Nuclear Families: Mitochondrial replacement techniques and the regulation of parenthood

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Abstract

Since mitochondrial replacement techniques (MRT) were developed and clinically introduced in the UK, there has been much discussion of whether these lead to children borne of three parents. In the UK, regulation of MRT has dealt with this by stipulating that egg donors for the purposes of MRT are not genetic parents even though they contribute mitochondrial DNA to offspring. In this paper, I examine the way that the Human Fertilisation and Embryology Act in the UK manages the question of parentage. I argue that the Act breaks the link typically made between genetic causation and genetic parenthood by redefining genetic causation solely in terms of nuclear genetics. Along with this, mitochondrial DNA is construed as a kind of supplement to the nuclear family. Drawing on the account of the supplement developed by Jacques Derrida, I argue that mitochondrial DNA, and the women who donate it, are seen as both essential to establishing the nuclear family, but also exterior to and insignificant for it.

Keywords: mitochondrial replacement techniques (MRT), parenthood, regulation of human reproduction, reproductive ethics, mitochondrial donation

The clinical use of mitochondrial replacement techniques (MRT)[1] was legalized in the UK through modifications to the Human Fertilisation and Embryology Act in 2015. Despite the fact that babies have been born using MRT in other countries, including Mexico and the Ukraine, the UK currently remains the only country in the world with specific legislation addressing MRT. Other countries, such as Singapore and Australia, are currently undertaking consultation processes to consider whether to make MRT clinically available in those countries as well, and these take their lead from the UK legislation.

[1] The best terminology to use to identify this technology is itself a matter of debate. While often termed mitochondrial donation, I avoid this terminology as it contributes to the view that what is being donated is "only" the mitochondria. This is misleading, since what is donated is the whole egg, though the nuclear DNA from the donated egg is ultimately discarded. The term "mitochondrial replacement therapy" prejudices the issue of whether the techniques are in fact therapeutic. Hence, throughout this paper, I maintain the acronym MRT to remain consistent with established terminology but take this to stand for "Mitochondrial Replacement Techniques" (See also Rulli 2017; Baylis 2017).

While there continue to be a number of ethical and practical concerns raised about MRT, perhaps the one that has most captured the public imagination is that of parentage. For a long time, it has been understood that all human offspring have two genetic progenitors, who could be considered parents by virtue of that genetic relationship. MRT challenge that presumption, since they involve the use of genetic material from three people in the creation of embryos. This has led to the media portrayal of them as giving rise to "three-parent babies," as well as to scholarly debate on whether mitochondrial donors meet criteria for being a parent.

My aim in this paper is to examine the way that the question of parentage has been dealt with in the Human Fertilisation and Embryology Act and modifications for MRT, as well as the reasoning underpinning those. I do not make a case for mitochondrial donors to be considered parents (or not) as such; rather, my focus is on *how parentage is regulated*, specifically in relation to MRT, but with implications for reproductive technologies more generally. The advantage of this approach is that it allows for a clearer view of the ways that the interactions between law and technology structure and make possible certain familial relations than has hitherto been the case in scholarly debates on MRT. As with other reproductive technologies, MRT is implicated in a tension in how new reproductive technologies make possible a diversity of new family forms while at the same time precipitating the regulation of that diversity.

From this perspective we see that in the UK regulation of MRT has dealt with parentage by stipulating that egg donors for the purposes of MRT are not legal, and perhaps not even genetic, parents, even though they contribute mitochondrial DNA to offspring created using the technology. It has long been recognized that being a genetic progenitor is neither necessary nor sufficient (as in adoption or gamete donation) to establish legal parenthood. Yet, it is something else to suggest that being a *genetic progenitor* is not sufficient to establish *genetic parenthood*. And yet, this is precisely what the UK regulation entails: with egg donation for MRT, genetic causality is no longer tied to genetic parenthood (see further NCoB 2012, 89; HSBD 2014b, 15-16). I contend that this is because, for the purposes of MRT at least, kinship is understood specifically in terms of nuclear DNA, hence, *nuclear families*. Mitochondrial DNA, I argue, is construed as a kind of supplement to the nuclear family. Drawing on the account of the logic of the supplement developed by Jacques Derrida, I argue that mitochondrial DNA, and the women who donate it, are seen as both essential to establishing the nuclear family, but also exterior to and insignificant for it.

In order to make this argument, I first provide a brief overview of MRT in the UK in section one of the paper. Following this, in section two, I will focus on the issue of parentage; in particular, I consider how this is defined in the Human Fertilisation and Embryology Act 2008, and the subsequent 2015 regulations to allow MRT. Central to my interest here is the way that the legislation negotiates different ways of attributing and permitting parenthood, including for gamete donors, while explicitly excluding egg donors for the purposes of MRT from parentage. In the third section of the paper, I examine the various shifting and

contradictory rationalizations deployed in the documents underpinning the alteration to the Act to allow MRT and the regulation of parentage this precipitated.

