

“Seeing: The interaction of physiology, culture, and technology”

**A synthesis of summative evaluation studies conducted by
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Sue Allen, Exploratorium, January 2003

1) Goals of the *Seeing* project

The Exploratorium’s *Seeing* Collection began as a National Science Foundation-funded project to create a new collection of exhibits about seeing. This new collection, which partly replaced the *Light, Vision, Color, and Optics* collection, was designed to add new insight to how the eye and brain function together and discuss how culture affects our understanding of what we see.

One of the key elements of this was to try to re-cast some of the existing exhibits to evoke in visitors a better appreciation of their own perceptual processes. Another key element of the project was the focus on seeing as an active act of interpretation and construction, that takes place as much in the brain as in the eyes.

From the Exploratorium’s National Science Foundation Grant Application:

“Seeing: The Interaction of Physiology, Culture, and Technology” is the first exhibit and program development project in a multiyear initiative at the Exploratorium called ‘Refocusing on the Floor.’ Seeing is designed to build on one of the strongest and most compelling sections of the Exploratorium exhibits, to add the proliferation of new research on vision and new technology, and to experiment with exhibit and program design techniques in a way that fosters visitors’ understanding of the personal and cultural influences on how we see and interpret the world.

The goals of this project are to create a new exhibit section and related programs that:

- (a) support visitors in developing their skills at seeing, noticing and visual thinking;*
- (b) make visitors conscious of the persuasiveness of visual information in daily life;*
- (c) help visitors access current research on vision and visual cognition;*
- (d) stimulate visitors to investigate the social and cultural influences on seeing;*
- (e) assist visitors in recognizing that seeing, interpreting, and understanding visual information are basic to the conduct of science.*

The *Seeing* exhibit collection opened on June 25, 2002, and is now part of the Exploratorium’s permanent collection.

Note: Extensive formative evaluation was conducted on all the major interactive elements in the collection, as well as the thematic exhibit clusters, resulting in a total of over 35 studies. However, this report focuses on the results of the summative evaluation only, because it was designed to take a broader view of the complete collection rather than identify design problems in the ongoing development process.

2) Structure of the summative evaluation

From July to September of 2002, four different summative evaluation studies were conducted under the general oversight of Beverly Serrell:

- a) The exhibit collection as a whole was evaluated with two studies: one using tracking and timing to assess visitor behavior and the other using cued interviews to assess visitors' interpretations of their experience in the area.
- b) Three individual exhibit elements were selected for in-depth study, using both uncued observations and cued interviews. The three exhibit were all previously existing exhibits that were to be rebuilt or re-cast during the course of the project to reflect the new emphasis of the collection. These elements were selected by the *Seeing* development team.

Rationale for Pre- versus Post- testing

What was unusual about these studies was that all of them, with the exception of the tracking study, were conducted in two parts: a "pre-test" assessment before the project began in earnest, and a "post-test" assessment after completion. This was done because the development team, under Kathleen McLean, wanted to do more than just assess the effectiveness of the final exhibit collection: they wanted to find out whether they had succeeded in their ambitious goal of re-casting some existing exhibits to create a new kind of visitor experience with a rather different set of "big ideas." Thus, the pre-post study design offered the team a chance to find out whether their changes and additions to the collection had resulted in a visitor experience that was, statistically speaking, significantly different from what it had been before the project began.

