



I N S T I T U T E F O R
Learning Innovation

Genetics: Decoding Life

Museum of Science & Industry, Chicago

Supplemental Summative Evaluation

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Executive Summary

This is a report from the supplemental summative evaluation of the exhibition, *Genetics: Decoding Life* at the Museum of Science and Industry, Chicago. The evaluation was designed to measure visitors' attention to the main messages of the exhibition, visitors' thinking and attitudes about genetics, and whether visitors made connection among their genes, themselves, and their families. The evaluation was designed to establish findings that complemented and built upon a previous summative evaluation. Two types of exit interviews were used to gather qualitative and quantitative data. A total of 290 interviews were conducted with the target audience of museum visitors over the age of 16.

The most compelling finding is the multiple ways that visitors made personal connections to genetics. Visitors made meaning from their experiences in the exhibition by making genetics personally relevant. These findings demonstrate that the exhibition was successful in its effort to make links between visitors and their genes, taking visitors on an emotional and intellectual journey in which they find topics that connect into both their concerns and their hopes.

Other key findings:

- Visitors were attentive to the core exhibition themes. Their descriptions of the exhibition demonstrated an understanding of not only the content of the exhibition themes, but also the educational, interactive, and personally relevant nature of the experience.
- The overwhelming majority of visitors were able to provide a correct definition of genes and heredity. Their responses reflected a strong tendency toward making personal connections in these definitions, rather than just strict technical content, consistent with the goals of the exhibition.
- All of the visitors noticed the live animals in the exhibition, and most listed more than the baby chicks (an important icon in the exhibition). Data showed that visitors understood that animals provide a simple model to help us understand ourselves and improve our health, reflecting a central message reiterated throughout the exhibition.
- Just under half of the visitors either reported that the exhibition changed the way they thought about genetics or were able to name something they had thought about or learned because of the exhibition.

A single exhibition experience is generally not expected to change visitors' beliefs about a topic. But overall, the data from this supplemental summative evaluation demonstrate that the exhibition was successful in meeting its goals, in particular, making visitors the central character in the exhibition. Central to this is the exhibition's success in helping visitors make connections among their genes, themselves, and their families.

Introduction

The Museum of Science and Industry, Chicago (the Museum) opened the exhibition¹ *Genetics: Decoding Life (Genetics)* in January 2002. The exhibition was developed to show how scientists are discovering, understanding, and using genes that affect us throughout our lives. Researchers have long considered genetics to be one of the most important topics to study in science, but also one of the most difficult to understand (Finley, Stewart, & Yarroch, 1982). Mindful of research like this, the Museum conscientiously conducted a series of evaluation studies throughout the exhibition development process that included front-end interviews, focus groups, and formative testing. These evaluation studies allowed the Museum to gauge visitors' pre-conceptions, interests, and understanding related to genetics to ensure that the final product would take visitors on an emotional and intellectual journey in which they found topics that connected into their hopes and concerns. After the exhibition was completed, a summative evaluation was conducted using tracking, timing, observations, and interviews. This summative evaluation measured how the exhibition (and specific exhibit units within it) held visitors' attention and engaged them, how visitors moved through the space, and some cognitive aspects of the exhibition's impact.

The Institute for Learning Innovation (Institute) conducted a supplemental summative evaluation of the *Genetics* exhibition to augment findings from the previous evaluations. The evaluation was led by Dr. Kirsten Ellenbogen, with support from Dr. John Falk, Ms. Kerry Bronnenkant, and Ms. Susan Foutz at the Institute. The evaluation design was developed in collaboration with Drs. Barry Aprison and Patricia L. Ward at the Museum. This supplemental summative evaluation focused on visitors' attention to the main messages of the exhibition, how the exhibition enriches visitors' thinking and attitudes about genetics, and whether visitors made connections among their genes, their own lives, and the lives of their families.

Methods

The supplemental evaluation relied on a short exit interview to gather data from a large number of visitors and an in-depth exit interview to gather detailed information from a small number of visitors. These interviews were designed to build upon the baseline data collected during the front-end evaluation. This combination of methods provided a way to gather complementary evidence that was both generalizable and rich.

The short exit interview consisted of five questions (both close- and open-ended) designed to complement data collected in the front end and summative evaluations. The questions focused on the visitors' understandings of the main messages of the exhibition and whether visitors made personal connections to genetics.

