Genetic Ancestry Testing with Tribes: Ethics, Identity & Health Implications

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Abstract: Genetic ancestry tests have gained in popularity across the United States as more Americans seek answers about their ancestral past. The tests have been used to verify or dispute family stories about ancestors or to allow people to seek a sense of belonging with a particular tribe or community. They can also be useful in medical research to identify genetic variants across populations. At the same time, assumptions about genetic testing – and the very idea of a "genetic" identity – pose challenges for communities that are defined in terms of political, social, and cultural identities. This essay explores a range of uses of ancestry tests and their potential implications for Native American tribes and communities. It concludes that the scientific and recreational use of genetic ancestry testing continues to increase over time, but limitations of the consistency of results across platforms and the generalizability of knowledge remain.

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In June 2016, Senator Elizabeth Warren's claims to Native American ancestry were challenged by a political rival, Scott Brown, who publicly urged her to take a genetic ancestry test in order to "prove" her Native American biological origins. Media sources had suggested that Warren had once checked a box indicating that she was "Native American," perhaps to gain race-based advantage when applying to her faculty position at Harvard Law School. Brown and others challenged Warren on her lack of involvement with Native American student groups while on campus and her lack of formal affiliation with any tribal group or organization. Senator Warren explained herself by describing family stories and an aunt's claims of Native American ancestry, which were based on memories of her aunt pointing to a picture of Warren's grandfather on the fireplace mantel and noting that he had high cheekbones, just "like all the Indians do."[1]

Encapsulated in this episode are four distinct ways in which people might claim identities linked to Indigenous people. Involvement in Native American

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campus communities might be considered a *social* expression of identity. Formal tribal affiliation should properly be seen as a *political* expression. Pointing to high cheekbones in the picture on the mantel makes an argument resting on certain *cultural* assumptions. And Brown's demand that Warren take a test reveals a new variation – *genetic* identity – on the old theme of race and blood quantum.

Tribal enrollment typically rests on both blood-quantum requirements and demonstrable genealogical connections to ancestors who appeared on tribal rolls and censuses. *Blood quantum* refers to the individual having a certain "fraction" of Native American "blood," and itself is a legacy of American racialism inherited by tribes in need of ways to define membership. Traditional methods of searching for ancestors and calculating blood quantum have relied upon genealogy, the study of family histories and ancestral lineages through historical documentation (including census data, family diaries, surname searches of birth and death records, and other sources). But individuals who are interested in researching their family history through genealogical information run into limits when the paper trail ends.[2] Wanting to seek scientific validation for oral stories that are passed down from one generation to the next, many Americans are now turning to genetic ancestry tests to learn something about their family pasts.

The media attention focused on Senator Warren not only helped fuel Americans' growing interest in using genetic testing to prove or dispute alleged relationships to ancestral pasts, but also raised concerns about the distinction between biological and social ties that might be used to demonstrate belonging to a community. Given the current limits of the science, a genetic test alone cannot validate or dispute Warren's claims. And what if it could? How might a genetic claim matter to the navigation of tribal membership criteria? How might it matter in other contexts?

Genetic genealogy utilizes scientific tools to examine a person's biological lineage in order to uncover links to other contemporary peoples' ancestors and hopefully glean information about the person's family history and lineage. Such testing may provide additional clues in both research and recreational contexts. Genetic ancestry tests may be able to reveal relationships between close biological relatives, suggest more distant population affiliations, or even confirm a suspected relationship with an ancestor. People around the world have taken pleasure in adding a genetics element to their genealogical pursuits.

But genetic ancestry test results' potential implications extend much further than an individual's interpretations of the data. The results could impact how genetics is used in health care, influence how people choose to identify while filling out the U.S. Census, affect whether individuals seek out tribal resources, and shape the way individuals report their race or ethnicity, which in turn could affect the availability of federal funds for services. Some people are thought to use the results of genetic ancestry tests to seek race-based admissions to universities or to apply for scholarships.[3]

Taking a test is simple: one will typically spit into a tube to collect a saliva sample or use a swab to gently scrape off a buccal sample from their inner cheek, then send the sample to a genetic ancestry company. The company then extracts DNA from the sample to examine it using a set of genetic markers that infer ancestral origins. AncestryDNA and other companies often convert the results into a narrative that seems definitive, leading customers to claim to understand themselves after discovering previously unknown connections to, say, the Mediterranean or the Middle East or Africa. But as I have suggested, Scott Brown was wrong: genetic ancestry tests are not robust enough to provide an answer about Senator Warren's specific claims to Native American ancestry. Why not? First, let's take a look at how the tests work and what their scientific limitations are. Then we will examine the social and political ramifications of the use of such tests.