Limitations of Pre- versus Post- testing

When reading the findings to follow, it is important to bear in mind two limitations of the studies:

- a) Different exhibit elements included: The pre- versus post- study of the whole collection did not compare identical sets of exhibit elements. There was a good reason for this: The original *Light, Vision, and Optics* exhibit collection at the Exploratorium was very extensive, comprising more than 250 exhibit elements. By design, the *Seeing* project involved a reworking of only some of these existing elements – viz., approximately 30 which supported the goals of the new project most closely. In addition, a lesser number of new exhibits were created. This meant that it was only possible to assess the true visitor experience with each collection by not insisting that the exhibits in the collections be identical.
- b) Artificial boundaries: For the pre- versus post- comparisons, the team and evaluators agreed that it would be necessary to clearly demarcate the boundaries of the exhibit collection being studied. In reality, both the original *Light, Vision, and Optics* collection and the *Seeing* collection had intentionally indistinct boundaries, but for the duration of the summative evaluation the team created temporary boundaries (using movable barriers or colored tape on the floor).
- c) All interviews cued: Following from point (b), all interviews were cued so that visitors could be asked to consider only those areas of the museum within the boundaries of the exhibit collection. This means that the interviews were probably "best case" in terms of visitors

paying attention and spending time in the exhibition, in comparison with uncued exit interviews more typically conducted in summative evaluations.

3) **Key Findings** (based on individual summative reports in Appendices)

a) The exhibit collection as a whole

- The median time that visitors spent in *Seeing* was 16 minutes, and the average number of stops was 18 (19% of the 93 elements in the collection). Serrell points out that this low percentage of elements stopped at is not unusual for comparably large, dense exhibitions. The average sweep rate of visitors, 400, made *Seeing* about average in terms of the speed with which visitors move through it.
- The most popular single element in the collection was *Change Blindness*, an element that simulated blinking, and revealed that a scene can be radically changed one component at a time, without the viewer ever noticing.
- The seven optical illusions, though non-interactive, were highly sustaining of visitor interest, with more visitors looking at all seven than looked at only one.
- The Judith Scott Gallery, displaying the work and creative process of an unusual artist, rated as one of the more popular exhibit elements if one counts the number of visitors who stopped at one or more elements in the gallery. However, there were also many visitors who “ducked into” the gallery and left immediately without stopping.
- Interviews showed that most cued visitors (81%) did notice different sections within the collection. Although their subdivisions were not always the same as the exhibit developers’, the overlap was high: 6 of the 8 sections most commonly named by visitors were aligned with 5 of the 8 sections designed by the development team.
- Most visitors thought that the *Seeing* section seemed different from other areas of the museum. The most common kind of difference was in terms of the content of the collection being focused on the topic of seeing and the eye. However, visitors also noticed differences in the design of the collection: 17% thought the collection was more detailed, concentrated, intellectual, or scientific than the rest of the museum, while 17% thought it was less hands-on, less interactive, and involved more reading.
- A sizeable number of cued visitors (38%) said they did not have enough of an introduction or overview to the collection.

The comparative pre-post study of cued visitors showed that the team did in fact succeed in creating a visitor experience in *Seeing* that was different from that in the original *Light, Vision, and Optics* collection, in ways that were aligned with the project goals. The most significant differences between the pre-and post-visitors to the *Seeing* Collection were that significantly more of the post-visitors:

- (a) *thought that the exhibits were about how we see and talked about seeing as interpretation;*
- (b) *found that the exhibits related to their daily lives;*

- (c) mentioned parts of the visual system and said they didn't realize how much you don't see if you're not paying attention;
- (d) said that they never knew or didn't realize that different people see things differently.

These findings correspond with four of the five original goals for the Seeing Collection, as indicated in the original grant proposal. (a-d above correspond roughly to a-d at the beginning of this document). However, the data did not show evidence of (e).

b) Three individual exhibit elements as examples of rebuilds

Three exhibit elements were chosen for in-depth study, to illustrate the process of rebuilding exhibits to create a different visitor experience, and to assess the success of such efforts. The exhibit elements were selected by the team early in the project, based on the criteria that they seemed relevant to *Seeing* and also seemed to have potential for improvement:

- They were difficult to use properly.
- They seemed overly complicated and esoteric.
- They seemed to be "about the gizmo" rather than about the perceptual system.

