

(Im)possible Baby

How to stimulate discussions about possibilities of two-mum and two-dad children.

by
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M.A. Design Interactions, School of Design
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Submitted to the Program in Media Arts and Sciences, School of
Architecture and Planning, in partial fulfillment of the requirements for
the degree of Master of Science in Media Arts & Sciences at the
Massachusetts Institute of Technology

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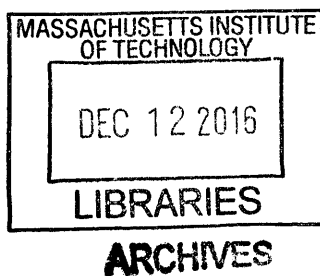
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1: Abstract

(Im)possible Baby is a speculative design project which aims to stimulate discussions about the social, cultural and ethical implications of emerging biotechnologies that could enable same-sex couples to have their own, genetically related children.

Delivering a baby from same-sex parents is starting to not look like a sci-fi dream anymore – recent developments in genetics and stem cell research, such as the achievements of scientists from Cambridge University in England and Israel's Weizmann Institute of Science ¹ have made this dream much closer to reality.

Jacob Hanna, the specialist leading the project's Israeli arm, said it may be possible to use the technique to create a baby in just two years. "It has already caused interest from gay groups because of the possibility of making egg and sperm cells from parents of the same sex," he said."²

Is creating a baby from same-sex parents the ethical thing to do? Who has the right to decide this, and how? This project aims to design and inspire debate about the bioethics of producing babies from same-sex couples.

In this project, the DNA data of a lesbian couple was analyzed using 23andMe to simulate and visualize their potential children, and then we created a set of fictional, "what if" future family photos using this information to produce a hardcover album which was presented to the couple as a gift. To achieve more public outreach, we worked with the Japanese national television service, NHK, to create a 30-minute documentary film following the whole process, which aired in October 2015.

Thesis Supervisor: Hiromi Ozaki
Assistant Professor of Media Arts & Sciences

¹Surani A Irie N, Weinberger L, et al. "SOX17 Is a Critical Specifier of Human Primordial Germ Cell Fate." (Cell. 2014.)
<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4310934/> (Accessed on 3, May, 2016)

² Lois Rogers "Cell breakthrough to bring two-dad babies"(The Sunday Times: 22 February 2015) (Accessed on 3, May, 2016)
http://www.thesundaytimes.co.uk/sto/news/uk_news/Science/article1522406.ece?shareToken=5754e61bc815db859745094a64bf36ac

(Im)possible Baby

How to stimulate discussions about possibilities of two-mum and two-dad children.

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(Im)possible Baby

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(Im)possible Baby

How to stimulate discussions about possibilities of two-mum and two-dad children.

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2. Introduction

2.1: Why speculative design?

Designers Anthony Dunne and Fiona Raby, who coined the terms critical design and speculative design, wrote in their book "Speculative Everything -Design, Fiction, and Social Dreaming (2013)" about their hopes for speculative design in the following way: "...we are optimistic. Triggered by the financial crash of 2008, there has been a new wave of interest in thinking about alternatives to the current system. And although no new forms of capitalism have emerged yet. There is a growing desire for other ways of managing our economic lives and the relationship among state, market, citizen and consumer. This dissatisfaction with existing models coupled with new forms of bottom-up democracy enhanced by social media make this a perfect time to revisit our social dreams and ideals and design's role in facilitating alternative visions rather than defining them. Of being a catalyst rather than a source of visions. It is impossible to continue with the methodology employed by the visionary designer of the 1960s and 1970s. We live in a very different world now but we can reconnect with that spirit and develop new methods appropriate for today's world and once again begin to dream."³

As mentioned in the abstract, this project is a speculative design project which aims to stimulate discussions about the social, cultural and ethical implications of emerging biotechnologies that enable same-sex couples to have genetically related children. Previously I have done a project titled: "I Wanna Deliver a Dolphin...(2012)" which approaches the problem of human reproduction in an age of overcrowding, overdevelopment, and environmental crisis. With potential food shortages and a population of nearly seven billion people, would a woman consider incubating and giving birth to an endangered species such as a shark, tuna or dolphin? This project introduces the argument for giving birth to our food to satisfy our demands for nutrition and childbirth and discusses some of the technical details of how this might be possible in the future with emerging biotechnologies. In comparison with this previous project, (Im)possible Baby aims to explore issues which are much more urgent and pressing for debate, since the required technology is already available today.

2.2: Reproduction rights: the next step of same-sex marriage rights?

In 2013, more than 25 countries and local governments around the world followed the Netherlands in legalising same-sex marriage. Recent developments in reproductive technologies are suggesting that same-sex couples may also be able to have genetically-related children in the near future - but can society allow such a change to happen?

In 2004, a research team led by Prof. Tomohiro Kono in Laboratory of Developmental Biology, Tokyo University of Agriculture, succeeded in creating a bi-maternal mouse by altering imprinted

³ Anthony Dunne and Fiona Raby "Speculative Everything -Design, Fiction, and Social Dreaming-"(MIT press, p9, 2013)

gene expressions.⁴ In other words, the team created a mouse without a father, by turning an egg cell into surrogate sperm.

In 2013, a team of Japanese scientists succeeded in creating mouse germ(reproductive) cells in vitro from induced pluripotent stem cells (iPS cells). "Starting with the skin cells of mice in vitro, we created primordial germ cells (PGCs), which can develop into both sperm and eggs." (Nature 500, 392–394, 22 August 2013). As you can see in the articles "Stem cells: Egg engineers"⁵ in Nature and "Stem Cells and Same Sex Reproduction"⁶, these findings let us dream of the possibility of giving same-sex parents the ability to have a baby that is genetically their own.

In 2015, there were more reproductive research findings from the joint team of Cambridge University in England and Israel's Weizmann Institute of Science⁷. They established a potentially important gene to induce cells to turn into germ cells, specifically the SOX17 gene. The Sunday times reported this as "Cell breakthrough to bring two-dad babies"⁸.

Now, in 2016, the latest news on relevant reproductive research comes from Spain. A science news site phys.org has been reporting research under the headline "Scientists use skin cells to create human sperm"⁹. The original paper title is "Human somatic cells subjected to genetic induction with six germline-related factors display meiotic germ cell-like features"¹⁰. This research demonstrates a way to make human sperm from human male skin in vitro.

Within a month the skin cell was transformed to become a germ cell, which can develop into sperm or an egg, but it did not have the ability to fertilise, they found.

"This is a sperm but it needs a further maturation phase to become a gamete. This is just the beginning," Simon said.¹¹

Although even the latest research does not give us enough knowledge to make functional sperm, this area of research has been progressing much faster than expected.

⁴ Helen Pearson "Mouse created without father", (Nature, 22 April 2004)

<http://www.nature.com/news/2004/040422/full/news040419-8.html> (Accessed on 3, May, 2016)

⁵ David Cyranoski "Stem cells: Egg engineers" (Nature, August 2013) <http://www.nature.com/news/stem-cells-egg-engineers-1.13582>

⁶ Ian Murnaghan "Stem Cells and Same Sex Reproduction" (ExploreStemCells, 7 September 2014, updated 2016) <http://www.explorestemcells.co.uk/stem-cells-same-sex-reproduction.html> (Accessed on 3, May, 2016)

⁷ Surani A Irie N, Weinberger L, et al. "SOX17 Is a Critical Specifier of Human Primordial Germ Cell Fate." (Cell. 2014.) (Accessed on 3, May, 2016)

⁸ Lois Rogers "Cell breakthrough to bring two-dad babies" (Published: 22 February 2015 © Times Newspapers Ltd 2015) http://www.thesundaytimes.co.uk/sto/news/uk_news/Science/article1522406.ece?shareToken=5754e61bc815db859745094a64bf36ac (Accessed on 3, May, 2016)

⁹ "Scientists use skin cells to create human sperm" © 2016 AFP <http://phys.org/news/2016-04-scientists-skin-cells-human-sperm.html> (Accessed on 3, May, 2016)

¹⁰ Jose V. Medrano, et al "Human somatic cells subjected to genetic induction with six germ line-related factors display meiotic germ cell-like features" (Scientific Reports 6, Article number: 24956, 2016) <http://www.nature.com/articles/srep24956> (Accessed on 3, May, 2016)

¹¹ "Scientists use skin cells to create human sperm" <http://phys.org/news/2016-04-scientists-skin-cells-human-sperm.html> (© Phys.org 2003 - 2016) (Accessed on 3, May, 2016)

2.3: Who decides and how? (Why open this problem to citizens?)

An experience from my own life will help illustrate my motivations for carrying out this project, as well as demonstrate the relevance of these questions to society at large. I used to live in London, where I was legally allowed to do oocyte cryopreservation (egg freezing). I also saw a few advertisements in women's magazines about "free" egg freezing. If you donated your surplus eggs, you could freeze your eggs for free. A few years later, I returned to Japan. At that time, I heard the news that Japanese single females would be allowed to have this procedure performed starting from fall 2013.

I was surprised at the difference in attitude and the long delay prior to the introduction of cryopreservation in Japan. Then I researched about who was making these decisions. As a person who might need this technology, of course, I wanted to know, think about, and discuss this issue.

The Japan Society for Reproductive Medicine Ethics¹² Committee are the decision makers in this case. This committee is an assembly of about twelve authorities: eight male doctors and four external researchers, who are: a lawyer, a cultural anthropologist, an ethicist and only one female: a sociologist. Despite deciding on a reproductive issue, the twelve committee members only include one female. An important, basically female issue seems to be decided by eleven males and one female. Even though these doctors are most likely experts in this field, I found it hard to avoid the feeling that this problem was being decided by older men who will never use this technology themselves.

Moreover, the committee's website featured a public comments report. They collected these "public comments"¹³ only for 17 days, and only 20 people participated. The backgrounds of the public participants were as follows:

- 4 out of 20 were non-academic people.
- 14 out of 20 were females.
- 8 out of 20 were in the age range 20-40 years old.

At most, only eight of the public committee members were potential users with a non-science related female voice. I wondered about the case of minorities - who can make a fair decision, and how? From examining the findings, we must acknowledge the bias in this decision-making system for those who are socially vulnerable.

¹² Japan society for reproductive medicine website.

http://www.jsrm.or.jp/guideline-statem/guideline_2013_01.html(Accessed on 3, May, 2016)

Japan society for reproductive medicine, public comment report of unmarried person's egg freezing

¹³ http://www.jsrm.or.jp/guideline-statem/guideline_2013_04.pdf(Accessed on 3, May, 2016)

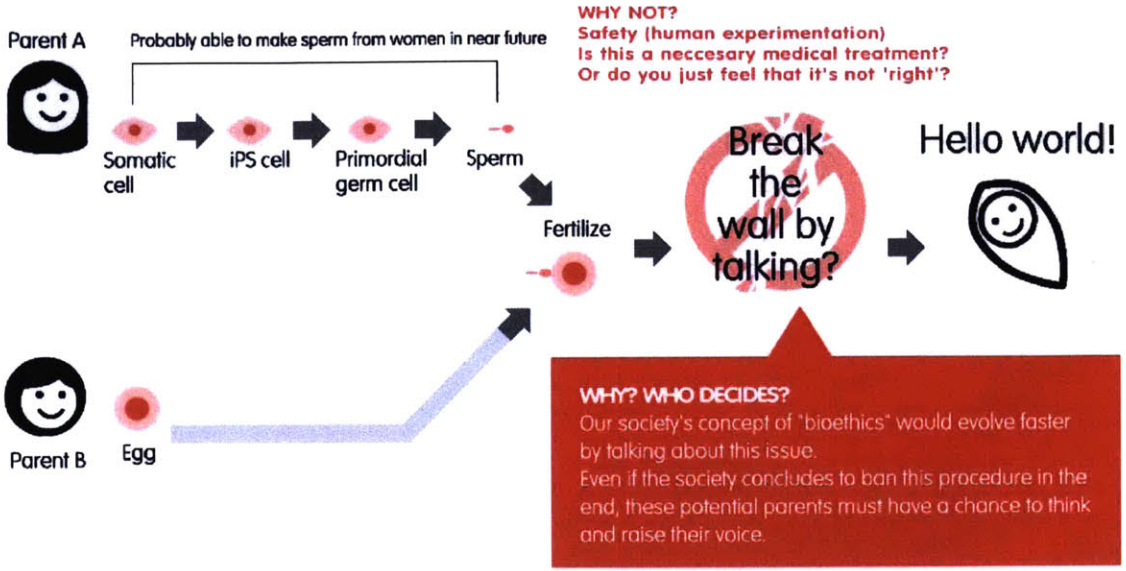


Figure 1. Illustration of ethical hurdles of the a genetically-related baby for same-sex couple (female couple version)

3. Related work and novelty of this project

GenePeeks and 23andMe's Family Traits Inheritor Calculator are examples of medical-purpose baby simulator/speculator business services. My project's aim as an art and design project is to stimulate the discussion about babies from same-sex parents, produced by future biotechnology research in induced Pluripotent Stem cells (iPSc). While the scientific research is important from a technical standpoint, the focus of this project is more about the bioethical discussion. Another important project is "Stranger Visions" by artist Heather Dewey-Hagborg¹⁴ in which human DNA samples were collected in public venues to have 3D portraits reconstructed from the genetic data. While the artist conducted sufficient research into genetic markers, single nucleotide polymorphisms (SNP) data, and 3D print software, the project focuses more on the ethics of biological surveillance.

