

Orphaned at conception: The uncanny offspring of embryos

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ABSTRACT

A number of advances in assisted reproduction have been greeted by the accusation that they would produce children ‘without parents’. In this paper I will argue that while to date these accusations have been false, there is a limited but important sense in which they would be true of children born of a reproductive technology that is now on the horizon. If our genetic parents are those individuals from whom we have inherited 50% of our genes, then, unlike in any other reproductive scenario, children who were conceived from gametes derived from stem cell lines derived from discarded IVF embryos would have no genetic parents! This paper defends this claim and investigates its ethical implications. I argue that there are reasons to think that the creation of such embryos might be morally superior to the existing alternatives in an important set of circumstances.

KEYWORDS

Gametes; Stem Cells; Ethics; Parenthood; Genetic relatedness; Embryos.

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INTRODUCTION

New developments in reproductive technologies often provoke fears about the future of the family. A number of advances in assisted reproduction have been greeted by the accusation that they would produce children ‘without parents’. In this paper I will argue that while to date these accusations have been false, there is a limited but important sense in which they would be true of children born of a reproductive technology that is now on the horizon. Several recent scientific results suggest that it may eventually be possible to derive functional gametes from human stem cell lines.¹ If our genetic parents are those individuals from whom we have inherited 50% of our genes, then, unlike in any other reproductive scenario, children who were conceived from gametes derived from stem cell lines derived from discarded IVF embryos would have no genetic parents! While they would have a genetic relationship with the embryos from which the gametes from which they were conceived were derived, there would never have existed any living person who could plausibly be called their genetic parent. This paper defends this claim and investigates its ethical implications. I argue that there are reasons to think that the creation of such embryos might be morally justified in an important set of circumstances.

PARENTING AND NEW REPRODUCTIVE TECHNOLOGIES

Given the role played by sex and reproduction in the human life cycle and in structuring social relations, it is little wonder that developments in assisted reproductive technologies have often met with concerns about their implications for the meaning of sex and reproduction and the concepts surrounding them, including relationships within the family. One fear that has come up a number of times in the history of the development of reproductive technologies is that these technologies make possible the birth of children ‘without parents’. As human infants are very dependent upon care in early childhood and because our relationships with our parents are typically our most formative relationships, the prospect that some children might not have parents is usually thought to be an extremely bad thing.

Thus, for instance, when artificial insemination by donor and then in-vitro fertilisation were first developed, several commentators protested that, by divorcing sex and reproduction, these technologies also threatened relationships within the family.² The children born as a result of IVF were described as ‘test-tube babies’ and critics expressed concerns that the

¹ P. Whittaker. Stem Cells to Gametes: How Far Should We Go? *Hum Fertil* 2007; 10: 1–5.

² J. Brandon & J. Warner. A. I. D. and Adoption: Some Comparisons. *Br J Soc Work* 1977; 7: 335–41; L. Kass. Making Babies: The New Biology and the ‘Old’ Morality. *Public Interest* 1972; 26: 18–56.

social and psychological ties that normally connect parents and children would be jeopardised by their strange origins.³ One religious commentator reportedly went so far as to claim that children born of IVF had neither mother nor father.⁴ Because in-vitro fertilisation was developed as an infertility treatment intended to *allow* infertile couples who very much wanted children to become parents, this criticism is not—on the face of it—especially powerful. However, there *have* been rare sets of circumstances where it has been unclear who the parents of a child produced by IVF were and similar events might cause us to wonder if a child had any parents at all.⁵ Thus, for instance, if a mix-up at the IVF laboratory led to an embryo being implanted in the womb of the wrong woman, the birth mother and her partner might deny that the resulting child is ‘their child’, while the couple whose gametes contributed to the creation of the embryo that was implanted might also deny any relation with the child—leaving the child with ‘no’ parents. More recently, the prospect of human cloning via somatic cell nuclear transfer (SCNT) has led a number of authors to suggest that *this* technology would produce children who had only one parent or perhaps even no parents.⁶ Reproductive cloning would create children who were the identical twins of the person being cloned, without an act of fertilisation or conception. If one thinks of the parents of a child as being the people who provided the sperm and egg from which he or she was conceived then it might seem that human clones have no parents.

PARENTHOOD: ITS NATURE AND SIGNIFICANCE

One thing that clearly *is* true of these and other assisted reproductive technologies is that they have both provoked and required a proliferation of concepts of the ‘parental’ relation. In discussions of the ethics of assisted reproduction it is now sometimes necessary to distinguish between social parents, gestational parents, genetic parents, commissioning parents, causal parents, ‘cytoplasmic’ parents, and mitochondrial parents.⁷ Different reproductive technologies separate out and make possible different combinations of all these different types of parental relationship. Distinguishing between these various ways of being a ‘parent’ of a child therefore allows us to identify the different people who can be said to be the parents of children born of IVF and of (hypothetical) cloned human beings and to see why claims that these children have ‘no parents’ are false.

³ G.D. Mitchell. In Vitro Fertilisation: The Major Issues – a Comment. *J Med Ethics* 1983; 9: 196–9.

⁴ R. Winston. 2007. *A Child Against All Odds*. London: Bantam Books: 256.

