Seeing 3-Exhibit Pre-Post Interview Study

Final Results

Interviews for Three Exhibits:

Seeing Yellow
Motion Detection
Peripheral Vision

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Introduction

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

The *Seeing* 3-Exhibit Pre-Post Study is a component of the *Seeing* Collection Summative Evaluation. It looks at pre- and post-data for three exhibits from the original *Light, Vision and Optics* collection: "Seeing Yellow," "Motion Detection," and "Peripheral Vision".

These three exhibits were chosen because the Exploratorium team felt they were all exhibits that could significantly improve.

- They were all difficult to use properly. "Seeing Yellow" had a spectrograph and filter that visitors weren't sure what to do with. "Motion Detection" was tricky for people to use correctly because it required a visitor to understand that they had to first get the cylinder to a place where it was invisible, and then move it, to show the intended effect. "Peripheral Vision" was difficult because the blocks fell off the table, the label was in the wrong place, the instructions didn't quite make sense, and everything was dark.
- The exhibits seemed overly complicated and esoteric.
- They seemed to be "about the gizmo" rather than about the perceptual system. Developers thought they could move the focus for all three exhibits more towards what the experience shows about human vision. For example, an attempt was made to make "Seeing Yellow" more about color vision and less about combining colored lights.
- At the time of the exhibits were chosen, the developers were considering combining "Motion Detection" and "Peripheral Vision" into one exhibit. They wanted to have information on both parts of the exhibit in case they did decide to join them. In the end, developers decided to keep the two exhibits distinct.[1]

Methods

[1] e-mail from Sue Allen, 1/7/03

The three exhibits were evaluated in their existing condition in December 2000 with an eye toward making them more effective for visitors. The *Seeing* team wanted to know what visitors understood, how they thought the exhibit related to the human visual system, and whether the exhibit was relevant to their lives. Based on the results of the first round of testing, the exhibit developers made changes to the exhibits, and the exhibits were tested again using the same interview instruments. The study was designed in a pre-versus post format to measure qualitatively and quantitatively whether there were significant changes in the visitor experience after the changes were made to the exhibits.

The Pre-Study was conducted during the months of December 2000 and January 2001. In the end we had 50 interviews for "Seeing Yellow," 49 for "Motion Detection," and 47 for "Peripheral Vision." The interviews were taped, transcribed and analyzed with the goal of helping the exhibit developers change the exhibits to make them more effective. The exhibits were reworked and put back on the floor of the museum as part of the new *Seeing* collection, which opened to the public in June 2002.

The Post-Study was conducted in September 2002. The same interview instrument and methods were used. The final count was 56 interviews for "Seeing Yellow," 49 for "Motion Detection," and 50 for "Peripheral Vision." This report represents the comparison of the data from the Pre- and Post-Studies, with an eye to assessing changes in the visitor experience as a result of the changes made to the three exhibits.

The pre-post results were compared and analyzed using a Chi-square test and significance was determined by a threshold value of $p < .05$. Where there were fewer than 5 visitors per cell, significance was determined using the Fisher Exact Probability Test. Chi-square results can be found in Appendix A: Coded responses by question.

Executive Summary

While there are some pre-post differences for these three exhibits, the changes are not dramatic. In the case of one exhibit—Seeing Yellow—this may be because the exhibit concept is very challenging for visitors. In the case of the two other exhibits, they were fairly successful to begin with. We may have experienced a ceiling effect, given the high number of pre-visitors getting the main messages. Nevertheless, there is something to glean from the research for each of these exhibits.

Seeing Yellow

There were a couple minor differences between pre- and post-visitors with regards to "Seeing Yellow."

- There were significantly more post-visitors who mentioned "cones" at some point during their interview. We'd hoped that visitors would have a better understanding of the message of this exhibit: that our cones and/or brains interpret both types of yellow light as the same color, even though they're actually not the same. Unfortunately, the data from the interviews doesn't support the idea that visitors are understanding this exhibit better. This pre-post difference is probably explained by the fact that the word "cones" appears twice in the post-exhibit label and not at all in the pre-exhibit label.

- Slightly more post-visitors commented that they couldn't tell the difference between the two yellows in the exhibit. This is an improvement, but it was only a trend and not a statistically significant difference.

Seeing Yellow is conceptually a very difficult exhibit. Visitors don't really understand it and they still find it confusing. However, data from the pre-post study of the whole *Seeing* collection shows that significantly more post-visitors talked about how different people see color differently.[2] The only other exhibit that deals with how different people see color differently is in the new *Seeing* collection is the exhibit "Disagreeing About Color." Discussion about these results with Exploratorium staff suggests that this exhibit

[2] *Seeing* Collection Pre-Post Study, Katherine Whitney & Associates, 1/2003

is responsible for the dramatic increase in visitors talking about how different people see color differently.[3]

The staff concluded that "Seeing Yellow" was more effective when a live person was there to help visitors understand it. It is perhaps better used as a teaching exhibit rather than a stand-alone exhibit on the floor.

Motion Detection

There was a ceiling effect going into the post-study of this exhibit, since such a high number of pre-visitors (80%) got the main message of the exhibit. It was not surprising, therefore, that we didn't see dramatic changes in the results.

- Significantly fewer post-visitors found the directions confusing. There had been some issues with the directions being confusing in the pre-test, so this is a positive change.

- There were significantly fewer post-visitors who talked about the predator-prey relationship in reference to this exhibit. The original exhibit had no text about predators or prey, but there were illustrations on the labels of an owl and a mouse. Clearly the graphics registered in visitors' minds, sending a confusing signal, since this exhibit was not directly about predators or prey. It is not surprising that no post-visitors mentioned predators or prey, since the graphics were removed in the post version of the exhibit.

Peripheral Vision

Peripheral Vision saw the most improvement in terms of more visitors getting the main exhibit messages

- In answer to the question "What did you do with this exhibit and what did you notice?" more post-visitors articulated the main message of the exhibit - that you can see differently in different parts of their field of view.