"GenePeeks is the most innovative way to identify genetic risk. By analyzing your DNA in combination with the DNA of potential sperm or egg donors, you can better protect your future baby from rare genetic conditions."

"Meet your unborn child – before it's even conceived¹⁵" Guided by these principals, we have invented a computational system that uses the genetic information of two prospective parents to determine the risk of disease in potential children. Our method computes a Variant Gene Dysfunction (VGD) score for every variant found in each parent. These scores are subsequently used to generate thousands of simulated genomes, or Virtual Progeny (VP), to quantify a family's risk of transmitting a serious disease to a future child."

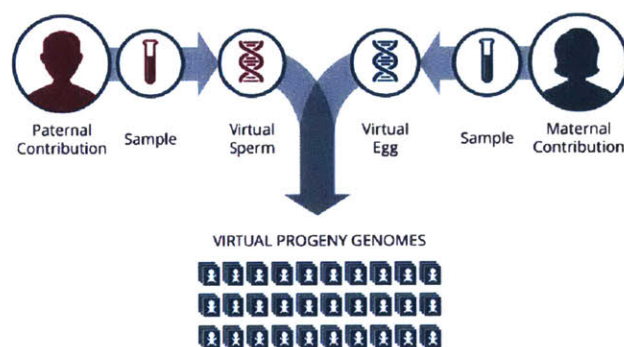


Figure 2. Platform illustration Image from GenePeeks¹⁶ ©GenePeeks. All Rights Reserved.

Family Traits Inheritor Calculator¹⁷ by 23andMe. "A US patent for a database that uses DNA testing to tell prospective parents which traits their future offspring may inherit has been criticised by experts. 23andMe says its Family Traits Inheritor Calculator can predict the risk of

¹⁴ Website of Heather Dewey-Hagborg <http://www.deweyhagborg.com/>(Accessed on 3, May, 2016)

¹⁵ Catherine de Lange ,New Scientist Magazine issue 2964. 09 April 2014(Accessed on 3, May, 2016) <https://www.newscientist.com/article/mg22229642.800-meet-your-unborn-child-before-its-even-conceived/#.VDmHCueppSt>

¹⁶ Website of GenePeeks <https://www.genepeeks.com/>(Accessed on 3, May, 2016)

¹⁷ Website of 23andme <http://blog.23andme.com/news/a-23andme-patent/>(Accessed on 3, May, 2016)

inheriting specific diseases as well as details such as height, weight, eye colour and even personality.”



Figure 3. Image from BBC ¹⁸(Oct 2013)
©BBC 2016. All Rights Reserved.



Figure 4. Family Traits Inheritor Calculator¹⁹ by 23andMe

“If they carry one particular genetic variant, two individuals with brown eyes can have children with almost any color eyes.
²⁰” ©23andMe. All Rights Reserved.

“In Stranger Visions artist Heather Dewey-Hagborg creates portrait sculptures from analysis of genetic material collected in public places. Working with the traces strangers unwittingly leave behind, Dewey-Hagborg calls attention to the developing technology of forensic DNA phenotyping and the potential for a culture of biological surveillance. Designed as an exploratory project based on emerging science, the forecast of Stranger Visions has proved prescient. “

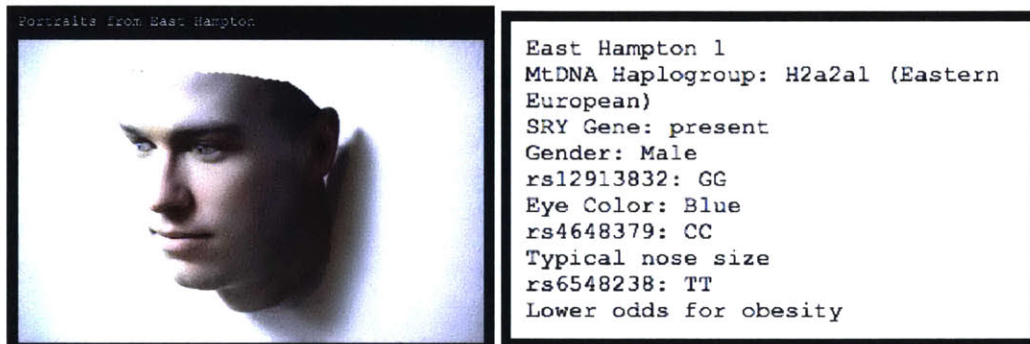


Figure 5 .Stranger Visions (2012-2013) by Heather Dewey-Hagborg. Image from her website²¹
©Heather Dewey-Hagborg . All Rights Reserved.

¹⁸“23andMe’s ‘build-a-baby’ patent criticised” <http://www.bbc.com/news/technology-24381149> (Oct 2013)(Accessed on 3, May, 2016)

¹⁹ <http://blog.23andme.com/news/a-23andme-patent/>(Accessed on 3, May, 2016)

²⁰ Read more at <http://blog.23andme.com/news/a-23andme-patent/#mcwggqAXkiDtoApjw.99>(Accessed on 3, May, 2016)

²¹ Website of Heather Dewey-Hagborg , page of strangervisions <http://deweyhagborg.com/strangervisions/> (Accessed on 3, May, 2016)

4: Making Process

In the first phase of this project, we analyzed the DNA data of a lesbian couple using 23andMe to simulate and visualize their potential children.

4.1: Finding a suitable same-sex couple willing to provide SNPs data

We purposely chose a mixed-race couple whose combined genetic trait data will produce a more obvious appearance in genetic difference. In addition, a mixed-race couple would communicatively reach a broader audience.

Although it would give more realism, empathy and persuasive power to the project, we chose the couple does legally married. Since it was the most popular service at the time according to the report, we used the personal genomics company 23andMe. 23andMe has about 1.2 million customers.²² That means our (im)possible baby simulator would have many potential users.

There are several ethical concerns that must be addressed. Handling human DNA data is “Research Involving Human Subjects”. As preparation for this, the author took the COUHES : Data or Specimens Only Research Course. Also, we made sure that subjects understood the meaning of sharing the DNA data with us, (they read and agreed when using the 23andMe - DNA Genetic Testing & Analysis service) we have sent and asked subjects to read the guidelines for the introduction to informed consent about handling DNA data. Finally, this project might be cruel and cause anxiety by showing the figure of the possible - but currently impossible to have - genetically-related children of their own. Thus, we asked them to think carefully about the participation in this project.



Figure 6. Image of 23andMe kit²³ ©23andMe All Rights Reserved

²² Website of 23andMe Press Releases <http://mediacenter.23andme.com/blog/researchkit/> (Accessed on 3, May, 2016)

²³<https://www.23andme.com/howitworks/> (Accessed on 3, May, 2016)

Asako Makimura : Japanese
Sex chromosomes :XX

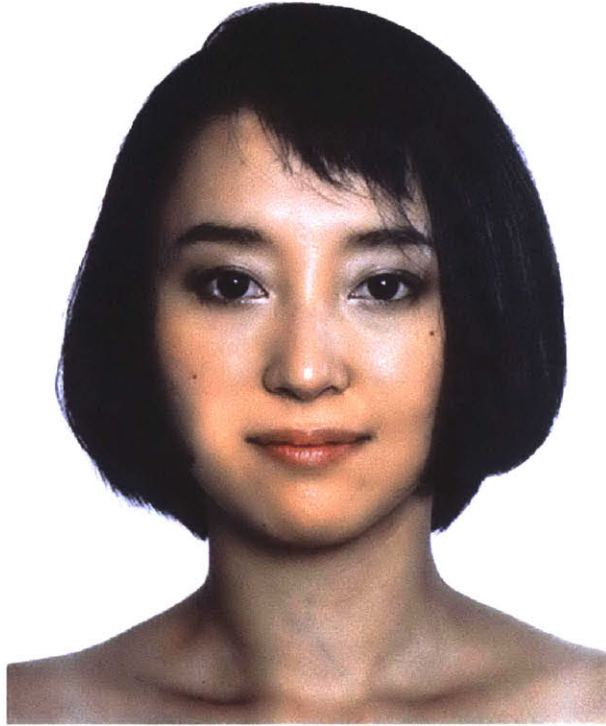


Figure 7. Photo of Asako Makimura

Partial genetic data of Asako

Boby part / Magnitude / SNPs ID / Genotype /Summary : Sort by Magnitude,
bigget to smaller

Red text indicates differences between Asako and Moriga

Face

rs17447439 (A;A) Distance between eyes (same as both parents)

rs805722 (C;C) Distance between center of eye and nasion

rs1258763 (C;T) Not applicable about nose width

rs987525 (C;C) Bizygomatic distance. Normal (0) risk for cleft lip.

rs9574565 (C;C) Distance between R-eye and pronasale

rs642961 (G;G) Distance between center of R-eye and pronasale.

Not protrusive and thicker lips for Asian

Hair / skin / eye

2.6 rs1426654 (G;G) Probably darker-skinned, Asian or African ancestry

2.1 rs26722 (C;T) Perhaps darker eye, hair, skin

2 rs1667394 (G;G) Darker skin, eye and hair color is more likely

2 rs1454292 (C;C) Curlier hair

2 rs6732426 (C;C) Curlier hair

2 rs11803731 (A;A) Straighter hair

1.1 rs16891982 (C;C) Generally non-European, but if European, 7x more likely to have black hair

1 rs1800407 (G;G) Blue/gray eyes more possible

1 rs1800401 (C;C) Blue/gray eyes possible

rs12913832 (A;A) Brown eye color, 80% of the time

Ear and body odour

2.5 rs17822931 (T;T) Dry earwax, no body odour, likely Asian ancestry, Reduced colostrum.

Moriga : French
Sex chromosomes :XX



Figure 8. Photo of Moriga
Partial genetic data of Moriga

Boby part / Magnitude / SNPs ID / Genotype /Summary : Sort by Magnitude,
bigget to smaller
Red text indicates differences between Asako and Moriga

Face

rs17447439 (A;A) Distance between eyes
rs805722 (C;C) Distance between center of eye and nasion
rs1258763 (C;T) Not applicable about nose width
rs987525 (C;C) Bizygomatic distance. Normal (0) risk for cleft lip.
rs9574565 (C;T) Distance between R-eye and pronasale
rs642961 (A;G) Distance between center of R-eye and pronasale.
Not protrusive and thicker lips for Asian.

Hair /skin / eye

2.7 rs1426654 (A;A) Probably light-skinned, European ancestry
2.1 rs1667394 (A;A) Blond hair & blue eyes is 4x more likely
2 rs16891982 (C;G) If European, 7x more likely to have black hair
2 rs12913832 (G;G) Blue eye color, 99% of the time
2 rs3124314 (T;T) Straighter hair
2 rs1454292 (T;T) Straighter hair
2 rs11803731 (A;A) Straighter hair
1 rs1800407 (G;G) Blue/gray eyes more possible
1 rs1800401 (C;C) Blue/gray eyes possible
Ear and body odour
2 rs17822931 (C;T) Wet earwax, slightly better body odour

4.2: Making a Simulator

(Im)possible baby simulator

Speculate your possible baby by uploading each parent's 23andMe .txt file

This application uses data from [SNPedia](#), matching your baby with the most interesting genotypes of magnitude 2 and above. We do not hold or store your personal data or results in any way. When uploading, please be patient for a few minutes while the app processes your results.