Scientific analyses using genetic ancestry markers have been conducted in human population studies in order to understand a number of scientific questions, including the underlying population genetic differences for health and medicine, the evolutionary history of humans, and worldwide human migration patterns. Genetic ancestry tests rely on statistical analyses to make inferences about a person's ancestral past. The tests examine the DNA markers (which are coded as base pairs A, C, G, and T) along each of the chromosomes and compare them against one another and against information from proprietary databases.

Genetic ancestry testing can encompass a broad variety of tests available within the laboratory setting and on the consumer marketplace. These tests typically include analyses with one of three types of genetic tests: mitochondrial DNA (mtDNA), Y-chromosome DNA, and autosomal (nonsex chromosome) DNA. Although no test can be used to analyze all types of DNA, specific tests may be used to glean information from a single ancestral line (through analyses of mtDNA and Y-chromosomes) or to uncover broader information regarding multiple potential ancestral backgrounds (through analyses of autosomal DNA).

What are the distinctions between the three types of tests? First, because mtDNA and Y-chromosome DNA are not subject to recombination (where genetic contributions from each parent are mixed up at each generation), large sections of DNA are largely unchanged from one generation to the next. The mtDNA tests examine certain haplotypes, or groups of DNA markers, that are passed largely unchanged from one generation to the next through the maternal line. Certain mtDNA haplogroups are found more commonly in some populations than others and have been used to suggest certain ancestral relationships. For example, mtDNA haplogroup L is found most frequently in people of African descent and is thus thought to have originated in Africa. Similarly, mtDNA haplogroup A is one of the main haplogroups in Indigenous Americans. A result that shows haplogroup A would thus suggest that a person has ancestry tracing to the Americas. Because mtDNA is only inherited from the mother, it can only reveal ancestry about the maternal ancestral line (for instance, a mother's mother's mother). Similarly, Y-chromosome DNA tests examine the haplogroups of the Y-chromosome, which is passed through the paternal line from father to son. Females, however, do not have Y-chromosomes, but may learn about their paternal lineage through the genetic testing of biologically close male relatives, such as a brother or father. The Y-chromosome would only reveal ancestry about the paternal ancestral line (for example, a father's father's father).

The third test – autosomal DNA – has become the DNA test of choice due to its wide coverage of genes across the entire genome. Because it is not restricted to the mtDNA or Y-chromosome, autosomal DNA may offer insights into more ancestors than just direct ancestors on the maternal or paternal lines (as mtDNA analyses and Y-chromosome analyses do, respectively). Autosomal DNA is inherited from both the mother and father and comes from nonsex chromosomes that are subject to recombination events that take place with each new generation. With each recombination event, different chromosome segments containing genetic markers are randomly selected and passed on to the offspring. Because autosomal DNA comes from both parents, it can reveal information from all ancestors going back several generations.

These genome-wide ancestry tests rely on a collection of genetic markers from autosomal DNA that show significant allelic frequency variation across populations (on the order of 30 to 50 percent), and use bioinformatic tools to estimate biogeographical ancestry. For example, a genetic marker that is found at a very high frequency in one population but not in other populations can help indicate which population a person is likely to be from. One marker alone is not enough to assert any ancestral ties, however; published studies examine as few as thirty-four and up to several thousand markers together to increase the granularity and confidence of presumed ancestry.[4] These collections of markers are known as Ancestry Informative Markers (AIMs). Significant computing power is required to statistically analyze large numbers of AIMs to generate probabilities. These probabilities may provide a higher-confidence estimate of where a person is likely to "be from," based on shared ancestry with other people in the reference populations. With the advent of whole-exome or genome sequencing technologies, scientists are able to use a larger collection of markers with a wider range of frequency variation to achieve higher granularity across populations.