[3] Presentation to Exploratorium team, 1/9/03

- In answer to the same question, more post-visitors also mentioned that they saw most clearly in their central vision.

Summary Results by Exhibit

SEEING YELLOW

The Exhibit - Pre-Study

The original "Seeing Yellow" consisted of a large rectangular black box, open on one side, mounted on 4 legs. The box contained three projectors set upon a white tabletop; two on the left side and one on the right. Each of the projectors shined white light through a colored filter. Of the two projectors on the left side, one shined light through a red filter and the other through a green filter. These two projectors were angled such that the paths of red and green light intersected each other. The projector on the right side shined white light through a yellow filter. The light from the three projectors shined across a white tabletop onto two translucent white plex discs sitting side by side, perpendicular to the tabletop, and separated by an opaque piece of black plex. In the exhibit text these pieces of plex are referred to as "blocks." The blocks absorbed the light from the projectors and indicated the color of the light projected.

Two small open-topped black boxes sat toward the right side of the exhibit, in front of the projectors with the yellow filter. One contained a round filter, which was half red and half green. The other contained a spectroscope. Both the filter and the spectroscope were tethered to the boxes.

A canted back-lit graphic panel ran along the front of the exhibit. The panel had directions, explanatory text and graphics. It also had two black knobs, one labeled "green" and one labeled "red."

Visitors approached the open side of the box and sat down to use the exhibit. They were instructed to turn the knobs and adjust the red and green lights from the projectors on the left to create yellow light. The yellow light they created by mixing red and green was to match the yellow light projected from the right. Visitors were then asked to use the filter and spectroscope to prove to themselves that, though the yellows on the two blocks look the same, one came from the combination of green and red light, and the other from pure yellow light.

Issues with the exhibit

For 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" on a deeper level. According to Exploratorium staff, the main point of "Seeing Yellow" is that our eyes and brain cannot differentiate between yellow created by the combination of red and green lights, and a pure yellow. People may think that when they put red and green light together it becomes yellow, but it doesn't. Our brains turn the combination into yellow.[4]

Changes made to the exhibit for the Post-Study

- The exhibit message was changed to emphasize the main idea and to be focus and support the section.
- The spectrascope was removed. A keyed drawer was created so Exploratorium teachers can access and use it for classes.
- Text was changed to clarify what the Red and Green filter is supposed to show.
- The text was shortened and a companion exhibit Compare Yellows was created to emphasize how different people see color differently.

Anticipated results from the Post-Study

After the second round of testing, we hoped to see that:

- more visitors could articulate that they can't tell the difference between the two yellows, and the reason has to do with how their cones work;
- with reference to the exhibit being relevant to the human visual system, more visitors could articulate *how* "Seeing Yellow" relates to the human visual system.

Seeing Yellow - Pre-Post Differences

Mentioning cones

There was a significant difference between pre- and post-visitors who made a reference to cones or referred to special cells in the eye for sensing color at some point during the interview.

22% of pre-visitors

[4] Tom Humphrey, 12/5/00

46% of post-visitors

As mentioned previously, this difference is probably explained by the fact that the word “cones” appears twice in the post-exhibit label and not at all in the pre-exhibit label.

Seeing Yellow - Detailed Results

What did you do with this exhibit and what did you notice?

When looking at this question we coded for visitors who:

a. said they were trying to match, or said they succeeded in matching the yellows;

b. noted that the two yellows are different: one is pure yellow and one is made up of red and green light;

c. mentioned that they (or their eye or their brain) can't tell the difference between the two yellows (i.e. the yellow created by a combination of red and green and pure yellow.)

There were **no significant differences** between the Pre- and Post-Studies.

• Matched colors:

Um, I tried to match the, uh, two colored blocks, well, the two colored blocks in the center together

I tried to get the left side which has the green and the red on it, I tried to get them to match the yellow beam that's coming from the, the right side of it.

• Different colors

One is made of just yellow, and one's made of red and green...

So, actually, [the filter] separated the two beams of light through one color of yellow which was telling me that, even though I see yellow here, it's still two beams, two colors going through there.

And then they had the explanation of why that was...that was just pure yellow light, whereas on the left side, it was formed by combining the red and the green light, you know, your eye perceived in as yellow, when the two lights combined.

• Can't tell difference

I noticed that although they looked the same without the filter, it's clear that with the red filter on top you can see the difference between red and yellow. And

then the green filter on the bottom, that you can see it green…yellow.

Then you put the filter up and you know, even though they could be the same color, you know, like right now, they both appear yellow to me, then you put the filter up and one side's yellow and the other side's green or red or whatever, I think that's kind of neat.

The exhibit was trying to describe how to combine red and green light to make a yellow and, the yellow light you could differentiate with the filters that there was still red and green in it even though my eyes couldn't tell that it was just yellow.

What do you think the exhibit is trying to show?

When looking at the answers to this question, we coded for visitors who:

a. said it was trying to show how the brain/eyes see color;
b. mentioned cones or color-sensing cells in their eyes;
c. said they couldn't tell the difference between the two yellows.

There were **no significant differences** between the Pre- and Post-Studies.

- how our brains/eyes process/see color

  [It shows] that there are only three types of color sensors and it shows how we, how our eyes, integrate those into seeing colors that we see.

  It shows you how your eyes are viewing color, and what's allowed in and what's allowed out.

  I assume the different ways we perceive color, the way our brain processes different colors.

- mentioned cones or color sensors

  We see things based on our combination of, or based on that cone structure that you've got, and, that color can be made up of different ways and your eye perceives it as the same

So I'm saying color vision is based on the combination of responses in each type of cone...

I do remember that it pointed out there were only three different kinds of actual colors that your rods and cones could perceive, was it three?

- can't tell the difference between the two yellows

...so even though these two kinds of yellow light are totally different, they stimulate your eye and brain to see the same color.

