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"He Beat You in the Blood": Knowledge and Beliefs about the Transmission of Traits among Latinos from Mexico and Central America

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Abstract

Purpose—Genomic literacy is becoming increasingly important. Knowledge about how Latinos from Mexico and Central America (MCA) think and speak about how traits are shared by family members is needed.

Methods—Semi-structured in-depth interviews were conducted with 16 MCA Latino men and women. Interviews elicited detailed information about participant beliefs and knowledge about intergenerational trait transmission, genes and genetics. Transcripts were systematically analyzed.

Results—Most participants had familiarity with the role of genes. Knowledge about gene function was limited. Participants used "blood talk" to discuss awareness that traits are transmitted between generations and to express that blood itself plays a crucial role often, but not necessarily, in conjunction with genes or DNA to transmit traits.

Conclusion—Health educators need to directly address potential confusion about blood's role in the transmission of traits. Culturally and linguistically appropriate materials are needed to present genetic and genomic information to MCA Latinos.

Keywords

Genomics; Genetics; Health Beliefs; Latino; Hispanic

INTRODUCTION

Scientific knowledge about how the genome affects human health has expanded dramatically since the human genome was sequenced in 2003. The scientific community has become increasingly aware that most traits are influenced by multiple genes, in contrast to

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inheritance patterns explained by Mendelian genetics [1]. The role of the epigenome in the transmission of traits is also receiving substantial attention within the scientific community [2,3]. The promise of personalized medicine due to increased knowledge about genomics is beginning to be realized; genomic knowledge will therefore increasingly be applied to clinical settings [4,5]. However, science has advanced far more quickly than public knowledge about genetics and genomics [2,6,7]. Many adults perceive that they have basic knowledge about genetics; however, their knowledge is often superficial or incorrect [8–11]. Most adults in the US lack the knowledge base that enables them to understand how gene-environment interactions affect their health and that of their families [6,7,10,12]. Many adults realize that increased susceptibility to developing illnesses can be passed between generations and that environmental exposures and behaviors can affect health; however, their explanatory frameworks are often inconsistent [13,14].

Substantial numbers of Latinos live in the US, underscoring the need for culturally appropriate educational materials. More than 50 million Latinos live in the US, of whom 14.8 million were born in Mexico and Central America (MCA) [15]; many more are children of Latinos born in MCA. Latinos are not restricted to regions in which their presence has been long-established. More than 825,000 Latinos live in North Carolina (NC), representing 8.6% of the state's population [16,17]. This represents a 119.6% increase since 2000 [16]. Furthermore, almost 40% of Latinos in the US born in Mexico and 34% of Latinos born in Central America who are at least 25 years old have less than a ninth grade education [15]. This suggests that many MCA Latinos may have limited knowledge about genomics, may have perceptions about trait transmission that are inconsistent with current biomedical knowledge, and may therefore need to be presented with genetic information that is culturally appropriate. Knowledge about how Latinos from MCA think and talk about the transmission of traits and basic genetic terms will enable health care providers and educators to communicate relevant genomic information more effectively.

Some studies have examined knowledge about genetics, and knowledge and attitudes about genetic testing among ethnically diverse samples that include African American, Latino, Asian, and white adults [10,18–20]. Participants' responses to open-ended questions about their knowledge of genetic terms or how traits are transmitted can be particularly illuminating. Although participants were aware that genetics is involved in traits or genes being passed down through families, few mentioned DNA or chromosomes in their responses. Many participants mentioned shared physical traits and diseases when talking about genetics [18]. Among adults who were directly asked what the term "genetic" meant, few were able to adequately answer the question [10]. Low-income pregnant women indicated that children's traits were passed to children through several means, including genetics. Although the role of genetics was prominent when discussing physical traits and risk for developing illnesses, genetic explanations often coexisted alongside non-biomedical explanations [19].

