

# ***What Shapes Your Traits? (v.2)***

## **Formative Evaluation**

### **(previously “*Is it Genetic?*”)**

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THIS IS **NOT** A DEFINITIVE FINAL REPORT

FORMATIVE evaluation studies like this one often:

- **are conducted quickly**, which may mean
  - small sample sizes
  - expedited analysis
  - brief reports
  
- **look at an earlier version** of the exhibit, which may mean
  - a focus on problems and solutions, rather than successes
  - a change in form or title of the final exhibit

## Purpose

- Determine whether visitors more frequently favor genetic or environmental factors that affect phenotypic traits, and whether it depends on the order in which these factors are presented (genetic factors first or environmental first first)
- Determine whether the exhibit helps visitors understand that the way in which we categorize human traits are often arbitrary.
- Determine what visitors think shapes their traits after engaging with the exhibit.
  - Only genetics? Only environmental factors? Both? Something else?
- Determine whether the exhibit helps visitors pick up on the interaction between environmental variables and genes.

## Exhibit Description

*What Shapes Your Traits?* is a digital interactive exhibit located in the Exploratorium's *Cells to Self* gallery (Figure 1) and is part of the Exploratorium's Phenomenal Genome project. The exhibit allows visitors to explore how genetic and environmental (non-genetic) factors affect some of their phenotypic characteristics. It is a second prototype of an exhibit previously known as *Is It Genetic?*, which itself was a reconceptualization of an earlier exhibit, *Genetic Inheritance*.

Just as with *Is It Genetic?*, visitors to *What Shapes Your Traits?* were presented with several phenotypic traits to investigate, some of which are affected by genetics more than others. *What Shapes Your Traits?* replaced the widow's peak trait from *Is It Genetic?* with another trait, smell, that had been removed from *Is It Genetic?* during the COVID-19 pandemic. The traits featured in this evaluation of *What Shapes Your Traits?* included the following:

- *Thumb position*: binary choice whether visitors clasp their hands with the left or right thumb on top
- *Earlobe attachment*: five-point scale for earlobe attachment, from attached to partly attached to free earlobes
- *Smell*: three choices for whether visitors perceived a foul smell, pleasant smell, or no smell at all from a bottle on the exhibit containing pheromones from male pigs
- *Eye color*: five-point scale for eye color, from blue to green to dark brown
- *Freckles*: five-point scale for freckle density on visitors' faces, from dense freckles to some freckles to no freckles at all
- *Dimples*: five-point scale from big dimples to small dimples to no dimples

*What Shapes Your Traits?* begins with a start screen (Figure 2), and from there it gives visitors a brief summary of what the exhibit is about (Figure 3). The exhibit then presents visitors with the above traits they can choose to explore (Figure 4). Visitors can then select where they fall on the scale of trait prevalence (Figure 5). Once visitors make this selection, the next screen they see provides more information about the genetic and environmental factors that may affect that particular trait (Figure 6). They can also see how their trait compares to those of other Exploratorium visitors (Figure 7). Visitors can continue exploring other traits as long as they like and revisit traits they have already seen.

The previous version of this exhibit, *Is It Genetic?*, moved away from a Mendelian framework and was reworked to better reflect the scientific community's current understanding of genetics: that an organism's phenotype results from a variety of factors, which can be genetic, environmental, or a combination of these. The current version, *What Shapes Your Traits?*, addresses issues that arose from a formative evaluation of *Is It Genetic?* in which visitors were still clinging to the idea that phenotypic traits arise only from an organism's genetic material. The current prototype features several changes aimed to improve visitors' understanding that phenotypic traits are due to a combination of and an interaction between genetic and environmental factors. Changes the development team made to this version of *What Shapes Your Traits?* from the previous exhibit (*Is It Genetic?*) include the following:

- *Title change*: from a title the team deemed to be deterministic (*Is It Genetic?*) to one that attempts to highlight ambiguity (*What Shapes Your Traits?*)
- *Nonhierarchical information*: presenting information about genetic and environmental factors side-by-side instead of one on top of the other (compare Figure 8 and Figure 9)
- *Consistent iconography*: using the same icons throughout the exhibit to denote genetic and environmental factors (see icons in Figure 3, Figure 8, and Figure 9)
- *Examples of environmental factors*: including more concrete examples of environmental factors that may affect how a trait presents itself (Figure 10)
- *Real people*: featuring more photographs of actual people and their traits instead of graphical representations (see Figure 11 and Figure 2 to compare the start screen of *Is It Genetic?* with that of *What Shapes Your Traits?*, respectively)
- *Simplified wording*: using "DNA" instead of "genes"