"I'm assuming that, I mean, when I, when I was reading this, the, um, censors and the cones, it seems like the eye takes in a certain amount of light and then it interprets it through the, through filters. That's kind of what I got out of it." - Pre-Study

That, 'cause of the way that our eyes are made, that we see colors the same, that our composed differently.

Do you think this exhibit shows you anything about the human visual system?

When looking at the answers to this question, we coded for visitors who:

a. mentioned cones or color sensing cells;

b. talked about how their eye or they brain couldn't tell the difference between the two yellows.

We didn't code for yes/no answers to this question because, in hindsight, it seemed an obvious question. Given the context of the interview most visitors answered yes, even if they couldn't explain how. So we looked at what they said about the human visual system. There were **no significant differences** between the Pre- and Post-Studies.

- mentioned or cones or color sensors or special cells for color.

  just that there's rods(?) and cones and they pick up different frequencies of light...

  I guess it explained that there are things in your eye that I didn't know about called color sensors, or I guess they're cone cells…but…yeah…so I didn't know, I didn't know that, and I didn't know that your eyes only have three types of colors sensors.

  Well, having read it here, I assume its, showing you that there's different receptor cells, three different receptor cells for colors in your eye. And what you actually see as a color is based on a combination of these primary colors that you're receiving.

- can't tell the difference between the two yellows

  But I did understand that by combining the two lights, that that was kind of tricking your eye, so you perceive yellow.

  Like if you see a yellow light you can't tell if it was just yellow to start with, that was the frequency of it. Or if it's a combination of, uh, the different colors.

that it shows how your eyes can be deceived in looking at colors and lights, like it may not really recognize a true color versus a blended...

Do you think this exhibit shows you anything about how we see color?

When looking at the answers to this question, we coded for visitors who:

a. mentioned cones or color sensing cells;

b. talked about how their eye or they brain couldn't tell the difference between the two yellows.

There were **no significant differences** between the Pre- and Post-Studies.

- mentions cones

  Well, if I understand it right, it's showing you that, in the same way that we create different colors by mixing color tones, or color tints, your rods and cones do the same thing, they operate on a principle of, they're able to perceive in three different colors, but they mix those, and your nervous system is able to interpret that as to different shades and different tones of color.

  It shows you how your eye has cones that are respondent, three different colors, and a blend of two colors, can look the same as a pure spectra of color.

  Just pretty much shows the color sensors and how we pick up all the different colors, really.

- can't tell difference

  Yeah. Specifically based on how I saw/perceived those both as equally the same color but yet through another filter, or through a filter, I can see that they're not.

  Well, think it does, in he sense that the colors had looked the same and now, but when you put a filter up they look different.

  I guess that our perception of color is, less sensitive than you might think, like you can't tell the difference between two colors, just looking at it, but they're actually different. You can't tell it's just how much the, what is it? The cones are stimulated.

Does this exhibit seem relevant to your life in any way?

When looking at the answers to this question, we coded for visitors who:

a. answered yes;

b. talked about mixing colors

We looked at mixing colors because this came up in the Pre-Study and the exhibit developers explicitly stated that the exhibit was *not* about mixing colors. We wanted to see if that misperception was cleared up in the Post-Study. However, there were **no significant differences** between the Pre- and Post-Studies on this or any of the other responses to this question.

- yes

  in terms of understanding how I see [RT] computer screen works

  remember in school science class doing different things with colors and blocking out colors

  I work in an environment where we're always tryin' to match odd colors and so we are always mixing colors with other colors and I'm okay at it

  painting; hues, lighting, stages, fixtures

  traffic signals

  color blindness

  I'm thinking philosophically then, does that mean things that are different could actually be the same, i.e. people of different races and colors?

  rainbows

- mixing colors

  ..it's a lot like your shadow exhibit where, uh, the shadows don't change colors but the (inaudible), um, is, is, is like this, it's mixing the, the light waves(?) to give you a perception (inaudible). I mean, that's how Van Gogh painted it (inaudible) he didn't paint a color, he painted two colors next to each other

so that when they hit your eye (inaudible) they made the right (inaudible).

It's kind of like you're watching, like, movies, kind of, and, like, I've taken photography so this is kind of relevant when you're mixing the three colors to get the right spectrum.

Is there anything about this exhibit that might be confusing to other visitors?

When looking at the answers to this question, we coded for visitors who:

a. answered yes;
b. said they weren't sure what to do;
c. said they found the instructions confusing
d. said they found the filter confusing
e. said they found the concept confusing or too complex.

There were **no significant differences** between the Pre- and Post-Studies.

- Not sure what to do

  When we first sat down we were both confused a little bit, about what it was.

  It took me a minute to find where I was supposed to look.

  Just, I suppose when I first saw it, it wasn't quite yellow, or, I wasn't exactly sure what I was supposed to do.

- Instructions confusing

  We had a hard time figuring out what are they talking about…the yellow strips.

  And, again, I read this quickly, and initially when I read it, I thought it meant turn the knobs all the way to the left, so maybe, this wording could be changed too.

  I: So you're saying so the instructions next to the knobs, is a little unclear?

  M: Yeah, because this paragraph's next to this knob, this paragraph's next to this knob, and yeah, I got it eventually, but first time I did it, it was a little confusing.

I stopped, I lost interest. There's too much type and the, the dark on all these light colors is not a good way to present that for people to read it.

- Filter confusing

The filter definitely needs to be labeled or something, say, 'filter,' that was hard to find.

Well, the part kind of about the filter at first, was confusing. I didn't know what I was supposed to do with it at first, and then, after messing around with it for a bit, I figured it out, 'Oh, okay, when I put it here, I can see the red light, or I can see the green that's showing through,'

- Concept confusing/too complex

What I found confusing was the concept of pure yellow light.

Well, it might help if you had a sign that said what it was trying to pinpoint because from this, um, nothing really hit me.

I'm not sure. I haven't read the rest of the exhibits, but they might not understand the cone... I don't know if you have an exhibit that explains how the cone cells work, but it's not in this exhibit.