⁵ C. Ayres. 2004. Mother Wins \$1m for IVF Mix-Up but May Lose Son. *The Times* 5 August: 3; L. Smith & O. Wright. 2002. White Couple in IVF Blunder Can Keep Black Twins. *The Times* 5 November: 5.

⁶ L. Kass. 1997. The Wisdom of Repugnance. *New Republic* 2 June: 17–26; J. Haas. 2000. A Catholic View of Cloning. In *The Human Cloning Debate*. G. McGee, ed. Berkeley, CA: Berkeley Hills Books: 279-80.

⁷ See K.D. Alpern. 1992. Genetic Puzzles and Stork Stories. In *The Ethics of Reproductive Technology*. K.D. Alpern, ed. Oxford: Oxford University Press: 147–69; J.L. Hill. What Does it Mean to be a ‘Parent’? The Claims of Biology as the Basis for Parental Rights. *N Y Univ Law Rev* 1991; 66: 353–420; T. Bayne & A. Kolers. Toward a Pluralist Account of Parenthood. *Bioethics* 2003; 17: 221–41; J.A. Robertson. Reconstituting Eggs and the Ethics of Cytoplasm Donation. *Fertil Steril* 1999; 71: 219–21. For the purposes of my argument here, it will suffice to distinguish between the first three ways of being a parent on this list. The distinction between these and ‘commissioning’ and ‘causal’ parents only becomes important in unusual scenarios of the sort beloved by philosophers in philosophical argument, whereas cytoplasmic and mitochondrial parents only appear in rare circumstances when manipulations of the oocyte are necessary to secure a healthy pregnancy.

The development of in-vitro fertilisation reinvigorated a distinction that was already familiar at the time, between social and genetic parents. Artificial insemination by donor, adoption, and—more prosaically—notions of illegitimacy had already established a distinction between a child's social and its genetic parents. A child's social parents are those individuals who fill the social role of parent for that child; that is, who provide him or her with the social and emotional support required to reach adulthood. Because IVF made it socially and psychologically easier for couples to have children using donor gametes, this technology has led to an increase in the number of circumstances where social parenthood and genetic parenthood might come apart. In these cases it is usually *social* parenthood that is privileged. At the same time, in so far as IVF is often motivated by the desire to allow couples to overcome infertility and avoid the need for adoption in order to enjoy the experience of parenting, this technology also emphasised the importance of *genetic* parenthood. Until the prospect of human cloning emerged (of which, more below), it was thought that there was only one way of becoming a genetic parent, which involved providing one of the gametes from which a child was conceived. Finally, in-vitro fertilisation also made 'surrogate motherhood'/contract parenthood possible, thereby requiring a distinction between *gestational* parenthood and social and genetic parenthood. A child's gestational parent is the person who was pregnant and gave birth to him or her. Until a technology of ectogenesis is developed, all children will have gestational mothers.⁸

Thus, rather than having 'no parents', children born of IVF may have an excess of parents, where these different roles have come apart. At the very least, they will have a gestational mother and two genetic parents (one of whom may be the gestational mother) and they will (hopefully) have one or more social parents.

The argument that human clones would have no parents is more interesting. While it is clearly false in relation to gestational parents and would most likely be false in relation to social parents, it nonetheless might seem to be true in relation to genetic parents. As I suggested above, if we think of the genetic parents as those individuals whose gametes fused to create an embryo, then, because cloning involves the creation of a new organism without fertilisation, it may appear as though clones have no genetic parents.

This conclusion is too swift. As I have argued elsewhere, the prospect of somatic cell nuclear transfer requires us to re-examine the notion of genetic parenthood and distinguish between causal/historical and informational accounts of what it means to be a genetic parent.⁹ When two individuals fuse their gametes in ordinary reproduction they cause a new organism to come into existence, which shares 50% of its genes with each of them. SCNT cloning would establish this latter relation—a relationship between the information stored in their genomes—between successive generations without the people thus related having the usual

⁸ There exists the theoretical possibility of inducing an extrauterine pregnancy in a man who could then give 'birth' to the child via Caesarean section (R. Winston. 1999. *The IVF Revolution*. London: Vermillion: 206–7). It is unclear if, should this scenario be realised, we should refer to this man as the 'male gestational mother' or the 'gestational father' of the child. For further discussion of this technology and its implications for reproductive ethics, see R. Sparrow. Is it 'Every Man's Right to Have Babies if he Wants Them'? Male Pregnancy and the Limits of Reproductive Liberty. *Kennedy Inst Ethics J* 2008; 18: 275–99.

⁹ R. Sparrow. Cloning, Parenthood, and Genetic Relatedness. *Bioethics* 2006; 20: 308–18; R. Sparrow. Therapeutic Cloning and Reproductive Liberty. *J Med Philos* 2009; 34: 102–18.

causal/historical relationship. Where these two relations have come apart, I argue that we must turn to the informational relationship to determine the genetic parents of cloned children. The person from whom the nuclear DNA is sourced has genetic parents; the clone is the identical twin of this person and therefore has the same genetic parents as them. This ‘informational’ understanding of parenthood is not without its difficulties.¹⁰ However, it is the most plausible understanding in the circumstances, not least because it supports the conclusion that clones *do* have genetic parents.

