

The Illusion of Identity: At-Home Ancestry Testing, Forensics and the Accuracy Problem

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ABSTRACT

Race, as a social construct, plays a significantly large role in the scientific field of genetics. This review analyzes several studies to reach a more comprehensive understanding of race's historical influence in genetics, the modern implications of this relationship, and the validity of race as a scientific category in genetics. While the scientific validity of race has largely been disproved, it continues to be used by scientists and geneticists, specifically in genetic disease research. Aside from the obstacles stemming from race's lack of legitimacy in science, its social implications are also a liability for scientific advancements because of how race has historically marginalized people groups. Moreover, the monetization of recent discoveries in genetics, including at-home ancestry test kits and molecular photofitting in forensics, are a cause for concern due to their lack of scientific accuracy. The process of racial categorization of test subjects is not as accurate as companies advertise, and this lack of transparency can lead to false conclusions about personal identity based on misinformation of at-home ancestry test results which rely upon a limited data set. In addition, this possibility of error in the DNA testing process can lead to the criminalization of innocent suspects. Therefore, awareness about both the primary motives of these companies, as well as the social implications of interpreting genetic test results, is critical to understanding the broader effects of race in genetics in society.

Introduction

Who are we? Throughout history, that question has plagued human consciousness. Our definition of who we are is inevitably intertwined with who we are not – and it is because of this that a concept such as race may exist. When we began categorizing ourselves into groups of “us” and “them” we created a rift; a divide that history has proven is much harder to overcome than it was to create. One of the most obvious ways to categorize people was by physical appearance and social norms; so, the idea of race was born. Initially, race began as a social construct; then scientists began to root it in different fields of biology. More recently, it has been incorporated into the field of genetics, which many scientists acknowledge has the potential for dire consequences. This literature review will demonstrate the predicament race in genetics presents, as well as the problem with race in science at large due to its lack of scientific validity. In essence, race is purely a social construct, and there is no scientific basis for race in genetics or any other scientific field. Therefore, it becomes dangerous to continue to include race as a scientific category – with applications in the workforce today – when its presence has little to no foundation in science. First, this review will provide an overview of the history of race in science, from the eighteenth century to present day; then, it will describe the modern applications of race, as a field of study, in genetics; next, it will demonstrate implementations of race in the workforce through at-home ancestry test kits, forensics, and molecular photofitting; finally, this paper will describe my personal experience with ancestry testing as a teenager and how it has impacted my perception of my own identity.

A Brief History of Race and Genetics

Race and genetics have been intertwined throughout history in complex ways. Michael Yudell writes, “race, its scientific meaning seemingly drawn from the visual and genetic cues of human diversity, is an idea with a measurable past, identifiable present, and uncertain future. These changes are influenced by a range of variables including geography, politics, culture, science and economics” (Yudell, 2011, p. 318). This description of race applies to all of human history; for as long as race has existed as a means to classify people, it has been under the influence of societal values and beliefs. Race is not a concrete concept, and thus has the flexibility to adapt as society evolves around it. Therefore, race in the context of biology and science has been restricted due to its social evolution. Although some social scientists have attempted to avoid the negative connotations associated with race by substituting race for words such as ethnicity, ancestry, or population, other social scientists maintain that examining human difference using race is disconnected from social prejudice, due to advanced technological methods (Yudell, 2011, p. 332). The reasoning for these two drastically different perspectives can be traced back to their historical beginnings to be fully comprehended.