The in-depth exit interview consisted of five questions that were the same as the short exit interview, and then five additional questions (all open-ended) designed to build upon

¹ In this report, the term 'exhibit' is used to refer to an individual exhibit unit. The term 'exhibition' is used to refer to the complete exhibition gallery. In all interviews with visitors, only the term exhibit was used.

the front end study's baseline data about visitors' understandings of genes and heredity. The interview also focused on visitors' understandings of the central organizing principles of the exhibition, namely that since animals and humans share many genes, we can learn about ourselves from studying animals.

Institute researcher Kirsten Ellenbogen trained seven volunteers to implement the short exit interview. The volunteers were: Mildred Armstrong, Linda Bronson, Gina Doman, Marjorie Gordon, Marian Joelson, Patti Prather, and Jerri Williams. This study would not have been possible without their careful, dedicated work.

During April and May 2003, the volunteer data collectors conducted short exit interviews with 265 people. Kirsten Ellenbogen conducted in-depth exit interviews with 25 people over three days in April 2003. A total of 290 interviews were conducted. Interviews were conducted on both weekdays and weekends. Respondents were randomly selected in order to get a representative sample of visitors who visited the *Genetics* exhibition. Interviewers were stationed at one of two locations near exits from the exhibition and approached the second person to cross an imaginary line in front of them. When the data collector finished the interview, she thanked the visitor and then waited for the second person to cross the imaginary line to begin the process again. Data collectors kept a refusal log to check for anomalies. Only 59 refusals in 349 attempts were recorded, resulting in a 17% refusal rate that is within the typical range for interview-based data collection.

Interviews were only conducted after visitors confirmed that they had just seen the *Genetics* exhibition. If visitors appeared to be under 20, they were also asked to confirm that they were over 16, in order to make sure that respondents were part of the target audience. Visitors' responses to open-ended questions were written down verbatim on the interview forms and later transcribed for analysis. Observation-based demographic data were collected to confirm that the sample was otherwise representative of the general museum audience (i.e., sex, adult only or adult with kids, time of day, approximate age range). Visitors were also asked if this was their first visit to the Museum, and if they had any special interest, knowledge, or training in science.

Analysis focused on establishing coding categories for open-ended questions so that the qualitative data could be analyzed in a quantitative manner. Note that every question was not completed in every interview, so the sample size for each question may differ. Additionally, the categories for some questions were not mutually exclusive, i.e., responses to some questions could be coded in more than one category, so the percentages totaled more than 100%. Quotations from visitors are referenced by an S or L to indicate whether they were from the short or long (in-depth) interview, e.g. (S223) or (L14).

Findings

Characteristics of the Sample

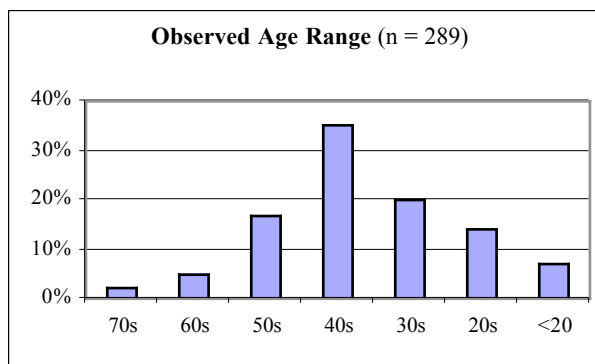
Almost half of the visitors to *Genetics* reported a special interest, knowledge, or training in science (47%). These interests were typically professional (e.g., nurse, teacher, research scientist), academic (e.g., major or minor in a science in college, took science classes in high school), or casual and amateur pursuits (e.g., space hobby, interest in bugs). Some respondents' attributed their interest in science to a personal connection to medical problems or genetic disorders (e.g., breast cancer survivor, disabled children). These sorts of personal connections to science in general, and genetics in particular were raised repeatedly throughout the interviews. This is discussed in more detail in the section 'Visitors' Connections Between Genetics and Their Lives' below. The prevalence of this sort of data suggests that the exhibition's emphasis on personal connections between humans and their genes is meaningful to visitors.

In general, the demographics of the sample detailed below are similar to the visitor sample interviewed in the front-end study. The Museum's Marketing Department collects demographic data through a self-administered, computer-based survey, providing aggregate data since September 2000. The demographics of the visitors interviewed in *Genetics* are compared to the Marketing data as appropriate below.