Several studies that have examined US residents' knowledge about genetics have restricted their sample to Latinos, while including Latinos born within and outside the US who trace their ancestry to diverse regions [21–25]. Most studies were based solely on fixed-response questions [22–23]. However, Latina women who were asked what genetic tests were and

how they would describe them indicated that they had little or no knowledge about genetic tests and could not explain what they were [24].

Few studies have focused primarily on Latinos living in the US who were born in MCA. Latino community members and leaders in Utah, most of who were born in Central or South America, provided feedback about educational materials that explained genetic testing for the *BRCA1/2* mutations. They recommended that definitions be provided for technical terms such as “gene” and “mutation,” suggesting that the terms’ meanings were unclear [26]. Pregnant women living in California’s Central Valley, most of who were born in Mexico, were interviewed about their knowledge of genetic testing for alpha fetoprotein (AFP) and birth defects. Many spoke about blood in the context of the transmission of traits; few were familiar with the terms “chromosomes” or “genes” [27].

This analysis is framed by the insights of Kleinman and Leventhal about the roles of culture and experience for individuals’ understanding about health and illness [28–30]. People draw upon diverse models, including common sense representations of reality, as they seek to understand their health and how diverse factors may cause illness or undermine well-being [28–30]. Furthermore, individuals’ accounts or common sense representations may be reinforced or modified as they interpret the statements and behaviors of others, including those who may interpret basic concepts differently or hold substantially different explanatory models. Individuals’ cultural resources enable individuals to present diverse accounts about illnesses or the transmission of traits that may be consistent or inconsistent with each other. Individuals’ accounts may be integrated or discordant with biomedical accounts. Just as individuals draw upon diverse models to explain whether or why they are ill, they can draw upon diverse terms or interpretations of terms to explain how traits are transmitted through families.

Additional knowledge about how MCA Latinos think and communicate about how traits are passed between generations is crucial to the development of culturally appropriate education materials about genomics. This knowledge will be valuable to MCA Latinos as genomic knowledge infiltrates health care options. For example, through “precision medicine”, the DNA of an individual’s cancer is identified to help predict which cancer treatment will be most effective [31]. Pharmacogenetics identifies genetic variation in individuals that may indicate who is likely to most benefit from a particular medicine or the appropriate dose for a specific person [32]. Knowledge about genetics will also enable parents to understand pre-natal and post-natal testing decisions and results better [33]. Furthermore, as genomic knowledge becomes increasingly integral to explanations of diseases that will be addressed in patient-provider encounters, health care providers will need tools to effectively communicate genomic information to their patients. Our goals were therefore to 1) identify how MCA Latinos think and speak about how traits are shared by family members, and 2) examine how MCA Latinos conceptualize and speak about genes and DNA as they relate to the transmission of traits.

MATERIALS AND METHODS

We collected data as part of a project to develop and test procedures for meaningful communication about epigenetics to Latino farmworker and non-farmworker households. This communication project is part of a larger study examining the association between pesticide exposure and neurological health [34]. Data for the assessment phase of the communication project were collected from 16 Latino adults, 8 men and 8 women. Farmworkers and non-farmworkers were equally represented within each gender. Men and women who worked as farm laborers and women who lived in households with farm laborers were considered farmworkers for this study. El Buen Pastor Latino Community Services in Winston-Salem, NC facilitated non-farmworker recruitment; North Carolina Farmworkers Project in Benson, NC facilitated farmworker recruitment. Project staff also drew upon personal contacts for recruitment.