There are two primary examples that are critical to understand in order to glean the context for the rest of this review. The first is Carl Linnaeus’s system of racial categorization and the research that followed in its wake. Linnaeus was a Swedish botanist and expert in natural history who created the “natural system” that consisted of four main groups that he divided humanity into: *Americanus*, *Asiaticus*, *Africanus*, and *Europeaeus*. His thinking was published in *Systema naturae* in 1735 and became the standard for the categorization of all humans (Müller-Wille, 2014). In the late 1700s, a German scientist named Johann Blumenbach built upon Linnaeus’s work and created a grouping of five racial categories: Caucasian, Mongolian, Ethiopian, American, and Malay. Blumenbach promoted Caucasian as the ideal race, where Mongolian and Ethiopian were extremes on one side of the spectrum, and American and Malay were extremes on the other side (Yudell, 2011, p. 379). A third scientist of significance is Samuel Morton, an American who promoted an explanation of white superiority to attempt to scientifically prove the reasoning for the cognitive and physical differences between races. Polygeny, the theory that each human race evolved from independent ancestors, was at the core of his work. Unfortunately, Morton’s ideas about race likely influenced the scientific accuracy of his work. In his study, he collected hundreds of skulls worldwide, measured their volume, and recorded that Mongolian and Caucasian skulls had the largest volume, which he reasoned corresponded to the highest level of cognitive ability. In comparison, his measurements showed that Africans had the smallest cranial volume, corresponding to the lowest level of intelligence. A century after Morton passed away, an evolutionary biologist named Stephen Jay Gould replicated Morton’s study and could not draw the same conclusions – leading to the belief that Morton fabricated some of his data due to his preexisting beliefs about race (Lewis et al., 2011). While the validity of Morton’s work was disproved, the lasting damage it did to society could not be reversed as Morton’s theories adhered themselves to community beliefs.

The second example is Thomas Jefferson’s *Notes on the State of Virginia*. Jefferson writes, “the first difference which strikes us is that of colour. Whether the black of the negro resides in the reticular membrane between the skin and scarf-skin, or in the scarf-skin itself; whether it proceeds from the colour of the blood, the colour of the bile, or from that of some other secretion, the difference is fixed in nature, and is as real as if its seat and cause were better known to us. And is this difference of no importance? Is it not the foundation of a greater or less share of beauty in the two races? Are not the fine mixtures of red and white, the expressions of every passion by greater or less suffusions of colour in the one, preferable to that eternal monotony, which reigns in the countenances, that immoveable veil of black which covers all the emotions of the other race? [...] I advance it therefore as a suspicion only, that the blacks, whether originally a distinct race, or made distinct by time and circumstances, are inferior to the whites in the endowments both of body and mind (Jefferson, 1832)”. Jefferson himself was regarded as a man of science in his time; thus, it is clear that racial categorizations and

distinctions were being made not only in Europe during the 18th century, but in North America as well. Understanding the historical place of race in genetics and science is vital to understanding its evolution into modern society.

Modern Applications and the Danger of Race in Genetics

The twenty-first century has brought about a new level of complexity to the relationship between race and genetics. At-Home Ancestry Testing kits that cost as little as ninety-nine dollars have become available to the public (Fulwilley, 2014), and this influx of testing is affecting everyday life as consumers begin to correlate personal identity with test results. However, the trouble with this invention is the inaccuracy of the marketing; companies marketing at-home ancestry test kits claim to have a much more accurate read on a customer's ancestry than scientific studies suggest (Duster, 2011, p. 2).

There are two distinctly different methods for determining ancestry: gender-specific methodology to test for biological ancestry and Ancestry-Informative Markers (AIMs) (Duster, 2011, p. 3). Gender-specific methodology involves using Y-Chromosomes in male customers and mitochondrial DNA (mtDNA) in female customers to trace ancestry. This method of genetic testing yields a definitive test result for *one* line of a customer's ancestry (Duster, 2011, p. 3). For example, people who are biologically male inherit their Y-Chromosomes from their biological fathers (Yashon & Cummings, 2017). Gender-specific methodology can identify not only the customer's father, but the customer's father's father, and possibly further depending on the strength of the data. As long as the data is available, this method of ancestry mapping can trace back multiple generations (Duster, 2011, p. 3).

One example of a practical application of this method is in confirming the ancestry of supposed descendants of historical figures. There was an ongoing, century-long debate on whether Thomas Jefferson had children with one of his slaves, Sally Hemmings. Utilizing Y-Chromosome ancestry tracing, Dr. Eugene Foster and a team of geneticists in 1998 — gender-specific methodology directly linked Jefferson's DNA to Sally Hemmings's descendants (Duster, 2011, p. 3; Walker, 2010).