The *Genetics* visitors interviewed come from an equal balance of group type, specifically almost half are part of a group of only adults and almost half are part of a group with adults and children. (See Tables below.) Just over half of the *Genetics* respondents (52%) reported that they had been to the Museum before. This is consistent with the Marketing data that indicated that 56% of the visitors have been to the Museum in the past two years. The *Genetics* sample consists of more females than males, in contrast to the Marketing data that has an almost equal proportion of males (52%) and females (48%). The largest segment of respondents is in their 40s (based on a sight-based estimate). (See Appendix 2, Table 1 for detailed data.) The Marketing data are from a younger population, with a mean age of 38. There are no definitive reasons for the differences between the demographics from the *Genetics* visitors and the visitors to the Marketing computer kiosk. It is possible, however, that any combination of attraction to computers to sampling errors may be responsible for the minor differences.

Sex (n=287)	
Female	61%
Male	39%

Group Type (n=268)	
Adults Only	51%
Adult with Kids	49%



Visitors' Connections Between Genetics and Their Lives

Visitors are the principal characters in the *Genetics* exhibition. Links between visitors and their genes are promoted through experiences and realizations connected to their own lives and the lives of their families. Analysis of the data from the short and in-depth interviews reveals that making connections was a meaningful part of the exhibition experience for visitors. This is demonstrated by visitors' responses to the question 'In what ways does genetics connect to your life?' (n=289). Almost all visitors (92%) were able to describe ways that genetics connected to their lives.

Visitors' responses to the question about how genetics connects to their lives incorporated six broad topics: 1) Heritage, 2) Physical or Behavioral Characteristics, 3) Made Me Who I Am, 4) Specific Personal Connections, 5) Medical or Scientific Applications and, 6) Everything in Every Way. (Responses were coded as more than one topic, as appropriate, so the percentages equal more than 100%. See Appendix 2, Table 2 for the complete distribution of topics.)

- 1) **Personal Heritage:** In describing how genetics connects to their lives, 38% of the visitors mentioned issues related to their children, family, and personal heritage of traits in general. Visitors made strong personal connections between genetics and their children, explaining "My kids look just like me," (S27). They demonstrated an understanding that genetics plays a role in the heritage of their family: "Genes make me similar to my parents and my children are similar to me and their father," (S28). This exemplifies one of the many ways in which visitors understand the interconnections among themselves, their genes, and their families.
- 2) **Physical or Behavioral Characteristics:** A quarter of the visitors' (25%) referenced physical or behavioral characteristics when they described how genetics connects to their lives. Visitors commented on this in general terms, "[Genetics] determines the way you look" (S154) and in specific terms, "It's why I am tall and skinny," (S104). Most of these responses related to physical characteristics, and specifically what people look like, for example, "Genetics are the reason I look like my parents, my color, my shape, and the like," (S114). Although most of the responses related to physical characteristics, a small number of visitors mentioned personality or behavioral characteristics, such as "Genes make up my ... pleasing personality," (S115). Visitors' comments in this category focused on the role that genes, rather than the environment, play in determining physical characteristics.
- 3) **Made Me Who I Am:** Visitors demonstrated an understanding of the role that genetics plays in shaping human life. Almost a quarter of the responses (24%) included a reference to this category. "Genetics makes up who you are," (S9) and "Genes made me what I am," (S26). In particular, visitors' responses in this category reflect an understanding that genetics not only makes them who they are, but also what they will become. "Genetics is cool. It also plays a major part in what I am or will become," (S203) and "It's your life and your future," (S174). Or consider, "It's how we got here and what's to come. It will determine what human

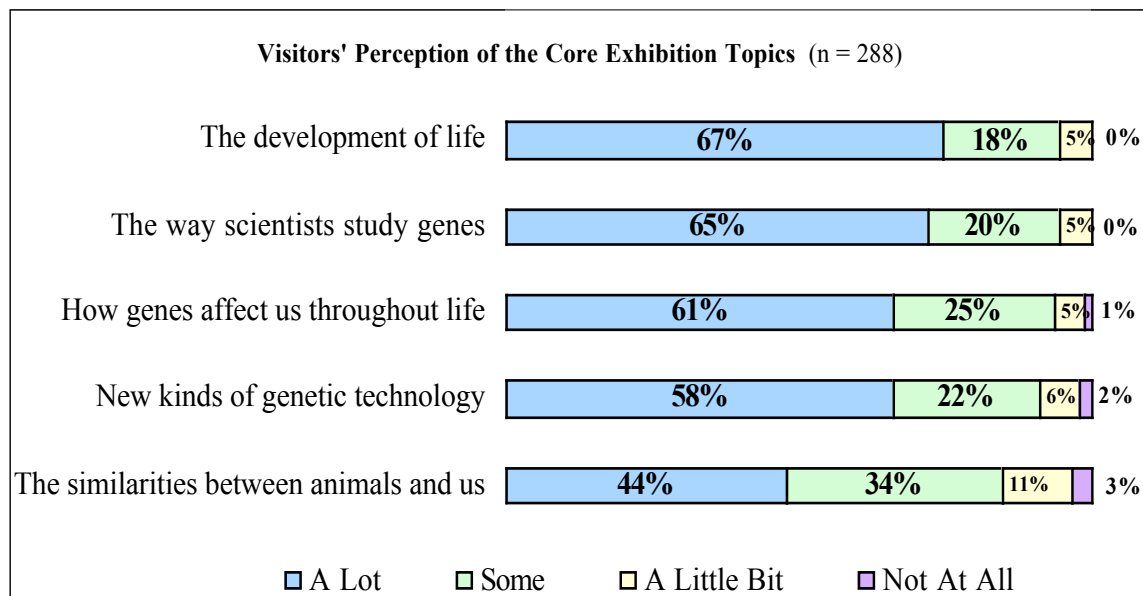
life forms are going to be in the future,” (S36). These responses suggest that visitors understood that genetics shapes aging, and even the evolutionary process.