The exhibits chosen were Seeing Yellow, Motion Detector, and Peripheral Vision. The latter two exhibits are quite similar in design and message, but were both chosen for in-depth study because at the time, developers were considering combining them into one exhibit and thought the result would make an interesting and informative case study. In the end, however, developers decided to keep the two exhibits distinct.

Exhibit 1: Seeing Yellow (Summary: minor changes to the exhibit were unsuccessful, but the challenges led to a strong new companion exhibit)

Original version:

Visitors turned two knobs to adjust a mixture of red and green lights from two projectors. The combination created varying hues of yellowish light, which visitors tried to match to a pure yellow light from a third projector. A filter and spectroscope were provided so that visitors could prove to themselves that, though the two yellows may look the same to the eye and brain, they are still different in nature and spectral composition. The label briefly explained this in terms of the receptors in the back of the human eye.

Issues with the original version:

In the Pre-Study, three quarters of the visitors interviewed successfully completed the first step of the exhibit, which was to combine red and green light to create yellow. However, far fewer understood "Seeing Yellow" as a window into the mechanisms of human vision.

Changes made:

- The exhibit message was changed to emphasize the main idea.
- The spectroscope was removed.
- Text was changed to clarify what the Red and Green filter is supposed to show.

- The text was shortened.
- A companion exhibit, *Disagreeing About Color*, was created to emphasize the involvement of the human eye and brain in color perception, by showing that different people see color differently.

Effects of changes:

- Uncued observations showed no improvement in visitors' engagement with the exhibit; in fact, holding times were marginally shorter and fewer visitors used the filter.
- Interviews showed that, even after the changes, visitors did not understand the main idea behind the exhibit.
- More post-visitors than pre-visitors mentioned "cones" at some point (probably reflecting its inclusion in the label).
- Although *Seeing Yellow* did not improve significantly, discussions of its inadequacies led to the creation of a whole new element, *Disagreeing About Color*. This new element, while not studied in depth, appeared to be quite successful: it was the 8th most popular element in the *Seeing* collection, and was mentioned by 33% of visitors when asked to talk about how "different people see things differently."

Exhibit 2: Motion Detection (Summary: the exhibit's usability improved, and its overall message was already clear, but detailed understanding was unchanged)

Original version:

Visitors were instructed to look straight ahead at a yellow pole and move a stationary object (a cylinder) just beyond the periphery of their vision. At that point, they were told to push a small button, which caused movement of colored lines on the cylinder. The specific message was that the human visual system can detect movement beyond the limits of what it can resolve in terms of stationary objects.

Issues with the original version:

Although 80% of the cued pre-visitors realized that the exhibit had something to do with peripheral vision, only 53% understood the specific message that it is easier to see motion than stationary objects in one's peripheral vision. Also, the original exhibit interface was confusing to some visitors, and only 40% of uncued visitors were observed to carry out the steps necessary to get the critical experience intended by the exhibit developers.

Changes made:

- An arrow was placed where visitors are supposed to put their noses or chins.
- Instructions were pared down and numbered 1-3, as per suggestion.
- Reference to diagonal lines was removed; the current text refers to cylinder markings.
- The place where visitors are supposed to focus their attention was changed to a target symbol.
- The small, inconspicuous button was replaced with a larger, back-lit red button.
- Diagrams showing how to use the exhibit correctly were added.
- The illustrations of an owl and a mouse were removed from the label.

- The main message - that we are "wired" to see motion even when we can't tell what it is that is moving - was emphasized.

Effects of changes:

- Fewer post-visitors reported that the directions were confusing.
- Uncued holding times increased.
- More post-visitors followed all the steps listed in the label in order to get the critical experience.
- Fewer post-visitors talked about predator-prey relationships.

There was no significant change in the number of visitors who articulated the main message of the exhibit (viz. the importance of movement in their peripheral vision), or who mentioned that special cells in the eye are responsible for detecting motion in their peripheral vision, or who mentioned that noticing motion in their peripheral vision is relevant to their daily lives.

