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Genetic "Knowing"

Part I

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Wrapped up in the promise of genetic "knowing" are delicate implications that result in complex quandaries, forcing us to decide upon matters the conclusions of which are far from neutral. For example: Is genetic testing for those planning to have children a responsible thing to do? [1] Conversely, is it irresponsible for parents to have intentionally chosen to *not know in advance* if their child may inherit a genetic disease? Should knowledge of one's genes be mandatory to prevent children from being born with debilitating and/or terminal genetic illnesses?

In this article, I will begin to unpack the underlying philosophical and theological meanings of "genetic knowledge"—the information gleaned from genome sequencing, testing, and screening—specifically as it concerns the child.

The aim of genetic knowledge is to equip intending parents to make informed decisions concerning the health and well-being of their child. The types of decisions parents can make will depend on how the genetic information is obtained, which can happen in several ways.

1. GENETIC KNOWLEDGE OBTAINED POST-CONCEPTION:

A. *IN UTERO* SCREENING

With prenatal genetic screening (PGS), parents can know before birth whether the child in the womb bears a physical disability. PGS includes maternal blood tests, an ultrasound and a structural review of fetal anatomy before 20 to 22 weeks of pregnancy. If screening detects an elevated risk of abnormality (exhibited hormonally in the mother's blood), specific disease symptoms (such as neural tube brain defects), or other major risk factors, a woman is offered a diagnostic test to confirm or rule out a disorder. Diagnostic tests include amniocentesis, chorionic villus sampling (CVS) or cell-free fetal DNA testing, also known as non-invasive prenatal testing (NIPT).[2]

The knowledge provided by PGS bears a latent choice: to carry the pregnancy to term and raise a child with major health-problems, or to abort the pregnancy so as to prevent the child being born with a disease or disability. Children who have chromosomal abnormalities diagnosed *in utero* such as Down syndrome are commonly aborted: a 2012 American study showed that there was termination in 70% of cases, a UK study revealed 90%, and after the introduction of a nationwide prenatal screening program in Denmark, the number of Down babies born was reduced by half.[3] When screening or diagnosis is done *in utero*, the only option to "prevent/eliminate" the occurrence of a chromosomal disorder (or genetic disease) is through abortion.

However, with the advent of assisted reproductive technologies (ARTs) in the late 1970s, choosing an abortion can be avoided through performing diagnosis at the embryonic level rather than *in utero*, known as Pre-Implantation (or pre-natal) Genetic Diagnosis (PGD).

B. IN VITRO (EMBRYONIC) SCREENING

Embryonic screening (PGD) is only available to those who conceive through *in vitro* fertilization (IVF), because it occurs on embryos at the two to four cell stage, before they are implanted in a woman's womb. A single cell is removed from the embryo and biopsied to determine its genetic constitution.[4] This way, any severe genetic abnormalities in the DNA can be detected *before* the embryo is implanted in the womb, so that only "healthy," i.e. non-affected embryos are selected for implantation. Children conceived naturally cannot be "screened" as embryos, for the earliest that genetic testing can be done *in utero* is during the first trimester (as early as 7 weeks) with NIPT, and an amniocentesis is performed during the second trimester: 14-16 weeks. It is only through IVF-PGD, that is, embryonic screening and selective implantation, that one could "guarantee" that their child does not carry a genetic disease.

2. GENETIC KNOWLEDGE OBTAINED *PRE*-CONCEPTION

With the advent of more efficient and cost-effective genome sequencing, new health technology companies have been launched to target diseases where advanced knowledge could make a difference in the "health outcome" of the child. In 2010, a new genetics company called Counsyl launched their product called "The Universal Genetic Test" for "family preparation," using a person's saliva to look for genetic markers linked to 109 inherited diseases that may have mutations that the parents unknowingly carry. Similarly, in 2014 the company GenePeeks was launched for individuals who wish to conceive using donor gametes. GenePeeks takes genetic screening to a whole new level: rather than just comparing the sequenced DNA of prospective parents and providing them with their carrier status (like Counsyl), GenePeeks uses "Matchright technology" algorithms to digitally simulate the process of genetic recombination thousands of times, in order to obtain the genetic makeup of 10, 000 possible embryos arising from the union of parent A and donor B. The DNA of these simulated embryos is sequenced to look for mutations associated with 500 severe pediatric conditions (autosomal recessive conditions), then the disease risk associated with the paring of parent A to whichever donor *x* is calculated. The final product is a "donor catalogue" with a list of "safer" donors that intending parent(s) can select from—that also describes positive traits such as height, eye color, and even the donor's education level and personality.[5]

Pre-conception genetic screening—accessed via genetic counselling—is becoming increasingly endorsed, so that couples can know whether they are at risk for having a child with a genetic condition *before* any child is brought into existence. The reasoning is as follows: if parents knew *in advance* that their child had a risk of inheriting a genetic disorder from their genes, they are equipped to make a more informed decision as to whether they should try and conceive a child at all. By knowing if they are carriers and the likelihood of passing on a genetic disease, they are in a position to do something about it, namely, to prevent a child from being born with a disease by choosing to use IVF-PGD rather than leaving it "up to chance" by conceiving naturally.