It is not entirely clear why we should care so much about genetic parenthood. However, the fact is that, in many circumstances, we do, both at the social and individual level. Individuals often care deeply about their genetic relationship to other people. As I noted above, many applications of assisted reproductive technologies are driven by the desire to become *genetic* rather than (merely) social parents. Where social and genetic parenting has come apart, such as in cases of artificial insemination by donor, children sometimes come to feel that it is important to know who their genetic parents were and—in cases where they are denied this information either deliberately or by circumstance—feel that they are harmed as a result of not knowing.¹¹ At least part of the explanation for this concern with genetic parenthood is the desire to be able to tell a story about ourselves that locates us as part of a narrative extending across generations. At the social level, various institutions attest to the importance of facts about genetic parenthood. Some societies attempt to provide for the welfare of children by insisting that their genetic parents shall be strictly liable for their financial support. Where it exists, public funding of IVF programs expresses support for the idea that the desire to become a genetic parent is sufficiently important as to place third parties under some obligation to provide assistance to help satisfy it.

The question of who *would be* the child of an embryo is also important when it comes to thinking about the ethics of the creation, use, and destruction of embryos. An important principle governing the ethics of assisted reproduction is the presumption of ‘reproductive liberty’: individuals should be free to determine whether or not they have children, with whom, and (perhaps) how.¹² Reproductive liberty is often at stake in decisions about the disposition of embryos, as these decisions will often determine who becomes—or does not become—a parent. Importantly, arguments about reproductive liberty presuppose that there is some sense to the question of who the parents of a child would be *prior* to any decision about who will become the child’s social parents, otherwise—given that *anyone* might become a child’s social parents—we have no way of identifying whose reproductive liberty is at stake; this sense will usually be provided by genetic parenthood. In particular, in so far as the right

¹⁰ H. Mertes & G. Pennings. Embryonic Stem Cell Derived Gametes and Genetic Parenthood: A Problematic Relationship. *Camb Q Healthc Ethics* 2008; 17: 7–14; L.M. Silver & S.R. Silver. Confused Heritage and the Absurdity of Genetic Ownership. *Harv J Law Technol* 1998; 11: 593–618; Sparrow (2006) *op. cit.* note 9.

¹¹ A.J. Turner & A. Coyle. What Does it Mean to be a Donor Offspring? The Identity Experiences of Adults Conceived by Donor Insemination and Implications for Counselling and Therapy. *Hum Reprod* 2000; 15: 2041–51.

¹² D. Brock. 1994. Reproductive Freedom: Its Nature, Bases and Limits. In *Health Care Ethics: Critical Issues for Health Professionals*. D. Thomama, & J. Monagle, eds. Gaithersbrug, MD: Aspen Publishers: 43–61; J.A. Robertson. 1994. *Children of Choice: Freedom and the New Reproductive Technologies*. Princeton, NJ: Princeton University Press.

to reproductive liberty includes the right *not* to become a parent, it is important to know who would become a genetic parent if the child were born.

ORPHANED AT CONCEPTION

To date, then, all reproductive technologies have implicated some person(s)—an individual who is living or (in cases of posthumous reproduction) who once lived—as the genetic parent(s) of the child. However, although these previous claims of parentless children have proved false, I believe the concern that children might be born without parents is valid—in a limited sense—for a technology that is now on the horizon.

Several recent scientific results suggest that it may eventually be possible to derive functional gametes from pluripotent human stem cells.¹³ Two teams of scientists have now reported that by suitably manipulating the chemical signals provided to pluripotent human stem cells they were able to coax these cells down the developmental pathway that leads to the production of sex cells.¹⁴ As yet, researchers have not been able to demonstrate that the resultant cells are functional gametes; this would require showing that they were capable of contributing to the formation of a healthy embryo—a procedure that is not without its own ethical pitfalls. Despite this, there are good reasons to believe that it will eventually prove possible to derive both sperm and eggs from pluripotent stem cells. Scientists have already managed to produce sperm and ova from embryonic stem cell lines in mice¹⁵ and have used the sperm to fertilise ova and produce healthy mouse pups.¹⁶ There is little reason to believe that what is possible in mice will be impossible in human beings.¹⁷ Moreover, we know that it *must* be possible for human embryonic stem cells to differentiate to become germ cells, as this is what happens in the development of the human embryo. Thus, it seems likely that with sufficient

¹³ Whittaker, *op. cit.* note 1.

¹⁴ K. Kee et al. 2009. Human DAZL, DAZ and BOULE Genes Modulate Primordial Germ-Cell and Haploid Gamete Formation. *Nature Online* 28 October. US: Nature Publishing Group. Available at: doi:10.1038/nature08562 [Accessed 26 May 2010]; K. Nayernia et al. 2009. *In Vitro Derivation of Human Sperm from Embryonic Stem Cells*. Available at: doi:10.1089/scd.2009.0063 [Accessed 26 May 2009]. The latter paper was withdrawn shortly after publication on the grounds that some text in the introduction had been plagiarised. Nevertheless, the laboratory that performed the research insists that this plagiarism did not impugn the validity of the science reported in the paper and have resubmitted a version for publication (See A. Abbott. 2009. Editor Retracts Sperm-Creation Paper. *Nature News* (Online) 30 July. Available at: doi:10.1038/news.2009.753 [Accessed 13 October, 2009]).