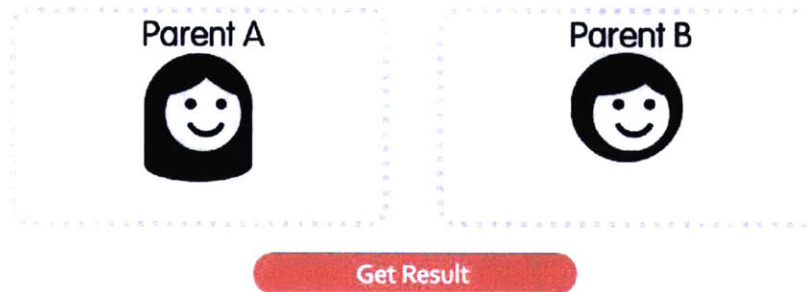


Figure 9. Image of the screenshot of the simulator
<http://aihasegawa.info/impossiblebaby/twoparents.html>

We developed a program²⁴ which speculates your possible baby by uploading each parent's 23andMe .txt file.

This application uses data from SNPedia²⁵, matching your baby with the most interesting genotypes of magnitude 2 and above. The application does not hold or store the user's personal data or results in any way. When uploading, the user must wait for a few minutes while the app processes their results.

23andMe data is only seeing the "single nucleotide polymorphism"* that is 1/1000 average in the genome.

The application randomly chooses one letter from one parent's genotype and combines this with another randomly chosen letter from the other parent's SNP data. In the application, mitochondrial DNA data is taken from parent1. The data from parent1 represents the egg and the data from parent2 represents the sperm. (Mitochondrial DNA cannot be inherited from sperm).

			Parent1 + Parent2 = Baby	
<u>rs13302982</u>	1	861808	GA	GG =AG
<u>rs55678698</u>	1	864490	CC	CC =CC
<u>16019299</u>	1	871267	CC	CC =CC
<u>rs1110052</u>	1	873558	GG	GT =GG
<u>rs147226614</u>	1	878697	GG	GG =GG
<u>16019302</u>	1	881843	GG	GG =GG
<u>rs2272756</u>	1	882033	GG	GG =GG
<u>rs67274836</u>	1	884767	GG	GG =GG
<u>16019303</u>	1	888554	CC	CC =CC
<u>rs13302945</u>	1	889159	CC	CC =CC
<u>16019304</u>	1	889182	GG	GG =GG
<u>16019305</u>	1	891343	GG	GG =GG
<u>rs13303106</u>	1	891945	GG	AG =AG
<u>16019306</u>	1	894379	GG	GG =AG
<u>rs13303010</u>	1	894573	AA	AG =AA
<u>16019308</u>	1	897792	CC	CC =CC

Figure

10. Illustration of how to make the baby SNPs set

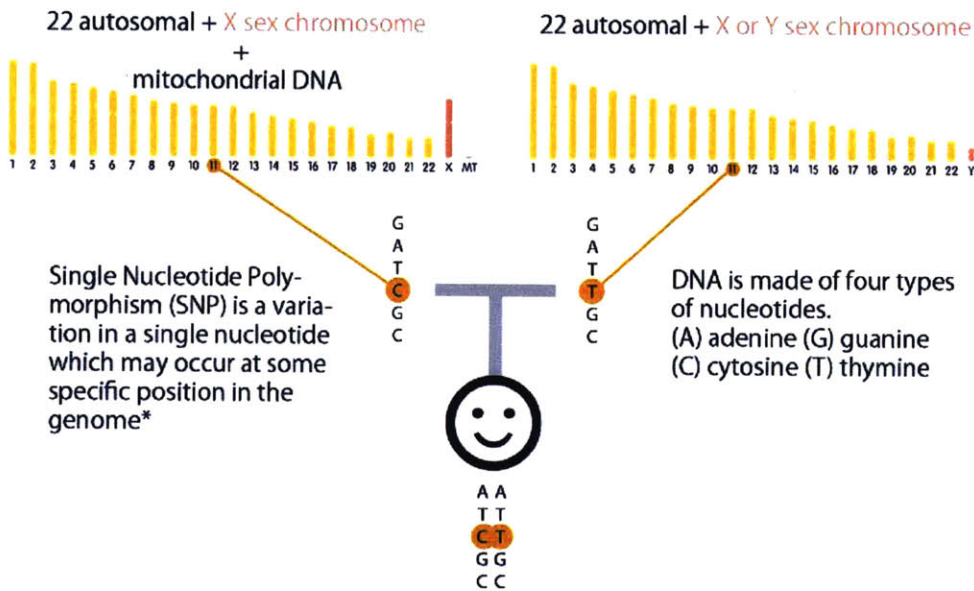
²⁴ The author is grateful to Jacquelyn L Liu for her assistance in developing this software.

²⁵ Website of SNPedia snpedia.com/index.php/SNPedia (Accessed on 3, May, 2016)

What is SNPs?



Generally, human reproduction occurs by fertilization of egg from the female and sperm from the male.



It is considered that the physical constitution and susceptibility of certain diseases is dependant on the location and type of SNPs.

Example: SNP "rs1815739" positioned at 66560624 on the 11th chromosome is considered to be related to muscle type. In this figure, C from the mother and T from the father, results in the child with type C T.

rs1815739
 (C;C) Better performing muscles. Likely a sprinter.
 (C;T) Mix of muscle types. Likely a sprinter.
 (T;T) Impaired muscle performance. Likely an endurance athlete.
 (SNPedia)

Figure 11. Illustration of SNPs

4.3: Result Page

The following is an example of the results from the simulator from two parent files. The page shows a simple list of Good News, Bad News and Neutral info based on the baby's generated SNPs. The length of the results depends on the person, although usually information in the range of about 200-300 SNPs will be available.

A user can download the raw data of the baby's SNPs from the yellow button. The data is a text file structured similarly to those generated by 23andMe, approximately 15 megabytes in size, and compressed with the zip format. Users can use \$5 analysis services at <https://promethease.com/> if they want to know more detailed analytical data. I also use this service for the visualization of the data. In particular, the case of several SNPs combining is key to making predictions, like the example below. The Promethease service is based on SNPedia, which is an open source wiki-like database. Thus, it is continuously being updated by its users from such online research as described.

(Im)possible baby simulator



Your Baby Report

Download Data

Good news

(warrior) multiple associations, see details
[Rs4680\(G;G\)](#)
reduced risk (0.84x) for late-onset (adult) asthma
[Rs1837253\(C;T\)](#)
Much lower 0.15x risk of Type 1 Diabetes.
[Rs9273363\(C;C\)](#)
greatly increased memory performance
[Rs17070145\(T;T\)](#)
stronger bones
[Rs9525638\(C;C\)](#)
slightly higher (1.35x) odds of good metformin response in type 2 diabetics
[Rs4585\(G;G\)](#)
lower risk of autism
[Rs3819331\(T;T\)](#)
Normal risk of Atopic Dermatitis.
[Rs6700998\(G;T\)](#)
Normal (lower) risk of sexual dysfunction when taking SSRI Antidepressants.

Figure 12. Capture of (im)possible baby simulator result page "Good news" means repute as good SNPs.

Bad news

Phenylketonuria

[Rs52642926\(G;G\)](#)

Phenylketonuria

[Rs52516092\(G;G\)](#)

Fanconi Anemia (FANCC-related)

[Rs104886456\(T;T\)](#)

Neuronal Ceroid Lipofuscinosis

[Rs137852695\(T;T\)](#)

Increased prostate cancer risk (odds ratio 1.6)

[Rs10993994\(T;T\)](#)

1.3x higher risk of narcolepsy compared to (A;G) genotype

[Rs2305795\(A;A\)](#)

Neutral info

23andMe = Tay-Sachs disease likely, but on other platforms this may be the normal form

[Rs28940871\(G;G\)](#)

homozygote for pachyonychia congenita Type I mutation

[Rs57424749\(C;C\)](#)

higher scores on anxiety-related personality traits; greater placebo response

[Rs4570625\(G;G\)](#)

mixed African/European ancestry possible

[Rs1426654\(A;G\)](#)

Impaired muscle performance. Likely endurance athlete.

[Rs1815739\(T;T\)](#)

Carrier of one CYP1A2*1F allele; Slow Caffeine Metabolizer.

[Rs762551\(A;C\)](#)

some reports of familial Mediterranean fever

[Rs3743930\(C;C\)](#)

Late riser. Wakes up 1 hour later than those with AA genotype.

[Rs7221412\(G;G\)](#)

bigger breast size (normal in European)

[Rs7816345\(C;C\)](#)

Shorter QT interval

[Rs10494366\(T;T\)](#)

increased susceptibility to novelty seeking

[Rs1800955\(C;C\)](#)

straighter hair

[Rs11803731\(A;A\)](#)

associated with higher HDL cholesterol

[Rs1566439\(C;T\)](#)

Reduced CYP2A6 metabolism; impaired nicotine metabolism?

[Rs1801272\(A;A\)](#)

[Return to Parent Upload](#)

Figure 13. Capture of (im)possible baby simulator result page "Good news" means repute as good SNPs.

4.4: Visualization

We made two SNPs files using the (im)possible baby simulator. We named the first generated file data as Mameko (which is a girl's name meaning "little bean" in Japan) and named the second generated file data as Powako(also a girl's name). This chapter shows how we visualized them.

SNPedia and several online articles were the essential tools for constructing the facial portraits of the couple's hypothetical daughters. Difficulties arose due to the fact that current genotype research is still fairly nascent. Since the project's purpose is to inspire debate, not to create facial portraits with 100% accuracy with genetic markers, it must be said that the results resemble fortune-telling rather than science at this time of writing.

4.5:Facial structure speculation

1: Make a 3D facial model from each parents' photos.

2: According to their childhood photos, construct each face as approximately 10 years old.

3: Merge the two faces to reach a "middle point," having traits from each parent.

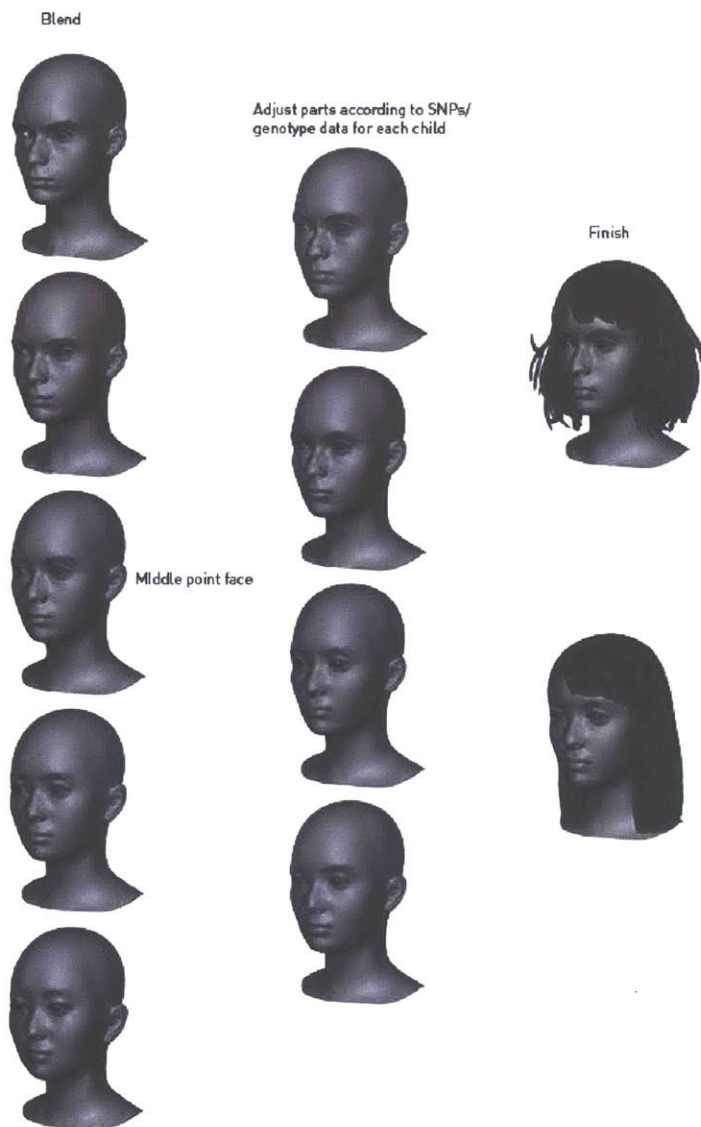


Figure 14. Image of how to make the face of children. Merge the two faces to reach a "middle point," having traits from each parent.