MRT in the UK

Mitochondrial organelles are contained within the cytoplasm of the female gamete—the ova––and contain approximately 37 genes. Mitochondria are commonly understood as the "batteries" of the body, since they are crucial for energy production in cells throughout the human body. Mutations within mitochondrial genes may give rise to mitochondrial diseases (mtDNA diseases), with a range of symptoms, including vision impairment, muscle weakness, diabetes, and deafness amongst others. Some women may be carriers of mitochondrial mutations but remain asymptomatic; their offspring, however, may be affected by mitochondrial diseases. Only their female offspring will subsequently pass those mutated mitochondria on to their own children, though, since mitochondrial DNA—and hence, mtDNA disease—is only inherited maternally. However, mitochondrial diseases can be caused by mutations in nuclear DNA, and as such can also be inherited in standard Mendelian patterns, or can even arise *de novo* (Gorman et al. 2016). These latter forms of mitochondrial diseases are not addressed by MRT.

MRT has been developed as a means of allowing women with mitochondrial DNA mutations to have children that are genetically related to them but have a significantly reduced risk of developing mtDNA disease. This is done through the replacement of mutated mitochondria with healthy mitochondria from a donor egg in the process of conception. What is actually swapped from one egg to another, though, is not the mitochondria but the nuclear DNA, that is, the genetic material found in the nucleus of the cell, which is commonly understood as providing the instructions for organic development. There are two main techniques for this to happen. The first is maternal spindle transfer (MST), where the transfer of the nuclear DNA from the egg of the prospective mother into the egg of a donor occurs prior to fertilization. The second technique, known as pronuclear spindle transfer (PNT), is done within hours of fertilization, when the pronucleus of a newly fertilized donor egg is replaced with the pronucleus of a newly fertilized egg of the prospective mother (using sperm from the same man).[2]

Notably, MRT will not be the most appropriate technology for preventing the transmission of mutated mtDNA in all cases; this depends on mutation loads and the likelihood that the couple would be able to produce an embryo without, or with sufficiently low rates of, mutated mtDNA so as to not have a high risk of mtDNA disease. Pre-implantation genetic diagnosis may be an effective and safer option in circumstances where it is likely that at least one

[2] Some commentators have pointed out that this is effectively the same technology that could be used for reproductive cloning (Baylis 2017).

embryo would not inherit the relevant mutations or would have a sufficiently low mutation load that the future child would be unlikely to be affected by mitochondrial disease.[3]

MRT has moved into clinical application in the UK, while other countries are still in the process of considering whether to allow clinical access to the technology or not. In the UK, after a robust process of public consultation and debate, the Human Fertilisation and Embryology Act were enacted by Parliament in 2015, to allow women affected by mtDNA mutations who were seeking to reproduce to access MRT in the UK.[4] At the time of writing this paper, one clinic has been granted a license to perform MRT, and a small number of women have been approved by the Human Fertilisation and Embryology Authority (HFEA) to undertake MRT at that clinic. There has not been an announcement of a live birth following the procedure at that clinic.[5]

The use of MRT is restricted to women for whom safer selective reproductive technologies (such as preimplantation genetic diagnosis, or PGD) will not be efficacious. The HFEA Code of Practice outlines that MRT is only available to patients when there is a "particular risk" that any embryos created from eggs will have mtDNA mutations, and that there is a "significant risk" that a person with those abnormalities will have or develop mtDNA disease (HFEA 2018, 303-304). Women seeking to use MRT must exhibit high mutation loads, meaning that any embryo produced with her egg and her partner's sperm is likely to evidence similar mutations and hence, if gestated, be affected by mtDNA disease.

At this point, it is important to note that the use of MRT is not simply a matter of enabling a couple, of whom the woman carries mutated mtDNA, to become parents to a child that does not carry mtDNA mutations. That could be achieved using donated oocytes or with adoption. Instead, using MRT allows such couples to have a child that is genetically related to (at least) both of the parents and does not carry a load of mtDNA mutations that is likely to cause mtDNA disease. In this, MRT presuppose a particular value in genetic relatedness and genetic parentage. This valuation of genetic relatedness points us toward an interesting tension, if not contradiction, at issue in MRT concerning the status of the donor involved.

