

Is it Genetic? Formative Evaluation

Sylvia de la Piedra

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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 analyses
 - brief reports

- **look at an earlier version** of the exhibit/program, which may mean
 - a focus on problems and solutions, rather than successes
 - a change in form or title of the final exhibit/program

PURPOSE

The goals of this formative evaluation on *Is it Genetic?* included gauging:

- visitors' interest in the exhibit
- areas of confusion for visitors
- what, if anything, visitors found out about genetics at the exhibit
- which traits presented in the exhibit are most interesting to visitors and why

EXHIBIT DESCRIPTION

Is it Genetic? (Figure 1a), located in the Exploratorium's *Cells to Self* gallery (Figure 1b) allows visitors to explore how genetic and environmental, or non-genetic, factors affect some of their phenotypic characteristics. It is a reconceptualization of an earlier exhibit, *Genetic Inheritance*, which presented many of the same traits but assumed a Mendelian framework wherein visitors had or did not have a physical characteristic. *Is it Genetic* was reworked to better reflect our current understanding of genetics: that a phenotype results from a variety of factors, not all genetic and multiple versus one gene, and do not fall neatly into binary categories.

In the version used in this evaluation, visitors were presented with six traits to investigate, some of which are affected by genetics more than others:

- *Hand clasp*: binary choice whether the left or right thumb rests on top when hands are clasped
- *Attached earlobes*: five-point scale from attached to partly attached to free earlobes
- *Eye color*: five-point scale from blue to green to dark brown iris color
- *Freckles*: five-point scale from dense freckles to some freckles to no freckles on face
- *Widow's peak*: five-point scale from big peak to subtle peak to no peak on hairline
- *Dimples*: five-point scale from big dimples to small dimples to no dimples

Upon choosing a trait to investigate, visitors can select where they fall on the five-point scale of trait prevalence (see Figure 1c), or, in the case of *Hand clasp*, make a choice between the two options. Once visitors make this selection, the next screen they see provides more in-depth information about the genetic and environmental factors that may affect that particular trait (see Figure 1d). They can also see how their trait compares to those of other Exploratorium visitors. Visitors can continue exploring other traits as long as they like and revisit traits they have already seen.