¹⁵ K. Hubner et al. Derivation of Oocytes from Mouse Embryonic Stem Cells. *Science* 2003; 300(5623): 1251–6; A. Kerkis et al. In Vitro Differentiation of Male Mouse Embryonic Stem Cells into Both Presumptive Sperm Cells and Oocytes. *Cloning Stem Cells* 2007; 9: 535–48; M.C. Nagano. In Vitro Gamete Derivation from Pluripotent Stem Cells: Progress and Perspective. *Biol Reprod* 2007; 76: 546–51; J. Hua & K. Sidhu. Recent Advances in the Derivation of Germ Cells from the Embryonic Stem Cells. *Stem Cells Dev* 2008; 17: 399–412; A.I.O. Marques-Mari et al. Differentiation of Germ Cells and Gametes from Stem Cells. *Hum Reprod Update* 2009; 15: 379–90.

¹⁶ K.J. Nayernia et al. In Vitro-Differentiated Embryonic Stem Cells Give Rise to Male Gametes that Can Generate Offspring Mice. *Dev Cell* 2006; 11: 125–32.

¹⁷ A.J. Newson & A.C. Smajdor. Artificial Gametes: New Paths to Parenthood? *J Med Ethics* 2005; 31: 184–6; S.P. Westphal. The Next IVF Revolution? *New Sci* 2003; 178(2394): 4–5.

understanding of the biochemical processes that control the differentiation of stem cells, we will eventually be able to manipulate them to produce functional gametes.¹⁸

If it becomes available, this technology will have many revolutionary applications and implications for reproductive ethics.¹⁹ These applications and implications will be even more dramatic should it be possible to extend this technology to derive gametes from embryos created by SCNT or from ‘induced pluripotent stem cells’ (IPS cells).²⁰ For reasons that will become clear below, I will largely be concerned with the implications of derivation of gametes from stem cell lines derived from donated embryos, but I will say something about these other possibilities below. Moreover, my concern here is with a very particular subset of these implications—those that might turn on the question of who might be the genetic parents of children conceived by such techniques.

I want to suggest that if an ovum derived from one embryonic stem cell line were fertilised using sperm derived from another embryonic stem cell line and if the embryo that resulted was then implanted into a woman’s womb, then any child that was born would have *no* genetic parents!²¹ The child would, of course, have a gestational mother and may have social parents (one of whom may be the gestational mother). However, there would be no individuals, living or dead, who would have the appropriate genetic relationship to the child to be described as its genetic parent.²²

It might be argued that the genetic ‘parents’ of such children would be the embryos from which the gametes were derived.²³ It is true that these embryos are the only organisms with a genome in the appropriate informational relationship to the genome of the child to stand in the relation of ‘genetic parent’. However, while they might serve as placeholders in a family tree, embryos cannot play either of the roles, discussed above, that we require of genetic parents. Individuals cannot interpret their lives and experiences in the light of ‘biographies’

¹⁸ D.J.H. Mathews et al. Pluripotent Stem Cell-derived Gametes: Truth and (Potential) Consequences. *Cell Stem Cell* 2009; 5: 11–14; Whittaker, *op. cit.* note 1.

¹⁹ Mathews et al. *op. cit.* note 18; Newson & Smajdor *op. cit.*, note 17; R. Weiss. 2003. Development in Mice Raises Issues for Human Reproduction. *Washington Post* 16 September: A12; G. Testa & J. Harris. Ethics and Synthetic Gametes. *Bioethics* 2005; 19: 146–66.

²⁰ K. Takahashi et al. Induction of Pluripotent Stem Cells from Adult Human Fibroblasts by Defined Factors. *Cell* 2007; 131: 861–72.

²¹ The idea that the children created from gametes derived from embryonic stem cell lines would have ‘no parents’ was first canvassed by Lee Silver (cited in Weiss *op. cit.* note 19). However, to my knowledge this paper constitutes the first sustained philosophical defence of this claim.

²² Another hypothetical reproductive technology, the use of oocytes sourced from aborted foetuses, either via transplantation of fetal ovarian tissue into the body of the mother (J. M. Berkowitz. Mummy was a Fetus: Motherhood and Fetal Ovarian Transplantation. *J Med Ethics* 1995; 21: 298–304) or through oocyte salvage and *in vitro* fertilisation (Ethics Committee of the American Society for Reproductive Medicine. Use of Fetal Oocytes in Assisted Reproduction. *Fertil Steril* 2004; 82(Supplement 1): 256–7) might lead to the birth of children who would, according to my interpretation, have no genetic mother; however, such children would still have one genetic parent—a genetic father.