Genetic material – in the form of mitochondrial DNA – from the donated ovum that is used in MRT carries through to the resulting child. Given this, a central question in discussions of MRT is how the genetic contribution of the donor is to be understood, and specifically the status of the donor in terms of parentage. That is, is the donor that contributes genetic material

[3] For further detail on mitochondrial disorders and their prevention, see Thorburn and Dahl (2001) and Craven et al. (2018). In PGD, early embryos created by in vitro fertilization can have one cell removed for genetic analysis. Those embryos carrying known mutations for mitochondrial disease are then not implanted, whereas those without the mutations can be.

[4] For a thorough review of this process, see Dimond and Stephens (2018).

[5] Because of patient confidentiality, this does not mean that there has not been a live birth following use of MRT (with the clinic favoring PNT)

to the resulting child to be understood as a parent? And if not, why not, especially given the motivating significance of genetic relatedness for MRT in the first place? The potential configuration of parentage that MRT suggests has led to public debate about "three-parent babies," as well as considerable regulatory efforts to secure and limit parentage vis-a-vis MRT. In the following section, I take up this issue of parentage and gamete donation for the purposes of MRT. My task here is not to argue that donors should or should not be considered to be a parent of the child produced through MRT using their eggs; rather, I examine the way that parentage has in fact been regulated in the Human Fertilisation and Embryology Act (hereafter HFE Act 2008) and its modification in the 2015 regulations [HFE (MRT) Regulations 2015; hereafter HFE (MRT) 2015].

MRT and Parentage

Before turning to the HFE Act and its modification, it is important to have a general understanding of the forms that parentage can take. Several categories of parentage are now broadly recognized, these being legal parentage, social parentage, and biological parentage. Perhaps the most transparent of these categories is legal parentage—that is, parentage established in law, as determined in different jurisdictions and according to relevant statutes and so on. Social parentage is a broader, and somewhat looser, category. Social parents are those who have taken on the social role of parent, regardless of their biological relationship to the child; a social parent may also be, but is not necessarily, a legal parent of that child. Biological parentage relies upon the identification of a biological connection to the resulting child and may incorporate both genetic and gestational parentage, or emphasize one or the other. Gestational parentage makes the act of gestating a fetus central to the determination of parentage, while genetic parentage prioritizes genetic ties.[6]

Genetic parentage itself may break down into different conceptions, such as an informational or causal account of genetic parentage. Of these, a causal account of genetic parentage appears to be the most plausible. As several contributors to debates on genetic parenthood (eg. Kolers 2003; Sparrow 2006; Mertes 2014) have pointed out, the informational account, according to which common genetic information establishes parentage, has paradoxical results. It would mean, for instance, that the siblings of a child, with whom the child shares the genetic information, would meet the criterion for being parents of that child. Consequently, what seems to be more important is not the sharing of genetic information *per se*, but the fact that the sharing or mixing of genetic material (in coitus or other reproductive processes) brings into being or gives rise to the genesis of the child. In other words, that process or act causes the child to exist. This account of parentage brings into focus the significance of the fact that the child would not have existed *but for* the genetic contributions of its progenitors.

[6] For a defense of the gestational account of parentage, see Gheaus (2018).

Even so, causal accounts of genetic parenthood have themselves been controversial. As Avery Kolers and Tim Bayne outline, a causal account of genetic parentage involves two claims: "(1) one has original (non-derived) rights over and responsibilities to something if and only if one brings that thing into existence; (2) a child's genetic parents, and only its genetic parents, bring it into existence" (2001, 278). They question these claims, but modified versions of the causal account have been developed in order to retrieve the intuitively appealing aspects of it.[7] For my purposes, it is not necessary to ascertain which is the correct account of parentage; what matters here is how legal parentage draws on and operationalizes them in different contexts.

Legal parentage maps onto these categories of biological parenthood in various, often complex, ways. For instance, a surrogate may be considered a biological parent insofar as they are the gestational parent, even if not the genetic parent. By the same token, a woman whose eggs are used in a surrogacy arrangement may be a genetic parent while not the gestational parent. Laws and other regulatory instruments regulate and authorize the intersections and disjunctions between these different forms of parentage; for instance, in many surrogacy arrangements, the commissioning biological (genetic) parents are required to adopt their child or seek a parental order, thereby initiating the transfer of legal parentage from the surrogate biological (gestational) parents to themselves. As this suggests, reproductive technologies have had a disruptive effect on parentage, whereby different conceptions of parentage are sheared off from counterpart conceptions.

This authorizing and regulating work is apparent in the Human Fertilisation and Embryology Act in effect in the UK. In addressing the issue of parentage and reproductive technologies, the HFE Act provides clear articulations of the definitions of legal parenthood that have authority in the UK. The Act places primary importance on the mother, and defines her as "[t]he woman who is carrying or has carried a child as a result of the placing in her of an embryo or of sperm and eggs, and no other woman, is to be treated as the mother of the child" (Section 33, HFE Act 2008). This definition means that the UK legislation instantiates a gestational account of parenthood.