AIMs account for genetic recombination: that is, the ways that the genetic contributions from each parent are shuffled at every generation. Each chromosomal segment containing genetic variants such as AIMs originates from one of the parents and is passed down from one generation to the next. Thus, each segment is tied to larger population ancestral histories. Geneticists are able to analyze the genetic variation across chromosomal segments to estimate the geographic origin of one's ancestors. For example, one chromosomal segment containing AIMs at high frequencies in one population would indicate a shared ancestor from another population in the same geographic region and is thus an indicator of shared or similar ancestral background. Some chromosomal segments might be derived from populations with common ancestors originating in Africa, whereas other segments might be traced to populations in Europe or Asia. Genetic ancestry tests use and make predictions about a person's ancestry based on comparisons of their genetic variation with other modern-day populations. Researchers use these tests to theorize about human migration patterns, as well as to examine how human populations have changed over time and how they differ at the molecular level.

23andMe, AncestryDNA, and African Ancestry are among the direct-to-consumer (DTC) genetic testing companies offering genetic testing kits to consumers interested in seeking information about their ancestry through scientific means.[5] Some DTC companies have proprietary social-media networks on which consumers can use their results to connect with others who may help them identify close relatives or distant kin based on shared genetic markers. These ancestry companies process and analyze samples by utilizing their own databases of genetic markers and reference samples originating from different populations. Because each company uses distinct datasets, the same type of test may produce different results across companies. Consumers of ancestry tests who submit their DNA to multiple companies may receive different – and sometimes contradictory – sets of results. In one case, a test by African Ancestry suggested that Oprah Winfrey had ancestry tracing to the Zulu in South Africa, yet in a different analysis a few years later, the results suggested she has 8 percent Native American and 3 percent East Asian ancestry and that 89 percent of her African ancestry does trace to sub-Saharan Africa, but not to the Zulu people.[6] In a 2006 study, law professor Henry Greely examined variation in results across sixteen companies and found that the companies offered a wide array of different platforms, each generating slightly different approaches and results.[7] Statistical estimates of ancestry are themselves based on probabilities that leave room for error. In 2003, the General Accounting Office reported submitting the same DNA sample for ten different tests to four different testing companies and found the results to be contradictory and inconsistent with one another.[8]

Current genetic ancestry databases are limited by the composition of individuals and populations sampled in a given geographic area, a fact that has particular consequences for Indigenous peoples, who are often woefully underrepresented in genetic test companies' databases. The individuals who are sampled do not necessarily reflect the entire genetic diversity within a geographic area, as they may lack common genetic variants or, on the other hand, possess rare genetic variants not found in the rest of the population. This limitation is of particular concern because lack of representation of genetic diversity within the databases may lead to inaccurate or inconsistent conclusions for test-takers. Most studies of genetic ancestry have been conducted in people of European descent, for example, and some ancestry tests have been able to pinpoint a country of origin if all four grandparents are from the same country. However, the lack of representation of Indigenous peoples in genetic research studies – which has decreased from 0.06 percent in 2009 to 0.05 percent in 2016 – limits the generalizability of knowledge about Indigenous populations.[9] In other words, a genetic genealogical claim to be Native American rests on a much less robust genetic data set and is therefore much less reliable than a finding about European ancestry.

Many people who seek results from genetic ancestry tests to validate a claim of having a great-great-great Native American grandparent will likely have very little usable information. With each generation, a child inherits about half of their genomic information from their mother and half from their father. Thus, one-half of a person's genome comes from one parent. Going back to the next generation, one-fourth of a person's genome would come from a grandparent and one-eighth from each great-grandparent. Thus, one-thirty-second would go back five generations and account for 3.125 percent of the inherited genetic information. If a person was interested in using an ancestry test to validate a claim of a great-great-great grandparent, the test would need to be robust and accurate enough to pick out a small portion of Native American ancestral contributions from across the genome.

Despite these issues, the market for ancestry testing companies has grown, with advertisements frequently appearing on social media and in newspapers, broadcasted on television, and even plastered on a zeppelin. Consumers without knowledge of the limitations of genetic ancestry tests, however, overinterpret the results, believing they represent *the* missing information about the consumers' identity, or as the "most accurate" information about their identity despite potentially conflicting familial histories or documentation. Further, some individuals may receive test results that contradict strongly held beliefs about their genetic heritage, or they may receive inconsistent results across different genetic ancestry companies. Some consumers may not be prepared to handle contradictory or inconsistent results, posing risks to their psychological well-being.