²³ Berkowitz, *op. cit.* note 22; Mertes & Pennings, *op. cit.* note 10.

of embryos. Institutions cannot assign responsibility for the care of children to embryos or consult embryos about the fate of embryos created with their gametes. More fundamentally, it is internal to the concept of parenthood that parents are *persons*, living or dead, who stand in the appropriate (social, gestational, causal, genetic, etc.) relationship to the child. Thus, I would suggest that to have embryos as genetic ‘parents’ is to have no genetic parents at all.²⁴ Instead, the children born of such matings might be said to be ‘orphaned at conception’.²⁵

It is also true that, while such children would not have genetic parents, they would have genetic *grandparents*. The couple who conceived the embryos from which the stem cell lines were derived would be the genetic grandparents of children conceived using gametes derived from these stem cells. However, once it becomes possible to create gametes from stem cell lines it will also be possible to create new embryos via the fusion of these gametes and then to derive gametes from these embryos. Repeated iterations of this process would lead to the creation of embryos that had no meaningful genetic relation to any living individual.²⁶

An important exception to the claim that children conceived using gametes derived from embryonic stem cell lines would have no genetic parents is the (hypothetical) case where the embryo from which the stem cells from which the gametes were derived was created by SCNT. In this case, the embryo would—with the possible exception of mitochondrial DNA introduced via the enucleated ovum—be genetically identical to the person whose somatic DNA was used and any children created from these gametes would be the genetic offspring of this DNA donor. This procedure would therefore constitute an extremely powerful technology to allow otherwise infertile persons to become genetic parents.²⁷ Similarly, if it becomes possible to produce pluripotent stem cells by genetically modifying—or otherwise manipulating—somatic cells and to derive gametes from these cells then this would also constitute a new route to genetic parenthood. Thus, these two technologies holds out the prospect of ‘artificial gametes’²⁸ that would allow pretty much anyone to become a genetic parent, regardless of their age or reproductive capacities, as long as they could find a woman willing to bear the child.

Mertes and Pennings²⁹ have recently put forward an account of genetic parenthood that requires that parents’ genes be *reshuffled* in the process of becoming a parent and that

²⁴ One of the referees for this paper observed that our concept of genetic parenthood might be transformed by the introduction of this (and other) new reproductive technology so that the attribution of genetic parenthood to embryos would not seem so strange. However, as it is hard to reason reliably about the possible application of our concepts in circumstances where they have been significantly transformed, I will not discuss this possibility: my argument here should be understood as an argument about the application of our *existing* concept of genetic parenthood, which does, I suggest, require that parents must be individuals rather than embryos.

²⁵ A further implication of this conclusion is that children who were conceived of the fusion of one gamete derived from an embryonic stem cell line and one gamete sourced from an individual, living or dead, would only have one genetic parent.

²⁶ I discuss some possible reasons for producing such embryos below.

²⁷ A. McLaren. Free-Range Eggs? *Science* 2007; 316(5823): 339; Newson & Smajdor *op. cit.* note 17; G. Testa & J. Harris. Genetics: Ethical Aspects of ES Cell-Derived Gametes. *Science* 2004; 305(5691): 1719; Testa & Harris *op. cit.* note 19.

²⁸ Newson & Smajdor *op. cit.* note 17.

²⁹ Mertes & Pennings *op. cit.* note 10.

therefore implies that the creation of children conceived by ‘artificial gametes’ would *not* result in the source of the DNA becoming a genetic parent. They defend this criterion on the grounds that relying only on the informational relationships to define genetic parenthood will lead to the counterintuitive conclusion that identical twins are the genetic parents of each other’s children. However, in their haste to avoid this implication, they reintroduce both causal and social notions of parenthood to their account. I believe that the questions of who caused a child to come into the world and who we would typically recognise as being in the social relationship of being their parent should properly be kept independent of the question as to whether or not someone is a *genetic* parent.³⁰

In any case, I need not settle this matter now. If these authors are right then the discussion below will also be relevant to the use of gametes derived from embryos created by SCNT or from IPS cells. If I am right then there are still interesting questions to answer about the ethics of the use of gametes derived from stem cell lines derived from donated embryos.

ETHICS AND ORPHANS

The conclusion that—at least in some cases—children created by the fusion of sex cells derived from embryonic stem cell lines would have no genetic parents has implications for the ethics of the creation of embryos from ESL-derived gametes for the purposes of research and therapeutic use of tissue derived from these embryos as well as for reproductive ends. Importantly, I believe these implications include opportunities to address some existing problems in reproductive ethics as well as new challenges.

Reproductive applications

To begin with the implications for reproductive ethics.³¹ The importance people often place on genetic parenthood is, I think a *pro tanto* reason to avoid creating children without genetic parents. All other things being equal, it is better to know who one’s genetic parents are. The testimony of (some) children born as a result of artificial insemination by anonymous donor suggests that lack of knowledge of one’s genetic parents can be a source of significant distress.³² However, it must be said that lack of genetic parents is hardly the worst evil that

³⁰ It might be objected that my own argument that we should think of the children conceived by ESL-derived gametes as having no parents rather than parents who are embryos relied on claims about the social roles of genetic parents. However, *any* definition of a concept will need to take some account of how it is used; I argue that it is internal to the concept of parenthood that parents are or were living individuals. My dispute with Mertes and Pennings is not that they make reference to social facts in arguing for a definition of parenthood but rather that they confuse the concepts of genetic and social parenthood when they rely upon claims about which persons we would recognise as *social* parents to settle the question of who are the *genetic* parents of a child.