Our data consisted of transcripts of semi-structured in-depth interviews lasting approximately 30 to 60 minutes. Interviews were conducted in Spanish at locations convenient to participants, including farmworker camps, homes, offices, and public facilities, during June through September, 2013. The research team developed an interview guide to ensure that the same domains were addressed in each interview. Major topics included in the interview guide are listed in Table I. All interviews were conducted by one research team member in her late twenties. She is a bilingual native Spanish-speaking woman whose parents were born in Mexico. Her Latino name and fluency in Mexican Spanish facilitated the development of rapport. Furthermore, her willingness to conduct interviews at the participants' homes and engage in preliminary conversation unrelated to the interview furthered trust. After a few introductory questions, participants were asked to explain why they think traits run in families. The interviewer did not use the terms "heredity" or related terms (e.g., "inherit") until participants used the words "hereditary" (*hereditario*) or "inherit(ed)" (*heredar*). Participants who used the words "gene(s)," (*gen*[*es*]), "DNA" (*ADN*), or "blood" (*sangre*) to explain why traits run in families were asked questions about each word or concept they addressed. All participants were subsequently asked questions to explore or expand upon their knowledge about genes. We thereby obtained detailed information about participants' beliefs and perspectives. The Wake Forest School of Medicine Institutional Review Board approved the study protocol. All participants provided written informed consent in Spanish before each interview.

Audio recordings were transcribed verbatim and translated into English by a bilingual native Spanish speaker. The team member who conducted the interviews carefully checked each transcript against the audio recording. She paid particular attention to the translation of idioms. In one case the transcriptionist translated a phrase as "hereditary" when the more literal translation of the text was "it is passed on in the family". The research team identified and defined concepts or "codes" central to our analysis based on current literature to create a coding dictionary. We added new codes and refined existing code definitions during the analytical process [35]. The first author systematically attached tags or codes associated with each concept to text segments representing the concept using ATLAS.ti qualitative data analysis software (Scientific Software Development GmbH, Berlin, Germany). A second team member reviewed each coded transcript. All discrepancies, which primarily was a

reviewer having overlooked a section of text that should have been marked with a relevant code, were resolved. The research team then separately analyzed all text associated with each of the following codes to identify range of meanings, uses, and applications: heredity, genes, DNA, blood, and mechanism [36]. As we analyzed the data, we assessed whether the responses varied by gender. Gender did not appear to be associated with different patterns of response. Participant quotations in the text are followed by parentheses containing the participant's identifying number; gender, male (M) or female (F); and country or region of origin, Mexico (Mex) or Central America (CA).

The transcripts of semi-structured in-depth interviews provide rich qualitative data that can demonstrate complexity of thought of a specific population [37]. Qualitative research is beneficial when exploring topics about which little is known, such as MCA immigrants' beliefs about trait transmission. Furthermore, the emphasis on participants' experiences and thoughts, including their use of multiple terms to explain trait transmission, provides rich data for examining how MCA Latinos think and talk about how characteristics are passed between generations [37].

RESULTS

Twelve and four of the participants were born in Mexico and Central America, respectively. Four participants had fewer than 9 years of formal schooling. Six had at least a high school education. All but one participant had been in the region for at least five years, and nine had been in the region for at least 10 years. Additional participant characteristics are listed in Table II.

Heredity

All participants used the term hereditary or related terms (e.g., heredity) when speaking about how traits were passed between generations or whether specific diseases were passed between generations. Heredity was commonly used to refer to the transmission of traits through the family. "We use 'hereditary' a lot, like to inherit from grandparents or uncle, or you look like … or you got your character from your uncle, your grandpa" (16-F, Mex). The majority of participants used the term heredity in the context of physical traits such as eye color, skin color, and hair characteristics.

> [Heredity means that] it is obtained from your parents, therefore, it is something that you cannot change because it is already in your blood, and it's evident through your physical appearance that you have inherited something physical from your dad (11-M CA).

However, the association between heredity and physical traits was not uniform. One woman, for example, made a distinction between characteristics affected by heredity and those affected by genes. A majority indicated that illnesses, such as diabetes, could be due to heredity, although that opinion was not uniform. A few participants suggested that aptitude (e.g., being artistic or having innate intelligence) is inherited. Some participants used the terms heredity or inheritance in the context of attitudes, behaviors, or resources that were passed from parents to children, but not through a biological mechanism. A few participants

reported that poor parenting can cause children to “inherit” poor behavior or psychological problems; others explicitly asserted that those behaviors are not inherited.