- 4) **Specific Personal Connections:** As described above, many visitors made general connections between genetics and their lives (e.g. “It’s why my children look like they do”), but 14% actually gave specific, detailed examples. A mother commented, “[Genetics connects to my life] in a lot of ways. He [my son] has a genetic condition, so it affects my family very significantly,” (L4). A father explained not only a personal connection, but also how his experience in the exhibition helped him communicate about genetics with his daughter to relieve her concerns, “I had one nephew – a twin – die of SIDS. This made it easier to explain to my daughter, why one twin may be different from the other,” (L21). These findings illustrate the powerful ways in which the *Genetics* exhibition takes visitors on an emotional and intellectual journey where they find topics that tap in to their hopes and concerns.
- 5) **Medical or Scientific Applications:** A small number of visitors (13%) referenced medical, scientific, or forensic and police-related ways in which genetics connects to their lives. “Genetics is useful in solving crimes, cracking the code to cure diseases and predict diseases,” (L6). Some responses directly reflected visitors’ concerns and hopes about medical or police issues, such as “We have a serial killer in Baton Rouge, and I wish they’d have more of this in our own town so we can catch this killer,” (S13). The percentage of visitors that spontaneously made an applied connection between themselves and genetics was small but powerful and should be viewed as one part of the larger body of data. Specifically, most visitors were attentive to the fact that the *Genetics* exhibition is about the ways scientists study genes and new kinds of technology. Visitors were also able to articulate why scientists study genes in animals. (See discussions about these findings below.) This suggests that visitors understood that genetics has medical and scientific applications, but they found other more meaningful ways to describe how genetics connects to their lives.
- 6) **Everything in Every Way:** A small number of visitors (12%) pointed out that everything about genetics relates to their lives, for example, “Everything I am and everything I do,” (L19). Some of the responses in this category demonstrated an appreciation for impact of genetics on human life: “It is basic to anyone’s life and to all forms of life. And if you understand the basis it can help us appreciate all forms of life,” (L11).

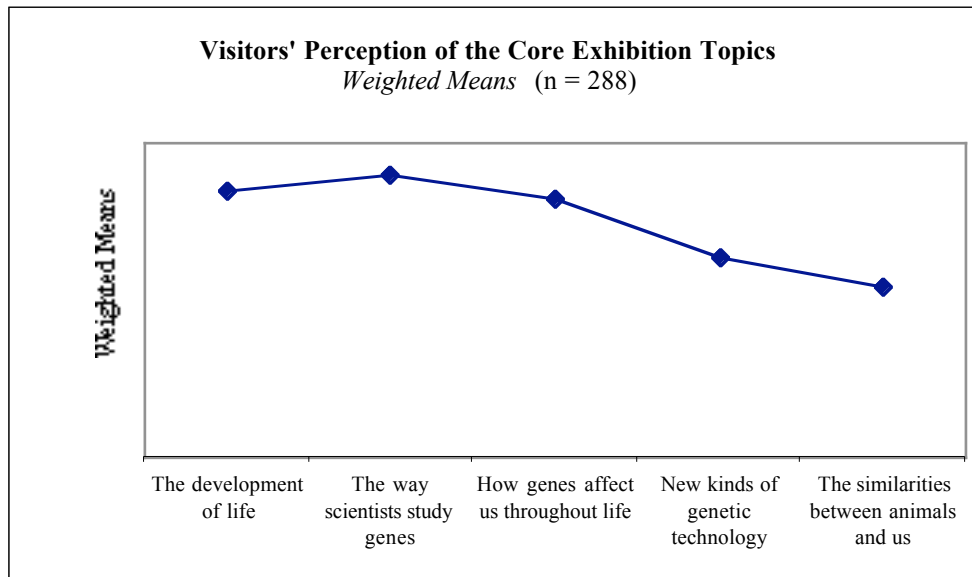
Visitors’ personal connections to genetics were evident in their responses to a number of the interview questions, including ‘How would you describe the *Genetics* exhibit to a friend?’; ‘What can you tell me about heredity?’; ‘Why do scientists study genes in animals?’; ‘Has the exhibit changed the way you think about genetics?’; and ‘How much do you feel the *Genetics* exhibit was about the similarity between animals and us?’