In an attempt to address visitors' bias that phenotypic traits are only due to genetics, the Phenomenal Genome team hypothesized that presenting visitors with environmental factors first, followed by genetic factors, would help them better understand that phenotypic traits are shaped by a combination of the two: genetics and environment. For this formative evaluation, visitors engaged with one of two versions of *What Shapes Your Traits?* One version featured all the genetic information first, followed by environmental information (Figure 8), and the other version flipped this order and featured all the environmental information first, followed by the genetic information (Figure 9). understanding that most of the traits are affected by a combination of genetic and environmental factors.



Figure 1. Location of *What Shapes Your Traits?* within the Cells to Self Gallery.



Figure 2. Start screen of *What Shapes Your Traits?*, featuring photographs of real people.

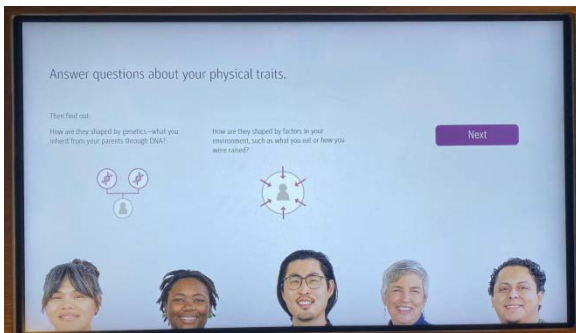


Figure 3. Introduction to what the exhibit is about.



Figure 4. Traits visitors can choose to explore further.

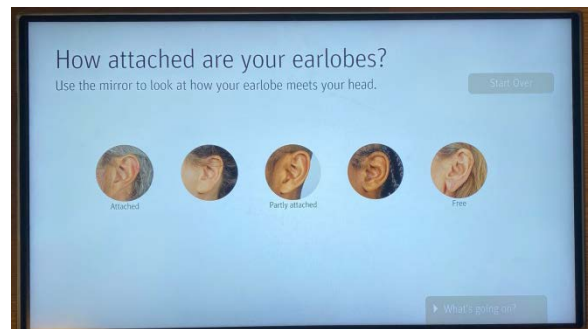


Figure 5. Scale of trait prevalence for earlobe attachment.

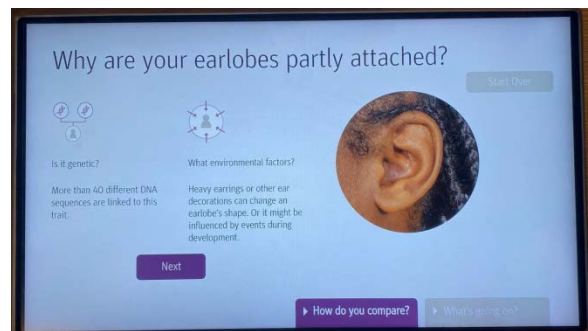


Figure 6. Information about the genetic and environmental factors that may affect earlobe attachment.



Figure 7. Comparison of other visitors' responses about how their own traits look.

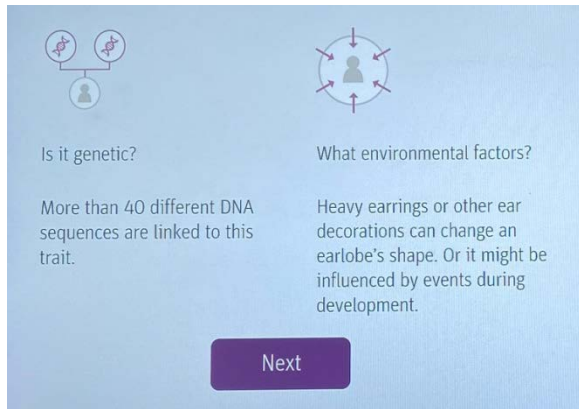


Figure 8. Version A of the exhibit, presenting genetic factors first, followed by environmental ones.

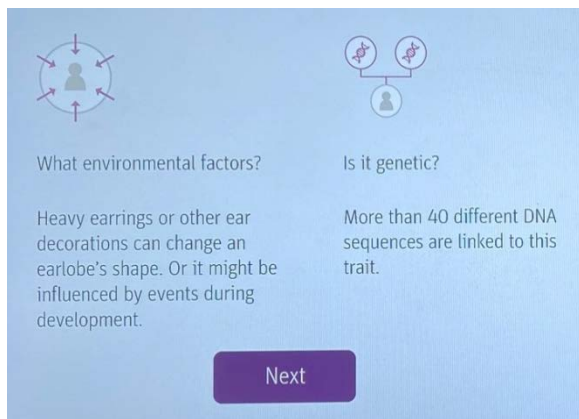


Figure 9. Version B of the exhibit, presenting environmental factors first, followed by genetic ones.