I think it's, there's not a good correlation, on the one hand you have different cone cells that respond to different unique wave lengths, and the other hand, how is it, working, what's that relationship, with the filtering out of certain aspects of these, it's almost like two different concepts.

MOTION DETECTION - Summary Results

The Exhibit - Pre-Study

The original "Motion Detection" consisted of a large, red, semicircular table. (The semicircle extended slightly more than 90 degrees to either side.) Visitors approached the flat (not the curved) side of the table to use the exhibit. Mounted on a circular pivot at what would be the approximate center of the circle (if it was a whole circle) and directly in front of where the visitor sits, was a long metal pole which extended toward the edge of the table, resting on the tabletop. At the end of the pole was a vertical white cylinder. The cylinder had a narrow rectangular window in it through which visitors could see black lines on a white ground. Just to the right of the circular pivot, next to the visitor, was a small button. Along the back, curved edge of the table were two graphic panels, perpendicular to the tabletop. The graphic panels had instructions and explanations of the exhibit, along with drawings of a mouse and an owl. Between the two text panels was a yellow pole.

Visitors approached the non-curved side of the exhibit, sat down and put their eyes near the level of the table. They were instructed to look straight ahead at a yellow pole and swing the white cylinder until they could "no longer see the colored diagonal lines." At that point, they were supposed to push the small button. This made the lines move inside the window of the white cylinder. The main message of the exhibit was that even though visitors can't see the white cylinder in their peripheral vision when the lines are still, they can see the lines moving.

Issues with the exhibit

Most of the pre-visitors (80%) got the basic concept of the exhibit—that it has to do with peripheral vision. Slightly more than half (53%) of the pre-visitors also got the main message of this exhibit, which is that it's easier to see motion in one's peripheral vision.

On the whole, visitors did pretty well with this exhibit. Changes to this exhibit were aimed at to help visitors understand the importance of motion in their peripheral vision.

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; current text refers to the cylinder markings.
- The main message - that we are "wired" to see motion even when we can't tell what it is that is moving - is emphasized.

Anticipated results

Since we were at a ceiling effect in the pre-study, with 80% of the visitors understanding that the exhibit is about peripheral vision, we didn't expect to see any dramatic changes in the post-test. We were looking for more subtle changes: more visitors articulating that the exhibit is about the importance of movement in their peripheral vision; more visitors mentioning that special cells in the eye are responsible for detecting motion in their peripheral vision; and more people mentioning that noticing motion in their peripheral vision is relevant to their daily lives.

Motion Detection - Pre-Post Differences

The only differences between the Pre- and Post-Study for "Motion Detection" was that significantly fewer post-visitors found the **directions confusing**. Forty-five percent (22 visitors) of pre-visitors vs. 22% (11 visitors) of post-visitors found the directions confusing.

We looked at each interview as a whole and found that there was **not a significant difference** between pre-and post-visitors who:

- articulated the main message of the exhibit
- articulated that the exhibit is about the importance of movement in their peripheral vision
- mentioned that special cells in the eye are responsible for detecting motion in their peripheral vision
- mentioned that noticing motion in their peripheral vision is relevant to their daily lives

Motion Detection - Detailed Results:

What did you try and what did you notice?

When looking at the answers to this question, we coded for visitors who

a. mentioned the main message of the exhibit: that you can't see some things in your peripheral vision until they move.

There were **no significant differences** between pre-and post-visitors.

- Motion main message

Well, I just tried the peripheral vision exhibit, and I noticed that you do notice objects that change, over things that are just still...first I, moved the white pillar around, to where my eye couldn't detect the black marks on it, and then I pushed the button to move the black marks and I could pick up the movement.

I tried moving the bar in front of my face and I noticed that I could actually see the diagonal lines until they got pretty far away, and then they kind of went out of focus but I knew they were still there, and once I pushed the button, and the lines were moving, then it was a lot easier to tell that they were there, right on the side of my face.

I put my nose where the nose was supposed to be, I moved the column, until the cylinder disappeared from peripheral vision, pressed the red button, and the cylinder then was noticeable.

What do you think this exhibit is trying to show?

When looking at the answers to this question, we coded for visitors who:

a. mentioned the main message of the exhibit: that you can't see some things in your peripheral vision until they move

b. said the exhibit is trying to show something about peripheral vision, but *didn't* mention the motion piece

c. talk about animals, and/or the relationship between predators and prey

• Motion Detection •

There were **no significant differences** between pre-and post-visitors mentioning a. the main message or b. talking about peripheral vision.

There were **significantly fewer visitors** in the Post-Study who talked about c. the **predator-prey relationship**. The label for the pre-exhibit showed drawings of an owl and a mouse, and though the text said nothing about the predator/prey relationship, many visitors picked up that message from the graphics alone. The graphics were removed in the post-exhibit with predictable results. Thirty-nine percent of pre-visitors (19 visitors) mentioned predator-prey, no post-visitors mentioned it.

- Motion main message

  That we actually have a highly refined peripheral vision that will pick up moving objects that I don't think you necessarily realize you have everyday as a skill or a talent or some survival instinct that we've been left over with, I guess. Yeah.

  That, even when you think that you can't see something, sometimes you can if it starts moving...

  That once things get out in your peripheral vision, you don't see them as well, but when it does move, it does catch your eye. You do see it.

- Peripheral vision

  Well, it's making, it's giving you an awareness of the nature of peripheral vision, I expect, it's trying to point out at least one facet of peripheral vision.

  ...but I would imagine that what it's trying to do, to see if you're aware of things happening behind you or on the side of you.

  for one thing, it certainly tells you about peripheral vision, and what you're able to see and at what point you're able to see it.

- Predator/prey

I think it's trying to show like the way that the human like geometry is set up with our eyes that we can only see a certain distance, like what's only in front of us. With predators such as like deer or any other kind of animal that need to be able to see in back of them at all times, it shows that they're a little bit more adapt to their surroundings.