Visitors' Understanding of the Core Exhibition Themes

A combination of open- and close-ended questions provided breadth and depth for the measurement of visitors' attention to and perception of the main themes of the *Genetics* exhibition. In the short and in-depth interviews, visitors were asked "How much do you feel the *Genetics* exhibit was about the following topics?" which provided a quantitative measure of visitors' attention to and perception of the five main exhibition themes in a cued situation: 1) How genes affect us throughout life, 2) The similarities between animals and us, 3) The ways scientists study genes, 4) New kinds of genetic technology, and 5) The development of life. Visitors were asked to directly rate how much the exhibition was about each of the five themes (a lot, some, a little bit, not at all). Visitors could also choose to say 'I don't know.' Only 12% or fewer of the visitors chose the 'I don't know' option for any of the five main themes. (See Appendix 2, Table 3 for complete analysis.) This issue was also raised with visitors through the open-ended question 'How would you describe the *Genetics* exhibit to a friend?'



Most visitors saw that the content of the exhibition reflected the five themes. For example, when asked how much the exhibition was about the 'The development of life,' two-thirds chose to respond 'a lot,' resonating with the strong imagery of the development of life in the exhibition. For four of the five themes, the majority of the visitor responses fell into the 'a lot' category. Visitors said that the exhibition was 'a lot' about 'The similarities between animals and us' at a significantly lower level ($p \leq 0.05$) than the other themes. An analysis of the weighted means provides a more holistic comparison of visitors' perceptions of the exhibition topics.



These weighted means show the general trend of the data, revealing the visitors' emphasis on the topics 'The development of life,' 'The way scientists study genes,' and 'How genes affect us throughout life.' These findings show that the visitors' perception of the content of the exhibition was consistent with the stated exhibition goals. The findings are supported by the analysis of the visitors' responses to the open-ended question 'How would you describe the *Genetics* exhibit to a friend?'

Visitors were asked this descriptive question in the short and in-depth interview (n=289). Responses tended to include content-related comments about: 1) Genes/Basics of Genetics, 2) Genetic Engineering/Cloning; and, 3) Baby Chicks/ Chick Hatchery. Visitors characterized the exhibition as 4) Interesting/ Informative/Educational and 5) Interactive/ Hands-on/ Engaging. Visitors also made 6) General Positive or 7) General Negative comments about the exhibition itself. (Responses were coded as more than one topic, as appropriate, so the percentages equal more than 100%. See Appendix 2, Table 4 for the complete analysis.)

- 1) Genes/Basics of Genetics: Almost a quarter of the visitors (23%) mentioned genes or the basics of genetics when talking about how they would describe the *Genetics* exhibition to a friend. For example, "We learned about genes and DNA," (S48) and "It helps in the understanding of DNA," (S23).
- 2) Genetic Engineering/Cloning: A small percentage (11%) of the responses included a specific mention of genetic engineering or cloning. Except for the baby chicks, this was the specific exhibit content that was mentioned most frequently. Visitors' responses in the category tended to be general, "Very fascinating reproduction, genetics cloning. I learned a lot about cloning," (S5) and "It's good to educate people on genetics and cloning. I learned a lot about cloning," (S5).