The process for determining female ancestry is similar, aside from the fact that it utilizes mtDNA instead of Y-Chromosomes. When a mother gives birth, all of her children inherit her mitochondrial DNA; however, only her daughters will pass this DNA on to future generations (Duster, 2011, p. 3). For reference, mtDNA fuels almost all of a cell's actions – it is the “powerhouse” of the cell (Fincham, 1994). Utilizing this fact in females, it is possible to identify a woman's mother, and her mother's mother, from any given female assuming that the sample of mtDNA is strong enough to provide this data (Yashon & Cummings, 2017). One practical application of this method was connecting granddaughters to grandmothers following Argentina's “Dirty War” from 1976 to 1983. When thousands of fathers and mothers disappeared or were murdered by the ruling group, their orphaned children were given to couples looking to adopt. Following the war, these orphans were able to reconnect with their grandmothers through mitochondrial DNA ancestry testing (Duster, 2011, p. 4). There can be significant power and benefits to the development of these DNA ancestry testing methods.

However, the primary consequence of this testing method is that it is severely limited in scope; only two ancestors of a much larger gene pool can be identified. For example, in a female, when their biological grandmother is traced only two of her four grandparents will be recognized in ancestry testing. This thinking follows for all generations – ancestry testing will only account for two of sixty-four great-great-great-great-grandparents, even though the sixty-two ancestors left out in that generation had an equal contribution to the descendant's genetic makeup as the two that were accounted for (Duster, 2011, p. 4). National Geographic's *The Genographic Project* used these two methods of testing – supplemented with twenty-two additional genetic markers – to determine ancestry (“The Genographic Project,” 2020). While National Geographic did correctly inform participants of the limitations of their testing methods, participants who received results still falsely concluded that if their results did not match the sample of a particular racial group, they were not genetically

linked to that group. This false belief had severe personal consequences, as participants began to doubt their racial identity. For example, Lorianne Rawson was a forty-two-year-old woman who believed herself to be a descendant of the Aleuts of Alaska and submitted her DNA to *The Genographic Project* when it was in the northern part of the Arctic. Her results linked her instead to the Yup'ik Eskimos, who were the enemies of the Aleuts (Duster, 2011, p. 4). Therefore, it is significant to note that while these results were presented to Rawson as definitive, they are in fact not so clearly defined and a lack of understanding of the limitations of the genetic testing process can lead to significant personal trauma when it may not be warranted.

The second distinct method of determining one's ancestry is through Ancestry-Informative Markers, or AIMs. AIMs are genetic markers found on the autosomes, or non-gender specific chromosomes that are inherited from both parents. Instead of examining specifics within those markers, as done with gender-specific methodology, geneticists examine how frequently they occur. AIMs are used most frequently in examining continental populations, where markers determine the ancestral populations of continents ("Ancestry-Informative Markers," 2019). The scientists researching AIMs claimed that the majority of the markers being examined were not population-specific, but as the companies providing ancestry tests have it in their business interest to remain the sole owners of their techniques, their precise levels of threshold frequency are undisclosed (Shriver et al., 1997; Duster, 2011, p. 5).

However, a study by medical anthropologists found that racial ancestry percentages were determined by formulas that compared the frequency of forty-four genetic markers, comparing reference populations of European, African, and Native American ancestry. Researchers hoped that this methodology would provide relative distinguishability, but those studying this topic must remember that reference groups consist of a small population of individuals. No continent-wide sampling had been done in these procedures. Once researchers came up with values for each racial group, they generated a baseline for the statistical concept of a 100% genetically pure individual belonging to one racial group. When a customer then sends in their DNA and tests for one-quarter of the genetic markers that indicate European ancestry, their results will report that they are 25% European (Duster, 2011, p. 6). However, this percentage is based on a reference group of individuals who cannot possibly hold all the genetic markers of an entire race because the population is too small. The results that are given to customers stating that they are a certain percentage of a race is relative; it is wholly based upon the reference group that company's researchers drew their baselines from. Prioritizing low-cost over result accuracy, researchers have settled for "opportunity samples" where a few hundred or thousand samples are collected from easily accessible populations. No researcher has collected samples from groups with linguistic, political, or cultural complexities that would make the sample collection process more difficult – including tribal groups such as the Zulu, Ibo, Hauser, Bantu, Lua, and Kikuyu tribes. The difficulty of obtaining DNA samples from these tribes is understandable, as are researchers' choices to use opportunity samples instead, but one consequence of this cannot be ignored: a recipient of this method of testing cannot be convinced that they are 50% African when the baseline used to make that claim is from a reference group of chance, and not targeted random sampling. This process of genetic testing relies on the statistically impossible concept of 100% genetic purity of a single race, which has never existed in human populations (Duster, 2011, p. 7).