Like it shows the picture of an owl. A lot of people know that owls can turn its head almost completely backwards. We know that deers, their eyes are positioned on the side of their heads so that they can see also behind them. But as far as humans, we can only see pretty much what's in front of us and barely see what's to each side

How, the animals that are prey know that the predator is coming-they can run away easy, 'cause they can see out of the corner of their eye.

Do you think this exhibit shows you anything about the human visual system?

When looking at the answers to this question, we coded for visitors who:

a. answered affirmatively

b. mentioned the main message of the exhibit: that you can't see some things in your peripheral vision until they move;

b. said the exhibit is trying to show something about peripheral vision, but *didn't* mention the motion piece;

c. says something about motion, but DOESN'T get the whole main message of the exhibit

d. talks about peripheral vision but DOESN'T mention the main message

There were **no significant differences** between pre-and post-visitors.

- answers affirmatively

Almost all visitors answered yes to this question. In hindsight, it was a pretty obvious question considering the context of the exhibit.

- Motion main message

Well exactly what I just explained about adding color, as in, or light, normally it would be out of my field of vision but by moving something and you know, the white lines for example, started moving, it popped back into vision, so, your body has the ability to, I guess push its threshold, like normally it would be out of sight, by adding motion or whatever it came back into sight.

Okay, so that says that it's able to detect motion. 'Motion sensitive cells in your brain….tells you that something is moving or changing,' All right, I hadn't read that last part until right now, so that, that makes sense. I mean it's sort of interesting, when you think about driving, and that your peripheral vision is able to see when something is moving or changing. So that's helpful. You know, when something's moving past you, or when you're driving

• Motion Detection •

When something is on your peripheral vision you may not see it but if it starts to move then obviously your eye picks it up, then you can see it more clearly.

- Motion but no main message

  I guess it shows that, I'm not real, well, I'm sure it does, it shows that we don't really notice things if they're not moving. And when they are moving they attract more attention with your eyes.

  You detect motion more than something that's not there.

  We're in tune with things that are moving.

- Peripheral vision but no main message

  Yeah. It shows you that you can see what's coming out of the corner of your eye without turning your head, or your eyes.

  your peripheral vision is limited

  that humans also have some capacity for peripheral vision and this sort of is an indication of at the angle that peripheral vision works

Does this exhibit seem relevant to your life in any way?

When looking at the answers to this question, we coded for visitors who:

a. answered affirmatively
b. mentioned the main message of the exhibit: that you can't see some things in your peripheral vision until they move
c. mentioned driving
d. mentioned peripheral vision

There were **no significant differences** between pre- and post-visitors.

- answered affirmatively

This was a tricky question, and people didn't always understand what the interviewer meant as "relevant." Sometimes visitors give an equivocal answer and probing gets details out that indicate that it is relevant. Sometimes they gave the probe "does this remind you of anything?" If they give examples of how this related or reminded them of everyday life, we coded their answer as a "yes:"

Yeah, I would say so. Sometimes you'll catch something out of the corner of your eye and, you know, and take a double-take like you don't see what you're seeing, things like that., I'll use an example. My wife's trying to scare me, walking through the house and, you know, I won't notice it but as soon as she starts to lunge at me I'll catch her out of my eye and I'll look over at her, 'what are you doing?' type thing.

Driving, definitely, 'cause like blind spots of cars and stuff, people, pedestrians moving. Sometimes you can see them in [..?..] sometimes you can't, that kind of thing.

- mentions motion main message

  Yeah, I think so, because it could be relevant for anything, like if you're crossing the street and a car is stopped, you might not notice it, if it's moving then you're probably going to notice it and not get run over, so, yeah.

  if you're guarding a guy and you start to see him in the corner of your eye, he starts moving, you can see him better while still keeping an eye on the guard

- mentions driving

  Sure. Driving, for example. Absolutely.

- mentions peripheral vision

  Yes. I think awareness of peripheral vision is very important and one of the most obvious cases of that is either riding a bicycle or driving an automobile, in that obstructions to your peripheral vision such as obstructing glasses or other people on your...or hats or anything else that are on the sides of your head really reduce your eye sensitivity.

Is there anything about this exhibit that other visitors might find confusing?

When looking at the answers to this question, we coded for visitors who:

a. answered affirmatively (if they say "It wasn't confusing to me, but others might find it confusing," we'd code that as a yes)
b. said that they had to read the directions
c. said that the directions were confusing
d. said that the they didn't know where to look

Significantly fewer post-visitors found the directions confusing. Forty-five percent (45%) of pre-visitors vs. 22% of post-visitors found the directions confusing.

chi p value = .033
chi2sub1=4.569

degrees of freedom = 1

However, there were **no significant differences** between pre- and post-visitors for the other issues.

- have to read directions (they talk about how they had to read the directions in order to understand the exhibit):

  Yes, I'd say that you have to really read the instructions all the way through first to make it work, otherwise, you're losing your concentration trying to read the instructions. Do one, and then you have to go back to two.

- directions are confusing

  The instructions in general. I had to read them several times.

  When I pushed the button I couldn't see anything, I kept re-reading the instructions, to make sure I would do it right.

- confused about where to look

  I didn't know where I was supposed to be looking/ I'm watching other people do this as well. Read the instructions carefully and do the same thing.

  The instructions was kind of confusing; I didn't know where to look at first.

PERIPHERAL VISION - Summary Results

The Exhibit - Pre-Study

The original "Peripheral Vision" consisted of a gray semicircular platform mounted on a table. Around the curved edge of the table were markings that indicated the degrees of a circle, with zero degrees at the center of the semicircle and 90 degrees marked at each side. At the edge of the circle at the center (0 degrees) was a small spring, mounted perpendicular to the surface of the table. Behind the spring was a lamp on a metal pole. The pole rose perpendicular to the tabletop, then made a 90 degree turn parallel to the tabletop. At the end of the pole was a light that shined down on the tabletop. On the pole, just behind the spring, were three bands of colored tape creating stripes of blue, yellow and red. Attached to the table by cables were three triangular blocks that had either a colored square, a shape or a word on each face.