As a logical consequence of this gestational account, other forms of parentage in family formation using reproductive technologies are derivative of the maternal relationship. That is, the father is defined as the man married to a woman at the time of insemination or conception *in utero,* except in circumstances where he has not consented to the placement of the gametes (egg and sperm) or embryo within her uterus (Section 35, HFE Act 2008).[8] Similarly, in cases

[7] For eg. Douglas and Devolder (2018); also see Palacios-Gonzalez (2019). For an extensive discussion of genetic causality in relation to MRT, see Palacios-Gonzalez (2018).

[8] There are numerous complexities to the attribution of legal fatherhood in the Act, to allow for different circumstances of sperm donation. Discussing these is outside the scope of this paper; the key point I press here is that the Act places emphasis on the relationship to the mother, rather than the genetic connection established through sperm, in defining fatherhood.

of same-sex relationships, the partner of the mother is considered the other parent, unless they did not consent to the placement of the egg, sperm or embryo in the gestational mother's uterus. Note, however, that the female partner of the mother is not considered to be another legal mother; she is referred to as a "female parent" (Sections 42-46, HFEA Act 2008).[9] Even so, the important point is that these forms of legal parentage come about because of that person's relation to the gestational parent—the mother—not their relationship to the (future) child as such.

Interestingly, defining parentage by reference to the gestational relationship also means that within the HFE Act 2008 a woman cannot be a legal parent merely because of egg donation. The HFE Act 2008 stipulates that "[a] woman is not to be treated as the parent of a child whom she is not carrying and has not carried, except where she is so treated" [that is, by virtue of her relationship with the gestational mother] (Section 47 HFE Act 2008). This stipulation means that egg donors are not legal parents simply by virtue of their genetic contribution to the resulting child. In other words, the (causal) genetic relationship established in egg donation is not sufficient, and nor is it necessary, to establish parentage. What is both necessary *and* sufficient is gestation.

That said, as foreshadowed earlier, the HFE Act does nevertheless grant significance to genetic relationships, for instance, in regulating surrogacy arrangements. As above, gamete donors are not by virtue of that donation legal parents, though they may be the genetic progenitors (genetically causal persons) of the child. However, as a genetically causal person, the person whose gametes were used to bring a child into existence can apply to become a parent through making a claim for parental orders. Section 54 of the HFE Act sets out the conditions for parental orders and stipulates that one of the conditions for legitimate claims to parental orders is that "the gametes of at least one of the applicants were used to bring about the creation of the embryo" (HFE Act 2008). The emphasis here on "bringing about" the child indicates that what is at work here is a causal account of genetic parenthood.

Given these legal parameters for determining parentage, including parental orders, how does the HFE Act relate to MRT and what is the parentage status of the donor? Because MRT involves the use of genetic and reproductive material from three people—the egg donor providing mitochondrial DNA, the woman providing the nuclear DNA (who is presumed to gestate the child) and the man who provides the sperm[10]—offspring of this technology were

[9] Thus, even if lesbian couples were able to access MRT, under the existing HFE Act only one of those women would be recognized as the legal mother, that is, the one who gestates. The partner may be a female parent, but not a mother, and even that not by virtue of her genetic connection to the resulting child but by virtue of her relationship to the legal mother. Of course, this does not negate the fact that for some couples using MRT may establish genetic motherhood in their own perception, regardless of what the law says on the matter. See Cavaliere and Palacios-Gonzalez (2018).

[10] Typically, the man providing the sperm would be the partner of the woman who provides nuclear DNA and gestation; hence he would be the father. It is conceivable, though, that the sperm would be donated by a man who is not her partner; then the gamete donor would not be the father. It is also

initially dubbed “three parent babies” in the media and popular discussions. The resulting child would contain the nuclear DNA of two people and these two people would typically be the legal “mother” and “father,” assuming that the embryo was in fact gestated by the woman whose nuclear DNA was used. However, the child would also contain the mitochondrial DNA of a third person, the egg donor.

Interestingly, the HFE Act explicitly rules out the possibility of the donor for MRT being considered a legal parent, modifying section 54 such that “where a child has been born following treatment services a person who donated mitochondria is *not eligible* to apply for a parental order on the basis of that donation alone” (HFE (MRT) 2015). In effect, despite their causal genetic connection to the resulting child, donors that provide eggs for use in MRT arrangements are *not* accorded the same legal status as other gamete donors. In order to understand why this is the case, and to consider the implications of the cordoning off of mitochondrial donors, we need to take a broader look at the rationale underpinning this exceptional status.