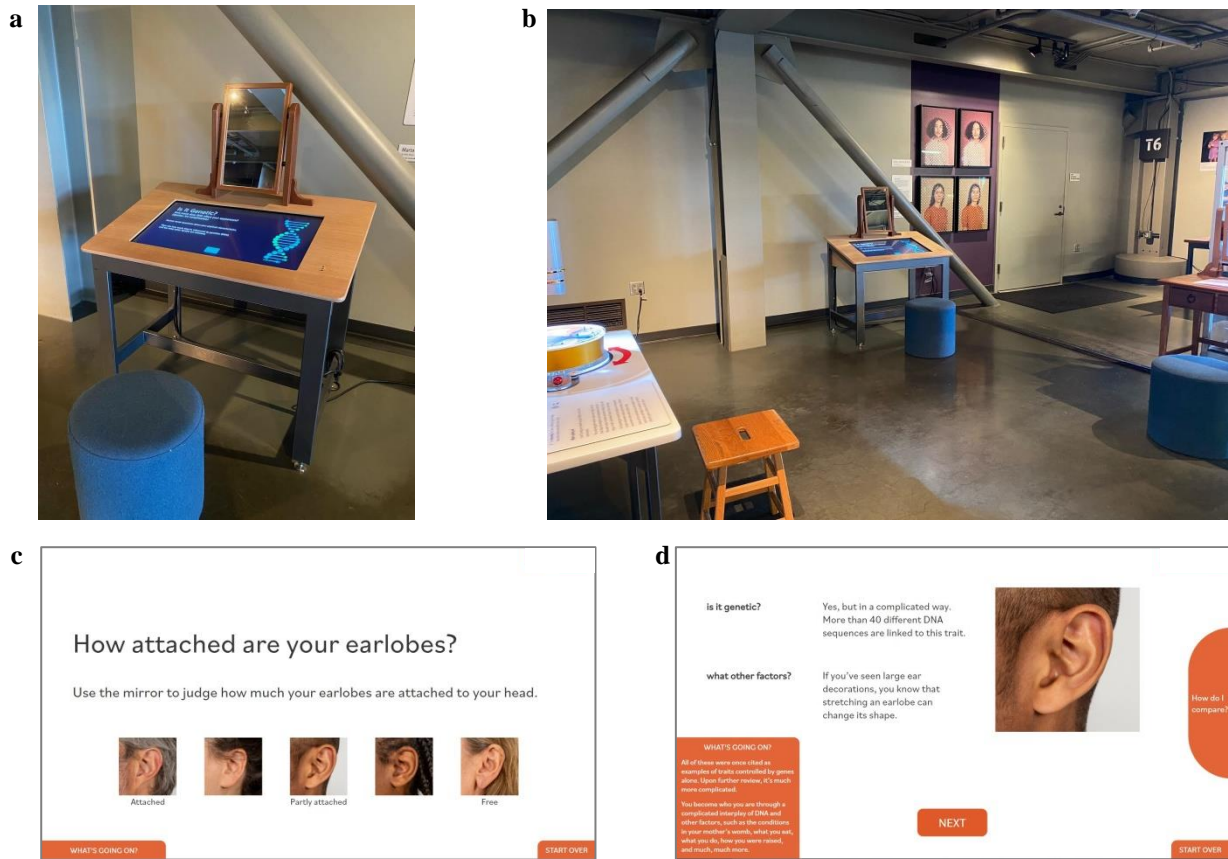


Figure 1. Close-up photograph of *Is it Genetic?* exhibit (a), photograph of exhibit placement in *Cells to Self* Gallery (b), example of five-point scale of Attached earlobes trait (c), and example of final screen visitors see about Attached earlobes trait (d).

METHODS

Between November 12-20, 2021, I interviewed visitors at the Exploratorium who used *Is it Genetic?* These interviews were uncued. The exhibit was set up in the museum's *Cells to Self* gallery, where I observed every other visitor at least eight years of age who faced the exhibit for at least 10 seconds. Once the visitor turned away from the exhibit, I approached them, asked for their consent (if a minor: I also asked for consent from an adult in their group), and interviewed them.

DATA COLLECTED

I interviewed $N = 20$ visitors. Half the visitors I interviewed were between the ages of 18-29, followed by those 30-59 years old (Table 1). Eleven of the 20 visitors I interviewed were female (Table 2), and most visitors were adults using the exhibit by themselves or with other adults (Table 3).

Table 1. Visitors' age group.

Age Group	Count (out of 20)	Fraction of visitors
8-12	2	0.10
13-17	0	0
18-20s	10	0.50
30s-50s	7	0.35
60+	1	0.05

Table 2. Visitors' gender.

Gender	Count (out of 20)	Fraction of visitors
Female	11	0.55
Male	9	0.45

Table 3. Visitors' group type.

Group type	Count (out of 20)	Fraction of visitors
Adults only	17	0.85
Children only	0	0
Teenagers only	0	0
Multigenerational	3	0.15

To get a sense of visitors' prior knowledge of and experience with genetics, I asked about prior relevant experiences. Eleven out of 20 visitors indicated having some prior relevant experience (Table 3).

Table 4. Visitor's prior relevant experience in regards to the exhibit content.

Prior relevant experience	Count (out of 20)	Fraction of visitors
Education	8	0.40
Interests or hobbies	2	0.10
Job	1	0.05
No background	9	0.45

RESULTS

What visitors found (not) interesting

The median holding time for visitors at *Is it Genetic?* was one minute and 52 seconds. As a point of comparison, the average holding time for an earlier version of this exhibit, *Genetic Inheritance*, was one minute and 49 seconds, a high holding time compared to other life sciences exhibits in the former *Traits of Life* collection. In the field, holding time is a commonly accepted metric for engagement, and the 1:52 holding time, therefore, suggests that visitors found *Is it Genetic?* engaging.