Genes/DNA

Most, but not all, participants were familiar with genes and knew that they had to do with the transmission of traits between generations. “[Genes] come from previous generations and … we are inheriting [them] from older families” (5-M Mex). Another participant stated “[Genes are], I don't know, like traits or something that we pass to our kids and our kids to their kids, something like that” (6-M Mex). Several participants offered the words genes or genetics to explain why children look like their parents. Participants could be familiar with the term genes but have limited understanding. As one participant stated, “Genes are spermatozoids, right? That’s my opinion but I don't know if I am wrong; that’s what I think” (15-M CA).

Half the participants brought up the term DNA during the interview, and were therefore asked about their understanding of DNA. DNA was used to explain at a general level how traits are passed between generations. Several participants discussed DNA in the context of the transmission of traits. “DNA … is where everything is, where all the physical features are that are passed from parents to children. It is where everything is generated to develop the baby” (7-M Mex). When asked to explain why a grandparent’s eye color might be the same as a grandchild, but not child, a participant stated, “Well that’s a very difficult question, but it’s like I said, it’s because of the blood or the DNA in the family” (2-F Mex). Some were aware of the limits of their knowledge. “I don't know much about [DNA] – just that DNA is the blood type, what makes our blood, what makes our own person, like what tells us apart from everybody else” (8-F Mex).

Participants mentioned several different physical traits in the context of genes: skin color, height, hair, shape/look of ears, nose, and eyelashes. A few participants mentioned DNA in the context of physical traits in families. A few thought that genes could be associated with the transmission of illness. “If my wife or I have bad genes, then sooner than later we will get an illness, or if I have genes of an illness, then I will get it” (6-M Mex). A small number of participants indicated that DNA was implicated in the development of illness. None refuted the position. A few participants mentioned that mannerisms, ways of talking and walking, voice tones, and expressions, were transmitted through genes or DNA.

Some participants discussed the appearance or configuration of genes or DNA. Those who addressed the size of genes/DNA did not seem to realize how small they are. “I think we need microscopes, something like that, to see the genes” (3-F Mex). One participant indicated that genes look “like globules or spirals” (7-M Mex), suggestive of the DNA double helix. Another stated, “DNA is like a little chain; they’re like molecules that form the blood.” (13-F Mex) A couple of participants’ descriptions suggest that genes or DNA look similar to red blood cells. One pictured genes “almost like red blood cells” (1-F CA). Another imagined that genes or DNA look “[l]ike round things like if they were doughnuts, but filled” (8-F Mex).

Participants who discussed DNA often used genes and DNA interchangeably. When asked to explain why children often have the same eye color as their parents, one man indicated that it has to do with the "genealogy that is transmitted, mainly the genes, the DNA, and things like that, right?" (11-M CA). However, participants discussed testing only in the context of DNA, with the exception of one woman who had undergone genetic testing during a pregnancy. Furthermore, most of the participants who discussed DNA mentioned DNA tests, primarily in the context of paternity testing.

Blood

All but one participant spoke about blood in the context of traits being passed between generations. "Blood talk" was used to explain that different family members have similar physical traits as well as shared illnesses. When asked why family members had the same health condition, a participant responded, "It is hereditary; it's already in the blood" (12-F Mex). Blood talk can also be used to explain why physical traits may appear to skip a generation. Temper was **rarely** discussed in the context of strong blood.

Many participants indicated that traits are, or are not, passed from one generation to the next because one parent (or one side of family) has blood that is stronger or weaker, more or less dominant, than the other, or in some way won. One woman reported that people from Mexico say, " 'He looks like your husband; he beat you in the blood.' I mean, they always say that it's because he has stronger blood or a stronger character, and that's why the kids look like them" (2-F Mex). A woman indicated that when talking with her husband about their children's resemblance to her, she tells her husband, " 'I may have stronger blood or my genes….' I tell him, 'I think my genes participated more in the process' " (13-F Mex). A man unfamiliar with the word gene stated, "If the mom's blood is stronger, then the kid is going to look more like the mom's family" (4-M Mex). Although many participants made reference to stronger or dominant blood, a few participants questioned this explanation, at least to a limited degree. Furthermore, use of "weaker blood" could also refer to increased susceptibility to illness. "What I have heard is that they are weaker in the blood because they develop diseases faster than others" (9-F Mex).