A separate panel with instructions and explanations for the exhibit stood next to the exhibit.

Visitors approached the flat side of the semicircular table. They were instructed to put their eyes near the level of the table surface and stare straight ahead at a small spring. A helper took the block, beginning at the outer edge (around the 90 degree mark), and moved it slowly along the edge of the table. Visitors were instructed to mention when they first noticed the block. They were then supposed to tell the helper when they could first notice the color on the block, when they could first notice the shape on the block, and when they could read the word written on the block. They were supposed to keep their eyes looking straight ahead the whole time.

The main message of the exhibit was that, though they can notice things in their peripheral vision, they can only see detail in their central vision.

Issues with the exhibit

In the pre-test almost every visitor who tried this exhibit was able to access it at some level. 98% reported that they sat down, put their head in position, and noticed when they

saw a block in their peripheral vision. They understood that this exhibit was about measuring your peripheral vision.

However, far fewer pre-visitors experienced the next level of the exhibit. Only 39% said they used the different types of blocks to measure and compare when they could identify color, when they could identify shape, and when they could read the 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 is being tried so the exhibit can be experienced without a "helper."
- Redesigning the "spring" target.
- Simplifying the directions and integrating the text.
- Making the directions more clear.
- Integrating the text with the exhibit.

The main message was changed slightly in the post-test to: "you can see different kinds of information in different parts of your field of view."[5] The pre-test main message was that "you can see things most clearly in your central vision."

Anticipated results

During the second round of testing, we hoped to see more visitors

- talking about how they could see differently in different parts of their field of vision
- concluding that they can only see detail in their central vision.

[5] e-mail from Veronica Garcia-Luis, 9/20/02

Peripheral Vision - Pre-Post Differences

Main Message

When asked "What did you do and what did you notice?" **significantly more post-visitors articulated the main message.** The main message changed between the pre-and post-studies. The percentages below reflect the pre-visitors who articulated the pre-main message: that their vision is clearest in the center, and the post-visitors who articulated the post-main message -that they can see differently in different parts of their field of view.

15% of pre visitors vs.
64% of post-visitors

And I noticed that I could detect the shape sooner, or, more clearly in my peripheral vision than I could the word. I had to wait 'til the word was right in front of me to read it.

I noticed I saw color first before shape, and then shape, and that the colors and shapes were easier for me to decipher than the words. And that... as it came closer to the center of my vision, that I could easily tell what shape it was...

Vision clearest in center

When asked "What did you do and what did you notice?" significantly more post-visitors who took the next step and articulated that they can see most clearly when things are directly in front of them.

15% of pre-visitors
34% of post-visitors

I tried to see when I could see a shape or a color of the object, from the side of, well, basically, out of the corner of my eye, and as I pushed the object forward, then I could tell that I couldn't see...the detail on it until it was right in front of me. I thought that was pretty interesting. You know, and then I tried, on the other side, I tried to see if I could read a word, and it took all the way until it was almost directly in front of me. I couldn't believe it. I was surprised.

The words were very hard for me to get. And I had to put them pretty much center in order to understand what they were,

Peripheral Vision - Detailed Results

This coding scheme for these interviews was pretty straight-forward. It was aimed at trying to determine whether people articulated the main message of the exhibit: *that you can see different kinds of information in different parts of your field of view.*

What do you think this exhibit is trying to show?

When looking at the answers to this question, we coded for visitors who:

a. articulated the main message of the exhibit: that they can see differently in different parts of their field of view;

b. said that they can see most clearly in their central vision

There were **no significant differences** between pre- and post-visitors.

- articulated main message

How our sight is constructed, you know, limited, and we can see certain things in certain places, we can't see everything everywhere.

Like how peripheral vision works and even if you cannot read whatever is next...the side of your eyes, there is a point where you can start reading what...as they come closer to your front vision or main vision.

- center vision clearest

It's telling you that you really need to be looking almost directly at the object to see it really clearly.

your eyes don't have the capacity to focus completely that's coming around at the side, until it actually comes in front of your eye.

This exhibit illustrates the function of the rods and the cones...where you've got light sensitive or color

sensitive parts of the eye and how they're very concentrated at the center of the retina.

Do you think this exhibit shows you anything about the human visual system?

When looking at the answers to this question, we coded for visitors who:

a. answered affirmatively

b. articulated the main message of the exhibit: that they can see differently in different parts of their field of view;

c. said that they can see most clearly in their central vision

There were **no significant differences** between pre- and post-visitors. We didn't expect to see big differences in visitors answering this question affirmatively. In the pre-test almost all visitors (91%) said that they felt the exhibit was relevant to the human visual system, and in hindsight their response seems obvious given the context of the exhibit. We'd hoped that more visitors would articulate the main message of the exhibit, or say that they see most clearly in their central vision.

- answered affirmatively

  Yes, I think so...Basically, We have a very wide range, from ninety degrees left and ninety degrees right, we have a very wide range of what we can see, but the things that we can really know what it is and observe it is only one thing, when you're looking straight at , it's the easiest way to do it...

  Yeah, of course, well, just a matter of telling us how our peripheral vision works, even if we are not looking at our side or left or right where we are standing, we can in some way be aware of other objects or some other things happening around us.

- vision different

  Just that different parts of our eyes see different...differently.

  To show, again, I would say, what level of detail, of visual detail people perceive at different points along a continuum.

  R: I think it just shows the like scope of your peripheral vision, that it's different for different

things, for shapes and words, and that you see things at different places in your head[laughs]

- central vision clearest

  The human visual system sees more clearly right in front than on the sides.

  It has to be right in front of you for you to be able to read it, to be able to really notice it well.

Does this exhibit seem relevant to your life in any way?