From a social standpoint, in June 2000's Rose Garden Ceremony, President Bill Clinton and genome sequencers Francis Collins and Craig Venter declared the fulfillment of the first draft sequence of human DNA. In doing so, Collins and Venter demonstrated that human genetic diversity cannot be captured by the idea of race, because human genetic sequences are 99.9% identical. Venter then went on to state how the "concept of race has no genetic or scientific basis," and Collins wrote how "those who wish to draw precise racial boundaries around certain groups will not be able to use science as a legitimate justification" (Yudell, 2011, p. 559). However, the opposing side to this argument is still present, as it has been relentlessly throughout history. Neil Risch, a genetic epidemiologist, claimed that race is essential to determine "differences in treatment response or disease prevalence between racial/ethnic groups" and showed open support for the "search for candidate genes that contribute both to disease susceptibility and treatment response, both within and across racial/ethnic

groups” (Yudell, 2011, p. 560). Risch maintained the belief that classifying genetic differences in racial groups was “scientifically appropriate” (Yudell, 2011, p. 561). Risch’s claim is not invalid; however, his thinking highlights the fear that the complexity of genetics and races will be equated to a concept much too simplistic because of preexisting notions about race. This fear is not unjustified, as race has made its way into the workforce – specifically forensics.

Genetics at Work in Forensics

While it is important to note the power of having genetic testing capabilities, even though the scope of these capabilities has significant limitations in accuracy, the application of genetic testing to the workforce is a cause for concern. Specifically, the forensic application of genetic testing has the potential to have dramatic consequences, if innocent individuals wrongly identified through genetic markers suffer consequences for crimes they did not commit. To understand these dangers better, let us establish the background for genetic application in forensics.

In 2004, physical anthropologist, population geneticist, and AIMs expert Mark Shriver was working on a project with a company, DNAPrint Genomics, to create a marketable product that could allow scientists to deduce an individual’s facial appearance based on their DNA ancestry results (Fullwiley, 2011, p. 808). For reference, Shriver had previously collaborated on multiple other projects involving genetics, including a 2003 study at UC San Francisco with a team of Hispanic physicians that aimed to identify health disparities in Puerto Ricans and Mexicans with asthma using AIMs, as well as a project that used African-American, African, and Caribbean DNA samples to try and discover health disparities in cancer rates with biologist Rick Kittles (“Rick Kittles, PhD”). Shriver approached his latest project with the initial step of identifying a person’s continental ancestry based on their AIMs, and then configure a digital rendering of their facial features using that data and a collection of photographs storing previous volunteer’s facial features. As of 2014, this process has since been renamed “molecular photofitting” (Fullwiley, 2011, p. 809). Curiously, since 2004 Shriver has built on his methodology and begun to include genes involved in facial morphology, or the structure of an individual’s face. This would be a seemingly logical course of action because the inclusion of genes that code for collagen are directly related to the face; however, because Shriver continues to depend upon ancestry markers that are not associated with facial morphology, the inclusion of collagen becomes questionable. Nonetheless, today Shriver has created a tool that generates an individual’s head structure, hair texture, skin color, and specific body build through usage of AIMs, and it is marketed by Parabon Snapshot™. Parabon Snapshot™, written on its website in 2014 at the time of Duana Fullwiley’s publication, had the statement “By mining and modeling the human genome for associations with forensically relevant phenotypes, we produce descriptive profiles of individuals from raw DNA samples.” This statement has since been taken down. Their promise, of having harnessed the ability to create a “digital mugshot” as Fullwiley puts it, is dangerous as the usage of AIMs to categorize race has been proven to be shockingly inaccurate – largely due to Yudell’s observation that race in biology essentially does not exist except as a social construct.

Shriver’s work on genetics did not end with his creation of digital mugshots; the National Institute of Justice then funded Shriver to study molecular photofitting in black populations. Shriver expressed that this was due to the genetic diversity of individuals with African ancestry, and when confronted with a reminder about racial profiling of black people in the United States, as well as false sentencing, he said, “If people don’t commit crimes, then they should not have to worry about being under police surveillance” (Fullwiley, 2011, p. 811). Unfortunately, Shriver then demonstrated himself to be an individual with an extreme amount of power over the justice system through his work in genetics, as well as an individual who lacked significant understanding about cultural experiences that differed from his own. His statement about police surveillance, and subsequently the American Judicial System, proves that. Shriver was not without good intentions; when questioned about his motive for his work, he said, “I just want to get the bad guys [...] hopefully this will actually

make black people safer” (Fulwilley, 2011, p. 811). When the person making decisions lacks exposure to different experiences, they are unable to make informed decisions that benefit the general public.