Most, but not all, participants expressed that traits are passed through blood and genes and, to a lesser extent, DNA. Some participants discussed strong blood, genes, and DNA in ways that suggested, at least initially, that "blood" is interchangeable with "genes" or "DNA." When asked how genes can affect eye color, one participant stated they do it "through the blood" (5-M Mex). Another participant indicated that DNA is everywhere, in the blood. Others made the connections between blood, genes, and DNA when asked to describe how genes or DNA appear. Less commonly, blood talk was used in a more literal way to discuss why children look like other family members. One woman not familiar with the word gene stated that children look like the family because "we have [children] in our belly and the blood. I mean the blood comes from aunts, mom, grandma, or family members; that's why they are like that" (12-F Mex).

Mechanism

Participants' explanations about how traits or genetic information are transmitted between generations were usually vague, and often referred to genes or blood being passed from parents to children. For example, one man suggested that genes are passed through the blood and/or intercourse, and that a child has "genes from both [the mother and father], he has [them] from both" (5-M Mex). When asked why her daughter has the same eye color as grandparents but not her parents, a participant stated, "I don't know how to explain it, but [it] has to do with blood, genes and DNA" (9-F Mex). Another man stated that genetics "is the transferring of… maybe blood types between me and my wife; we are a unit together and it must grab from both" (14-M CA). As previously mentioned, some participants talk**ed** about strong blood **in** the context of trait transmission.

A few participants drew upon terms and concepts associated with biomedical understandings of infectious diseases to explain why offspring have particular traits. One man suggested that sperm can become "infected" through pesticide exposure and damage the conceived child. A woman indicated pesticide exposure results in women's infected blood and genetic mutations, leading to children being born with disabilities. A third participant brought together ideas about pesticide exposure, transmitted diseases, and negative health problems in a child.

Several participants drew upon other explanations to discuss why some people have particular physical traits or illnesses. God-based explanations were usually, but not always, given in addition to other explanations. One man who had previously discussed the transmission of DNA during sexual intercourse stated, "Many people think that illnesses are God's punishments or that he gives them to us" (11-M CA). Some explanations were unique. One individual indicated that parents' "traits or … blood or … character … [are passed] successively generation through generation until the fifth generation …. [W]hen the fifth generation ends, you start a new cycle" (3-F Mex). An individual who had knowledge about an autosomal recessive disorder also provided a unique explanation in which she integrated some knowledge she had about a recessive trait with her practical knowledge about how filters work.

DISCUSSION

Our findings are consistent with Kleinman's and Leventhal's insights about the role of culture and experience for individuals' understanding about health and illness [28–30]. Participants used diverse concepts, understood concepts in different ways, and reported multiple models to explain how physical traits and, among some participants, mannerisms, personalities, or illnesses, are transmitted between generations. These accounts were often rooted in common sense ways of understanding what they had observed in their families. They may reflect beliefs common across MCA or unique to specific MCA or US regions. Also, participants had potential access to diverse cultural models through formal education, exposure to diverse media, and interactions with health care providers. Different exposures may have reinforced or modified their explanatory models about how traits are transmitted between generations.

Although many participants were familiar with the term gene and were aware that physical traits are transmitted through genes, participants' knowledge about what genes (and DNA) are and how they function was limited. MCA Latinos who addressed the location or appearance of genes or DNA often had models inconsistent with biomedical models. Familiarity with the terms genes or DNA or knowledge that genes and DNA are integral to the transmission of traits should not be considered evidence that individuals have basic knowledge about genetics. Our findings are consistent with research about multi-ethnic populations and the US population more generally [6,8–11], and a reminder that lay usage of scientific terms may be substantially different from usage by scientists, physicians, or genetic counselors [38–39]. Furthermore, as with variability of humoral medical beliefs, there was variability of beliefs about the hereditary role of blood [40,41].