The incorporation of genetic tests is not entirely new in the tribal membership context. A few groups or individuals have attempted to use genetic ancestry test results as evidence to prove or confirm their relationship to an existing tribe. Federally recognized tribes in the United States have the power to determine their own tribal membership and have different criteria for determining what types of evidence they will accept. One notable example of the use of genetics to seek tribal membership is the Freedmen of the Five Civilized Tribes. The Freedmen were descendants of freed African American slaves who were once owned by the Cherokee or other tribes and, once freed, lived and integrated with the Five Civilized Tribes. After the Civil War, the Cherokee Nation signed a treaty that granted its former slaves "all the rights of Native Cherokees." In 2011, however, they were disenrolled from the Cherokee Nation under the claim that they did not have actual Native American ancestry tracing back to an existing tribe. Descendants of the Freedmen then tried to utilize genetic tests to demonstrate a biological link to the tribes. In general, Native American tribes have rejected this type of genetic ancestry information in tribal citizenship applications.[10]

Still, results from genetic ancestry tests can pose challenges to tribes from individuals who use them to seek a tribal affiliation, especially if they have had no previous connection to the tribe. In determining membership, most tribes rely on proof of direct descent from an enrolled tribal member, typically in the form of blood-quantum documents. In some cases, individuals seeking tribal membership have utilized maternity and paternity genetic testing to demonstrate direct lineage with an enrolled parent; for example, to grant citizenship if an applicant's father is not listed on a birth certificate or to confirm parentage with someone who is enrolled in a tribe. Conversely, some tribes have used paternity and maternity tests to disenroll tribal citizens when suspected parentage turns out to be false.[11] Tribal disenrollment may lead to loss of access to resources and support, social stigma, denial of identity, and psychological harm. Others have used genetic testing to *limit* tribal enrollment eligibility.[12] These tests are genetic in nature, but are very limited in scope and only indicate whether there is likely a direct parent-child relationship.

Can ancestry tests provide enough precision to specify tribal affiliations? The short answer is no. In *Native American DNA*, Kim TallBear describes the limitations of genetic ancestry companies that purport to tell someone their percentage of Native ancestry and the tensions that these genetic results can have in terms of sociocultural identities.[13] It is far too easy for individuals to erroneously cross-map statistically generated percentages (such as 3 percent Native American) to the well-established and problematic practice of blood-quantum measurement (such as one-thirty-second Cherokee). While some of the testing companies can certainly test for genetic markers that are found at much higher frequencies in Native Americans than other groups and thus make some predictions about Native ancestry, the markers are not enough to make a definitive claim to Nativeness, much less to a specific tribal identity. Often, I receive emails asking me for advice on which DTC test to use to determine Native American ancestry. Although I am not in the business of making recommendations for one ancestry testing company over another, I am particularly concerned if consumers tell me they are seeking out a test in order to gather additional evidence that their family stories of Native American ancestry from a particular tribe are indeed true. Despite advances in genetic tests' capacity to pinpoint ancestral relationships, none of the companies can definitively state that ancestral relationships are aligned with any particular tribe. No genetic tests can determine tribal affiliation, nor can they definitively prove Native American ancestry.

As we have seen, the key reason behind these limits is simply that there are not enough data in the databases to make strong conclusions. But it is worth interrogating that absence. Obviously, Indigenous peoples are a smaller demographic presence in most locations – the result of centuries of colonialism and violence – so there is simply a smaller pool from which to draw. It is also the case, however, that Native Americans have largely refused to participate in genetic research related to human migration and ancestry. The refusal took on a powerful salience after activists began protesting the Human Genome Diversity Project's efforts to recruit "isolated human populations" (in other words, Indigenous people) before their genetic variation was "irretrievably lost" through admixture with other populations.[14] The reticence to participate was on the grounds that the frame of "irretrievable" and inevitable loss reproduced older ideologies that insisted on Native Americans' vanishing and disappearance. Additionally, the results of such projects have offered no direct benefit to the tribes or individuals; in that sense, they too are colonial in nature. It is also worth noting the multiplicity of tribes that exist across the United States; most are too small for a researcher to recruit enough members to definitively identify the necessary number of distinct genetic markers to make genealogy a condition for tribal membership.

Scientific challenges to tribal origins can have harmful implications for tribes more generally, as these claims can be used as points of leverage for those opposed to tribal claims to homelands, territory, or human remains. Significant psychological distress can arise if a person's beliefs about their ancestors' origins conflict with scientific interpretations of genetic data. Tribes have also been concerned that scientific evidence can be used to contradict or challenge their cultural and deeply held beliefs about their origins. Many of these genetic studies indicate that the ancestors to current Native Americans migrated across the Bering Strait from Asia. These results may carry political implications if they are used to challenge tribal sovereignty and land rights. Nor are they as clear-cut as they may seem. In terms of scholarly debate, they may also fail to align with the developing archeological record, or with other disciplines such as linguistics, both of which work with their own models of deep time and migration history.