Exhibit 3: Peripheral Vision (Summary: the exhibit's usability improved dramatically, and its message was made clearer)

Original version:

Visitors were instructed to put their eyes near the level of a table surface and stare straight ahead at a small spring. A helper took a multi-sided block, displaying one of a set of possible symbols or words, and moved it slowly from visitors' peripheral vision towards the central spring. Visitors were instructed to mention when they first noticed the symbol on the block. The main message of the exhibit was that, although people can notice things in their peripheral vision, they can only see detail in their central vision. Ideally, visitors could also compare the different distances at which they could identify colors, shapes, and words.

Issues with the original version:

Only 39% of pre-visitors said they had used the different types of blocks to measure and compare when they could identify colors, shapes, and words in their peripheral vision. And only 37% of pre-visitors were able to articulate the main message of the exhibit, which is that they saw things most clearly when they were looking straight at them.

Changes made:

- Expanding the under table of the exhibit to make it more usable.
- Creating a system of cable ties for the different blocks being tried so the exhibit can be experienced without a "helper."
- Redesigning the "spring" into a target.
- Simplifying the directions and integrating the text.
- Making the directions more clear.
- Adding diagrams to show how to use the exhibit correctly.
- Integrating the text with the exhibit.
- The main message was changed slightly from "you can see things most clearly in your central vision" to "you can see different kinds of information in different parts of your field of view."

Effects of changes:

- Uncued holding times increased.
- More visitors used the exhibit correctly, as required to have the critical experience.
- Nearly every observed action showed improvement from pre to post.
- There were increases in the number of visitors who articulated both the old and new main message of the exhibit - that you can see differently in different parts of your field of view, with greatest clarity being in the center of vision.

What was learned from the summative, in-depth studies of the three exhibit elements?

- None of the changes transformed these exhibits into wildly popular or sustaining elements; gains made were modest.
- We were generally successful at changing the exhibit interfaces so that more visitors could have the critical experience intended by the exhibit developers. Two of the three elements (MD and PV) showed such improvements.
- We were less successful at changing visitors' interpretation of the experience in terms of an intended message about the human visual system. In two of the three elements (SY and MD), we attempted subtle shifts of the exhibit's message, without achieving significant change. The only clear success in terms of message came in PV, and in this case it is not clear how much of this improvement was due to the removal of interface barriers to the critical experience.
- Discussions of the failure of one element (SY) led to the creation of an entirely new element which was much more successful at engaging visitors as well as getting across a important related idea (viz. subjectivity of color).

What was learned from the summative evaluation overall?

- Visitors recognize the new *Seeing* collection as an identifiable, distinct part of the Exploratorium, with a particular topic and design.
- The main topic of the collection is clear, although its subsections are somewhat less so.
- Popular elements in the collection include the optical illusions, the Judith Scott gallery, and the individual elements Change Blindness and Distorted Room.
- In terms of the visitor experience, the project team did meet four of its five stated goals.
- Some evidence suggests that it was easier to improve the interface of existing exhibits, thereby increasing visitors' access to the critical experience, than to re-frame the interpretation of these experiences. If this is true more generally, then one might suspect that the success of the change in focus from the *Light, Vision, and Optics* collection to the *Seeing* collection was probably more due to the changing set of exhibit elements than the re-framing of existing elements.

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material are those of the authors and do not necessarily reflect the views of the National Science Foundation. Additional support was provided by the National Endowment for the Arts.



5) Appendices: Complete reports

Appendices A-D give the complete reports for all four studies, as follows:

Appendix A (Beverly Serrell): Tracking and Timing study, with notes about the other three studies.

Appendix B (Katherine Whitney): Whole-collection cued interview study.

Appendix C (Katherine Whitney): In-depth cued interview study of 3 elements.

Appendix D (Joshua Gutwill): Uncued observational study of 3 elements.