4: Adjust traits according to SNPs genotype data.²⁶



Mameko

Figure 15. Mameko's 3D facial data and related SNPs

²⁶Fan Liu, et al "Genetic determination of human facial morphology: links between cleft-lips and normal variation" <http://journals.plos.org/plosgenetics/article?id=10.1371/journal.pgen.1002932> (Accessed on 3, May, 2016)
Shouneng Peng, Jingze Tan, et al "Detecting Genetic Association of Common Human Facial Morphological Variation Using High Density 3D Image Registration" <http://journals.plos.org/ploscompbiol/article?id=10.1371/journal.pcbi.1003375> (Accessed on 3, May, 2016)
Ryosuke Kimura, et al "A Common Variation in EDAR Is a Genetic Determinant of Shovel-Shaped Incisors" <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2756549/> (Accessed on 3, May, 2016)

The facial structure is adjusted according to six SNPs, rs17447439, rs805722, rs1258763, rs987525, rs9574565, rs642961. We checked the similarity of the child's SNPs to those of their parents. In cases where the genotype corresponded to one parent's genotype, we tuned the corresponding facial parts to resemble that parent.

According to the SNPs ID rs1258763's genotype is (T:T), this means Mameko's nose width is wider, different from both parents.



Powako

Figure 16. Powako's 3D facial data and related SNPs



Figure 17. Mameko's face photo details with skin and hair details

Partial genetic data of Mameko : Body part / Magnitude / SNPs ID / Genotype /Summary : Sort by Magnitude, bigger to smaller

	rs17447439	(A;A)	Distance between eyes (same as both parents)
	rs805722	(C;C)	Distance between center of eye and nasion (same as both parents)
	rs1258763	(T;T)	Nose width (TT= AA) wide
parents)	rs987525	(C;C)	Bizygomatic distance. Normal (0) risk for cleft lip. (same as both
	rs9574565	(C;C)	Distance between R-eye and pronasale (same as Asako)
	rs642961	(G;G)	Distance between center of R-eye and pronasale. Not protrusive and thicker lips for Asian (same as Asako)
Hair			
2.5	rs1426654	(A;G)	Mixed african/european ancestry possible.
2	rs16891982	(C;G)	If european, 7x more likely to have black hair.
	rs6732426	(C;T)	Not applicable about curlier hair.
2	rs11803731	(A;A)	Straighter hair
1	rs3827760	(C;T)	Increased odds of straighter, thicker hair as well as shovel shaped incisors (AG=CT) and may slight larger tooth size.
Skin			
2	rs1015362	(A;G)	2-4x higher risk of sun sensitivity (in other words, freckles and sunburn) if part of risk haplotype
2	rs4911414	(G;T)	2-4x higher risk of sun sensitivity (in other words, freckles and sunburn) if part of risk haplotype
Ear and body odour			
2.5	rs17822931	(T;T)	Dry earwax, no body odour, likely Asian ancestry, Reduced colostrum.



Figure 18. Powako's face photo details with skin and hair details

Partial genetic data of Powako : Body part / Magnitude / SNPs ID / Genotype /Summary : Sort by Magnitude, bigger to smaller

	Rs17447439	(A;A)	Distance between eyes (same as both parents)
	Rs805722	(C;C)	Distance between center of eye and nasion (same as both parents)
	rs1258763	(C;T)	Nose width (same as both parents)
	rs987525	(C;C)	Bizygomatic distance (same as both parents)
	rs9574565	(C;T)	Distance between R-eye and pronasale (same as Moriga)
	rs642961	(A;G)	Distance between centre of R-eye and pronasale. Not protrusive and thicker lips for Asian (same as Moriga)
Hair			
2.5	rs1426654	(A;G)	Mixed African/European ancestry possible
2	rs16891982	(C;G)	If European, 7x more likely to have black hair
2	rs11803731	(A;A)	Straighter hair
2	rs6732426	(C;C)	Curlier hair
	rs3827760	(T;T)	Not applicable about thicker hair as well as shovel shaped incisors.
Skin			
2	rs1015362	(A;G)	2-4x higher risk of sun sensitivity (in other words, freckles and sunburn) if part of risk haplotype
2	rs4911414	(G;T)	2-4x higher risk of sun sensitivity (in other words, freckles and sunburn) if part of risk haplotype
Ear and body odour			
2	rs17822931	(C;T)	Wet earwax, slightly better body odour

4.6: Iris speculation

As preparation for speculation of eye color and iris visualization, I studied the research report "Eye Color" by Arielle Yablonovitch and Ye Henry Li,²⁷ mainly. To double-check the result, as mentioned above, I used SNPedia²⁸ and their service Promethease.com²⁹. Both of these services provide very powerful tools.

For both Mameko and Powako, we have gs256 SNPs that is Magnitude 2.5, which is the biggest magnitude number in their SNPs list.

Note about Magnitude in SNPedia³⁰

Magnitude is a subjective measure of interest. Over time it should be adjusted up or down by the community. It is generally interpreted as follows...

- 0 You have the common genotype, for which nothing interesting is known.
- 0.1 You have the common genotype, but its interesting that this varies for others
- 1 Semi-plausible but not very exciting
- (blank) No one has yet assigned a magnitude. Treated as a 1.
- 2 looks interesting enough to be worth reading
- 2.1 hmm, interesting
- 3 Probably worth your time
- 10 Really significant information!

Numbers bigger than 10 are allowed and expected in the future. Since User:Watson and User:Steven Pinker requested not to learn their APOE4 gs216 status that serves as useful a landmark in the scale. Several rare genotypes are higher magnitude. The genotypes with highest magnitude I4000378(I:I) MAGNITUDE :10 REPUTE :Bad SUMMARY :BRCA1 (breast cancer) 5382insC

"Gs256" is the name of genoset that represents combinations of SNPs that have been linked to phenotypes. It has a criteria of condition or combination of the SNPs. According to the SNPedia database Gs256 is :

Gs256 Heterozygous for what [PMID 22065085] calls blue eye color haplotype #1. It seems 'blue', might be overstating it. In the eye color research community, there seems to be a distinction between the dark brown eyes typical for asian and african ancestry, and 'blue' for lighter eyes found in europeans.

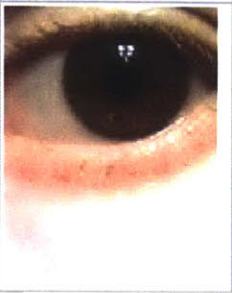
Gs256	
Magnitude	2.5
Repute	
Summary	Blue eyes
Criteria	Gs256/criteria

²⁷ Arielle Yablonovitch and Ye Henry Li "Eye Color" (2012)
<http://web.stanford.edu/class/gene210/files/projects/EyeColorPresentation.pdf> (Accessed on 3, May, 2016)

²⁸ SNPedia about eye color http://www.snpedia.com/index.php/Eye_color (Accessed on 3, May, 2016)

²⁹ Promethease website <https://promethease.com/> (Accessed on 3, May, 2016)

³⁰ SNPedia about magnitude page <http://www.snpedia.com/index.php/Magnitude> (Accessed on 3, May, 2016)

ImgURL	link
	Gs256/criteria and(rs4778138(A), rs4778241(C), rs7495174(A), not(gs255))
<p>Figure 19. Iris related Image and data from SNPedia³¹ ©SNPedia.. All Rights Reserved</p>	

Since they have an asian parent Asako, their eye colour is probably brown. Mameko has Rs1533995 (G;G). This means her iris has no crypt (complicated water shadow-like iris pattern), and has a simple iris pattern like Asako. Powako has (A;G) therefore she has a crypt, which is the same as Moriga's iris. Mameko and Powako's SNPs ID rs3739070 are (A;A), which indicates a higher likelihood of having furrows, which is the same as both parents. Mameko has (T;T) for Rs4900109, which means no pigmentation ring (same as Asako). Powako has (T;G), thus her eyes have two colors. Inner and outer colors are different, which is also the case for Moriga. All family members have (C;C) for rs11630290, which indicates that Iris nevi are melanin accumulations on the anterior border layer. In other words, they have freckle-like dots in the iris.

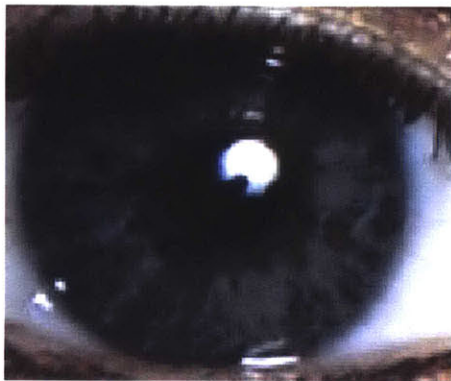


Figure 20. This is close up image of Moriga's iris. Able to see crypt, pigmentation ring, nevi and furrows.

³¹Website of SNPedia about eye color http://www.snpedia.com/index.php/Eye_color (Accessed on 3, May, 2016)

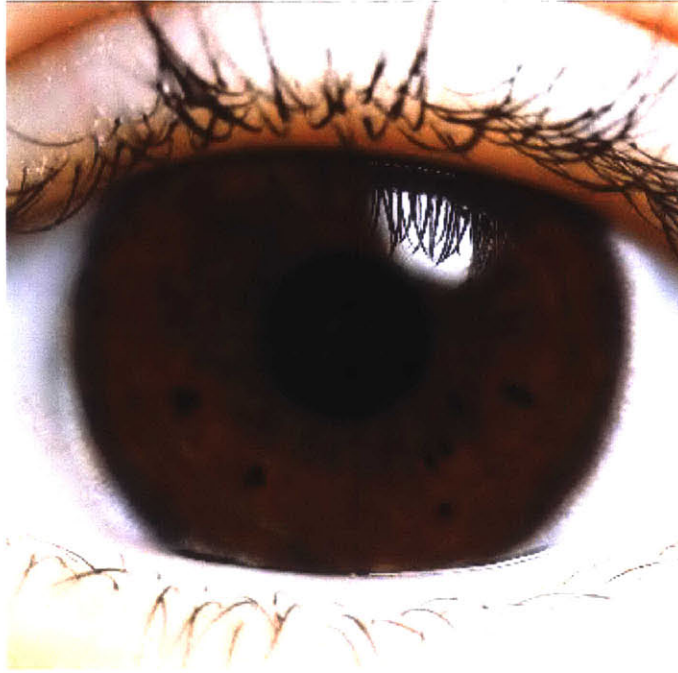


Figure 21. Mameko's iris close up photo

Mameko

Eye color

2.5	gs256	There seems to be a distinction between the dark brown eyes typical for Asian and African ancestry, and 'blue' for lighter eyes found in Europeans.
2.5	rs1426654	(A;G) Mixed African/European ancestry possible.
2	rs16891982	(C;G) If European, 7x more likely to have black hair.
2	rs1061147	(C;C) Reduced 0.34x risk of Age Related Macular Degeneration.
2	rs4911414	(G;T) 2-4x higher risk of sun sensitivity if part of risk haplotype.
	rs1800414	(A;G) Blue/gray eyes less likely.
	rs2238289	(C;T) Usually brown eye color.
	rs4778241	(A;C) Usually brown eye color.
	rs12913832	(A;G) Brown eye color.

Iris

	rs1533995	(G;G) No crypt (same as Asako)
	rs3739070	(A;A) Furrows 87%, more pronounced furrows (same as all family members)
	rs4900109	(T;T) No pigmentation ring (same as Asako)
	rs12896399	(G;T) Pigmentation ring 93% G= Pigmented rings (same as Moriga)
	rs11630290	(C;C) Iris nevi are melanin accumulations on the anterior border layer (same as all family members)



Figure 22. Powako's iris close up photo

Powako

Eye color

2.5	gs256	There seems to be a distinction between the dark brown eyes typical for Asian and African ancestry, and 'blue' for lighter eyes found in Europeans.
2.5	rs1426654	(A;G) Mixed African/European ancestry possible.
2	rs16891982	(C;G) If European, 7x more likely to have black hair.
2	rs1061147	(C;C) Reduced 0.34x risk of Age Related Macular Degeneration.
2	rs4911414	(G;T) 2-4x higher risk of sun sensitivity if part of risk haplotype.
	rs1105879	(G;G) Blue/gray eyes less likely
	rs2238289	(C;T) Usually brown eye color
	rs916977	(A;G) Brown eye color is more likely
	rs4778241	(A;C) Usually brown eye color
	rs12913832	(A;G) Brown eye color

Iris

rs1533995	(A;G) Crypt frequency 84% A=More crypts (same as Moriga)
rs3739070	(A;A) Furrows 87%, more pronounced furrows (same as all family members)
rs4900109	(G;T) Pigmentation ring 93% G= Pigmented rings (same as Moriga)
rs12896399	(G;T) Pigmentation ring 93% G= Pigmented rings (same as Moriga)
rs11630290	(C;C) Iris nevi are melanin accumulations on the anterior border layer (same as all family members)

4.7: Storytelling and Communication

Making a family album

I then created a set of fictional, hypothetical family photos using the genetic SNP data. The family album was produced as a hardcover album which I presented to the couple as a gift.