Regulating alterity in reproduction

In this section, I turn to the rationale used to underpin the status of ova donors for the purposes of MRT in the HFE Act. Looking at other documents, we can see that the exclusion of ova donors for MRT from parentage rests on two key claims, which can be identified as the organ donor claim and the personal identity claim. Both of these have previously been the target of critical discussions, but these do not yet bring out the full implications of how the claims work together to bolster a particular version of family formation. I elaborate the claims in turn, before considering their broader implications.

As I noted above, in 2015 regulations were introduced in the UK to allow for MRT being used in assisted reproduction to prevent mitochondrial disease caused by mitochondrial mutations. Along with that, section 54 (relating to parental orders) of the HFE Act 2008 was modified in order to explicitly and specifically exclude women who donate eggs for use in MRT from the possibility of lodging a claim to parentage. The capacity to make a claim on the basis of gamete donation is necessary to allow commissioning parents in surrogacy arrangements to become the legal parents of the child born of their gametes but gestated by another woman, who in the UK is considered the mother until parentage is transferred to the commissioning parents. However, in the context of MRT, this introduces the theoretical possibility that the egg donor may make a parenting claim; and in order to foreclose that, such donors are explicitly excluded from that possibility. To summarize, then, in order to exclude the third person in surrogacy arrangements—that is, the surrogate—and allow the

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conceivable that the gestator of the re-nucleated egg is neither the mitochondrial donor nor the female nuclear donor. This proliferation of different forms of parentage makes it apparent how even the terminology of “three parent babies” is premised upon a heteronormative imaginary.

commissioning parents to take the position of legal parents, it is essential that gamete donation can underpin claims to parentage; however, to do the same in MRT, the exclusion of the third person—the gamete donor—requires that gamete donation *must not* be construed as a basis for making a parenting claim.

In order to achieve that, egg donors for MRT are themselves redefined. According to consultation documents on draft regulations produced by the UK Department of Health (Health Science and Bioethics Division 2014a, 20; also see 2014b, 29), they are to be construed not as gamete donors (despite the fact that they donate gametes), but as *more like* organ donors. This is puzzling for two reasons. First, this organ donor claim establishes an analogy between the donation of organelles and the living donation of solid organs such as kidneys. However, the donation of one entails the transfer of inheritable genetic material and the other does not. Second, while organ transplant may be understood as repairing an existing body, there is no obvious sense in which this would be true of MRT. In maternal spindle transfer, what might be said to be "repaired" is a gamete, and even in pronuclear transfer, one is hard-pressed to recognize the just-fertilized egg as a pre-existent body. In both cases, the "repair" gives rise to a new body—one that did not and would not have existed without the "repair."[11]

The tension in the organ donor claims is especially apparent when we keep in mind that donors of mitochondria donate not simply the mitochondrial organelles but rather the whole egg, which is then denucleated to allow transfer of the nuclear DNA from the intended mother. Once fertilized, the egg, including cytoplasmic components other than mitochondria, gives rise not only to the embryo but also to the placenta, which ultimately allows implantation and gestation. In essence, the donor egg helps to make possible in a very literal sense the coming into and ongoing existence of the embryo, through its implantation and development *in utero*.[12]

This points to difficulties in the second claim that underpins the exclusion of ova donors for MRT from parentage, that is, the personal identity claim. The key claim here is that mitochondrial DNA does not impact upon the personal characteristics and traits of the child born through MRT, since these come from the nuclear DNA (Health Science and Bioethics Division 2014a; 2014b).[13] Put differently, nuclear DNA is constitutive of personal characteristics and traits, whereas mitochondrial DNA is construed as having no impact on

[11] Notwithstanding the phenomenology of transplant, in which the body created through transplant may be experienced as "new" and not pre-existent. See Svenaeus (2012) and Sharp (2006).

[12] Note that the claim here is not presuming a continuity of numerical identity between the early embryo and subsequent child. The point is simply that the material structures of the egg, including those in the cytoplasm, contribute to the implantation, development, and gestation of the embryo itself. On the complex question of numerical identity, see Liao (2017).

[13] Note that the Nuffield Council on Bioethics Working Group on mitochondrial donation took a different view on identity issues (NCoB 2012, 52-57)

them. This view raises several interesting questions about genetics and identity, some of which have been discussed previously in regard to MRT (see Bredenoord et al. 2011; Wrigley, Wilkinson and Appleby 2015; Scully 2017; Palacios-Gonzalez 2018). Not least of these relates to the relationship of disease to personal characteristics and traits, or what is sometimes called qualitative identity. That is, is a genetic disease (such as mitochondrial disease) a personal characteristic, and therefore part of a person's qualitative identity? The intuitive response to this is that having a genetic disease or not does indeed matter for who one is, that is, for one's qualitative identity. Does it, then, make a difference whether that genetic disease arises from nuclear DNA or mitochondrial DNA? It seems counter-intuitive to suggest that qualitative identity is affected in the case of genetic diseases caused by nuclear DNA, but not in the case of genetic diseases caused by mtDNA, but that is the view proposed in the identity claim.[14]