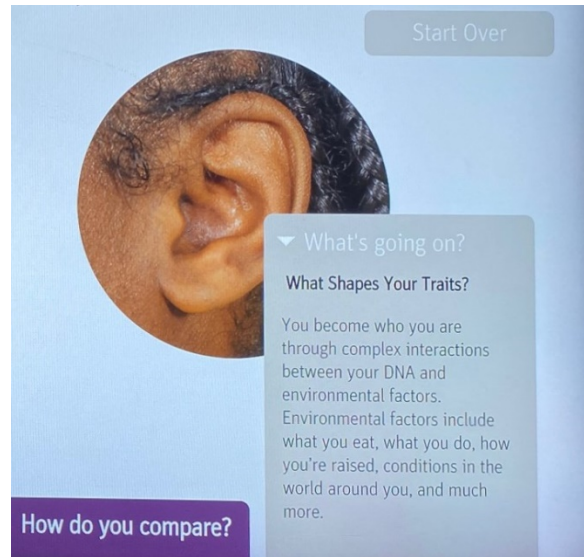


Figure 10. Concrete examples of environmental factors listed under the "What's going on?" tab.

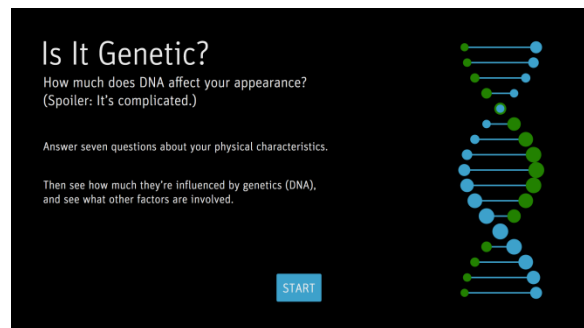


Figure 11. Start screen of previous exhibit version, *Is It Genetic?*, featuring icons instead of photographs of people (see Figure 2 for comparison).

## Methods

Data collection took place on Saturdays and Sundays between March 17–24, 2024. Visitors were approached using uncued recruitment, after they had used the exhibit. The evaluator approached every third visitor who faced the exhibit for at least 10 seconds unless 15 or more minutes had passed since the last interview, in which case they approached the next visitor to face the exhibit for at least 10 seconds. If part of a group, the visitor who the evaluator determined to be driving the exhibit experience (e.g. making decisions on which buttons to press) was the one who they approached to be interviewed. Visitors were only interviewed if they gave affirmative verbal consent, and, if a minor, an adult from their group was also asked for their verbal consent. The evaluator also confirmed that minors interviewed were at least eight years old. See Appendix A for more information about the recruitment process and script.

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## Results

### Demographics

A total of 22 visitors were interviewed (n= 11 for each exhibit version). Three of these visitors (14%) used the exhibit by themselves, 10 used it with one other person, and nine used it in a group of three or more. Most groups consisted of adults only (59%) while the rest included both adults and minors (41%). See Figure 12 for a breakdown of visitor group composition by exhibit version and Figure 13 for a breakdown of interviewed visitors' age groups (self-estimated by evaluator).

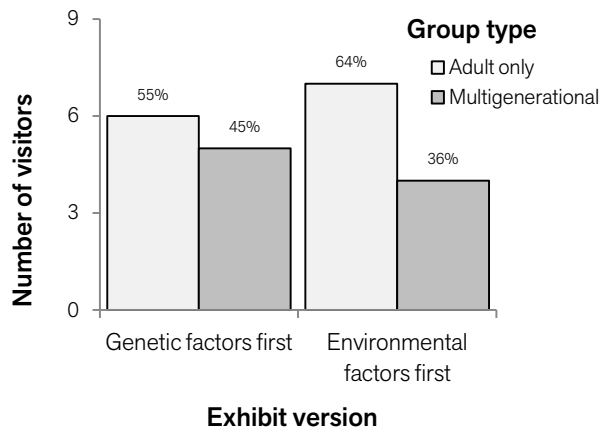


Figure 12. Visitor group composition by exhibit version.