When asked to rate the exhibit using a Likert scale from *Not Interesting* (1) to *Interesting* (5), most visitors said they found the exhibit *Somewhat Interesting* (4), with four visitors giving it a higher rating and four others giving it lower ratings. Results are shown in Table 5.

Table 5. Visitors' interest rating of Is it Genetic?

Interest rating	Count (out of 20)	Fraction of interviews
Interesting	4	0.20
Somewhat interesting	12	0.60
Neutral	3	0.15
Somewhat not interesting	1	0.05
Not interesting	0	0

Visitors' most common response when asked what they found interesting about the exhibit reflected increased awareness of their own traits and the variation within those traits across different people. People also expressed appreciation for learning more about the role genetics and one's environment play in how a trait is manifested, as well as interest in comparing their traits to those of other visitors. Figure 2 shows these results and Table 6 has examples of visitors' responses.

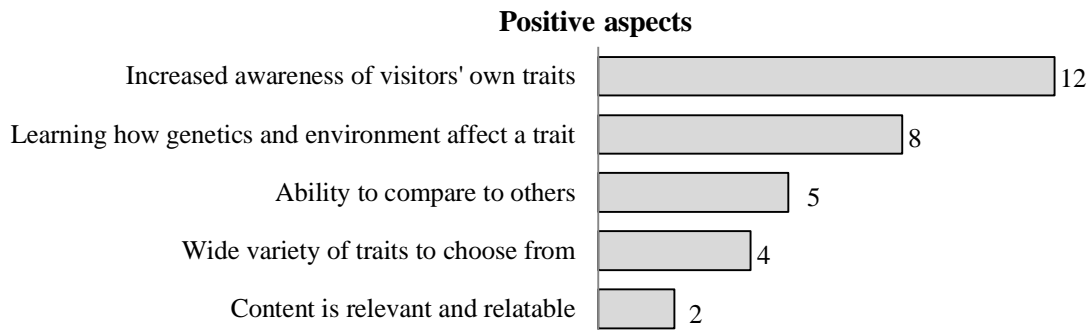


Figure 2. Positive aspects of the exhibit expressed by visitors.

Table 6. Examples of visitor comments on positive aspects of the exhibit.

Increased awareness of visitors' own traits	
V06	Made me think about something I never thought about. [Evaluator: <i>can you say more about that?</i>] I've never thought about my dimples.
V09	I didn't realize there was such variation [in earlobe attachment].
V10	I didn't realize to what degree people have different dimples.
V11	I know there's a range there, I just never stopped to think about where I classify myself.
V12	I didn't realize there was a little curve up in there [pt to own widow's peak].
V14	Just to see how I didn't know that many people had attached ears. [AE?] And the hands. I never thought about it [clasps hands].
V18	I have not thought about this, that people have different ears.
V19	Because I never really thought about different earlobes in humans.
Learning how genetics and environment affect a trait	
V08	It's interesting to find each different trait has different manifestations in the DNA.
V10	The traits that were genetic and ones that aren't quite genetic.
V11	It's interesting to think about what is genetic and what is not. [...] When I clicked this [pt to <i>What's Going On</i> button] it said there were things, aspects that were previously thought to be genetic, and that was interesting.
V13	I thought it was interesting what's not governed by our DNA.
Ability to compare to others	
V04	The general concept makes everyone question and compare with who you're [at the exhibit] with.
V12	The fact that I could compare to other people.
V19	Seeing the statistics of what kind of traits each person had in the museum.
Wide variety of traits to choose from	
V18	It has many [traits] to pick.
V19	Seeing so many variations of different traits.
Content is relevant and relatable	
V03	It could connect to anyone so anyone can do it.

Conversely, when responding to aspects of the exhibit visitors did not like, responses fell into one of two categories: (1) people expressed the exhibit content was not interesting or contained information they already knew, and (2) the information presented did not delve deeply enough, and visitors were left

wanting to know more about the traits they explored. See Figure 3 for this breakdown and Table 7 for examples of visitors' responses.