Furthermore, on the face of it, the personal identity claim stands in tension with the organ donor claim in one important respect. The organ donor claim implies that MRT has a qualitative impact on personal identity insofar as MRT is construed as repairing a pre-existent body *á la* solid organ transplants. However, the personal identity claim rejects precisely this implication: the claim there is that the use of donated mitochondrial DNA *does not* impact on the qualitative identity of the resulting child, or, at least, that it does not affect identity in a sufficiently significant way as to warrant claims to parentage. Relatedly, nor is it sufficiently significant to warrant practices such as donor identification, for instance, that are increasingly normalized in relation to gamete donors in other contexts.[15]

What becomes apparent here is that the exclusion of ova donors from the possibility of parentage in the HFE Act actually introduces a split between a causal genetic relatedness and genetic parentage. That is, while the gestational model of parentage that the Act relies upon means that *causal genetic relatedness* does not necessarily give rise to *legal parentage*, it is something else again to suggest that it may not even be sufficient to establish *genetic parentage*. As Kolers and Bayne point out, the causal accounts of parentage rest on the view that "a child's genetic parents, and only its genetic parents, bring it into existence." (2001,

[14] One implication of my point here is that MRT has an impact on qualitative identity. Consider the question counterfactually: is the child born of this particular egg (maternal nuclear DNA and donated mtDNA) and sperm combination with MRT qualitatively different from a child that would have been born of this particular egg (maternal nuclear DNA and maternal mtDNA) and sperm combination (all other things being equal) without MRT? The *prima facie* answer to this question is yes, since one will have a high risk of developing mtDNA disease and the other will not. For further discussion of the view that MRT makes a qualitative difference to the characteristics of a person (albeit at the early embryonic stage) see Bredenoord, Dondorp, Pennings, and Wert (2011).There may be further complexities relating to whether PNT or MST is used, but it is not necessary to tease these out for my purposes here.

[15] On the issue of donor identification, see Turkmendag (2017); and Appleby (2017).

278)[16] Whether the inverse—that a person who genetically brings into existence a child is its genetic parent—also holds in general may be a moot point; however, as regards MRT in the UK regulations, the causal connection is definitively broken and so is its significance for parentage. In other words, while the child of MRT would not have come into existence *but for* egg donation, and genetic material from the egg donor carries over into the child, the egg donor is not to be considered a genetic parent.

The introduction of this split is interesting when we recall that MRT provides a way for prospective parents to have not a healthy child as such, but a child that is (causally) genetically related to both parents (Kolers and Bayne 2001, 278).[17] In order to allow that, while also excluding the third person from genetic parentage, genetic causality and genetic parentage is more specifically defined in terms of *nuclear DNA.* This gives a particular twist to the idea of the nuclear family. Furthermore, in so characterizing the nuclear family, mitochondrial DNA (and the women who donate it) is cast as supplementary to the real genetic connectedness entailed in family formation. Let me elaborate this point.

Identifying or drawing out the logic of the supplement was a central aspect of the approach to textual analysis developed by Jacques Derrida, called deconstruction. For Derrida, the supplement is an element within an argument or text that is essential to that argument or text but simultaneously cast as extraneous to it. In other words, the supplement in a logical system is something that is seen as both foundational to a particular way of thinking, and simultaneously cast as superfluous to it. As he puts it, "what is necessary—what is lacking—also presents itself as a surplus, an overabundance of value, a frivolous futility that would have to be subtracted, although it makes all commerce possible" (Derrida cited in Bernasconi 2014, 22). Going further, the supplement makes the system possible while always rendering it unstable and threatening destruction. Because of that, the supplement is also cast as external to the system, (while remaining essential to its justification or functioning).[18] While Derrida's

[16] Arguably, one reason that makes the exclusion of mitochondrial donors from parentage desirable is the fact that mitochondrial genomes are not unique to particular individuals; rather they are found in broad groupings called haplotypes. One might suggest, then, that the basis for excluding a donor is that the shared genetic connection between her and the child would also mean that all other members of that haplotype were also parents. This is obviously undesirable. However, this view confuses an informational and causal understanding of genetic relatedness. No one but the donor in that haplogroup *causes* the child to come into existence, even if they share genetic information.

[17] In fact, as the use of MRT precludes subsequent use of PGD for genetic testing of the embryo prior to implantation, it may be argued that MRT actually contributes to decreasing the likelihood of a healthy child being born. See Human Fertilisation & Embryology Authority Human Fertilisation & Embryology Authority (2016, 32); Human Fertilisation & Embryology Authority (2018, 305).