The use of DNA samples from primarily African people in forensics, while it may be well-intentioned, inherently aids racial profiling and bias through the criminal justice system. Due to the inherent bias all humans develop over their lived experience, it becomes impossible to act as an impartial party in judicial situations concerning race – everyone has a personal stake in the outcome. Perhaps the issue is not to stop the advancement of molecular photofitting in forensics, but rather increase awareness about the risks of using primarily one racial group’s samples; because how can one be impartial when the system was built off the back of a fundamentally judgemental concept: race?

Fulwilley illustrates a real-life scenario of molecular photofitting in forensics in their article, “Can DNA ‘Witness’ Race?: Forensic Uses of an Imperfect Ancestry Testing Technology” (Fulwilley, 2011). On August 11, 2004, Derrick Todd Lee was convicted of murder and rape in south Louisiana. His conviction was the first of a series of murder and rape cases. His racial identity was African American. Lee’s conviction was primarily based on his Y-Chromosome STR DNA profile, which matched the DNA samples found on the victims of a serial killing in the early 2000s that he was accused of. This serial killing involved the deaths of seven women in the Baton Rouge area of Louisiana.

However, Lee’s initial conviction was a separate process. First, a DNA sample was taken from him and went through a genetic analysis process that placed him into one of four racial groups, categorized by continent. This analysis made Lee the first person in the United States to be made a suspect in a crime by a DNA test that racially profiled his DNA. The technology that categorized Lee’s DNA was called “DNAWitness” – and this name was no accident. DNA Print Genomics Inc. – the company that created DNAWitness – wanted to promote the idea that technology now contained the power of an ‘expert witness’ through the suspect’s DNA. DNAWitness essentially compares the sample collected with AIMs, a set of genetic markers. Using AIMs conveys that the inventors of DNAWitness believed the DNA sample collected from the suspect would contain variations in allele markers that would make them eligible for grouping into one of four categories: African, Asian, European, and Native American. In Lee’s case, he was classified as 85% sub-Saharan African and 15% Native American. Originally, Louisiana law enforcement had been searching for a Caucasian male – and Lee being a suspect, law enforcement concluded that they may have been incorrect in that search. DNAWitness instead generated results for a ‘lighter-skinned black man,’ which it found through a series of probability tests for ancestry percentages from Lee’s DNA (Fulwilley, 2011).

DNAWitness has the potential to be a powerful tool, but Fulwilley argues that it not only does not meet legal and scientific standards for trial admissibility, but ignores specific legal logic on using racial categories for deciphering DNA. DNAWitness has a significantly large margin of error, and while it may generate profiles, the probability those profiles are inaccurate is high. Furthermore, excluding the science, because interpreting results from DNAWitness involve a degree of subjectivity and bias, the justice system is vulnerable to false readings of phenotype. Because many AIMs are skin and hair coloring alleles, the extent DNAWitness may accurately claim, according to Fulwilley, is the prediction of an individual’s skin color.

DNAWitness is designed to only account for variations in allele frequencies of single nucleotide polymorphisms, otherwise known as coding DNA. The creators of DNAWitness interpret certain frequencies of these alleles as one of their four racial categories – however, these allele frequencies are also present in other world populations outside of those four groups – Asian, European, Native American, and African – due to factors such as genetic convergence, genetic drift, or evolution. Genetic convergence refers to similar genetic changes in separate populations, due to mutations that are coincidentally identical (Stern, 2013). Genetic drift refers to random variations in allele frequencies between generations (“Genetic Drift,” 2019). Failing to acknowledge these factors in DNAWitness makes it so that researchers must rely on direct ancestry and gene flow as the sole reason for shared allele frequencies among racial categories. As a result, the legal community should hesitate before placing their complete trust in these tests, as they lack a regulatory standard.