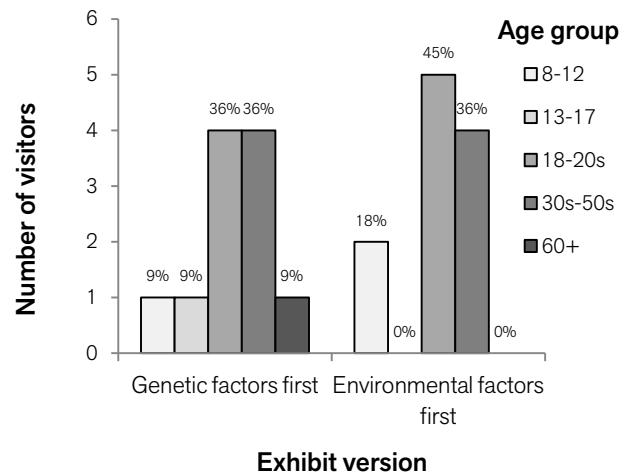


Figure 13. Age groups of interviewed visitors by exhibit version.

### Holding Time

Mean holding time for visitors who were interviewed was 2 minutes and 37 seconds. The mean holding time by exhibit version was only one second off from the overall mean (Table 1).

Table 1. Mean holding time by exhibit version.

	Exhibit version	
	Genetic factors first	Environmental factors first
Mean holding time	2:38	2:36

## Visitor Interest

Overall, visitors seemed to find the exhibit version featuring genetic information first more interesting than the one featuring environmental information first (Figure 14). The version featuring genetic factors first had a mean interest rating of 5.4 on a 7-point scale (1 being “not at all interesting” and 7 being “completely interesting”). The version featuring environmental factors first received a mean rating of 3.8 from visitors, or close to rating of 4, or “neutral.” We did not run any statistics given the small sample size.

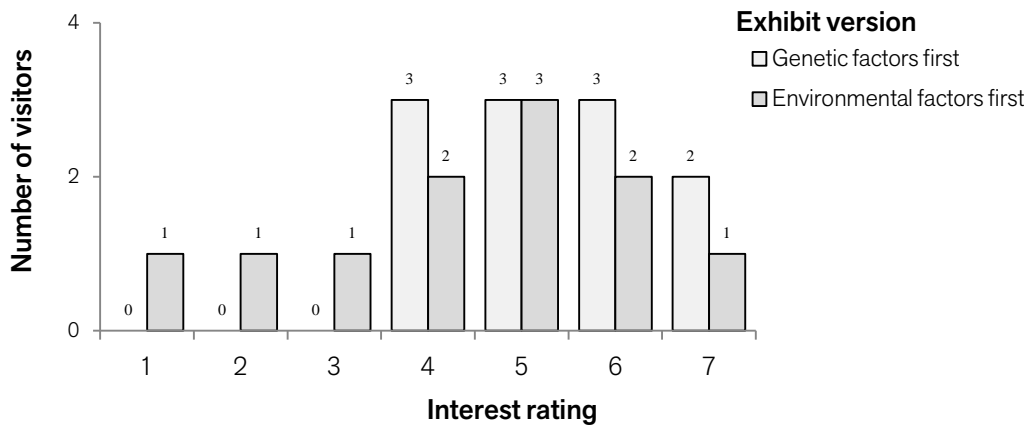


Figure 14. Visitors' interest rating by exhibit version. Visitors rated the exhibit on a 7-point scale, with 1 being "not at all interesting" and 7 being "completely interesting."

## Factors affecting traits

When asked what they think affects what a person's traits look like, about half the visitors interviewed only mentioned genetic factors, regardless of the exhibit version they saw; the other half of visitors mentioned it was a combination of genetic and environmental factors. While the sample size is too small to make statistical inferences, it would seem that the order in which genetic and environmental factors are presented does not affect visitors' understanding that most of the traits are affected by a combination of genetic and environmental factors. Nonetheless, this breakdown is more even than the proportion of visitor responses from the previous exhibit version, *Is It Genetic?*, which mentioned mostly genetic factors. See Table 2 for a detailed breakdown of these comparisons and Appendix B for visitors' verbal responses.

Table 2. Factors visitors said affect what a person's phenotypic traits look like, broken down by exhibit version. The last column compares the percentages from the previous iteration of the exhibit (*Is It Genetic?*).