[18] For an example of Derrida's approach to the logic of the supplement, see his discussion of Jean-Jacques Rousseau's conception of the natural in *Of Grammatology*. Derrida shows how Rousseau defined the "natural" and the "maternal" both as what "*ought to be* self-sufficient" and yet defined by processes of "substitution" (*Of Grammatology*, 145-146). Of course, Derrida's account of the supplement is contestable; however, I am not setting out to defend it here. That is a task for a very different paper.

writing is not always easy to parse, this insight into the supplement is illuminating for thinking about the status of mitochondrial DNA in the discussions of MRT and its regulation in the UK.

The regulation of MRT illustrates the logic of the supplement remarkably well. In the two claims underpinning the exclusion of the ova donor for MRT from parentage discussed above, mitochondrial DNA is simultaneously recognized as foundational to the reproduction of the nuclear family, and cast as a frivolous extra that can be excluded from it; that is, it is seen as supplemental to the nuclear family. There are three ways in which this logic is apparent. First, in the organ donor claim, ova donation in the context of MRT is construed as simultaneously a matter of reproduction, and yet not a matter of reproduction. It is reproduction insofar as the donor gametes are required for completing the project of having a child that is genetically related to (at least) both parents; yet, it is not a matter of reproduction insofar as the mitochondrial organelles are treated as akin to organs, the donation of which might repair a pre-existent body but not give rise to one that would otherwise not exist.

Second, within discussions around MRT, mitochondria are understood as having a dual status. On the one hand, mitochondria are recognized to be of crucial importance: they are the "batteries" of the body,[19] multiple copies of which exist in all bodily cells (except red blood cells) in the human body. Their disfunction is also clearly significant, insofar as it may cause devastating conditions. Indeed, they are sufficiently significant that legislative reform and significant public expenditure was required to allow the technology that would assist in preventing the transmission of mutated mitochondria from one generation to the next. On the other hand, though, they are said to be not especially significant: they are said to have no impact on personal qualitative identity and, consequently, do not warrant the possibility of donors being understood as genetic—let alone legal—parents.

Third, while mitochondrial DNA is rightly understood as genetic material, it is also construed as *not really* genetic. For instance, it is not understood as establishing a genetic relationship that might warrant practices such as permitting the identification of donors to resulting children at young adulthood, as is the case for other donors of gametes for the purposes of reproduction. Nor does it, as I have suggested, underpin a relationship of genetic parentage. Instead, mitochondria is treated as exceptional to the rules of genetics, which are based on characteristics of nuclear DNA. In short, there is a sense in which mitochondrial DNA is cast as the feminine other of the (masculine) norm of nuclear DNA.[20]

[19] Though also see Turkmendag (2017) on the way that the battery metaphor was used in UK debates to downplay the significance of mitochondria. This metaphor is itself an illustration of how the supplemental logic that I am drawing out works, in that, as a battery, mitochondria as seen as both essential (the power source without which the body/thing cannot function) but also inessential (only the battery, which can be replaced without changing the essence of the body/thing itself).

[20] On the cultural understanding of nuclear DNA as masculinist, see Rothman (1995).

The debates around MRT demonstrate that mitochondria and mitochondrial DNA do not fit well with hegemonic ways of thinking about genes and genetics. Broadly speaking, genes are construed as a set of instructions that ultimately make us who we are; genes more or less strictly determine our individuality. There is, then, at least a rhetorical connection made between genes and uniqueness. Furthermore, it is commonly understood that we are who we are because we inherit genes from our parents (as genetic progenitors), and roughly equally from both of them. In short, the inheritance of genes both connects us to our progenitors and makes us distinct from them and from all other persons (except identical siblings or, potentially, clones).

The small number of genes found in mitochondria do not fit within this cultural template. Individuals do not have unique admixtures of mitochondrial genes, as they are inherited wholly from the maternal line. Further, mitochondrial genomes are oddly communal; by not combining, they remain largely unchanged through the generations, with differences in genes arising in large groupings or haplotypes. Finally, while each cell in the resultant child carries a single copy of its parent's genes, they can contain multiple copies of mitochondrial genes. Given these differences in inheritance, mitochondrial genes challenge a basic set of assumptions made about genetic material, and, in doing so, require a rethinking of the "ontology" of the gene that commonly underpins ideas about genetics, personal identity, and parenthood.