Even though there was no official standard for molecular photofitting when Fulwilley wrote her article in 2014, there was a set of accepted legal standards in science and technology.

Whether the expert's technique or theory can be challenged in some objective sense, or whether it is instead simply a subjective, conclusory approach that cannot be reasonably assessed for reliability;

Whether the technique or theory has been subject to peer review and publication;

The known potential rate of error of the technique or theory when applied;

The existence and maintenance of standards and controls; and

Whether the technique or theory has been generally accepted in the scientific community (qtd. in Fulwilley, 2011).

At the time of Fulwilley's publication, DNAWitness failed four out of these five basic standards. While these Federal Rules were curated in terms of scientific evidence in law, not specifically referring to or accounting for DNA testing, they remain true for all scientific evidence. As such, Fulwilley found them a reasonable standard. On December 1, 2000 amendments to these rules caused the statement, "an attack on the procedure used to test DNA for evidentiary purposes can be an effective challenge to the weight of any DNA evidence admitted" to be spotlighted (Fulwilley, 2011). Alternatively, when genetic results from DNA testing technology such as DNAWitness is presented in a manner that makes it seem without fault, innocent suspects may suffer – because the technology is not as exact as it claims to be.

Today, many varieties of genetic technology provide aid to courts of law. None were approved without extensive discussion, research, and debate about their accuracy between scientists and law enforcement. However, the margin for error remains large, so the ultimatum that a suspect belongs to a certain racial group is misleading. As Fulwilley writes, "DNAWitness may offer precise mathematical ancestry percentages, but the accuracy of that precision remains debatable." In some cases, tools such as DNAWitness may be beneficial, but this does not outweigh the risk of their inaccuracy.

The Problem with Race in Science

Race has little to no benefit in science. As a social construct, it becomes impossible for scientists to remain impartial when reviewing results concerning race; therefore, race presents itself as a liability to scientific advancement rather than an asset. However, many geneticists continue to maintain that race has scientific validity, and in doing so, race and genetics as a social construct and a field of scientific study, remain hopelessly intertwined. The benefit to many scientific advancements that include race as a category of study is large – for example, genetics in forensics where human DNA was used to generate a rendition of a suspect's facial features. However, one must question the social implications of these studies; for example, using primarily African DNA when constructing DNAWitness on the basis that African DNA contains the highest amount of genetic variation. The scientific basis for that action is true; however, so is the historical marginalization and racism against people of African ancestry in the United States. Scientists must be mindful of social norms and constructs when they are conducting studies involving race.

Having genetic testing on the basis of race is not inherently bad. However, as Troy Duster observes, legal guidelines for company transparency are critical for consumers' understanding of their purchase. Many consumers who purchase at-home ancestry test-kits are not educated about the company's testing process, and are falsely led to believe that their ancestry test results are fully accurate – when in fact, the complexities surrounding racial categorization are much greater. Making this information easily accessible to consumers is the marketing company's responsibility to avoid misinterpretation of ancestry test results. The reasoning behind this lack of transparency is easy to pinpoint: the monetization of ancestry test kits. Ancestry test companies' primary concern is making a profit, and in doing so, they employ marketing strategies that may lead to the omission of certain information so they may sell the maximum number of kits. Moreover, it would require significant funding for the government to regulate genetic testing – so, while federal regulation, legal standards,

and transparent marketing would be a significant step, if not an effective solution, towards the issue of interpreting at-home genetic testing results, in practice, it may not be the most practical. This thinking applies to the forensics field as well, where transparency in results generated by DNAWitness and other such technologies would be critical to both law enforcement and lawyers in court rulings and determining suspects.

Money plays a large role in the validity of genetics. If it were not so, much more transparency could be achieved and it is likely that more social growth would ensue as the public understood that race is not a biological concept. If the steps outlined above, suggested by Duster, could be executed, then there is much potential for scientific and social benefit. But the reality is that in this current global economy, it is unlikely that those steps are realistic without motivation from customers. Perhaps then, genetic testing companies and the federal government may be motivated to change their current operational strategies.