³¹ In what follows I will assume that the technology has been shown to be appropriately safe and effective, through animal or other studies. It is worth noting that it would *not* be necessary to show that this technology involved *no* risk of birth defects before it would be ethical to use it; rather, all that would need to be shown is that the risks involved were comparable to those involved in natural pregnancy (Testa & Harris, *op. cit.* note 19, p. 56) or perhaps even only comparable to those undertaken when IVF was first trialled.

³² Turner & Coyle *op. cit.* note 11.

can befall children. What is most important as far as the welfare of children is concerned is that they have social parents. The evidence from studies of adoption, IVF, and artificial insemination by donor suggests that loving care from *social* parents is sufficient to provide children with the basis for social and psychological flourishing.³³ Moreover, even if lack of knowledge of their genetic parents often causes people significant distress, children born without genetic parents will still have ‘lives worth living’ and will therefore be unable to claim to have been harmed by a decision that, had it been made otherwise, would have led to the birth of another person entirely.³⁴

There is, however, another argument against bringing children without genetic parents into the world that focuses on the connection between social and genetic parenthood in the eyes of adults. As noted above, if children have loving social parents, the absence of genetic parents need not prevent them from having rewarding lives. Yet, in some circumstances—such as paternal neglect—genetic parenthood represents a last-ditch reference point for the assigning of responsibility for care of children. There is therefore some reason to be concerned that children without genetic parents would be especially vulnerable to the risk that no one will feel any responsibility to care for them. If, for instance, the commissioning parents of a child without genetic parents were to die or to lose interest in caring for the child and the contract mother had no interest in caring for it, then there would be no one left who had any distinctive relationship with the child.³⁵ This child would be left with no parents at all! However, a similar dilemma is not impossible if a child is conceived using both donor sperm and donor egg and both the donors disavow responsibility for the child. It also seems likely that appropriate regulation and legislation, which made commissioning parents legally responsible for any children produced and that (perhaps) also required commissioning parents to identify another couple willing to accept responsibility for the child should they be unable to care for him or her, would resolve this problem.

On the other hand, there are a number of reasons to believe that the conception of children from ESL-derived gametes would have certain advantages over the use of donor gametes, donor embryos, or adoption, as a solution to infertility. There are *two* distinct sorts of possible harms associated with a lack of knowledge of one’s genetic parents, which thus far have always gone together, and the creation of embryos from ESL-derived gametes would allow us to eliminate—or at least greatly reduce—one of them. It would also reduce the likelihood of harms to those people who otherwise would have been the genetic parents of children born to infertile couples using donor gametes or donated embryos.

Where donor gametes or donor embryos are used to bring children into the world, or where children are adopted, there is a risk of possible harms to these children arising out of the

³³ F. MacCallum & S. Golombok. Children Raised in Fatherless Families from Infancy: A Follow-up of Children of Lesbian and Single Heterosexual Mothers at Early Adolescence. *J Child Psychol Psychiatry* 2004; 45: 1407–19; S. Golombok, F. MacCallum & E. Goodman. The ‘Test-tube’ Generation: Parent-child Relationships and the Psychological Well-being of In Vitro Fertilization children at Adolescence. *Child Dev* 2001; 72: 599–608; S. Golombok et al. Families Created by Gamete Donation: Follow-up at Age 2. *Hum Reprod* 2005; 20: 286–93; S. Golombok. Unusual Families. *Reprod Biomed Online* 2005; 10 (Supplement 1): 9–12.

³⁴ Testa & Harris *op. cit.* note 19, p. 164.

³⁵ A. Lippman & S.A. Newman. The Ethics of Deriving Gametes from ES Cells. *Science* 2005; 307(5709): 515.

possibility that they will be deprived of knowledge of their genetic parents. In so far as we feel that the biographies of our genetic parents are relevant to understanding our own lives, then lack of knowledge about our genetic parents may hamper our efforts to situate our own lives within a larger social, environmental, and/or historical context. There are also circumstances wherein knowledge of one's genetic parents is relevant to one's own life prospects, either because one has adopted projects, the success or failure of which might be strongly influenced by one's genetics, or for medical reasons. These circumstances are likely to become more common as we learn more about genes and their significance via the Human Genome Project and its various successors. Thus, a lack of knowledge of one's genetic heritage may become a significant source of stress and uncertainty. Donor-identified donation will eliminate the risk of such harms but at the risk of reducing the number of people who would be willing to serve as donors.³⁶

However, there is also a possible harm associated with the suspicion that one was *abandoned* by one's genetic parents. *This* harm is *not* necessarily assuaged by donor-identified donation. Indeed, knowledge that some particular person did not feel that their genetic relationship to you was important enough to motivate a social relationship may make the feeling of abandonment *worse*. Children conceived of gametes derived from embryonic stem cell lines would not be vulnerable to this latter harm; not having genetic parents, they could not feel abandoned by them.³⁷

The use of ESL-derived gametes therefore has a possible advantage over donor gametes, which is that it would reduce the likelihood of psychological harms to the child due to their separation from their genetic parent(s).³⁸ Of course, these anticipations of the psychological harms and benefits of being born without genetic parents are necessarily speculative at this point. The ultimate assessment of the impact of such unusual origins must await the testimonies of those children—if any—born without genetic parents.

