also require power, strength. We knew we couldn't create both in one rig. So, we engineered a manifold appendage" (103). The Mother's double hand -- "a tough, carbon-composite outer shell from which a delicate 'secondary' hand . . like a small black orchid sprout[s]" (104) -- is emblematic of the novel's approach to technology, which maintains machine/human division despite its apparent

posthuman premise of machine-human relationality. At the novel's conclusion, the robot-gestated and -reared child, Kai, senses the presence of his "real human being" mother, whose personality provided the founding "code" for the robot surrogate, within his mother robot. He attempts to reverse the substitution -- mother robot for human mother -- with his imagination, "willing with all his might to shut out the vision of [his mother, Rosie] as a powerful machine, to hold in his mind the image of his mother, the flesh and blood at the heart of her metal shell" (314). There is no commingling here, but rather a series of neat substitutions: soft human-like hands tucked inside strong machine hands; human souls tucked inside robot shells. As a result, the robot's mechanicity is effaced and normative humanness is both preserved and reproduced: Kai can "feel" his "real human" mother through the robot surrogate, "the way that one person feles another" (314), a feeling that is metaphorical, rather than material; tactility has no apparent bearing on their relationship or ontology. The novel preserves (literally) essentialist notions of motherhood in its depiction of "the Mother Code, a computer code meant to embody the very *essence* of motherhood" (emphasis added 74), overlooking the potential material entanglements of robot care. Much like science fiction featuring artificial wombs, speculative accounts of robot mothers efface intercorporeality, treating maternal, infant, and child subjects as discrete, primarily cognitive beings who remain unaffected by technological substitutions.

Conclusions

Fictions of artificial wombs and robot care provide insight into the humanist paradigms of maternity and human development that pervade public imaginaries, imaginaries that are further reified in emerging gestation and childcare technologies. In this way, gestational and childcare technologies embody transhumanist, that is to say, technologically-inflected humanist, assumptions about "the human" as a discrete, sovereign individual. The predominant imaginaries that guide the development of these "maternal" technologies are indebted to what Barad terms an "atomistic

metaphysics," to "the idea that the world is composed of individuals with separately attributable properties" (812 -13). While there is a risk that our use of the term "posthuman touch" could be mistaken for a reference to a more transhuman phenomenon (machines augmenting or replacing human bodies in pursuit of perfect invulnerability) guided by such an "atomistic metaphysics." In fact, we are suggesting that these techno-maternal interventions and innovations actually *overlook* the posthuman materiality of pregnancy, maternity, child development. These "maternal" technologies are imagined, designed and implemented according to a distinctly humanist vision of gestation and infancy, of individual/world relations. In doing so, they ignore and overlook the posthuman entanglement of human animal life.

The assumption that parts of "maternity" can simply be replaced with machines stems from a humanist vision of pre-existing subjects in a mother/child (instrumentalist) dyadic relation. As Irina Aristarkova argues, a fundamental flaw in ectogenesis research is the assumption "that the embryo and the mother are two separate and therefore separable entities" (2005, 51). This logic, Aristarkova argues is driven by a patriarchal "devaluation of maternal participation in the process of human development devaluation of maternal" (Aristarkova 2005, 51), and guides the development, not just of ectogenetic technologies, but also of postnatal maternal technologies such as so-called mother or nanny robots, where human caregivers are imagined to be easily supplanted by robotic equivalents. As a result, the texts and technologies we have examined are dominated by transhumanist, rather than posthuman, logics, where machines simply and unproblematically replace humans and their physical, social and intersubjective processes.

As discussed above, evidence from neuroscience, developmental psychology, anthropology and sociology confirms that touch plays a crucial role in infant survival and development, making it fundamental for and constitutive of (human) animal being (e.g., Stack 2001). However, "maternal" technologies, real and imagined, largely ignore the formative, fundamental role of touch as "the most basic mammalian maternal behavior" (Feldman 373), treating gestation and child rearing as