Personal Insight

Now, why? Why does any of this matter? If the legal and ethical implications of genetic testing technologies such as DNAWitness are disregarded – which is difficult to do, as they are incredibly relevant – then I would say at-home ancestry testing and the like put one fundamental human value in jeopardy: identity. To provide context, let me share a bit about my personal identity. I am a seventeen-year-old teenage girl growing up in Seattle, Washington and I personally identify, ethnically, as Chinese-Mexican-Filipino-Italian. If I were to do an at-home ancestry test, according to my own family history, I would expect to receive ethnic results of approximately 50% Chinese, 25% Filipino, 12.5% Mexican, and 12.5% Italian. Racially speaking, I identify as multiracial. Following my research on this topic, I was given the opportunity to try one of the at-home ancestry testing kits for myself, sold by *23andMe*. *23andMe* reported my racial and ethnic identity as follows:

Table 1. 23andMe test results

Broad Racial Categorization	Region Specific Racial Categorization
76.4% East Asian	47.3% South Chinese
	5.8% Southern Chinese and Taiwanese
	23.2% Filipino and Austronesian
	0.2% Broadly East Asian
17.2% European	4.4% Spanish and Portuguese
	3.3% Greek and Balkan
	3.0% Italian
	2.2% Broadly Southern European
	3.0% Ashkenazi Jewish
	1.3% British and Irish
3.3% Western Asian and North African	1.4% North African
	0.8% Egyptian
	0.2% Iranian, Caucasian, and Mesopotamian
	0.9% Broadly Western Asian and North African
2.7% Indigenous American	
0.4% Unassigned	

I'd like to use myself as an example to illustrate this concept of human identity, exclusive of genetic categorization. As stated before, I personally identify as multi-racial. My racial categorization has not been called into question by these test results; they reflect my personal identity. However, I found the variety of

ethnic results I received surprising, and I think that I would have had a much more serious debate about my ethnic identity had I not understood the margin for error of the methods used to obtain these results. *23andMe* reported that I am approximately the same percentage Chinese and Filipino as I expected from family history. However, I am not quite sure what to make of the Mexican and Italian percentages. According to *23andMe*, I am significantly less Italian than my family history had me believe. Also, what happened to my Mexican portion? Poof! But, my relatives speak Spanish and we identify as Mexican. Identifying as Latina is a part of my heritage, so if I adopted my *23andMe* test results as true, then I would lose that part of my identity. This is why I believe it is critical to separate ancestry and racial categorization. Perhaps there is some value to race as a scientific category, no matter the degree of inaccuracy, in some medical studies. That isn't my decision. However, I will say that as a member of a group of consumers with family histories, cultures, languages, and recipes that were in our lives long before ancestry-testing made an entrance, it is vital for us to understand the science behind the products we are purchasing. The accuracy statistics and the methods and procedures used to give us our results are all vital to building our understanding of how these tests fit into our personal lives. Only after understanding all of this, can we make an informed decision about our identities.

Do we want to change how we think of ourselves, based on what *23andMe* or another at-home ancestry testing company has told us? Does that make sense with what we already believe? Does it fit into what we want to believe? What can we trust?

Personally, I'm not changing a thing about the way I perceive my ethnic identity. My culture is in the languages I speak, the food I cook, and the family I'm around. My culture is built into me; it isn't something that a statistic can tell or change about me. In my mind, based on the accuracy statistics I've learned about, it isn't worth it to alter the way I perceive myself.

But I can't say the same for the way the world thinks of me. We live in a world where ancestry-testing could be the future, and racial categorization based upon AIMS or gender-specific methodology might become a part of our everyday lives. It might impact our admittance into the workforce as young people, or our ability to receive promotions as adults. As someone who is just beginning to understand the broader world of occupations and adulthood, I'm not sure how my ancestry test results could grow to impact the opportunities I am given as I age. But as we live in a system that has always been under the influence of race and groups of "haves" and "have-nots," it would be hard to imagine that these tests won't play a role. Think *GATTACA*, and the dystopian-world generated by human DNA tests. These innocent testing practices could spiral, and forever widen the wealth gap – the difference between what people are realistically able to achieve in their lifetimes, and what they must achieve in order to have a high quality of life.