IMPLICATIONS OF GENETIC KNOWING

Genetic knowledge is not neutral. By "equipping" parents to make an informed choice, it places them in the position of having to choose *how* to have children who may be afflicted with genetic disease.[6] If parents knew beforehand that they were carriers for a genetic disease, but chose to forgo IVF-PGD to conceive naturally, they knowingly risk bringing a diseased child into existence. The very possibility of genetic knowledge undoubtedly changes the way we view reproduction. For instance, "routine, broadly targeted prenatal genetic testing means

that having a child with a major genetic disease or disability will largely cease to be a surprise and instead become a deliberate choice," as journalist Michael White observes.[7] The possibility—and now *prevalence*—of genetic knowledge introduces a definite shift towards having an "informed" pregnancy, one in which the child's health is "planned" and/or chosen.[8]

How would a healthcare system care for children born with disabilities or genetic diseases, if there were an emphasis on prevention instead of treatment? Would it alter our understanding of responsibility on behalf of the parents? For instance, pharmaceutical companies might choose not to pursue a drug for a rare disease if screening seems likely to eliminate most future cases[9]—an interesting point which does not seem to be a far-fetched possibility.[10]

Furthermore, what happens when adults intentionally select the type of children "allowed" to be born—do we as individuals and as society lose anything by eliminating the potential for children to be born with such conditions?[11] Another way of asking this question is to consider what the disabled or seriously ill child offers us; what experience transpires through witnessing and being with the suffering child, especially ones with a terminal diagnosis? Stories of parents and families who experience the beauty of life with a diseased or disabled child offer us a unique perspective of the condition of suffering that is not extraneous to being human.[12] Calling the experience of a severely diseased child's life 'beautiful' is not to be trite or lessen the reality of their suffering, but opens up theological and philosophical considerations: what does it mean to suffer, how is suffering connected to love, and how does suffering allow us to experience beauty and hope?[13]

Genetic sequencing, screening, and diagnosis are technological processes that provide information that is not simply neutral, but rather already contains a host of associated courses of action which are also laden with profound philosophical, anthropological, and theological implications, to be explored in Part II. As a "knowing" fundamentally enabled by technology, merely acquiring genetic information is not bereft of the technological imperative aimed towards action. Inherent within this "action" is an underlying conception of the meaning of procreation, the family, and the child that is fundamentally inadequate to the ontological truth of the human person. ■

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[1] Although it is the purpose of this article to outline a response to this question, it is important to see that the question itself frames the terms of the debate at the very outset: parenthood and reproduction is already thought to be something that parents first initiate, choose, and plan, and the meaning of responsibility is thus on those grounds. Although parents *do* engage in choice as to when to conceive, the meaning of the child and of procreation/parenthood is an ontological reality rooted in God and creation: not primarily a matter of *choice.* The sacrament of marriage already entails children and family as part of the common good, something that a man and women receive and say 'yes' to in the vocation of marriage. While it seems that the only "responsible" choice is a planned one, we need to first understand the meaning of procreation and the child to see that children are never something to be planned and manufactured, but only received. See Karol Wojtyla's *Love and Responsibility* (trans. Grzegorz Ignatik) for a philosophical and theological analysis of the meaning of procreation and parenthood in light of Creation.

[2] Testing through amniocentesis or CVS seeks to confirm a diagnosis, but are often 'invasive' and carry a minor but significant risk of inducing miscarriage (widely quoted as "1%," but see: "Pregnancy Loss Following Amniocentesis or CVS Sampling—Time for a Reassessment of Risk, *Journal of Clinical Medicine*, September 2014. http://www.ncbi.nlm.nih.gov/pmc/ articles/PMC4449654/). In 2013 came the emergence of a new "non-invasive" form of prenatal testing called "cell-free fetal DNA" and chromosomal microarray testing. How it works: a sample of the mother's blood is taken to obtain placental DNA which circulates in her system, and which is considered identical to fetal DNA, then analyzed for abnormalities of specific *chromosomes* (13, 18, 21, X, Y) associated with conditions like Down syndrome and Turner syndrome. There remain

cases of uncertainty (variants of unknown significance) where it is unclear how seriously the child will be affected. Uncertainty has always been present in prenatal testing, but these new technologies (NIPT and CMA) carry uncertainty to a new level, creating more confusion when decision-making. See: http://healthydebate.ca/2014/05/topic/non-invasive-prenatal-testing

[3] White, Michael. "Next-generation prenatal tests are turning fate into choice," *Pacific Standard*. October 9, 2015. http://www.psmag.com/nature-and-technology/gattaca-is-here