- 3) Baby Chicks/ Chick Hatchery: Previous studies of the *Genetics* exhibition and the baby chick hatchery have shown that the baby chicks are a strong icon exhibit for visitors. A well-established definition of an icon exhibit comes from the Museum Impact and Evaluation Study: “An exhibit of special importance to visitors or to the institution. Icons are well known and usually have been there for many years. Visitors often go well out of their way, and will endure inconvenience to visit icons,” (Anderson & Roe, 1993; p. 17). It is not surprising then, that more than a quarter of the visitors mentioned the baby chicks when asked how they would describe the exhibition to a friend. Most expressed wonder, such as “Amazing, I haven’t seen a chick hatch since I was a little boy. It’s intriguing and holds your interest,” (S219). Some responses indicated that visitors focused on the content related to the breeding of the chicks: “I liked seeing the baby chicks. It explains about things like breeding,” (L23).
- 4) Interesting/ Informative/ Educational: Most visitors included a comment about their general experience in the *Genetics* exhibition in response to this question. Specifically, 53% mentioned that the exhibition was interesting, informative, or in some way an educational or learning experience. For example, “A lot of information, and it’s done in a way I can understand it,” (S7), or “It is very thought provoking, very educational, and informative,” (S36). Visitors not only found the experience interesting and informative for themselves, but also believed that this would be an important piece of information if they were describing the exhibition to a friend. This speaks to the visitors’ emphasis on the experience of museum going, and the exhibition’s success in creating an effective learning environment.
- 5) Interactive/ Hands-on/ Engaging: In addition to general comments about the exhibition being interesting, informative, or educational, 15% of the visitors mentioned that the exhibition was interactive, hands-on, or engaging. A typical parental comment was “It’s based on interactivity which is good for the kids,” (S3). Parents were particularly positive about their children having hands-on experiences in science. But the visitors’ comments also indicated that they valued the interactive experience as an adult: “The exhibit is nice because of the hands-on experience,” (S28). Another visitor explained, “I like hands-on things. It’s explained on a level everyone can understand,” (S19). These comments suggest that visitors saw both the exhibition experience and content as important.
- 6) General Positive: Visitors used the question “How would you describe the *Genetics* exhibit to a friend?” as an opportunity to provide a critique of the exhibition. Some visitors (19%) gave a positive review, most commonly including a brief critiquing statement such as ‘it’s good.’ Visitors also made more specific comments, about the exhibition experience. For example, “I like it. The information is good. It is neat,” (S121) and “Comprehensive, definitive, simple for most people to understand,” (S226) are typical of the review-style positive comments made by visitors.

- 7) General Negative: A small number of visitors (6%) used this question as an opportunity to give negative critiques. These comments generally related to noise level, crowdedness, or a specific interactive that did not seem to be working. Visitors' comments about an exhibit not working included concerns about use, such as not finding or seeing something. For example, "[I'm] disappointed I did not see chicks hatch," (S8) and "Could not see the elderly worm," (S104) suggest that the visitor's expectations were not met even when the exhibition was functioning properly. There were a wide range of negative comments. Consider "I don't like rats, eyeballs, chicks, and different bugs," (S179) in contrast to "I don't like the film about genetics. It could have been made a bit more about micro-rays (sic), a bit about perspective studies and emphasize things such as heart disease," (S265). These comments reflect the diversity of perspectives and expectations that visitors bring to the Museum.

Overall, visitors did focus on the content of the exhibition when specifically asked, but when they had an opportunity to provide a more general description, their spontaneous responses showed that they focused on the overall, interactive visitor experience in the exhibition rather than genes and genetics. The data in this section measures visitors' attention to and perception of the core content themes of the exhibition. These findings are strengthened by more detailed data in the following three sections that review responses to questions only asked in the in-depth interview (n=25). These data reveal richer information about visitors' understanding of genetics, specifically in relation to genes, heredity, and the role of animals in genetics research.

Visitors' Understanding of Genes

During the in-depth interview (n=25), 96% of the visitors demonstrated an accurate understanding of genes when asked 'What can you tell me about genes?' The responses reflected a personally relevant view of genes that was consistent with the focus of the exhibition, rather than strictly technical definitions. For example, when the responses were coded into topics, only eight percent of the responses (i.e. two people) included DNA, a technical description, a metaphorical description, or genetic applications. (Responses were coded as more than one topic, as appropriate, so the percentages for topics equal more than 100%. See Appendix 2, Tables 5 and 6 for the complete data analysis.)

Instead, visitors' responses to the in-depth interview emphasized what genes do (40%), and that genes determine traits (40%). One visitor succinctly stated, "Genes decide who and what we are," (L3). Another described in more detail, "They're everything that is good and bad with us. They become the map upon which we have everything from strengths to weaknesses, (L19). Visitors mentioned genetic determinacy and traits often, for example, "Genes determine what you look like, different traits, tendency toward disease, and your sex," (L15). To a lesser extent, visitors mentioned that genes carry information (16%). These responses suggest that the exhibition's emphasis on personally relevant topics, such as the connections between visitors and their genes, had an impact on visitors' perception of genetics.