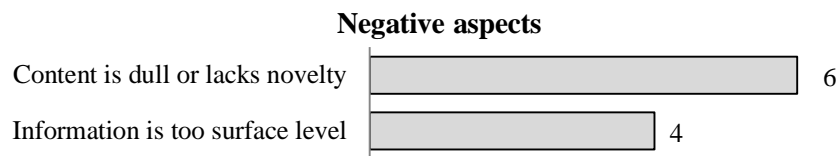


Figure 3. Negative aspects of the exhibit expressed by visitors.

Table 7. Examples of visitor comments on negative aspects of the exhibit.

Content is dull or lacks novelty	
V02:	It seemed like most of them were the same. Like they had the same answers. They, like the freckles, are not super interesting.
V08:	It's interesting to find each different trait has different manifestations in the DNA. I wish I didn't have to choose each time, and it's quite slow.
V15:	Some of the things I already knew from general knowledge.
Information is too surface level	
V07:	I thought it was going to be more interesting. I wanted to learn more. [Evaluator: Anything else?] It was too short.
V11:	It's interesting to think about what is genetic and what is not. But it felt like it was surface level.

While using the current version, *Is it Genetic?*, visitors explored an average of 3.9 traits. Almost all six traits were used equally except for *Widow's peak* and *Freckles* (Table 8).

Table 8. Number of visitors who explored each trait.

Trait	Number of visitors
Eye color	15
Hand clasp	15
Earlobe attachment	15
Dimples	14
Widows peak	12
Freckles	8

Since one of the goals of the evaluation included identifying what makes certain traits more interesting to some people, I asked visitors which trait they found most interesting. Most visitors chose *Eye color*, closely followed by *Hand clasp* (Table 9).

Table 9. Traits visitors identified as most interesting.

Most interesting trait	Count (out of 20)	Fraction of visitors
Eye color	6	0.30
Hand clasp	5	0.25
Earlobe attachment	3	0.15
Dimples	3	0.15
Widows Peak	2	0.10
Freckles	1	0.05

To get a better understanding of how visitors were thinking about genetics, I asked additional questions about the trait they identified as most interesting. However, because *Hand clasp* was a binary trait and the only trait presented as definitively not a result of genetics, I asked visitors who selected it to identify the next most interesting trait, allowing my follow-up questions to focus on the other traits that were organized with a five-point scale. Table 11 shows traits visitors said were most interesting, excluding *Hand clasp*. Of the five visitors who had first identified *Hand clasp* as the most interesting (Table 10), two selected *Earlobe attachment* as the second-most interesting, two others selected *Widow's peak*, and one chose *Freckles*.

Table 10. Traits visitors found most interesting, excluding *Hand clasp* since it was the only binary trait.

Most interesting trait (excl. <i>Hand clasp</i>)	Count (out of 20)	Fraction of visitors
Eye Color	6	0.30
Earlobes	5	0.25
Dimples	3	0.15
Widows Peak	4	0.20
Freckles	2	0.10

What visitors found confusing or frustrating

To identify any issues that impede people's understanding of the exhibit content, I asked whether there was anything visitors found confusing or frustrating about the exhibit. Most people did not, but there were two who did (Table 11). Their statements are shown in Table 12.

Table 11. Visitors' responses about confusing or frustrating aspects of the exhibit.

Anything confusing or frustrating?	Count (out of 20)	Fraction of visitors
Yes	2	0.10
No	18	0.90

Table 12. Aspects of the exhibit visitors found confusing or frustrating.

Confusing or frustrating aspects of the exhibit	
V14:	Maybe more info. Is it evolution with the earlobes?
V19:	What was confusing was the widow's peak. I couldn't tell whether I was one or the other.