[4] Dayal, Molina B et al, Preimplantation Genetic Diagnosis, *Medscape Online Journal*, Dec 30, 2015. Accessed March 28, 2016 at: http://emedicine.medscape.com/article/273415-overview#a3

[5] de Lange, Catherine. "Meet your unborn child—before it's even conceived," *New Scientist*, April 9, 2014. https://www.newscientist.com/article/mg22229642.800-meet-your-unborn-child--before-its-even-conceived/
Lee Silver, founder of GenePeeks, wrote in his 1997 book *Remaking Eden* of a futuristic world in which parents can pick their child out of a virtual catalogue—an online database which digitally renders physical visualizations of what their hypothetical child would look like, analogous to what his "Matchright technology" now enables.

[6] To read about these situations and how morally difficult and heart-wrenching they become, see Counsyl's blog, which has stories of parents who used their services. Especially: http://blog.counsyl.com/2015/10/28/grateful-for-the-dna-test-she-almost-didnt-take/ and http://blog.counsyl.com/2015/07/30/finding-out-youre-one-in-a-million-can-be-life-changing/

[7] White, Michael. "Next-generation prenatal tests are turning fate into choice," *Pacific Standard*. October 9, 2015. http://www.psmag.com/nature-and-technology/gattaca-is-here

[8] While "the current [reproductive] practice is mostly to screen once a woman gets pregnant … [w]ith Counsyl's test, we can **change the emphasis to pre-pregnancy screening with more options, including pre-implantation genetic diagnosis** … Ideally, women should understand that *having carrier testing before pregnancy is as important as refraining from alcohol during pregnancy*" (emphasis added), Elena Ashkinadze, Program Supervisor in Genetics at UMDNJ-Robert Wood Johnson Medical School, quoted in Counsyl's press release.

[9] Shaywitz, David. "Precision Medicine Hits Reproductive Health," *Forbes Magazine.* August 31, 2015. http://www.forbes.com/sites/davidshaywitz/2015/08/31/impatient-for-precision-medicines-impact-look-at-reproductive-health/

[10] In 2014, a filmmaker intrigued by how consumer genetics could change our society produced a 'science-factual' film, *The Perfect 46*, set in the very near-future, where genomic sequencing soon becomes standard practise in 39 states. Though everyone is now equipped with their genome, few know what to do with the enormous amount of information at their fingertips. When a geneticist creates a personal genetics company that pairs a person with their ideal genetic partner to have a healthy ("perfect") baby (eerily similar to Lee Silver's GenePeeks), the results are unimaginable.

[11] This is a question often asked in the context of the elimination of children born with Down Syndrome. Note that Down Syndrome is not a genetically inherited condition, but a chromosomal mutation occurring in utero. Thus, it cannot be eliminated by IVF-PGD. In "The Case for Conserving Disability," Rosemarie Garland-Thomson presents a "reading of disability" as generative rather than as a deficit. She argues that "disability is inherent in the human condition" and that we "evolve into disability. Our bodies need care; we need assistance to live; we are fragile, limited and pliable in the face of life itself. Disability is thus inherent in our being. What we call disability is perhaps the essential characteristic of being human." See: Garland-Thomson, Rosemarie, "The Case for Conserving Disability," *Journal of Bioethical Inquiry.* September 9, 2012. http://www.ncbi.nlm.nih.gov/pubmed/?term=Garland-thomson+conserving
http://www.downsyndromeprenataltesting.com/the-case-for-conserving-disability/

[12] See the story of Eliot, a baby boy born with Trisomy 18 (Edward's Syndrome) who lived for only 99 days, depicted through a beautiful and poignant video his parents made that has reached over 1 million viewers: http://www.everylifecounts.ie/stories/eliot-mooney/

[13] Counsyl features the 2010 film *Extraordinary Measures* in their press release as an example of genetic disease their technology seeks to prevent and eventually eliminate. The film features the true story of the Crowley family, and their father's fight to find a cure for his two children with a rare and terminal genetic condition. It's an incredible story, and the film depicts the beauty and hope that originates from the experience of having a severely diseased child, the very condition that Counsyl seeks to prevent. Unfortunately I cannot take up the expansive questions of suffering and beauty in the context of this paper, but see two authors who have explored such themes: Parravicini, Elvira. "Aspects of Beauty: The Medical Care of Terminally Ill Newborns," *Humanum Review*. 2014 Issue One. http://humanumreview.com/articles/aspects-of-beauty-the-medical-care-of-terminally-ill-newborns; Ashfield, Ruth. "Meeting Suffering," *Humanum Review*. Fall 2013. http://humanumreview.com/articles/meeting-suffering; see also Jean Vanier's *Becoming Human*, on his life-time experience living with men and women with severe intellectual and physical handicaps.