When looking at the answers to this question, we coded for visitors who:

a. answered affirmatively
b. talked about driving

There were **no significant differences** between pre- and post-visitors. We didn't expect to see a big difference here in pre- and post-visitors since a large number (89%) of pre-visitors answered this question affirmatively. We'd hoped that more post-visitors would articulate the main message of the exhibit or talk about seeing most clearly in their central vision. However, very few mentioned either of these themes in response to this question.

- answered affirmatively

  Yeah, I think so, it does. In the sense that, I mean, we don't really take notice of what we do with our eyes and everything and how we look, this sort of gives you a brief description and idea of how your eyes work, and what you can do.

  Sure, just in the sense of understanding the way that the human mind works, and understanding the way that vision works and those are interesting things to be aware of on a day-to-day level. And also, well I suppose, peripheral vision is probably pretty important to the way that people get about on a day-to-day basis, walking around on the streets and seeing cars and things like that.

- talked about driving

  Oh yeah, definitely. Driving is an example.

  Relevant. I suppose, 'cause you get an idea of when you're driving, what your peripheral vision is, and how you don't notice things unless they're right in front of you.

  Uh, driving, because there you're looking at where, you know, your peripheral vision is, you're picking up movement of the front of a car coming up beside you, you don't need at that point to know exactly where it is or exactly what it is, but it gets your attention to

where you know you need to look to check and see what it is.

Is there anything about this exhibit that other visitors might find confusing?

When looking at the answers to this question, we coded for visitors who:

a. answered affirmatively

b. said the directions were confusing;

There were **no significant differences** between pre- and post-visitors.

- answered affirmatively

  I guess that I found the beginning confusing. I didn't know where to start.

  There's, just in the Information Age that we are in, there's a lot of reading, and you know, trying to figure out, and, you're also in a room that's filled with things, where people are reading and trying to figure things out…and I think that people these days are more into having somebody show them how to do something probably than having to re-figure it out for themselves, it's a sad state…[laughs].

- Directions, instructions confusing

  I think the instructions are a bit long. So maybe the steps can be shorter...

  I think the instructions are kind of hard to follow.

  Well, you do have to kind of be systematic and careful about the directions, you know I think, Jamie probably would have figured it out if he had taken the patience to read the directions, but the pace of the show, is such that, someone might not take the time to read the directions. The blocks were kind of hard to position too, they were a little awkward to position. You know, like maybe a button to push, that would move the block or something, I don't know. Or just a smoother operation

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APPENDIX A

Coded Responses by Question

Seeing 3-Exhibit Pre-Post Study

Katherine Whitney & Associates
1/9/03

SEEING YELLOW - Coded responses by question

1. What did you try with this exhibit and what did you notice?

There was **not a significant difference** between pre- and post-visitors who said that they were trying to, or that they did, **match the two yellows**, or adjust the lights so the blocks or the yellows matched.

	Yes	No	Tot	% Yes		
Pre	38	12	50	76%	χ^2 =	0.094
Post-	45	11	56	80%	d.f. =	1
Tot	83	23	106		Pr =	0.759

There was **not a significant difference** between pre- and post-visitors who **noticed that the yellows, are different:** that one is pure yellow and one is made of red and green light.

	Yes	No	Tot	% Yes		
Pre	12	38	50	24%	χ^2 =	1.660
Post	21	35	56	38%	d.f. =	1
Tot	33	73	106		Pr =	0.198
					Fisher Exact=	0.14751

There was **not a significant difference** between pre- and post-visitors who mentioned that they (or their eye or their brain) **can't tell the difference between the two yellows** (i.e. the yellow created by a combination of red and green and pure yellow.)

	Yes	No	Tot	% Yes		
Pre	5	45	50	10%	χ^2 =	0.402
Post	9	47	56	16%	d.f. =	1
Tot	14	92	106		Pr =	0.526
					Fisher Exact=	0.402

2. What do you think this exhibit is trying to show?

There was **not a significant difference** between pre- and post-visitors who thought the exhibit was trying to show **how our brains/eyes process/see color.**

	Yes	No	Tot	% Yes		
Pre	19	31	50	38%	χ^2 =	0.004
Post	22	34	56	39%	d.f. =	1
Tot	41	65	106		Pr =	0.949

There was **not a significant difference** between pre- and post-visitors who mentioned **cones or color sensors.**

	Yes	No	Tot	% Yes		
Pre	6	44	50	12%	χ^2 =	2.129
Post	14	42	56	25%	d.f. =	1
Tot	20	86	106		Pr =	0.145
					Fisher Exact =	0.1346 9

There was **not a significant difference** between pre- and post-visitors who thought the exhibit was about how we (or our eye or our brain) **can't tell the difference between the two yellows** (i.e. the yellow created by a combination of red and green and pure yellow.)

	Yes	No	Tot	% Yes		
Pre	8	42	50	16%	χ^2 =	0.811
Post	14	42	56	25%	d.f. =	1
Tot	22	84	106		Pr =	0.368

3. Do you think this exhibit shows you anything about the human visual system?

There was **not a significant difference** between pre- and post-visitors who **mentioned cones** or color sensors or special cells for color.

	Yes	No	Tot	% Yes		
Pre	6	44	50	12%	χ^2 =	0.004
Post	8	48	56	14%	d.f. =	1
Tot	14	92	106		Pr =	0.952

There was **not a significant difference** between pre- and post-visitors who mentioned that they (or their eye or their brain) **can't tell the difference between the two yellows** (i.e. the yellow created by a combination of red and green and pure yellow.)

	Yes	No	Tot	% Yes		
Pre	5	45	50	10%	χ^2 =	0.141
Post	8	48	56	14%	d.f. =	1
Tot	13	93	106		Pr =	0.708

4.Do you think this exhibit shows you anything about how you see color?