straightforwardly mechanical behaviours and tasks that can be fulfilled by any appropriately programmed body. In other words, cultural and scientific imaginaries of artificial wombs and childcare robots rely on and reproduce models of discrete, interchangeable, instrumentalized bodies,[12] ignoring the complex tactile relationality that forges human animal being from gestation through infancy to early childhood. This approach reinforces humanist visions of human beings as independent units largely unmarked by, and untethered to the material environments (human and otherwise) that produce and sustain them. As a result, we regard these technologies and their fictional counterparts as problematic in their repetition and amplification of instrumentalist, utilitarian models of the humanist -- that is, individualist and autonomous -- human. With some notable exceptions, science fiction frequently imagines humans (even *in utero* and infancy) as individual, cognitive subjects whose personhood, agency and materiality are only tangentially related to the embodied world they inhabit and engage. In general, these fictions pay little attention to the impacts and possibilities of posthuman touch and the embodied contact that is depicted is treated as inconsequential. Our phenomenological approach to these "maternal" technologies, real and imagined, questions how far technology can (or even should) intercede for "maternal" touch, and, furthermore, what the impacts and effects of such technological substitutions might be. Through our analysis we have suggested that a posthuman inflection that acknowledges the significance of "maternal" touch and intercorporeal embodiment should be foundational for the development and implementation of "maternal" technologies.

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[1] See, for example, Devlin, Lewis, Perry, Winter on the Biobag and the article "Brave new world? Artificial womb prototype offering hope for premature babies" about the Eindhoven project.

[2] In her book *Sex Robots and Vegan Meat*, journalist Jenny Kleeman describes the carefully choreographed images of the "Biobag" depicted in the promotional video created by CHOP's communications department (196). As Kleeman points out, the video contains no photographs or videos of the actual artificial womb in use, relying on black and white drawings and researcher interviews to communicate the details of the project.

[3] For further details, see Sharkey and Sharkey; Egon van den Broek.

[4] See, for example, Emre.

[5] See, for example, Dolezal, ""Phenomenology and Intercorporeality"; Lymer, "Merleau-Ponty and the Affective Maternal-Foetal Relation," Miglio, "Affective Schemas"; Wynn, "The Early Relationship of Mother and Pre-Infant."

[6] "Fetomaternal microchimerism (FMc) is a special form of chimerism observed in placental vertebrates in whom a small number of fetal cells called PAPCs migrate into the mother and integrate into maternal organs during pregnancy" (Tan et al. 16). This common sharing of DNA is, according to Shildrick, one of many "scenarios that do not fit the oppositional self/non-self paradigm" (16).

[7] Roboticist Illah Reza Nourbakhsh opens his book *Robot Future* with an account of his first viewing of *Star Wars* (1977), which, he claims, initiated "my love affair with robots" He goes on to suggest the film did the same "for an entire generation of robotics researchers" (xiii).

[8] For more on speculative fiction as the "testbed of futurity," see Stuart Murray's "Disability Embodiment, Speculative Fiction, and the Testbed of Futurity," forthcoming in the *Journal of Literary and Cultural Disability Studies* (2021).

[9] The artificial parents in *Raised by Wolves* are referred to as androids, rather than robots. Androids are humanoid robots and the tropes and narrative stakes associated with the android mother is much the same as the more visibly mechanical robot mothers in *I Am Mother* and *The Mother Code*.

[10] There is a large body of popular and scholarly work exploring narratives, mythical and historical, of feral children, those, like Amala and Kamala, the so-called "wolf girls of midnapore," allegedly reared by nonhuman animals. Scholarship, sensational histories, films and novels about feral children share a fascination with the markedly non-normative humans that result from extended and exclusive close contact with nonhuman animals during childhood, children whose postures, gait, facial expressions, eating habits, communication, and more, tend to mimic those of their nonhuman companions. For further details, see Michael Newton's *Savage Girls, Wild Boys: A History of Feral Children* and Adriana S. Benzaquén's, *Encounters with Wild Children: Temptation and Disappointment in the Study of Human Nature*.

[11] The film depicts Mother's moral instruction and testing, which rehearses deontological and consequentialist perspectives and challenges Daughter to conduct thought experiments akin to Philippa Foot's infamous trolly dilemma ethical quandaries. These scenes rely on the kind of universalizing morality critiqued by Carol Gillian in *A Different Voice* in their depiction of morality as a series of neat, decontextualized equations.

[12] In her essay, "Ectogenesis and Mother as Machine," Aristarkova discusses the "Mechanization of the maternal body in philosophy and the life" to highlight a fundamental flaw in ectogenesis research, namely, the assumption "that the embryo and the mother are two separate and therefore separable entities." She reads ectogensis as part of a history of "devaluation of maternal participation in the process of human development devaluation of maternal" (51).