What visitors found out at the exhibit

To gauge visitors' understanding of the relationship between genes and traits, I posed several questions. First, I asked visitors if there was anything about the exhibit they found surprising. Four visitors expressed being surprised by something at the exhibit (Table 13). Their statements are shown in Table 14.

Table 13. Visitors' responses about surprising aspects of the exhibit.

Anything surprising?	Count (out of 20)	Fraction of visitors
Yes	4	0.20
No	16	0.80

Table 14. Aspects of the exhibit visitors found surprising.

Surprising aspects of the exhibit	
V01:	The hand clasp. Never thought it wasn't genetic.
V11:	It was interesting to see how you [Exploratorium] categorized the different ranges of the traits. I figured they were there or not, the freckles.
V12:	Apparently I have really dark brown eyes. And the hand clasp. I never noticed my left thumb is on top.
V14:	I expected the [number of people with] freckles to be higher.

Follow-up questions about the remaining five traits aimed to assess visitors' understanding of the relationship between genetics and traits, specifically, if visitors thought a trait can result from genetic and non-genetic factors and if they attributed a trait to a single gene versus multiple genes. When I asked visitors what they thought affected the type of trait they had identified in Table 11, most people provided responses that only included genetic factors (Table 15) despite *Eye color* being the only trait presented as definitively only influenced by genetics¹.

¹ Except in the rare case of an injury or infection.

Table 15. Types of factors visitors mentioned that affect a trait.

Types of factors	Count (out of 20)	Fraction of visitors
Only genetic factors	16*	0.80
Genetic and environmental factors	2	0.10
Unsure	2	0.10

* Of these, 6 visitors were referring to *Eye color*, which indeed results only from genetic factors.

As there were 16 visitors who mentioned the word ‘gene(s)’ or ‘genetic(s)’ to the above question, I asked these a follow-up question about the number of genes they thought played a role. Twelve of these visitors understood it was many genes (Table 16). The remaining 25% of visitors did not seem to grasp this, despite most² of these traits being a result of more than one gene. This may indicate the exhibit did not always efficiently convey this information

Table 16. Amount of genes visitors said affect a how trait looks.

Amount of genes	Count (out of 16)	Fraction of visitors (16)
Many genes	12*	0.75
Only one gene	1	0.06
Unsure	3	0.19

* Two of these visitors were referring to *Widow’s Peak*, which is unclear whether it is influenced by genetics.

Most people who responded that only genetic factors affect a trait also responded that more than one gene affects a trait (Figure 4).

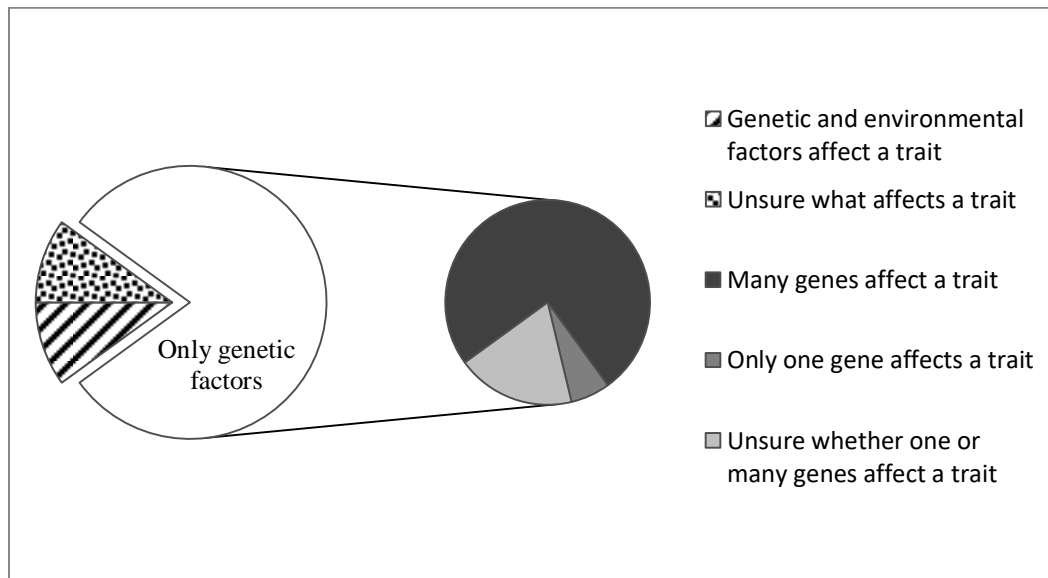


Figure 4. Visitors’ responses on the type of factors that affect a trait and how many genes contribute.