Visitors' Understanding of Heredity

One of the three overall learning objectives of the *Genetics* exhibition is about heredity, specifically that the passage of genes from one generation to the next is what makes life possible and is ultimately what connects us with all other living things. During the in-depth interviews when visitors were asked, ‘What can you tell me about heredity?’ 76% were able to provide a correct description (n=25). Less than a quarter (24%) provided a vague or incorrect description of heredity. (All responses to this question were first coded as accurate or inaccurate/vague definitions of heredity, so percentages equal 100%. Then responses were coded as more than one topic, as appropriate, so the percentages equal more than 100%. See Appendix 2, Table 7 for the complete data analysis.)

A more specific examination of visitors' responses shows that 55% included a spontaneous mention of the word ‘pass’ or ‘generation.’ For example, “How things are passed down in genes,” (L7) and “What sort of biological traits go from generation to generation,” (L22). Analysis also reveals that 38% gave a specific example of what gets inherited, such as “Recessive genes, it takes two to make red hair,” (L21). To a lesser extent (21%), visitors specifically mentioned genes or DNA in their description of heredity. Overall, these responses demonstrate an understanding of the concept of heredity.

Visitors' Understanding of the Role of Animals in Genetics Research

Visitors are the principal character in the *Genetics* exhibition, but animals are also important characters in the exhibition story. During the in-depth interview (n=25), visitors were first asked if they noticed the live animals in the exhibitions, and if so which ones. All of the visitors reported that they noticed live animals. All but one visitor mentioned the baby chicks – a dominant feature of the exhibition from the visitors' perspective. Four of the visitors (16%) were only able to name the baby chicks, but 84% listed two or more animals they noticed. Two visitors referred to the mice as hamsters, but otherwise the visitors correctly identified the animals. (Visitors listed more than one animal, so the total equals more than 100%.)

	Visitors who Stopped at Exhibit <i>Tracking & Timing Data</i> (n=127)	Live Animals Noticed <i>Interview Data</i> (n=25)
Chicks	89%	96%
Mice	67%	56%
Frogs	52%	32%
Fish	20%	12%
Flies	28%	8%
Worms	21%	4%

This interview data is comparable to the tracking and timing data collected in an earlier summative study that included tacking and timing (Selinda Research Associates, 2003).

The top three animals are consistent across the two studies: chicks, mice, and frogs. The tracking and timing data showed that 89% of all of the visitors studied stopped at the chicks exhibit. It is not surprising that a larger percentage of visitors named the chicks in the interviews, however, as they are a highly visible exhibit. There is an interesting difference between the number of visitors who stopped at the flies and worms exhibits according to the tracking and timing data and the number of visitors who named the flies and worms in the interviews. One possibility for the difference could be that visitors did not think of flies and worms as animals when asked ‘What animals did you see?’ Another interpretation would be that visitors did not recognize what the flies or frogs were when they stopped at the exhibit. Data from the earlier summative study, however, included interviews with visitors at the fly exhibit that indicates that visitors recognized what the flies were.

Visitors were highly attentive to the animals in the exhibition; they did see animals as integral components of the exhibition. One of the goals of the exhibition is for visitors to see these animals as genetic relatives. There are two key messages reiterated throughout the live-animal exhibits in the *Genetics* exhibition: 1) We share many genes with these animals, and 2) These animals are powerful models for us to learn how our genes work, how genes program our development, how defects in genes can cause disease, and how we can combat disease.

During the in-depth interview (n=25) visitors were asked ‘Why do scientists study genes in animals? What sort of things do they do?’ The majority of visitors (64%) spontaneously made a connection between humans and scientists’ study of animals. Only two visitors (8%) explained that scientists study animals to learn about animals and made no connection between studying animals and humans. In general, visitors’ responses to this question fall into four distinct but interrelated categories: 1) Learn about ourselves, 2) Animals are similar, 3) Improves human life, and 4) Animals are easier to study. (Responses were coded as more than one topic, as appropriate, so the percentages equal more than 100%. See Appendix 2, Table 8 for complete data analysis.)

- 1) Learn about ourselves: In addition to making a link between studying animals and humans, 28% of the visitors specifically explained that scientists study animals to learn about humans, or ourselves. For example, “Because it relates to humans and we can learn more about ourselves,” (L1). Although most visitors made a connection between the study of animals and humans, these visitors’ responses showed a specific connection to learning about human life.
- 2) Animals are similar: More than a quarter of the visitors (28%) specifically described how animals are similar to humans, often explaining that animals serve as a model for humans. For example, “To understand, animals serve as a model for humans,” (L9) and “To learn more about us, better to see how it works in them before testing it in humans (L19).