In two separate cases, the Havasupai and the Nuu-Chah-Nulth peoples challenged genetic researchers for misuse of their DNA samples. Both tribes had donated their DNA samples for biomedical research (diabetes and arthritis studies, respectively), but in both cases samples were used for secondary analyses of human migration studies without permission and published with tribal identifiers.[15] In both cases, scientific results suggested that the tribes originated from Asia and crossed the Bering Strait, which contradicted intergenerational beliefs about ancestral origins. In both cases, researchers failed to ask for permission to conduct such research and failed to communicate the findings with the tribes. This ethical breach thus further compromised the politics of traditional knowledge. It failed to allow tribes to raise concerns about stigmatizing interpretations, such as the reporting of inbreeding coefficients, which suggested to tribes that they had engaged in taboo activities. In response to such ethical issues, as sovereign political bodies, tribes have established their own institutional review boards in order to more effectively participate in research oversight.

In addition to being useful for learning about human biological relationships, genetic ancestry tests can also be employed by medical researchers in studies of disease susceptibility across human populations.[16] Genetic ancestry tests have been used in medical research to tease out ancestral components that might reveal whether a disease or trait is more prevalent in one population than another. By isolating the ancestral markers in DNA, researchers are able to hone in on the genetic variants that are associated with diseases or other phenotypes. In groups that have a long history of mixing – Hispanic populations, for example, which have ancestral contributions from Europe and the Americas – teasing out genetic ancestral components can help researchers determine if a particular trait or disease is associated with specific proportions of European or Native American ancestry.

Health research studies have also incorporated genetic ancestry estimates into analyses, controlling for ancestry in order to disentangle clinical phenotypes (physical characteristics) that are more common within a certain population. This generates some useful applications, such as precision medicine, which aims to utilize patients' genomic information – including ancestry estimates – in determining optimal therapeutic options for each individualized patient. Pharmacogenomics tailors drug and dosing prescriptions to individuals with certain genotypes, thus potentially enhancing clinical treatments to individuals.

In 2015, President Obama announced the Precision Medicine Initiative (renamed the *All of Us* Research Program), which conducts longitudinal studies of cohorts in order to gain deeper understandings of genomics, clinical treatments, and health outcomes. The program aims to recruit one million Americans, including a large number of American Indian and Alaska Native people, to further understand the relationships between genes and health. The program will follow this population cohort to learn which triggers – whether genetic or environmental – are likely to lead to a particular health outcome. For example, one precision-medicine study found that, if Hispanic children with acute lymphoblastic leukemia had a high proportion of Native American DNA, one extra round of chemotherapy improved their survival outcomes.[17]

Precision medicine seems to be a promising direction for genetic work, but its relationship to Indigenous people is not unproblematic. Furthermore, only a few genes have been directly connected to specific disease states (Huntington's Disease, for example) and even fewer genes have been directly connected to a better understanding of effective drug interactions. And while the incorporation of ancestry results in the clinical setting may potentially benefit patients, there are always dangers inherent in conflating social constructions of racial identity with genetic information. Combined with small population pools and a troubled ethical history surrounding consent and consultation, a better ethical standard is needed to structure the interaction between biomedical genetic research and Indigenous communities in a way that maximizes benefits while minimizing harm.

As shown in this essay, while the use of genetic ancestry tests may yield surprising and useful insights about a person's genetic history, much of the technology's commercial use is premature and may leave consumers with inconsistent results across companies. In this sense, the tests are truly best understood as recreational. Although genetic science and research continues to advance, one must proceed with caution with DTC test results, especially for populations that are historically underrepresented in databases, like Native Americans. While genetic identity science could take decades to realize its full potential, other forms of expression, such as social, political, and cultural identities, will continue to drive the insights and perspectives that people have about themselves. These expressions and identities are intertwined and complex, and they refuse the possibility of a seemingly "neutral" genetic science. The conjuncture of genetics and Indigeneity, it is clear, will remain one of both potential and challenge. Research design and applied science must be reimagined in a landscape complicated both by the recreational identity industry and by tribal assertions of sovereignty in relation to research, citizenship, history, and ethics.

ENDNOTES

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