However, the use of ESL-derived gametes would have a further advantage over the use of donor gametes, which is that it removes any possibility of harm to the donors. Individuals who have donated gametes or embryos, or who have made children available for adoption, may later come to be curious about their genetic offspring and want to establish contact with them. If they are unable to do so, or are prevented from doing so, they may experience significant distress. Even if donors consented to donation on the condition that they would never know the identities of the children (if any) born as a result of their donation, the

³⁶ I. Craft et al. Will Removal of Anonymity Influence the Recruitment of Egg Donors? A Survey of Past donors and Recipients. *Reprod Biomed Online* 2005; 10: 325–9; J.N. Robinson et al. Attitudes of Donors and Recipients to Gamete Donation. *Hum Reprod* 1991; 6: 307–9.

³⁷ A similar point is made in relation to the use of ova salvaged from aborted foetuses in Ethics Committee of the American Society for Reproductive Medicine, *op. cit.* note 22.

³⁸ At first sight, it might appear that there is a danger that individuals might feel 'neglected' by their genetic *grandparents*, who donated the embryo from which the gametes from which they were created were derived. However, on closer inspection it makes little sense to hold grandparents responsible for the fate of their grandchildren, as the intervening agency of parents (or, in this case, of the researchers who created and fused the gametes derived from the embryo donated by the grandparents) blocks the attribution of responsibility to grandparents. Thus, even if some individuals do feel this way, it is not reasonable for them to do so; this in turn diminishes the extent to which we should take such feelings into account in considering the ethics of this technology.

importance people place on genetic parenthood means that they will sometimes come to regret this choice and to desire contact with ‘their’ children. Use of ESL-derived gametes or embryos created from them would eliminate the risk of such an outcome. This is, I think, a significant point in favour of the use of ESL-derived gametes in reproduction.

If it becomes possible to produce functional gametes from IPS cells or SCNT then presumably the demand for adoption or donor gametes will be greatly reduced. Individuals will be able to become genetic parents by using ‘artificial gametes’ instead. However, there may still be cases where a single person wants to produce genetic offspring without relying on gametes donated by anyone else and without being willing (or able) to become both the child’s genetic father and mother. In this case there will still be a useful role for ESL-derived gametes. Moreover, once it becomes possible to produce ESL-derived gametes it will be possible to ‘mass-produce’ embryos without genetic parents and to freeze them for storage and transport. Depending on the trouble and expense involved in deriving artificial gametes from IPS cells, the use of such mass produced embryos may be cheaper than the use of artificial gametes. If this turns out to be the case then there may still be a significant market niche and a useful role for parentless embryos.

Research and therapeutic applications

Thus far I have been discussing the question of who would be the parents of children conceived from ESL-derived gametes in the context of reproductive decision-making. However, this question is also relevant to possible research and therapeutic uses of embryos. There is some reason to think that the use of embryos created using ESL-derived gametes (and tissue, including gametes, derived from them) in research and therapy will be superior to the use of donated embryos and/or gametes. Of course, if embryos have intrinsic moral value³⁹ then this value will not be affected by altering the relationship between embryos and living individuals. However, to the extent that there are evils involved in the use of embryos—or tissues derived from embryos—in research or therapy that are related to their connections to living individuals then these evils may be reduced by the creation of embryos that would have no parents.

Medical research currently makes use of tissue donated for this purpose by individuals, who may still be alive or who may be deceased. Such research places both the tissue donors and the medical researchers in a certain amount of moral jeopardy in so far as the results of the research may affect the interests of the tissue donors (or their relatives) and therefore their attitude (and behaviour) towards the researchers. For instance, if researchers discover or produce something with significant financial value using the cells of some particular individual, then that individual may come to feel that they should have some share in or right over the profits of this result.⁴⁰ Similarly, the derivation of gametes or the creation of

³⁹ Congregation for the Doctrine of the Faith. 1987. *Instruction on Respect for Human Life in its Origin and on the Dignity of Procreation: Replies to Certain Questions of the Day*. Vatican City: CDF. Available at: http://www.vatican.va/roman_curia/congregations/cfaith/documents/rc_con_cfaith_doc_19870222_respect-for-human-life_en.html [Accessed 17 November 2008].

⁴⁰ J.M. Healey Jnr & K.L. Dowling. Controlling Conflicts of Interest in the Doctor-Patient Relationship: Lessons from Moore v. Regents of the University of California. *Mercer Law Rev* 1991; 42: 989–1005.

embryos from donated tissue may have quite profound impacts on living persons—and, to a lesser extent, on the relations of deceased individuals—as it alters the reproductive options available to them and implicates their reproductive liberty. For research purposes it therefore seems preferable, where possible, to use tissue and gametes derived from embryos that would have no parents rather than donated tissue or gametes.

Whether or not there will be an important role for tissue derived from embryos created by ESL-derived gametes in medical *therapy* will depend on progress in ‘regenerative medicine’ and on how quickly the potential of IPS cells is realised. Medical researchers hope that it will eventually prove possible to treat a wide range of medical conditions using transplants of stem cells or tissues derived from stem cells.⁴¹ For most therapeutic applications, tissue from IPS cells or ‘therapeutic cloning’ would be preferable because such tissue, being genetically identical to the patient’s own, is highly unlikely to be rejected. It might therefore appear that if it becomes possible to produce tissues for therapy from either of these sources then there will be no role for tissue derived from ‘parentless’ embryos.