- 3) Improves human life: Almost a quarter (24%) of visitors made a connection between scientists studying animals and improving or helping human life. For example, “It is important because it helps them figure out how genes work in humans, helps people with gene defects,” (L20).
- 4) Animals are easier to study: One-fifth (20%) of the visitors commented that it was easier to study animals. Visitors responses ranged from the straightforward “Animals are a little more cooperative than humans,” (L6) to the detailed, “[It is] simpler to break it down in a less complex organism,” (L17).

Overall, visitors demonstrated an understanding of the connections between animals and themselves. More specifically, these data show that visitors understood that animals provide a simple model to help us understand ourselves and improve our health.

Impact of the Exhibition on How Visitors Think About Genetics

At the end of the in-depth interviews, visitors were asked ‘Has the exhibit changed the way you think about genetics?’ (n=25). If respondents answered yes, they were asked ‘In what way?’ Two-fifths (40%) of the visitors said that the exhibit had changed the way they thought about genetics. Another eight percent (i.e. two people) said that it had not really changed how they thought, but offered something they had learned or thought about because of the experience. Most of the visitors (52%) said the exhibit had not changed they way they thought about genetics. (See Appendix 2, Tables 9 and 10 for complete data analysis.)

When asked to explain how their thinking about genetics had changed, visitors responded positively (n=10). For example, “Lots more to genetics than I thought. It’s more complex and more powerful,” (L3). Of the visitors who said that the exhibition had changed the way they thought about genetics, most (54%) explained that the experience in some way improved, broadened, or reminded them about issues in genetics. For example, ‘It helped me to be more informed.’ (L20) and “It’s broadened my view in showing how all forms of life are interrelated,” (L11). These data suggest that even a single experience at one exhibition can have an impact on the public’s familiarity with genetics — a topic that is fundamental to understanding science and increasingly, fundamental to making informed decisions in day to day life.

Conclusions

This supplemental summative evaluation focused on how the *Genetics* exhibition enriches visitor attitudes and thinking about genetics, and specifically whether the learning goals and measurable outcomes have been met. The exhibition is organized around the principle that scientists are discovering, understanding, and using genes that affect us throughout our lives. Central to this is the focus on the visitor and the connections among their genes, their own lives, and the lives of their families.

The most compelling finding is the myriad ways that visitors made personal connections to genetics. Visitors made meaning from their experiences in the exhibition by making genetics personally relevant through their children, their parents, their heritage, and specific personal experiences. These findings demonstrate that the exhibition was successful in its effort to make links between visitors and their genes, taking visitors on an emotional and intellectual journey in which they find topics that connect into both their concerns and their hopes. The visitor is the central character in this exhibition. It has been argued that positioning the general public as experts in the way genetics shapes their lives is a critical step in the democratization of policy decisions about social and ethical genetics issues (Kerr, Cunningham-Burley, & Amos, 1998). The findings from this study suggest that compelling museum exhibitions can play a role in making people understand the connections between their genes and themselves. This is a critical issue, as genetics becomes more prominent in our everyday lives.

Visitors were attentive to the core exhibition themes. Their descriptions of the exhibition demonstrated an understanding of not only the content of the exhibition themes, but also the educational, interactive, and personally relevant nature of the experience. The findings highlight visitors' diverse perspectives and expectations, but point to a common desire for informative, interactive exhibition experiences.

The overwhelming majority of visitors were able to provide a correct definition of genes and heredity. Visitors' emphasis on what genes do, rather than what genes are, are one example of the visitors' strong tendency to focus on content that could be personally relevant. The findings demonstrate that visitors not only have an understanding of genes and heredity as fundamental concepts in genetics, but also an understanding of heredity as an active and relevant process controlled by genes. This distinction is a critical one in shifting learners' conceptual understanding of genetics (Venville & Treagust, 1998). Specifically, the concept of heredity is more fundamental to understanding genetics than the concepts of genes or DNA.

All of the visitors noticed the live animals in the exhibition, and most listed more than the baby chicks (an important icon in the exhibition). Data showed that visitors understood that animals provide a simple model to help us understand ourselves and improve our health, reflecting a central message reiterated throughout the exhibition.

Just under half of the visitors either reported that the exhibition changed the way they thought about genetics or were able to name something they had thought about or learned because of the exhibition. These data suggest the potential for experiences in the *Genetics* exhibition to have a lasting impact on visitors' connection with genetics, a fundamental but conceptually difficult science concept.

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