Non-appearance related SNPs (e.g breast size or obesity) could possibly reveal the risks of gene related illness, personality and ability through future research. For this reason, I hide each specific genotype to avoid the possibility of reconstructing the parent's illness risks. (The original family album does not hide the genotype data. This part has been blurred in the documentary film.)

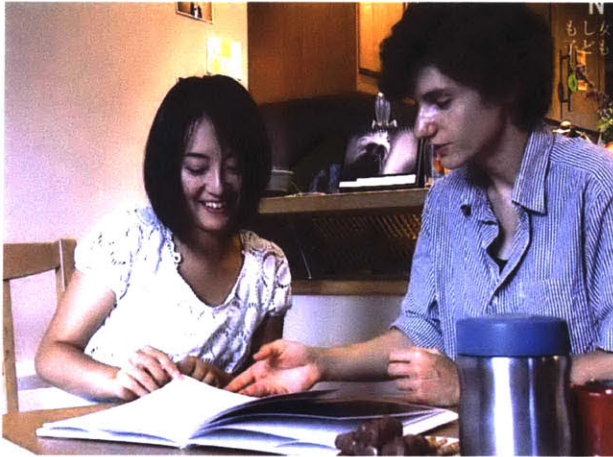


Figure 23. Image from NHK Heartnet TV. Asako and Moriga opening the album.³²

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Figure24. Asako asking who's eye is this in the book cover. ©NHK (JAPAN BROADCASTING CORPORATION) . All Rights Reserved

³²Website of the NHK Heartnet TV <http://www.nhk.or.jp/hearttv-blog/700/237751.html> (Accessed on 3, May, 2016)

Breakfast (Diet and food preference)



Figure 25. Asako and Moriga try to make Mameko eats coriander, and Powako eats asparagus.

In the photo, there are few hints that reveal the related SNPs ID, genotype, magnitude and short descriptions of these daughters.

This breakfast scene shows Mameko sniffing a coriander leaf and making a disgusted expression. She has the genotype "rs72921001 (C;C)," which means that she is more likely to think that coriander tastes like soap. Powako is eating an asparagus and looking at the camera with eyes full of mischief. She has the genotype "rs4481887 (A;G),"³³ which means she is more likely to be able to smell asparagus metabolites in her urine. She is looking forward to smelling it soon at the toilet. Asako told us she is also able to smell it in her own urine.

Mameko's diet and food preference related SNPs

Subject / Magnitude (Sort by Magnitude, bigger to smaller) / SNPs ID / Summary

Sweet

1	rs838133	Typical odds preferring sweet snack
0.1	rs5400	Normal sugar consumption

Bitter

1.2	gs184	Able to taste bitterness
1.1	rs713598	Possibly unable to taste bitter in some foods

³³ Asparagus anosmia research was performed by 23andMe and presented at the 2009 ASHG according to genetic future. Website about the Asparagus anosmia research <https://www.snpedia.com/index.php/Rs4481887> (Accessed on 3, May, 2016)

	0.1	rs1726866	Able to taste bitterness
	0.1	rs10246939	Able to taste bitterness
Smell			
	3	rs72921001	More likely to think coriander tastes like soap
	1.5	rs6591536	More able to detect β -ionone (floral) fragrance
	1.5	rs4481887	Least likely to be able to smell asparagus metabolites in urine

Diet			
	2.2	rs2200733	1.5x increased risk of Atrial Fibrillation and Ischemic Stroke.
	2	rs2987983	1.2x increased risk of prostate cancer
		rs7192	Normal risk for developing a peanut allergy

Caffeine			
	2.5	gs157	More stimulated by coffee
	2.1	rs762551	Slow Caffeine Metabolizer.

Alcohol			
	3.5	rs671	Asian Flush; worse hangovers; Increased risk of esophageal cancer; East Asian ancestry; Disulfiram probably not effective for alcoholism.
	2.1	rs738409	Slightly less damage from alcohol
	2	rs2832407	Topiramate may work to reduce heavy drinking best for this genotype
	1.9	rs27072	Lower risk of alcohol withdrawal seizures, and perhaps lower odds of ADHD.

Powako's diet and food preference related SNPs

Subject / Magnitude (Sort by Magnitude, bigger to smaller) / SNPs ID /Summary

Sweet

	1	rs838133	Typical odds preferring sweet snack
	0.1	rs5400	Normal sugar consumption

Bitter

	1.2	gs184	Able to taste bitterness
	1.1	rs10246939	Possibly unable to taste bitterness
	1.1	rs1726866	Possible unable to taste bitterness
	1.1	rs713598	Able to taste bitterness

Smell

	2	rs4481887	More likely to be able to smell asparagus metabolites in urine
	1.5	rs6591536	Less able to detect β -ionone (floral) fragrance
	1	rs72921001	Less likely to think coriander tastes like soap

Caffeine

	2.5	gs157	More stimulated by coffee
	2.1	rs762551	Slow Caffeine Metabolizer.

Alcohol

3.5	rs671	Asian Flush; worse hangovers; Increased risk of esophageal cancer; East Asian ancestry; Disulfiram probably not effective for alcoholism.
2.1	rs738409	Slightly less damage from alcohol
2	rs2832407	Topiramate may work to reduce heavy drinking best for this genotype
2	rs27072	2x risk of severe alcohol withdrawal. Possible increased odds of ADHD.

Diet

2.5	gs277	Increased risk of Atrial Fibrillation in one of the 2 SNPs mentioned by 23andMe.
2	rs2200733	1.4x increased risk of Atrial Fibrillation and Ischemic Stroke.
2	rs4961	1.8x increased risk for high blood pressure
1.7	rs7192	1.7x increased risk for developing a peanut allergy

Playing Tag (Physicality)



Figure 26. Mameko and Powako play tag in the backyard.

This page shows physicality-related genotypes, such as muscle type, height, obesity and breast size.

Mameko

Height

rs1042725	Average height
rs6060369	0.44cm taller
rs910316	0.68cm taller on average

Obesity

3	rs1800497	Less Alcohol dependence. Higher risk of Postoperative Nausea. Lower obesity.
2.5	gs282	You are part of the 12% of the population who can lose weight with any type of exercise
2.5	gs284	Any diet works for you
2.5	rs1121980	1.67x risk for obesity
2.5	rs9939609	1.3x risk for T2D; obesity risk
2	rs17782313	Adults likely to be 0.22 BMI units higher
2	rs10871777	Adults likely to be 0.22 BMI units higher
1.1	rs7568369	0.90x reduced risk of obesity
1.1	rs7412	More likely to gain weight if taking olanzapine

Muscle

2.1	rs1815739	Mix of muscle types, likely sprinter
-----	-----------	--------------------------------------

Breast

2	rs7089814	1.1x breast size (bigger breast size)
2	rs7816345	Bigger breast size (normal in European)
2	rs12173570	0.83x breast size (smaller breast size in female)

Powako

Height

1.5	rs1042725	~0.4cm taller
	rs910316	0.68cm taller on average
	rs6060369	Normal height

Obesity

3	rs1800497	Less Alcohol dependence. Higher risk of Postoperative Nausea. Lower obesity
2.5	gs282	You are part of the 12% of the population who can lose weight with any type of exercise
2.5	gs284	Any diet works for you
2.5	rs9939609	1.3x risk for T2D; obesity risk
2.1	rs10871777	Adults likely to be 0.44 BMI units higher
2	rs17782313	Adults likely to be 0.22 BMI units higher
1.1	rs7568369	0.90x reduced risk of obesity
1.1	rs7412	More likely to gain weight if taking olanzapine

Muscle

2.1	rs1815739	Mix of muscle types, likely sprinter
-----	-----------	--------------------------------------

Breast

2	rs7089814	1.1x breast size (bigger breast size)
2	rs7816345	Bigger breast size (normal in European)
2	rs12173570	Bigger breast size (normal in female European)

10th Birthday Party (Personality and performance)



Figure 27. 10th birthday party of Mameko and Powako.

Mameko

3	rs1800497	Normal (A2/A2): Better avoidance of errors. Normal OCD risk, normal Tardive Diskinesia risk, lower ADHD risk.
2.5	rs4680	Warrior. Val, less exploratory, higher COMT enzymatic activity, therefore lower dopamine levels. Higher pain threshold, better stress resiliency, albeit with a modest reduction in executive cognition performance under most conditions
2.5	rs4570625	Higher scores on anxiety-related personality traits. Greater placebo response
2.5	rs53576	Optimistic and empathetic; handle stress well
2.3	rs2143340	>2x risk of dyslexia and poor reading performance
2.1	rs6313	Depression, panic, stress response
2.1	rs1800955	Increased susceptibility to novelty seeking
2	rs17070145	Increased memory performance
1	rs2952768	Less drug dependence, decreased effectiveness of analgesics
	rs6330	More anxious females, less anxious males
	rs4606	Complex; possible association with anxiety related behaviours

Powako

3	rs1800497	Normal (A2/A2): Better avoidance of errors. Normal OCD risk, normal Tardive Diskinesia risk, lower ADHD risk.
2.5	rs4680	Warrior. Val, less exploratory, higher COMT enzymatic activity, therefore lower dopamine levels. Higher pain threshold, better stress resiliency, albeit with a modest reduction in executive cognition performance under most conditions
2.5	rs53576	Optimistic and empathetic; handle stress well
2.1	rs6313	Depression, panic, stress response
2.1	rs1800955	Increased susceptibility to novelty seeking
2.1	rs17070145	Reduced memory abilities
1.5	rs165599	May indicate increased susceptibility to schizophrenia
1	rs2952768	Less drug dependence, decreased effectiveness of analgesics
	rs6330	More anxious females, less anxious males
	Rs4606	Complex; possible association with anxiety related behaviours



Figure 28. This image is the original photograph. Taking the photo of the couple at first and add children image later.



Figure 29 (above) 30(below) "The Annunciation 2015" by Ai Hasegawa (2015)

Note: Aesthetics

The images above references the famous story of Annunciation of Virgin Mary. The lily often appears in the paintings as a symbol of the purity, innocence and parthenogenesis. We made this image to question the meaning of religion and innocence, and poetically invite viewers to imagine how future biotechnologies could change our traditional perception of this world.

The title includes 2015 for this project; this mentions that the children's visualizations are based on the 2015 gene expression research.

Also, we purposely tried to make very average family photos with an "uncanny valley" touch for the children's faces to give a hint that they are merely computer graphic and data babies.



Figure 31. The Annunciation by Leonardo da Vinci (1472-1475) Florence Uffizi (s)



Figure 32. The Annunciation by George Hitchcock (1887) Potter Palmer Collection 1930 (s)

5: Making a documentary film to follow the couple's feeling and guide the discussion.

To achieve more public outreach, I worked with the Japanese national television station NHK to create a 30-minute documentary film which documented the whole process of analyzing the DNA and designing the photo album.

The film also included our interviews of scientists and the married lesbian couple about their views on bioethics.



Figure 33. Asako and Moriga spit saliva into 23andMe kit. Figure 34. 3D modeler editing the face.
©NHK (JAPAN BROADCASTING CORPORATION) . All Rights Reserved



Figure 35. Moriga speaking her feeling about this project. Figure 36. Asako speaking her feeling about this project by NHK documentary film, NEXT -for the future- and HeartnetTV³⁴, broadcast 3 times in October 2015. ©NHK (JAPAN BROADCASTING CORPORATION) . All Rights Reserved

³⁴Website of the NHK(JAPAN BROADCASTING CORPORATION) Heartnet TV <http://www.nhk.or.jp/hearttv-blog/700/237751.html> (Accessed on 3, May, 2016)

5.1: Interviews from the TV documentary film and exhibition interview

To gain further insight, we carried out interviews with the couple, as well as with other sexual minorities, such as transgender people (female to male and male to female). Many of the latter ones have chosen to remove their reproductive organs. We also interviewed scientists and a professor of law to learn the real needs and situation today.

5.1.1: Interview with Asako & Moriga (married lesbian couple)

Q: How did you feel about this project at first?

Asako: To be honest I just want to meet my child, even if it's just imaginary. Also, I know this sounds cheesy, but I think this project is meaningful. I think this project will allow the surrounding debate to become more expansive, more concrete, rather than concluding by simply writing these things off as "going against nature's laws" or "playing God".