As a teenager, I'm trying to figure out where I fit in. I've had my first job, and I've started to learn how the way I look and how I present myself impacts the opportunities I'm given. I present to the world as multi-racial – a quite obviously Asian and something-else mix – short, and female. I am the epitome of unthreatening. The people I meet expect me to be smart and approachable. And in my experience, we become who we are expected to be. Why is that? When we're young, we aren't anybody yet. We can't see the future and predict who we're going to be, and the majority of us do not possess the mental capacity to decide who we're going to be when we're kids. So we become who the world told us we could be. That's based on the way we look, the color of our skin, the languages we speak, the accents we may or may not have. Who we are, is, unfortunately, dictated to us by a system that has existed long before we came around, and, unless changed from the ground up, will likely exist long after.

My parting message is caution. The world has always sorted people into boxes. That's by unconscious bias, by the storybooks we're read as kids, the princesses or soldiers we pretend we are as children. By the media we're given to absorb. But there is a difference – there can be a difference, if you choose it – between who the world told you you are, and who you decided you wanted to be. These ancestry tests are another way to sort people into boxes. Whether those boxes – in the scientific community – are good or bad remains to be seen; however, some of the case studies shared in this review have already demonstrated the personal danger

of basing personal identity off of these test results. These tests are evidence that we need to keep in mind who the world decides we are, but we don't need to be those people. Understanding and maintaining that sense of self gives you the power back. To be cautious and aware, because there is a system in place that will perceive you a certain way. But also, to understand that this is your life. At least in your own mind and in your own home, how you live it and how you understand yourself is your choice.

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References

- Duster, T. (2011). 5. Ancestry Testing and DNA Uses, Limits, and Caveat Emptor. *Race and the Genetic Revolution*. <https://doi.org/10.7312/krim15696-006>
- Fincham, J. R. S. (1994). *Genetic Analysis*. <https://doi.org/10.1002/9781444313833>
- Fullwiley, D. (2011). 6. Can DNA "Witness" Race? Forensic Uses of an Imperfect Ancestry Testing Technology. *Race and the Genetic Revolution*. <https://doi.org/10.7312/krim15696-007>
- Fullwiley, D. (2014). The "Contemporary Synthesis": When Politically Inclusive Genomic Science Relies on Biological Notions of Race. *Isis*, 105(4), 803–814. <https://doi.org/10.1086/679427>
- The geographic project® geno 2.0 next generation helix product privacy policy*. (2020). National Geographic. <https://www.nationalgeographic.com/pages/article/genographic>
- Jefferson, T. (1832). Notes on the state of Virginia. <https://doi.org/10.5962/bhl.title.33567>
- Lewis, J. E., DeGusta, D., Meyer, M. R., Monge, J. M., Mann, A. E., & Holloway, R. L. (2011). The Mismeasure of Science: Stephen Jay Gould versus Samuel George Morton on Skulls and Bias. *PLoS Biology*, 9(6), e1001071. <https://doi.org/10.1371/journal.pbio.1001071>
- Müller-Wille, S. (2014). Race and History. *Science, Technology, & Human Values*, 39(4), 597–606. <https://doi.org/10.1177/0162243913517759>
- Richmond, S., Howe, L. J., Lewis, S., Stergiakouli, E., & Zhurov, A. (2018). Facial Genetics: A Brief Overview. *Frontiers in Genetics*, 9. <https://doi.org/10.3389/fgene.2018.00462>
- Rick Kittles, PhD*. (n.d.). The University of Arizona. <https://medicine.arizona.edu/person/rick-kittles-phd>
- Shriver, M. D., Smith, M. W., Jin, L., Marcini, A., Akey, J. M., Deka, R., & Ferrell, R. E. (1997). Ethnic-affiliation estimation by use of population-specific DNA markers. *American Journal of Human Genetics*.
- Stern, D. L. (2013). The genetic causes of convergent evolution. *Nature Reviews Genetics*, 14(11), 751–764. <https://doi.org/10.1038/nrg3483>
- (2019). Ancestry-Informative Markers. Definitions. <https://doi.org/10.32388/475844>
- (2019). Genetic Drift. Definitions. <https://doi.org/10.32388/492378>
- Walker, C. E. (2010). *Mongrel nation : the America begotten by Thomas Jefferson and Sally Hemings*. University of Virginia Press.
- Yashon, R., & Cummings, M. (2017). *Genetic testing: What do we know?* Momentum Press.
- Yudell, M. (2011). A Short History of the Race Concept. *Race and the Genetic Revolution*, 13–30. <https://doi.org/10.7312/columbia/9780231156974.003.0001>