² The exhibit states it is not yet clear whether the *Widow’s peak* trait is a result of genetics.

Lastly, I asked visitors whether there were additional factors that the exhibit did not touch upon that may also affect a trait. Nine people could not think of any (Table 17), eight of whom had responded that only genetic factors affect a trait (Table 15). Six other visitors were not sure whether there may be other factors that affect a trait. This suggests most visitors may need additional support to understand the role environmental factors play with genetics in affecting a trait.

Table 17. Additional factors not presented in the exhibit that visitors said can affect how a trait looks.

Other factors mentioned	Count (out of 20)	Fraction of visitors
None	9 [*]	0.45
Environmental factors	5 ^{**}	0.25
Unsure	6	0.30

^{*} Eight of these visitors stated that only genetic factors affect a trait (Table 15) .

^{**} One of these visitors backtracked almost immediately, stating environmental variables would not make sense.

SUMMARY AND NEXT STEPS

Results of this formative evaluation showed *Is it Genetic?* helped increase visitors' awareness about their own traits and how they may compare to those same traits in other people. However, the data suggest that visitors still clung to the (Mendelian) idea that traits derived solely from genetic factors.

Of the six traits featured in the exhibit, visitors explored an average of about four per visit, with *Widow's peak* and *Freckles* being the least popular. However, this is not necessarily a reason to rid the exhibit of these traits. In fact, visitors who expressed negative aspects about the exhibit spoke about the type and depth of information the exhibit offered. These visitors mentioned feeling the text provided about some traits was dull or something they already knew and that it did not delve deeply enough into the genetic and environmental factors that contribute towards a trait. Rather than focusing on removing less-popular traits, future iterations of this exhibit could consider tackling these issues by adding more information about each trait or increasing the depth of the information that is already provided, especially since visitors expressed wanting to know more than what the exhibit provided.

Lastly, an important finding of this evaluation was the insight provided into how visitors may see the role genetic and non-genetic factors play in how a trait is manifested in a person. Future versions of *Is it Genetic?* may benefit from highlighting the importance of non-genetic, environmental factors in trait manifestation, nudging visitors to understand that genetic factors usually involves multiple genes.

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APPENDIX A: INTERVIEW QUESTIONS

Interview Questions

1. How interesting did you find that exhibit? Would you say that was ...

Not Interesting	Somewhat Not Interesting	Neutral	Somewhat Interesting	Interesting
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- a. What made it _____ for you? Anything else that made it _____ for you?

2. Was there anything surprising about the exhibit?

NO YES

- b. [if YES] What was surprising about that?

3. Was there anything confusing or frustrating about the exhibit?

4. Can you remember any of the traits you looked at?

Hand Clasp	Earlobes	Eye Color	Freckles	Widow's Peak	Dimples
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5. Of these traits , which was the most interesting to you?

- a. [if Hand Clasp] What was the second-most interesting? (*Circle both*)

Hand Clasp	Earlobes	Eye Color	Freckles	Widow's Peak	Dimples
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6. Was it easy to determine whether you have **[trait]**?

- a. Is there anything surprising to you about that?

7. The exhibit shows a range of **[trait]**. Did that surprise you?

- a. [if NO] Why not?

[if YES] Why did that surprise you?

8. What do you think affects whether a person has **[trait]**? [Probe if necessary: *Did you think it was just one gene or many genes?*]

- a. Are there other factors that affect it?

9. Do you have any background that you feel helped you make sense of the exhibit?