Moriga: I was just worried that participation in this project would make Asako somewhat sad. I had to check-in with her over and over... would she be okay? Personally, I'm confident that I will be fine.

Q: How did you think when you saw the text data of the children?

Asako: The child seems similar to my wife. She's really positive. I hate sports, but she loves sports.

Q: It's almost like showing you a star that you might never reach. I'm worried that an unachievable dream might hurt you.

Asako: I think even if it's just within a screen, I'm happy. Imagining that I get to meet our daughter on screen, I think it makes me happy. If I imagine that.

Q: When I heard that you named your children Mameko and Powako³⁵, I got a feeling that you were afraid to give them realistic names.

Asako: Exactly. I was worried that if I gave them realistic names, I would no longer be able to differentiate the imaginary from reality. I've been trying to steer clear from convincing myself that I'm actually meeting my daughter. If I don't, it starts seeming all too real. I think I'd get overwhelmed.

Q: If the technical aspects of creating a child become a real possibility, and if this becomes legalized, what do you think you would do?

Asako: I would celebrate. I think there are a lot of people who would be incredibly happy about it.

Moriga: I think they're asking if you'd go through the process.

Asako: Oh? I think I'll cross that bridge when I get to it.

Moriga: What if it happened now? Would you want to?

³⁵ Mame means bean or small in Japanese, Powako's "Powa" is coming from bean in French.

Asako: We'd have to talk about but. But I...

Moriga: Don't think about it too much. Just speak your thoughts. Would you want a kid?

Asako: How would you feel though? If this was real?

Moriga: I still don't want kids. I don't really have a reason. I just don't want to. If you could have a child with me, would you think about it?

Asako: I don't know. My mind goes blank. Like it's refusing to think about it.

Q: How was the life after receiving the family album?

Asako: I still have the internal conflict about having created somewhat of a mirage. We still occasionally talk about Mameko and Powako. When nothing is going on, we'd be walking home, it would just come up. For some reason, it feels like they're here. It might sound a bit weird.

Q: I'm concerned that you're experiencing a kind of loneliness that you wouldn't have before.

Asako: All I have is appreciation. When I saw that picture at the birthday party, it was an incredible reminder that I had also been raised year-by-year and celebrated each year. Personally, I've only had the experience of being raised. But maybe, even if it wasn't actually real, I got a little taste of what it means to raise another person.

-Interview a few months after

Q: What if Mameko and Powako really existed?

Asako: We'd want to raise them, and live together. They'd be our children, it'd be all well and good.

Moriga: I want to take them hiking.

Asako: You'll take them hiking?

Moriga: And camping.

Asako: Take me, too. Mommy will work hard, so they can study whatever they want.

Q: Are you eager to have children?

Moriga: I am not eager to have children. I've never wished to have children.

Asako: I'm not eager to have children now, either. Long ago, when I was little, I believed that I had to have children. That it was women's duty, as a gender, to get married and have babies.

Q: What made you change your mind?

Asako: I saw various ways of life. Also... I realized that life is... not to be lived according to what other people say, that it's okay to live your life the way you think is right.

Q: Why did you not want biological children?

Moriga: I had already realized that I could only love women, but... I had never seen such... relationships around me, so I thought that it would never happen for me. That's why I decided to enjoy life, travel a lot, meet different people and live on my own.

Q: What is the relationship between parenthood and loneliness?

Asako: There is this yearning for a person who'll always be on your side, no matter what, against the whole world. An easy-to-understand embodiment of this yearning is the image of the perfect mother, perfect father, perfect child. But that's just an image of a perfect family. It's a myth. A life

spent pursuing this myth seems a bit hard to me. People are a lonely species, and nothing can change this. In that case... we must accept loneliness, accept that life is lonely. That is the starting point.

Moriga: Sharing is just an illusion, after all.

5.1.2: Interview with Satsukipon (model, writer, male-to-female transgender)

Satsukipon is MtF (Male-to-Female). She was designated male at birth, but then transitioned to female, and now she is living as a woman. Recently, she has been yearning to have a child.

Q: Do you want to have children?

A: I didn't like children, but I suddenly changed in the past couple of years. I don't understand it myself. Had I always wanted children, I wouldn't have changed my gender. I changed it because I thought I didn't want children.

Q: What if you could have biological children?

A: If this technology is put into practice physically, it will be possible for me to have children. But then I might be denied this chance because of ethical reasons. Society might consider it ethically wrong, but if I have a child I am confident that I will love it for as long as I live. I'm also sure that everyone around me will shower this child with affection. Considering all this, I think that as long as there is love, it should be all right.

5.1.3: Interview to Obata (Art Installer, female-to-male transgender)

Q: What are the requirements for changing your gender in the family register?

A: For a female-to-male gender transition, you need surgery to remove the reproductive organs. In Japan today, such surgery is not covered by insurance, so it costs in the range of a million yen. I still haven't had surgery. It restores psychological well-being, but cannot guarantee physical health. The liver is weakened, so alcohol should be avoided.

Q: Have you ever wanted to give birth?

A: I have never wanted to give birth. I have never even considered it, so I don't know...

Q: What if you could have a biological child with your partner?

A: I would like to preserve the genes of the person I love rather than my own. I'd hate the idea of buying a stranger's sperm to preserve my partner's genes. If that was possible, life would become more diverse. Like with Ms. Makimura... Celebrating birthdays with your children growing up and growing old together, all these family things, family events, if you will... All these happy, colorful occasions will multiply. Perhaps because it is impossible, I really want to do it.

5.2: Interview with experts - How should we face this rapidly advancing technology? -

5.2.1: Interview to Yoshimi Yashiro Ph.D (Associate Professor, Uehiro Research Division for iPS Cell of Ethics Center for iPS Cell Research and Application(CiRA), Kyoto University)

Q: If children had any illnesses specific to using this technology, how would we take responsibility? what should be done?

A: Just like what happened with IVF and artificial reproduction, the safety needs to be tested thoroughly to see if the newborn will be as healthy as others. Until that process is done - no child should be born this way.

I believe that as long as it's a product of a conscientious process to maximize safety and security, it's absolutely fine to make germ cells, be it from iPS cells or ES cells. I don't see anything wrong with same-sex couples having their own children. The biggest priority should be to build a society in which varying philosophies are accepted, and more number of people have the chance for more happiness.

5.2.2: Interview with Professor Tomohiro Kono Ph.D. (Laboratory of Developmental Biology Department of BioScience, Tokyo University of Agriculture, who overturned pre-existing notions on birth at 2004. He succeeded in creating the first mouse born of two mothers through genetic manipulation.)

Q: How did you feel when you made Kaguya? (two-mother mouse)

A: "I was happy but I felt frightened by what I had done at the same time."

Q: Can't you see this as a fertility treatment for same-sex couples?

A: "Well, that's not within the realm of medicine. Fertility treatment, as you just brought up, is about supplementing something that is missing from the person's potential to have a child. For example, the ovary is dysfunctional, or there's a problem with the person's ability to produce sperm—aiding with those is medicine."

Q: Why is it ethical to lengthen life and unethical to create life for you?

A: Maybe you can have organs made with iPS cells transplanted to yourself, but decisions to have medical treatments can be made by the individual. The client can, with her will, and she can take responsibility for its consequences. But that's not the case with life. The new borns are the next generation...you can't ask for their consent to be born this way. If people start to think that life can be created so easily, I don't know if that leads to a happier society. I don't know myself... Even if the safety of this technology is verified, would it be appropriate to immediately apply it to people? Absolutely not! There hasn't been sufficient discussion about what kind of society are we aiming to create through this technology. The technology has the potential to wield a huge impact across generations. The rules for its application as medical care ought to change in the future. I don't think

that creating iPS cells and sperm from a sterile man qualifies as medical care at this point. I think it has something to do with the issue of life.

Q: Why is there an illogical and emotional dissent in this argument?

A: It's because life is such an essential element of our nature, that this issue should not be settled merely through logical arguments. Human sensibilities are another extremely important standard for making decisions. If someone says they believe in God and you ask them why they believe, you'll get stuck in a pointless argument.

5.2.3: Interview with Professor Mikihiko Wada, Ph.D. (Professor, Faculty of Law, Hosei University. The Civil Code, "Law and Genetics", "Law and Evolutionary Biology & Psychology")

Mikihiko: I will give my opinion not based on personal creeds and beliefs, but as a researcher of law acting in accordance with my conscience and sense of responsibility.

Q: What is your opinion as a researcher of law on same-sex marriage?

A: Physiological aversion and discomfort are not valid reasons to oppose it. From the perspective of protecting the legitimate rights of minorities, Japan should introduce same-sex marriage under our current Constitution. According to Article 24, "marriage shall be based on the consent of both sexes." The words "husband and wife" are used but this has a simple explanation. As it is clear from the history of enactment of the Constitution in 1946, its purpose was to correct the gender inequality in Japan's family system and stipulate the equality of men and women. Articles 13 and 14 stipulate that "All of the people shall be respected as individuals." The equality under the law stipulated in Article 14 takes precedence, so the concept that same-sex marriage is illegal under Article 24 is wrong. I believe that same-sex couples have the right to have biological children.

Q: What about the right of same-sex couples to have biological children?

A: The stance of the Supreme Court of Japan on such issues is extremely passive and since relevant legislation has not been enacted yet, unfortunately any lawsuits demanding such rights based on interpretations of the Constitution are doomed to fail. This is the situation at the moment.

6: Social reaction

Finally, the project reviewed the public's reaction triggered from this documentary program after it was aired nationally in Japan, and also after it was subtitled and released online, available to more people internationally.³⁶ We were interested in exploring how to balance the discussion. We should not "over kill" the people's comments and feelings.

6.1: Twitter

We showed the Twitter # tag in the documentary film when it broadcasted at October 5th, 12th, 21st, on NHK Japan. We have collected twitter reactions: 953 tweets by 657 people in the Together tool.³⁷

We sorted and counted the tweets manually. We have talked to the Social machine group researcher about whether there is any usable system for twitter analysis for the Japanese language. Unfortunately such a system does not seem to exist at this time. Yahoo Japan's sentiment analysis tool was not yet meaningful enough to use for this project. Actually counting negative and positive comments are also very difficult. However, we can count the words that show the hints to understand the context. Thus, we have just categorised roughly positive, negative and neutral.

The table of words ranking (out of 953 tweets)

Number	Negative related words	Japanese words original
47	Bad /Don't	ダメ、駄目4、だめ4
37	Difficult	難しい
32	Evil/Bad	悪
27	Denial	否定
21	Opposite	反対
11	Sad	悲
8	Painful	辛
8	Scary	怖い
6	Conflict	葛藤
3	Unreasonable	無理
2	Anger	怒
2	Tough	キツ

Number	Positive related words	Japanese words original
34	Heart	胸5+心29=34
34	Wonderful	素晴らしい
28	Was good	よかった
28	Thanks	ありがとう
25	Nice	素敵
23	Tears (of being moved)	涙
19	Impressed	感動
12	I cried(of being moved)	泣いた
9	Hope	希望
6	Happy	嬉しい(うれしい)
4	Favor	賛成
4	Crying(of being moved)	泣

³⁶Website of the NHK Heartnet TV <http://www.nhk.or.jp/hearttv-blog/700/237751.html> (Accessed on 3, May, 2016)

³⁷ Website of Together <http://together.com/li/882876> (Accessed on 3, May, 2016)

1	Cruel	残酷
1	Fool	バカ
1	Shit	クソ
0	Die	死ね、しね、シネ
0	Idiot	アホ

3	Amazing	すごい
5	Affirmation	肯定

Number	Other words	Japanese words original
585	Children	子供
69	Ethics	倫理
35	Discussion	議論
21	Realization	実現
8	Surprise	驚
7	Impact	衝撃

"The dark side of Guardian comments"³⁸ is a research conducted by the UK newspaper Guardian which studied the comments on their 70 million online news articles to analyze many aspects of how people reacted to their news. The study included analyses such as which topics were more controversial, which writers tended to be more abused based on their gender and ethnicity, and so on. In a similar manner to this research, we have tried to analyze the relationship between comments' tendency and gender. The Guardian research used the service "genderize.io."³⁹, a protocol to define the gender through the name.

On the other hand, Japanese Twitter handle names are more gender-free, so it is difficult to identify the gender and their sexual orientation through their Twitter name. It is difficult even if we manually checked each twitter timeline contents. Also, we started to understand that the gender is fluid and users are able to show different genders on the internet. Additionally, this topic involves a lot of discussion and participation of gender-free or fluid people. Thus, we have realized that it is extremely difficult and also inappropriate to automatically judge the gender and get meaningful data from this. This topic would be another thesis-level research.