	Genetic factors first		Environmental factors first		Previous version ( <i>Is It Genetic?</i> ) Percentage
	Count (out of 11)	Percentage	Count (out of 11)	Percentage	
<b>Only genetic factors</b>	5	45%	6	55%	80%
Mentioned environmental factors after probing	2	18%	2	18%	-
<b>Both genetic and environmental factors</b>	5	45%	5	45%	10%
<b>Either genetic or environmental factors (depending on the trait)</b>	1	9%	0	0%	-
<b>Unsure</b>	0	0%	0	0%	10%

## Traits Used

Visitors engaged with all six traits. Eye color was the one visitors most often explored, while thumb position and freckles were the least used. See Figure 15 for a more detailed breakdown of the traits visitors explored on each exhibit version. Overall, visitors seemed to find it easy to determine what their own traits looked like and to choose where they, themselves, fell within the categories provided (Figure 16).

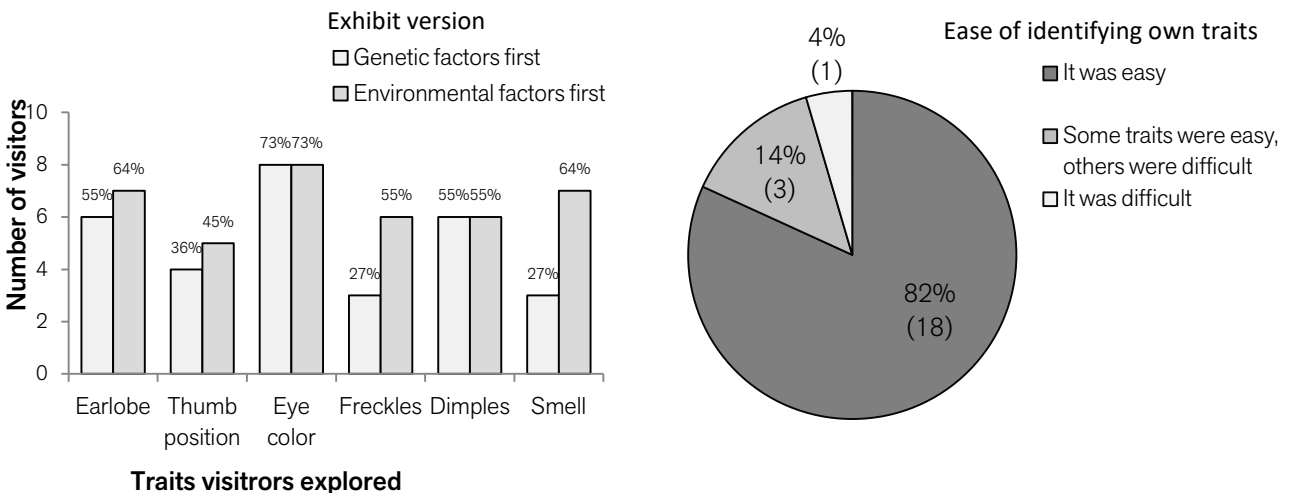


Figure 15. Traits visitors explored in each exhibit version.

Figure 16. Visitors' self-reported ease of determining where their own traits fell within the categories provided in the exhibit.



## Possible Next Steps

Considering the order of the information presented—genetic or environmental factors first—did not seem to influence whether visitors leaned away from the idea that only genetic factors affect phenotypic traits, it is likely either version of the exhibit will work just as well. Visitors did seem to somewhat prefer the version in which genetic information is presented first. It is possible this is due to an expectation of learning about genetic information given the exhibit is located in the Cells to Self gallery, which focuses on genetics. However, it is not possible to say with any certainty whether that is the case.

Nonetheless, it does seem that the changes made from the previous version of the exhibit, *Is It Genetic?*, made the biggest difference in steering visitors away from thinking only genetic factors affect the way their traits present. Potential next studies could attempt to disentangle the various changes that were made between *Is It Genetic?* and *What Shapes Your Traits?* Nonetheless, the sum of these changes, outlined in the Exhibit Description, seemed to make an impact.

Given these findings, the order in which genetic and environmental information is presented in the next iteration of the exhibit should be consistent with the other exhibits and labels that are part of the Phenomenal Genome collection.

## Acknowledgements

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## Appendix A

### Interview instrument

#### Uncued Recruitment

Approach for an interview (every 3<sup>rd</sup> user unless 15+ minutes have passed)

- The primary user of the exhibit you just observed (at least 8 years old)
- After they have turned and left the kiosk
- If that person is a minor, approach both that person AND an adult in his/her group.

#### Recruitment Script

Excuse me, my name is XXX and I work here at the Exploratorium.