However, again, this will depend in part upon the difficulty, expense, and—crucially—amount of time involved in creating IPS cells or cloned embryos and then deriving useful tissue from them. An alternative to the use of these technologies would be the use of ESL-derived gametes to establish a bank of embryonic stem cell lines with specified tissue types for the purposes of transplant. This may even be the *only* workable solution if our ultimate goal is the creation of replacement organs for transplant from stem cell lines. If a patient needs a new organ quickly, it may not be possible to produce this using stem cell lines derived from IPS cells or cloned embryos. Instead, we must hope that ‘generic’ replacement tissue can be developed and organs created for transplant on demand. Derivation of gametes from embryonic stem cell lines could make a useful contribution to this project as it would allow for rapid selective ‘breeding’ for the appropriate tissue type through the creation of successive generations of embryos.⁴²

Moreover, the derivation of pluripotent stem cells that are genetically identical to the donor raises its own ethical questions. As I have argued elsewhere, the creation of cloned embryos for therapeutic purposes impinges on the reproductive liberty of the parents of the DNA source.⁴³ In creating an embryo that is genetically identical to the embryo from which the DNA donor developed, one is creating an embryo that is the genetic offspring of the DNA donor’s parents. Respect for these individuals’ reproductive liberty and consistency with practices surrounding the use of embryos in reproductive contexts suggest that the DNA source’s genetic parents should be consulted about the fate of this embryo. More controversially, if IPS cells are capable of becoming a whole organism then the reproductive liberty of the parents of the DNA donor will also be implicated by the creation of IPS cells,

⁴¹ R.P. Lanza, J.B. Cibelli & M.D. West. Human Therapeutic Cloning. *Nat Med* 1999; 5: 975–7; S. Holland, K. Lebacqz, & L. Zoloth. 2001. Introduction to *The Human Embryonic Stem Cell Debate*. S. Holland, K. Lebacqz & L. Zoloth eds. Cambridge: MIT Press: xv–xxvii; J. Harris. Stem Cells, Sex, and Procreation. *Camb Q Healthc Ethics* 2003; 12: 353–71; T.B. Okarma. 2001. Human Embryonic Stem Cells: A Primer on the Technology and its Medical Applications. In *The human embryonic stem cell debate*. S. Holland, K. Lebacqz & L. Zoloth eds. Cambridge: MIT Press: 3–13.

⁴² Mathews et al. *op. cit.* note 18, p. 13.

⁴³ Sparrow (2009) *op. cit.* note 9.

which again suggests that the donor's genetic parents have an interest in the uses to which these cells are put. Of course, the rights of the parents of the DNA donor *may* be outweighed by the urgent medical needs of patients. Yet, if we take seriously the idea that the reproductive liberty of third parties can be implicated in decisions about cloned or pluripotent stem cells this may be a more problematic calculation than first appears. If, for instance, a couple who wanted a child had created an embryo through IVF, it would be a brave bioethicist indeed who argued that another party could demand that that embryo should be destroyed in order to provide them with tissue for medical therapy. If it proves possible to achieve adequate clinical outcomes using tissues produced from embryos created from ESL-derived gametes then this would avoid the need to resolve these difficult ethical issues.

CONCLUSION

If scientists manage to derive functional gametes from embryonic stem cells, it will herald a new era in assisted reproduction. Reproductive scenarios that were once firmly in the realm of science fiction will become reality and our thinking about the ethics of assisted reproductive technologies will need to advance to keep up. Indeed, given the rapid pace of advances in stem cells and in reproductive medicine it is important that philosophers and bioethicists begin thinking about these possibilities now.

This paper is intended as a contribution to this project. I have argued that children created using gametes derived from stem cells derived from donated embryos would be the first children in history to justify a long-standing anxiety about reproductive technologies and have no genetic parents. However, a proper understanding of the nature and significance of different forms of parenthood suggests that this possibility is less threatening than first appears. While the ultimate assessment of the ethics of the creation of children with no parents must wait until we have the data about the psychological effects of having no genetic parents, it seems highly unlikely that these effects would prevent such children from having 'lives worth living'. The creation of children with no genetic parents would not therefore be *prima facie* unethical. Moreover, I have identified a number of reasons that actually argue in favour of the creation of children without genetic parents in circumstances that would otherwise require the use of donor gametes or the sourcing of children for adoption. The production of human tissue devoid of genetic ties to any individual, living or dead, may also have significant benefits for the use of human tissue in research and in therapeutic applications.

It may turn out that advances in the manipulation of induced pluripotent stem cells and/or the science of somatic cell nuclear transfer will render many of the potential applications of ESL-derived gametes redundant. However, there is some reason to think that the creation of embryos using ESL-derived gametes might still play a useful role both in reproduction and medical research. Whether this will ultimately prove to be the case is likely to depend on: the rate of progress in the science and application of regenerative medicine; the relative costs of the creation of artificial gametes and parentless embryos; and, on our assessment of the weight of the ethical issues involved in somatic cell nuclear transfer. In the meantime, both the science and the ethics of the creation of 'orphans at conception' are clearly worthy of further investigation.

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