On the other hand, we found that the complicated contents are really interesting, especially since many of them give us another point of view. Here are a few interesting points coming from the recent collection of Twitter comments (The full set of original Twitter comments is in Japanese, so if you are a non-Japanese reader, please visit this online page⁴⁰ through a translation service) after the documentary program was aired:

³⁸Becky Gardiner, et al "The dark side of Guardian comments"
<https://www.theguardian.com/technology/2016/apr/12/the-dark-side-of-guardian-comments> (Accessed on 3, May, 2016)

³⁹Website of the genderize <https://genderize.io/>(Accessed on 3, May, 2016)

⁴⁰ Website of Togette <http://togette.com/li/882876> (Accessed on 3, May, 2016)

- Why not? What is the difference with IVF?
- Calling this “shallow” or “irrational” is no better than flat-out refusing to discuss the issue.
- Can we think of this as medicine? How about the case of people with gender identity disorder who have medical operations?
- This technology might restore a more old-fashioned idea of the family, one connected strictly by blood (genetically), which does not adopt outsiders.
- Nowadays, “taboo” lives only in religion.
- Maybe in the future, males will no longer be needed?
- Men would be able to make a baby without the ovaries, so women would be needed only for the surrogacy. Men would think women are machines for delivery, even more so than now.
- There might be less prejudice against older women who cannot deliver babies.
- Actually, this problem is all about how to remove the feeling of disgust about homosexuality.
- Technically, it will be real soon. Thus, we should have a discussion now in order to be prepared. Art is one of the methods.
- The human animal seeks the fulfilment of desire. We will stop at nothing, pursuing our aims relentlessly.
- Making babies with technology is a part of our evolution.
- Being excluded from marriage and reproduction is a privilege for a gay person, like me. I would not want to face more difficult disputes and choices.
- If same-sex marriage and reproduction becomes common, would the diversity and inclusion culture cultivated by the LGBTQ community disappear?
- If same-sex couples were able to make babies, it would make their situation similar to that of male-female couples, who are often divided by arguments about whether they want to have a baby or not.
- I cannot accept such an arrogance, which aims to achieve all through technology and money.
- I definitely disagree. Such an act, which goes against the natural law, will cause great problems in the future.
- The attempt to express such a theme as art makes me shudder (disgust).

7: Findings

7.1 : My personal views after analyzing the discussions in Japan.

At this point in the project, I have been unable to find any logical, reasonable arguments against the idea of two-mother babies. I've found that people have a tendency to be against this technology for emotional reasons. Many people tend to have emotive responses that are triggered by instinct and gut feelings, rather than logic.

E.g. "I think these gay people should have an adoption."

In response to this argument, one can argue that everyone should have an adoption - this role should not only be pushed onto gay couples.

I also found that there were comments such as "I do not trust scientists 100 percent ... they might have their own colored glasses. However, because they are not conscious of it, they believe that they are speaking the objective truth."

I agree that we, as the public, also have the cultural tendency to accept what scientists say as "the truth" because of their accepted role in society. But, counter to this widely accepted notion, the practice and knowledge of scientists become more and more narrow as they advance in their professional careers. Therefore, it can't be expected of scientists to consider radical alternatives or speculative scenarios, such as the scenario this project aims to explore.

7.2: Media lab discussion session

The thesis author Ai Hasegawa and her adviser Sputniko! (Hiromi Ozaki) had a private screening and discussion event at the MIT Media Lab members event on 29th October 2015 . Kevin Esvelt, a biologist, an assistant professor of MIT Media Lab and director of Sculpting Evolution group⁴¹ and Paola Antonelli, the senior design curator at New York's Museum of Modern Art, joined us as guest speakers. Kevin has made huge contributions to the gene editing technology by inventing the technology called "Gene Drive". It is such a powerful tool that enables gene editing to change the genes of the whole species. By releasing an insect with modified genes using Gene Drive into the nature, the edited gene will be 100% inherited to the next generation. This means that after a few iteration of generations, the whole species will carry that gene. Because this technology has so much impact, Kevin's research shares a similar dilemma to our project - who will decide the usage of such technology and how? We talked about the importance of "responsible science" that opens the science to the public. Kevin said that "We should not believe blindly, that we have to communicate and discuss about what scientists think and then what others think. Then we can find out what we want for the technology and future." That was exactly what I felt I learned from doing this project, so it was nice to reconfirm this with an actual scientist.

Paola also invited us as a guest speaker for her design class in Harvard Graduate School of Design. We also organized a bioethics unconference at the MIT Media Lab Tokyo members meeting in February 2016 with participants of about 100 people.

⁴¹Website of the sculpting evolution group <http://www.sculptingevolution.org/> (Accessed on 3, May, 2016)



Figure 37. Photo Image of Kevin Esvelt, Paola Antonelli and Ai Hasegawa discussion session

7.3: How the artworld and other media reacted

The (Im)possible Baby project won the Art Division Excellence Award⁴² at 19th Japan Media Arts Festival⁴³ and I have done several artist talk sessions and a large exhibition at the festival.



Figure 38. Announcing of the prize winner of the 19th Japan Media Arts Festival © Agency for Cultural Affairs. All Rights Reserved



Figure 39. Web TV: Fuji TV "News no kimo Evening"⁴⁴ 30 minute live interview at April 3rd broadcasted in Japan. ©Fuji TV All Rights Reserved

I did an exhibition of this project at Gallery Kapelica in Slovenia, a month before the vote for the legalization of same-sex marriage in the country. Thus, this project had received a lot of attention

⁴²Website of the (Im)possible Baby project <http://festival.j-mediaarts.jp/en/award/art/im-possible-baby-case-01-asako-moriga/> (Accessed on 3, May, 2016)

⁴³ Website of the Japan Media Arts Festival <http://festival.j-mediaarts.jp/en/> (Accessed on 3, May, 2016)

⁴⁴ Website of the archive of the Houdoukyoku http://www.houdoukyoku.jp/pc/archive_play/00152016040301/6 (Accessed on 3, May, 2016)

and Slovenian National TV interviewed me and documented my solo exhibition "Annunciation" which was aired on national Slovenian TV and was uploaded to their internet news site.⁴⁵

"Bio Art: Altered Realities" by William Myers⁴⁶, a book showcasing the latest Bio Arts included the (Im)possible Baby project was published. The Japanese version is scheduled to be published in May 2016 which will include the latest outcome of this project with additional text and photos.

We have done three exhibitions of this project, at Gallery Kapelica, Slovenia on November 2015, The National Art Center, Japan on February 2016, and Mori Art Museum, Japan from March 2016 to July 2016.

The exhibition at Mori Art Museum is titled "Roppongi Crossing 2016: My Body, Your Voice". This exhibition was about the emergence of alternative histories, images on physical body and gender, as well as landscapes. This is a series designed to offer a comprehensive survey of the Japanese contemporary art scene, staged by the Mori Art Museum triennially since 2004. Through the different methods of art production of the 20 artist groups selected by the curators from Japan, South Korea, and Taiwan working together, the exhibition will examine a wide spectrum of Japanese contemporary art and contemplate the society and art of today for this 5th edition.

This project was situated at the end of the show to close the exhibition, which the curator Natsumi Araki described as "the close of voyage of identity towards the future." In the exhibition, we showed the details of the SNPs information, reaction comments and interviews (which are also detailed in this thesis) to stimulate the visitors thought. Huffington Post Japan wrote an article titled "The brave minority voices make you move, and the earth". The article written by Ryan Takeshita, the chief editor of Huffington Post Japan⁴⁷, contained the following comment, which was in response to how I exhibited the opinions and reactions I received for (Im)possible Baby: "Let's respect the opinion of the minority and embrace diversity - those words seem seemingly positive, but it is also as a hidden trap. 'You are you, and everyone of us is individually different' - these seemingly positive phrases can also lead to a lack of interest to other people's issues and problems.

That's why we, as humans in society, have endlessly experimented to manage and unite our rich diversity of opinions, in ways such as elections, and sometimes unfortunately by fascism, or doing a large-scale historical experiment like the European Union, which united together many European countries with such different histories and cultures. These experiments are all an attempt to unite people who are fundamentally all very different.

However, trying to unite people is not an easy job - and it's often a pain. There will always be someone with a much larger voice, or, like the terrorists in the EU, there will be uncontrollable monsters who try to speak out in violent ways.

I still have hope in the internet. The internet has an infinite space - any opinion or an article can be published and be seen. Yes, there are issues of seeing the same kind of news repeatedly on Twitter or Facebook, but you can use tools like the hashtags to organize the news to your liking. Or, you can

⁴⁵ Website of the archive of the Houdoukyoku http://www.houdoukyoku.jp/pc/archive_play/00152016040301/6 (Accessed on 3, May, 2016)

⁴⁶ William Myers "Bio Art: Altered Realities" (Thames & Hudson, October 6, 2015)

⁴⁷ Ryan Takeshita, "The brave minority voices make you move, and the earth" (copy right of The Huffington Post Japan, Ltd 5.01.2016) http://www.huffingtonpost.jp/ryan-takeshita/brave-words-move-the-world_b_9811804.html (Accessed on 3, May, 2016)

search and easily bump into an opinion that's completely different from yours. The internet has a magical power that allows a diversity of opinions to come together, not as "One" but still as a diversity of opinions."⁴⁷



Figure 40. "Speculate the future reproduction- art activist" Numero Tokyo (March 2016)
© FUSOSHA All Rights Reserved.



Figure 41. "Think about future of family by same-sex couple" Pen (February 2016)
©CCC Media House Co., Ltd. All Rights Reserved.

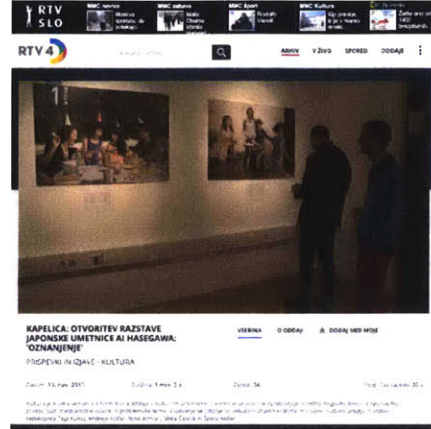


Figure 42. Website of Slovenia National TV⁴⁸ about "Annunciation" at Gallery Kapelica⁴⁹
© MMC RTV Slovenia All Rights Reserved.



Figure 43. Photo of the author talking about the project at the 19th Japan Media Arts Festival in the National Art Center, Tokyo.⁵⁰
©Agency for Cultural Affairs All Rights Reserved.