Blood talk was integral to most participants' discussions about the transmission of traits between generations. Although it may initially appear that reference to blood conflicts with genetic explanations, this is not necessarily the case. Many participants appeared to use blood and genes (and DNA among those who discussed DNA) interchangeably. Blood talk was used metaphorically to talk about the transmission of traits between generations without either rejecting genetic explanations or confusing figurative expressions with biomedical explanations. Familiarity with blood talk appeared to affect, at least to a limited degree, some Latino participants' perceptions about genetics. Blood talk was used to express the belief that blood itself plays a crucial role, often, but not necessarily, in conjunction with genes or DNA to transmit traits. Blood talk is often a central way that MCA Latinos speak about the transmission of traits and is consistent with a report about Latina women in California's Central Valley receiving prenatal care [27]. However, this analysis provides detail about the substantial variability in both the content of blood talk and the significance ascribed to blood itself in the transmission of traits among MCA Latinos.

Most participants reported that genes/DNA are involved in the transmission of traits from parents to children. Their general statements were often consistent with biomedical explanations, although quite general. Several participants integrated information from diverse spheres, including infectious disease and filters, with their knowledge about genetics. The cyclical explanation was reported by only one participant; however, it is similar to an explanation provided by a Latino community member from another study [42].

Genomic literacy is becoming increasingly important [6,7]. Personalized medicine is a reality, as genomic advances are increasingly being integrated into medical care [4,5,31–33]. Direct-to-consumer marketing of genetic tests are increasingly common [43]. However, the general public, including MCA Latinos, lacks the background to understand adequately the potential benefits and limitations of genomic information. This lack of knowledge may hamper MCA Latinos from benefitting from advances in research. The inability to understand and communicate knowledge about genomics may be particularly detrimental to individuals who already face challenges communicating effectively with health care providers. Educational materials and strategies need to be developed to convey advances in genetic and genomic knowledge to MCA Latinos. These educational materials need to be culturally-appropriate to be effective. The knowledge about how MCA Latinos think and talk about how traits are transmitted between generations will therefore be crucial.

MCA Latinos are disproportionately low-income, and therefore have higher levels of negative environmental exposures than the general population. Latinos are more likely than the general population to live near hazardous waste treatment, storage, and disposal facilities in some regions of the US [44]. Low-income Latinos are also more likely than others to live near ports that have substantially elevated diesel particulate matter [45]. Although Latino children as a whole do not have an increased risk of having elevated blood lead levels, children who live in old buildings do face increased risk [46]. Furthermore, Latinos are at risk of being exposed to other heavy metals, as are other low-income individuals living in the US. The negative health effects of these environmental exposures have been long known; however, knowledge about the genetic and epigenetic mechanisms through which these exposures lead to negative health effects has expanded. Particulate matter, which includes diesel exhaust particles, causes epigenetic changes, and contributes to respiratory illnesses [47]. Women living near industries that emit heavy metals are at increased risk of having children that have chromosomal anomalies [48]. Exposure to toxic metals can also cause epigenetic changes that result in persistent negative changes [47,49]. Knowledge about genetic and epigenetic effects of environmental exposures may enable MCA Latinos to work with each other and their advocates more effectively to reduce toxic exposures within their communities.

Participants were recruited from one region of the US. Although MCA Latinos living in different US regions may have some unique cultural exposures, they are likely to share many relevant characteristics and cultural exposures. Analysis of transcripts of interviews conducted with a larger sample of participants may identify additional concepts and explanatory models to explain the transmission of traits; further research is therefore warranted. The study's research methods are not designed to determine the frequency of specific attitudes and beliefs about genomics among MCA Latinos, nor are they designed to compare attitudes of Latinos from different MCA regions. However, the findings do demonstrate a range of ways that MCA Latinos think and speak about inheritance of traits.