We're trying to improve one of our new exhibits. I think you were just using it. It's this one here [pt to kiosk]. May I ask you some questions about your experience? It would really help us figure out what to do next. It will take about 10 minutes. Is that okay with you? [IF INTERVIEWING MINOR, turn to adult] And would that be ok with you?

[If Yes, continue to interview.]

[If No] That's okay. May I give you a sticker to wear? So, we won't stop you again to ask you questions. Have a good day.

#### Interview Questions

1. On a scale from 1 to 7, how interesting did you find this exhibit? With 1 being 'not at all interesting' and 7 being 'completely interesting' ?
  - a. What made it a \_\_\_\_\_ for you? [Probe: Anything else that made it a \_\_\_\_\_ for you?]
2. What, if anything, do you think this exhibit was trying to show? [Probe: Anything else?]
3. What, if anything, was confusing or frustrating about the exhibit? [Probe: Anything else?]
4. Can you remember any of the traits you looked at? Earlobe, Thumb position, Eye Color, Freckles, Dimples, Smell)
5. Was it easy to figure out where your own traits fit with the options on the screen? [clarify if needed: Was it easy to decide which button to pick when it asked you to select what your traits look like?]
6. Is there anything surprising to you about that? [if YES, probe if needed: What was surprising about that?]

7. What do you think affects what traits someone has? [*clarify if needed: What **causes** someone's traits, like what their earlobes look like, or whether they have dimples?*]
  - a. [*If they only mention DNA, genetics, etc., ask: Did you think it was just one gene or many genes?*]
  - b. Are there other factors that affect it?
8. Do you have any background that you feel helped you make sense of the exhibit?

**At the end**

Those are all my questions. Thank you very much for your help! May I also give you a sticker to wear? It will let other people know that you've already helped us out today and we won't stop you again to ask you questions. Thanks again. Have a great visit.

## Appendix B

### Visitor responses

Responses to Question 7 from the interview instrument (see Appendix A): What do you think affects what traits someone has?

#### Exhibit version: Genetic factors first

<b>Genetic factors only</b>	
Visitor	Response
V11:	Mostly genes.
V15:	Family. [Eval: What about family?] Like your past and your family's past.
V17:	DNA.
V21:	I think it's genes, genetic expression. [13-17 year old from group: What about environment?] Not for eye color.
V25:	Genetics
<b>Environmental factors mentioned after probing</b>	
Visitor	Response
V11:	There's nurture and nature, so environmental factors.
V17:	Mainly DNA but environment could apply other consequences.
<b>Both genetic and environmental factors</b>	
Visitor	Response
V03:	Well, like it explained with the earlobes, you are born with earlobes from your parents and grandparents, but if you wear earrings and have a big giant piercing, things are gonna change. So you can change some things.
V07:	Combination of genetics and if you've been exposed to any chemicals and how you've lived your life.
V13:	There's a lot of factors. Genetics firstly, and like this [point to exhibit] one said, also environment. Just those two.
V19:	I think it is a combination of heredity and environment, and wearing heavy earrings.
V23:	Genetic and environment.
<b>Either genetic or environmental, depending on the trait</b>	
Visitor	Response
V05:	I thought environment was gonna be for a lot of them but it was just a few, so that was surprising.

**Exhibit version: Environmental factors first**

<b>Genetic factors only</b>	
Visitor	Response
V02:	Ancestors, race, part of the world they come from.
V04:	DNA.
V10:	Genetics. [...] Many genes. They also talked about subtle differences in DNA affecting smell. A little more estrogen or testosterone affects smell. Curious about the word "pheromone." Highly disputed [in the medical field].
V16:	Mostly your genetics, coming from either mom or dad's genetics. [...] Just whoever has the stronger genes, depends on parents or grandparents.
V20:	How their families are. [...] How your ears look similar to family.
V22:	Their DNA.
<b>Environmental factors mentioned after probing</b>	
Visitor	Response
V10:	Environmental [factors also affect traits], but didn't get too deep into that, trying to entertain the four-year-old.
V16:	[Other group member mentioned earlobes from the exhibit] Oh yeah, if you're wearing earrings 24/7.
<b>Both genetic and environmental factors</b>	
Visitor	Response
V08:	Based on what I learned, it's environmental factors and genes.
V12:	Those two factors: genetic structure and personal social experience.
V14:	Genetics and the environment.
V18:	Genetics and environment.
V24:	Mixture of their genetics and the environment they've been in since birth.