This points to the ways that family formation is gendered along specific culturally accepted norms, and reproductive technologies such as MRT participate in these norms, even while "troubling" them (Butler 1990). Danielle Griffiths (2016) has discussed MRT in the context of the preservation of the heteronormative family unit, suggesting that while the technology may have potential to undermine the idealized family unit, construed as two parents with children genetically related to each conceived within the relationship, the law around it bolsters the cultural legitimacy of this understanding of the family. With Derrida's notion of the supplement in hand, we can see that the important point, though, is not simply that the regulation of MRT reinforces the cultural hegemony of the idealized heteronormative family unit, even while the technology of MRT appears to challenge it. Rather, MRT and its regulation reveal how the idealized heteronormative family unit is both dependent on the supplement of mitochondrial DNA and destabilized by it. This logic is not unique to the regulation of MRT, though is perhaps made most evident in it.

MRT stands out in this regard because it crystallizes two particular ways of understanding the supplementarity at the heart of the nuclear family. Looking back at the quote from Derrida earlier, a supplement (in his view) can only be added to something that is itself incomplete and, in doing so, reveals that incompleteness. If we can take this at face value, MRT makes apparent that the nuclear family is itself unstable, with its appearance of stability achieved through a constant management and regulation of alterity—that is, something other than the nuclear reproductive unit—from the nuclear reproductive unit, even while it depends on that

alterity for its own formation. One way in which this occurs is through regulation and laws that establish who can or cannot make claims to parentage in forms of reproduction and family formation that involve a third person such as a gamete donor or surrogate. Another way in which it occurs is through the exteriorization of non-nuclear DNA—such as mitochondrial DNA—from the real (nuclear) genetic relationship understood to be at the heart of reproduction. The kick in this, of course, is that mitochondrial DNA is nevertheless essential to reproduction. Even while the idealized heteronormative imaginary of the nuclear family cannot abide mitochondrial DNA, it cannot do without it.

That said, I am not claiming that the HFE Act is informed by the *intent* to maintain the heteronormative family unit; I only point out that this is one of the effects of the regulation of parentage in the Act, which privileges the nuclear genetic connection and relies on the contradictory logic that I have outlined to exclude donors for the purposes of MRT from parentage claims. Indeed, this may be a mere side effect of a more pressing political agenda. Specifically, what is at stake in the drive to break apart mitochondrial and nuclear DNA is a political imperative to distinguish between MRT and techniques that allow for inheritable modification of the human nuclear genome, such as that foreshadowed by the CRISPR-Cas9 system for genome editing.

As Karine Ludlow discusses, while the authors of the UK Department of Health Report allow that MRT may be a form of inheritable genome modification, they nevertheless contend that it is *not* a form of inheritable genetic modification (Ludlow 2018). This is because the latter is defined as modifications to nuclear DNA only. Thus, the definition of the genetically causal parental relationship in terms of nuclear DNA is necessitated by the political imperative to allow MRT while retaining the impermissibility of inheritable modifications to the nuclear genome, such as through genome editing. At this point, it becomes clear that what is at stake in the construal of parentage in terms of nuclear DNA is not only a particular image of the ideal family, but also the regulatory relationship of MRT to another technology, namely, genome editing.

Concluding remarks

MRT has generated significant discussion around matters of parentage, since the children borne of MRT contain genetic material from the gametes of three people. My aim in this paper was to examine the way that parentage has been dealt with in the Human Fertilisation and Embryology Act and its modifications for MRT and the reasoning underpinning those modifications. What is interesting about this is that the UK regulation stipulates that gamete donors for the purposes of MRT have a parental status different from gamete donors for the purposes of other assisted reproductive projects, such as surrogacy arrangements. Specifically, the HFE Act institutes a split between being a genetic progenitor (that is, a

person in a genetically causal relationship to the resulting child) and being a genetic parent. This is because parentage is construed in terms of nuclear DNA, and, I argue, mitochondrial DNA is cast as *supplementary* to the form of the nuclear family and the genetic parental relationship generated by genetic causality. That is to say, it is cast as both essential and extraneous to reproduction in and of the nuclear family form. This construal of mtDNA, and the women who donate their eggs for MRT, appears throughout the rationalizations underpinning the regulation of MRT such as in the organ donor claim and personal identity claim that I discussed.

Significantly, though, the stakes of this are not simply a matter of reinforcing a particularly heteronormative family form; rather, what is also at issue is the extent to which MRT will act as a kind of wedge technology for genome editing. The political imperative that countries currently seeking to allow access to MRT face is the quandary of separating out one form of heritable genome modification from another, that is, distinguishing between MRT and genome editing using techniques such as the CRISPR-Cas9 tool. The UK has achieved this by shearing off mitochondrial DNA, such that what counts as properly genetic for the purposes of regulating inheritable genetic modifications to human embryos is only nuclear DNA. Whether regulators in other countries take the same path will depend in part on their willingness to embrace the same contradictory logic of the supplement adopted by the UK.

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