This analysis makes a substantial contribution to the field by providing a detailed description of the beliefs and knowledge about intergenerational trait transmission held by MCA Latinos. Although most MCA Latinos have general familiarity with the role of genes in the context of transmission of traits between generations, their knowledge about how genes work is often limited. Furthermore, the prominence and substantial variation in use and meaning of blood talk among MCA Latinos suggest that health educators and healthcare providers may need to directly address potential confusion about blood's role in the transmission of traits.

The ability to convey genomic information in ways that are culturally and linguistically appropriate for MCA Latinos will become increasingly important as genomic knowledge becomes further integrated into practice, and knowledge about genomic effects of toxic environmental exposures increases. Further research is needed to better understand MCA Latino's health beliefs about trait transmission, and to develop and evaluate culturally appropriate educational materials about genomics. Effective education about genomics may enable MCA Latinos to make informed health decisions and facilitate their meaningful

participation in public health discussions that draw upon genetic and genomic information to address their communities' health.

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Table I

Major Topics Addressed by Interview Guide

1	Background information about participant
2	General questions about shared traits
	Why do children have similar or different eye color?
	What words do you use to talk about characteristics that run in families?
	Why do relatives share some characteristics such as physical features, disease, temperament, and behaviors?
3	Participant's understanding about how traits are passed through a family (mechanism)
4	[If genes or DNA were mentioned by participant in the general questions section]
	Participant's understanding about the role of genes' and/or DNA' role in the transmission of traits
	What traits and characteristics are affected by genes/DNA?
	Can someone know what another person's genes/DNA are?
	Can you tell by looking at someone what his/her genes/DNA are?
	Are there some genes you can't tell just by looking at a person?
5	[If blood was mentioned by participant in the general questions section]
	Participant's understanding about the role of blood in transmission of traits
	What does [phrase about blood used by participant] mean?
	Ask questions addressed in section 4, but in context of blood.
6	[If heredity mentioned by participant in general questions section]
	Participant's understanding about the role of heredity in the transmission of traits
	Could you tell me more about heredity?
	Questions addressed in section 4, but in context of heredity
7	[If genes not explicitly addressed above]
	Do you think genes affect eye color?
	What else do genes affect?
	Can you know what another person's genes are?
	Can you tell just by looking at a person what his/her genes are?
	Are there some genes that you can't tell just by looking at a person?
8	Additional information about genes asked of all participants
	What else can you tell me about genes?
	What do genes look like?
	How are genes passed from parent to child?
9	Factors that influence people's physical responses to pesticide exposure

Table II

Participant Characteristics

ID	Gender	Farm worker	Age	Country of Birth	Years in Region	Education	Married	Child < 18
1	F	No	<40	Central America	10 – 14	9 – 11	No	Yes
2	F	No	<40	Mexico	5 – 9	<9	Yes	Yes
3	F	No	≥40	Mexico	10 – 14	≥12	No	Yes
4	M	Yes	≥40	Mexico	5 – 9	9 – 11	Yes	No
5	M	Yes	≥40	Mexico	5 – 9	9 – 11	Yes	Yes
6	M	Yes	<40	Mexico	10 – 14	9 – 11	Yes	Yes
7	M	No	<40	Mexico	10 – 14	≥12	Yes	Yes
8	F	No	<40	Mexico	< 5	≥12	Yes	Yes
9	F	Yes	≥40	Mexico	10 – 14	<9	No	Yes
10	M	No	≥40	Mexico	15 – 19	≥12	No	No
11	M	No	<40	Central America	5 – 9	<9	Yes	Yes
12	F	No	≥40	Mexico	< 5	<9	No	No
13	F	No	<40	Mexico	5 – 9	≥12	Yes	Yes
14	M	No	≥40	Central America	10 – 14	≥12	Yes	Yes
15	M	No	<40	Central America	15 – 19	9 – 11	No	Yes
16	F	No	<40	Mexico	10 – 14	9 – 11	Yes	Yes