Figure 44. Photo shows that many people stopped to see this project ©Yusuke Hashizume All Rights Reserved.⁵¹

⁴⁸Website of the Slovenia National TV# about "Annunciation" at Gallery Kapelica
<http://4d.rtvlo.si/arhiv/prispevki-in-izjave-kultura/174372332> (Accessed on 3, May, 2016)

⁴⁹Website of the Gallery Kapelica http://www.kapelica.org/index_en.html#event=1010 (Accessed on 3, May, 2016)

⁵⁰Website of the Contents of the Current Media Arts <http://mediag.jp/project/project/19.html> (Accessed on 3, May, 2016)

⁵¹Yusuke Hashizume's twitter account https://twitter.com/prof_butterfly(Accessed on 3, May, 2016)

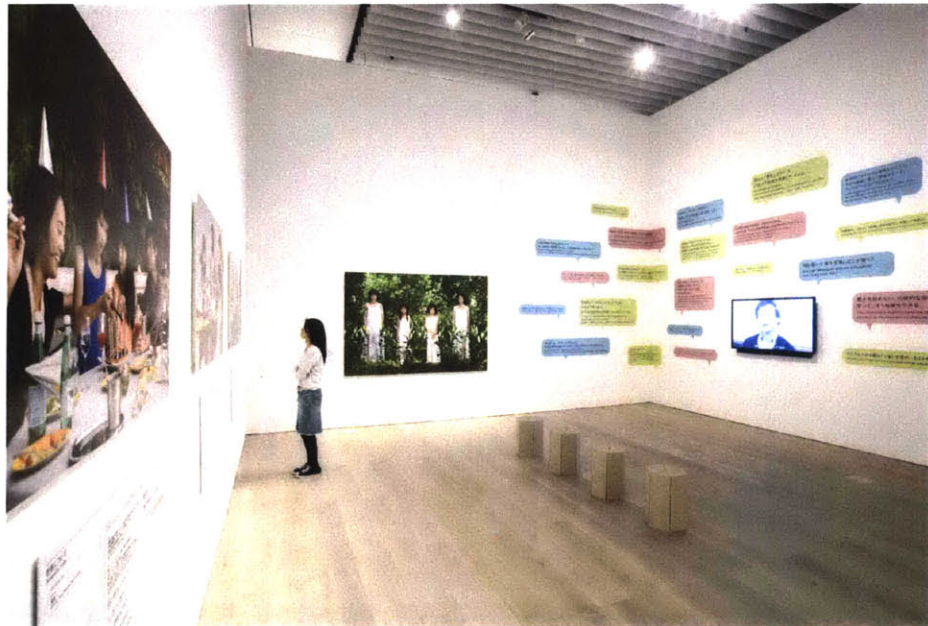


Figure 45.46. Photos of (im)possible baby exhibition at Mori Art Museum "Roppongi Crossing 2016: My Body, Your Voice" ©Mori Art Museum⁵²

⁵²Website of the Mori Art Museum "Roppongi Crossing 2016"
<http://www.mori.art.museum/english/contents/roppongix2016/index.html> (Accessed on 3, May, 2016)

8: Conclusion

8.1: Next steps for Speculative Design

As mentioned in the introduction, we speculative designers must confront the issue described by Anthony Dunne and Fiona Raby: "It is impossible to continue with the methodology employed by the visionary designer of the 1960s and 1970s. We live in a very different world now, but we can reconnect with that spirit and develop new methods appropriate for today's world and once again begin to dream."⁵³ Acknowledging this, I worked with the national TV station NHK to create a television program to engage with a broader range of people, not only with the elite visitors of the museum/art gallery environment. I also chose to focus on a socially engaging topic that urgently needs to be discussed and reflected. In my view, many known speculative design projects achieve the following two steps: 1) finding the problem (redefining how we see something as a "problem" and reconfiguring our belief of what is considered good or valuable), 2) communicating with the masses to spark imagination and discussion. However, doing this project made me realize the increasing importance of the next step for speculative design: 3) guide a meaningful discussion, and design a system that collects and reflects from the input of the audience.

In the speculative design field, I strongly believe (Im)possible Baby has achieved to receive the most amount of public engagement outside of the expert-design sphere, because of the immense reaction and movement the NHK program has created in Japanese society. I am now working to make a new English-language version of this documentary to spread the impact globally. Observing the reaction of this project and analyzing the data has helped me see the problems and the next step forward for speculative design, which is the 3rd step mentioned above.

One of the main criticisms of speculative design is that it has an elitist approach, and that many projects sit in an elite environment, not engaging with a larger, public audience^{54 55}. Also, the environment of "engagement" has changed so much in the last 10 years - social media has made it much easier for people to immediately react and discuss after viewing the speculative design they

⁵³Anthony Dunne and Fiona Raby *"Speculative Everything - Design, Fiction, and Social Dreaming-"*(MIT press, p9, 2013)

⁵⁴Archive of the blog discussion at DESIGN AND VIOLENCE MoMA (Dec, 2013)
<http://designandviolence.moma.org/republic-of-salvation-michael-burton-and-michiko-nitta/>(Accessed on 3, May, 2016)

⁵⁵Luiza Prado de O. Martins. *"Questioning the "critical" in Speculative & Critical Design"* (Feb 4, 2014) (Accessed on 3, May, 2016)
<https://medium.com/a-parede/questioning-the-critical-in-speculative-critical-design-5a355cac2ca4#.mpffn99hb>(Accessed on 3, May, 2016)

saw online or in real life. I feel that speculative designers now need to take much more notice and reflect from these reactions, not just leave the discussions alone. To successfully pursue the 3rd step, 3) guide a meaningful discussion, and design a system that collects and reflects from the input of the audience - collaborating with research such as big data analysis and machine learning would be very beneficial. One example is "The Electome: Measuring Responsiveness in the 2016 Election"⁵⁶ "a research project by MIT Media Lab's Social Machines Group which analyzes the opinions on Twitter about the 2016 Election. I believe a project like this could be evolved to analyze the discussions stimulated by speculative design projects.

Collaborations with policy makers and politics would also be another way to further the impact of speculative design - but it needs to be done in a careful manner so that speculative design is not used as a mere tool for propaganda and communication.

⁵⁶ Website of Sosial Machines group <https://www.media.mit.edu/research/groups/social-machines> (Accessed on 3, May, 2016)

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My sincere thanks also goes Asako Makimura and Moriga. Without this couple's cooperation, (im)possible baby would never be delivered to the world.

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Asako Makimura & Moriga	Digital Frontier Inc.	Jacquelyn L Liu
Project Adviser	Interview	Photographer
Sputniko!	Mikihiko Wada, Ph.D. Professor Faculty of Law Hosei University	Dygoro Sasaki
Production Adviser		Rieko Igarashi
(MIT Media Lab, Design Fiction Group)	Dr. Yoshimi Yashiro (CiRA) Associate Professor Uehiro Research Division for iPS Cell of Ethics Center for iPS Cell Research and Application(CiRA) Kyoto University	Make-up
Yuki Saito (NHK)		Anna Sadamori
Scientific Advice		Assistant
Dr. Ryosuke Kimura (Department of Human Biology and Anatomy, Graduate School of Medicine, University of the Ryukyus)	Tomohiro Kono Ph.D. Professor Laboratory of Developmental Biology Department of BioScience Tokyo University of Agriculture	Yena Park
Technical Adviser		Andrew Saito
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		Katsuto Tamagawa
		Special Thanks : SNPedia

Website for this project

<http://aihasegawa.info/?works=impossible-baby-case-01-asako-moriga>

Appendix 1

Possible extensions of this work

Design the next communication plan to include a wider audience and generate a higher variety of responses, e.g. an English-speaking audience.

For future work, I would like to try the case of a male couple from the USA, and use more advanced technology such as single cell whole genome sequencing (more accuracy without shuffling the DNA data). To guide the discussion deeper, I need to increase the accuracy of the visual simulation of the baby to give the impression of reality, by using these technologies.

“Veritas Genetics⁵⁷ today announced that the company is making it possible for participants in the Personal Genome Project (PGP) to be among the first to get their whole genome sequenced and interpreted for less than a \$1,000. Led by Veritas Genetics Co-Founder Dr. George Church, Professor of Genetics at Harvard Medical School and Director of the Personal Genome Project.⁵⁸” BOSTON, Sept. 29, 2015 /PRNewswire/ --

I believe this will be the next “23andMe”, the standard of genome sequencing for regular consumers. This service has the ability to see much more detailed genetic data. If I could use this for the “Asako and Moriga” case, I could simulate a genetic throwback. (23andMe data cannot tell the genotype to determine which gene comes from the mother or the father).

Also there is a new technology that allows you to read DNA from a single cell. If I can read the DNA data of a sperm from a male, it means I can read the actual data of the baby created from the sperm. This is due to the fact that the sperm cells are already shuffled DNA waiting to be fertilized, ready to become a baby in the genetic point of view. It is more difficult to achieve this with female eggs, because to harvest the egg requires the injection of hormones and invasive surgery, which puts a lot of stress for the participating couple in this project.

⁵⁷ Veritas Genetics <http://www.veritasgenetics.com>

⁵⁸ <http://www.prnewswire.com/news-releases/veritas-genetics-breaks-1000-whole-genome-barrier-300150585.html>

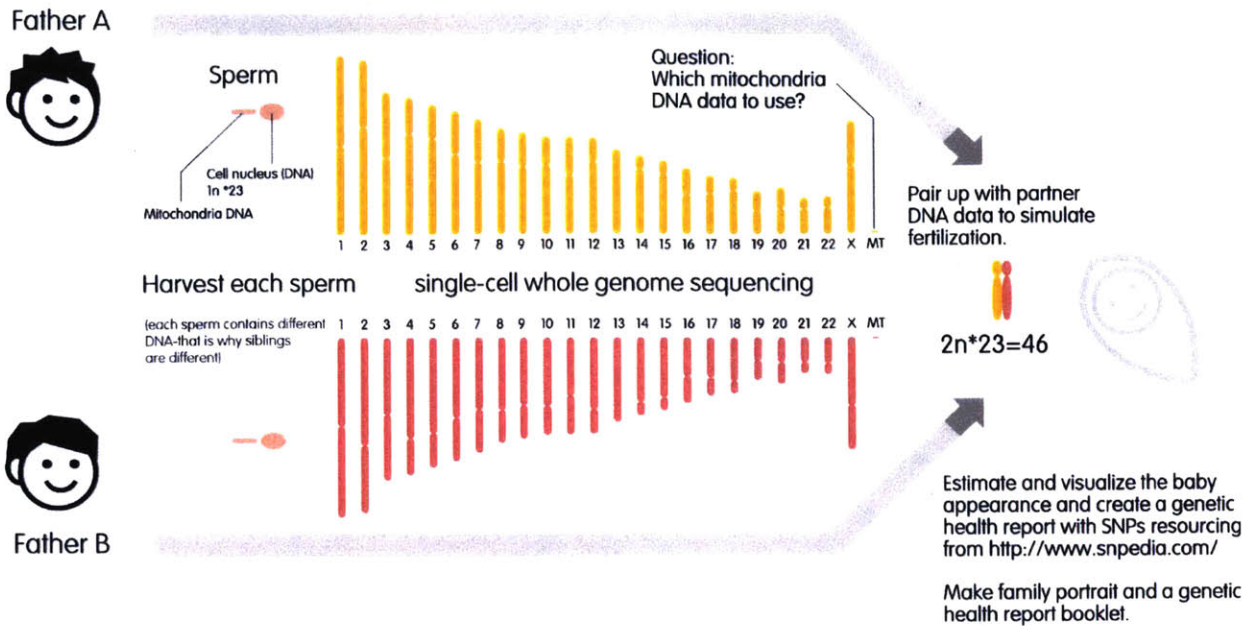


Figure 47. Data simulation from each sperm's DNA This could work for female as you see below illustration.

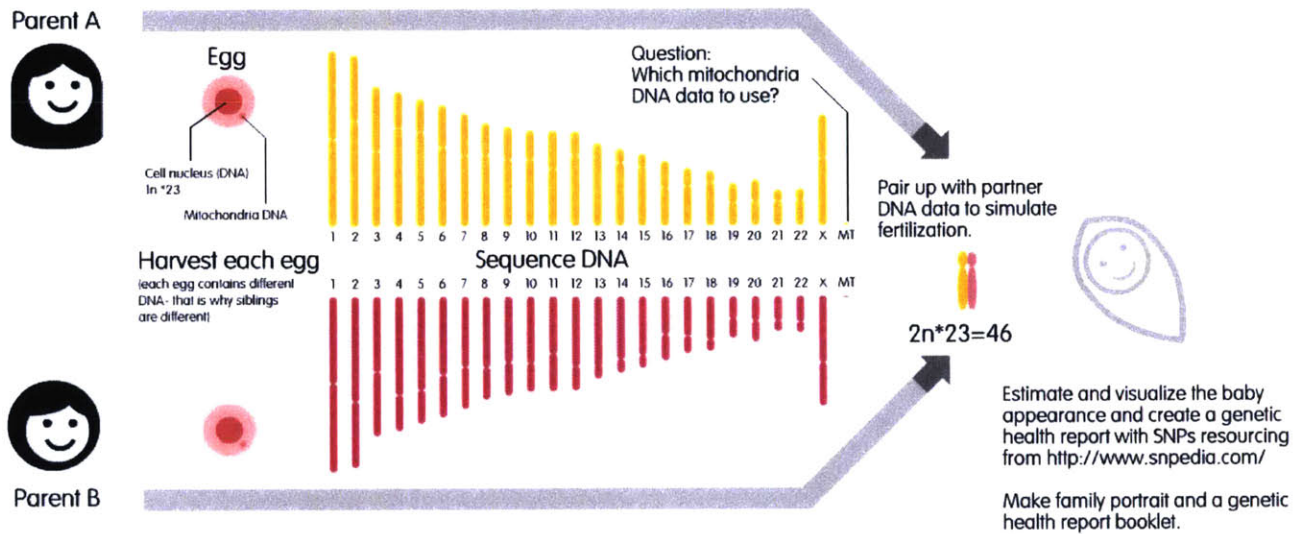


Figure 48. Data simulation from each egg's DNA. However, harvest the eggs require the medication and operation, so more difficult than male. Thus the next version is male is suitable to do.