There was **not a significant difference** between pre- and post-visitors who mentioned cones, but there **was a trend toward more post-visitors mentioning cones.**

	Yes	No	Tot	% Yes		
Pre	2	48	50	4%	χ^2 =	3.766
Post	10	46	56	18%	d.f. =	1
Tot	12	94	106		Pr =	0.052
					Fisher Exact =	0.034

There was **not a significant difference** between pre- and post-visitors who mentioned that they (or their eye or their brain) **can't tell the difference between the two yellows** (i.e. the yellow created by a combination of red and green and pure yellow.)

	Yes	No	Tot	% Yes		
Pre	7	43	50	14%	χ^2 =	0.001
Post	9	47	56	16%	d.f. =	1
Tot	16	90	106		Pr =	0.980

5. Does this exhibit seem relevant to your life in any way?

There was **not a significant difference** between pre- and post-visitors who said that this exhibit seems relevant to their life.

	Yes	No	Tot	% Yes		
Pre	26	24	50	52%	χ^2 =	0.030
Post	29	27	56	52%	d.f. =	1
Tot	55	51	106		Pr =	0.863

There was **not a significant difference** between pre- and post-visitors who **talked about mixing color.**

	Yes	No	Tot	% Yes		
Pre	10	40	50	20%	χ^2 =	0.617
Post	7	49	56	13%	d.f. =	1
Tot	17	89	106		Pr =	0.432

6. Is there anything about this exhibit that might be confusing to other visitors?

There was **not a significant difference** between pre- and post-visitors who thought the **exhibit might be confusing** to other visitors.

	Yes	No	Tot	% Yes		
Pre	20	29	49	41%	χ^2 =	0.070
Post	20	35	55	36%	d.f. =	1
Tot	40	64	104		Pr =	0.792

Of those who thought the exhibit might be confusing, there was **not a significant difference** between pre- and post-visitors who **were confused about what to do.**

	Yes	No	Tot	% Yes		
Pre	5	15	20	25%	χ^2 =	0.315
Post	9	15	24	38%	d.f. =	1

Tot	14	30	44	Pr =	0.575

Of those who thought the exhibit might be confusing, there was **not a significant difference** between pre- and post-visitors who **were confused about the instructions.**

	Yes	No	Tot	% Yes		
Pre	12	8	20	60%	χ^2 =	0.000
Post	11	9	20	55%	d.f. =	1
Tot	23	17	40		Pr =	1.000

Of those who thought the exhibit might be confusing, there was **not a significant difference** between pre- and post-visitors who **were confused about what to** do.

	Yes	No	Tot	% Yes		
Pre	4	16	20	20%	χ^2 =	0.156
Post	4	16	20	20%	d.f. =	1
Tot	8	32	40		Pr =	0.693

Of those who thought the exhibit might be confusing, there was **not a significant difference** between pre- and post-visitors who **were confused by the exhibit concept.**

	Yes	No	Tot	% Yes		
Pre	1	19	20	5%	χ^2 =	2.771
Post	6	14	20	30%	d.f. =	1
Tot	7	33	40		Pr =	0.096

General Observations:

There **was a significant difference** between pre- and post-visitors who made a **reference to cones** at some time during the interview (Pre = 22% and Post = 46%).

	Yes	No	Tot	% Yes		
Pre	11	39	50	22%	χ^2 =	5.904

Post		26	30	56	46%	d.f. =	1
	Tot	37	69	106		Pr =	**0.015**
						Fisher Exact=	0.014

There was no significant difference between pre- and post-visitors who said they **can't tell the difference between the yellows.**

		Yes	No	Tot	% Yes		
Pre		12	38	50	24%	χ^2 =	2.175
Post		22	34	56	39%	d.f. =	1
	Tot	34	72	106		Pr =	0.140
						Fisher Exact=	0.101

MOTION DETECTION - Coded Responses by Question

1. What did you try and what did you notice?

There was **not a significant difference** between pre- and post-visitors mentioning the **main message** of the exhibit—that you can't see some things in your peripheral vision until they move— when asked what they noticed.

	Yes	No	Tot	% Yes		
Pre	25	24	49	51%	χ^2 =	0.041
Post	27	22	49	55%	d.f. =	1
Tot	52	46	98		Pr =	0.840

2. What do you think this exhibit is trying to show?

There was **not a significant difference** between pre- and post-visitors mentioning the **main message** of the exhibit—that you can't see some things in your peripheral vision until they move— when asked what they thought the exhibit was trying to show.

	Yes	No	Tot	% Yes		
Pre	21	28	49	43%	χ^2 =	0.000
Post	22	27	49	45%	d.f. =	1
Tot	43	55	98		Pr =	1.000

There was **not a significant difference** between pre- and post-visitors who thought the exhibit was trying to show something about **peripheral vision.**

	Yes	No	Tot	% Yes		
Pre	34	15	49	69%	χ^2 =	0.859
Post	39	10	49	80%	d.f. =	1
Tot	73	25	98		Pr =	0.354

There **was a significant difference** between pre- and post-visitors who **mentioned animals and the predator/prey relationship**. This result was expected and can be explained by the fact that the graphics in the Pre-Study exhibit showed illustrations of (but no text about) an owl and a mouse. These illustrations were removed from the exhibit in the Post-Study. This finding was expected and has no bearing on the overall results of the exhibit modifications. It does point out, however, the power of visual images.

	Yes	No	Tot	% Yes		
Pre	19	30	49	39%	χ^2 =	21.154
Post	0	49	49	0%	d.f. =	1
Tot	19	79	98		Pr =	0.000

3. Do you think this exhibit shows you anything about the human visual system?

There was **not a significant difference** between pre- and post-visitors who thought the exhibit was trying to show something about the **human visual system**. This is not unexpected. Most people both pre and post thought the exhibit had to do with the human visual system. An obvious response given the context.

	Yes	No	Tot	% Yes		
Pre	46	3	49	94%	χ^2 =	0.000
Post	45	4	49	92%	d.f. =	1
Tot	91	7	98		Pr =	1.000

[6]

There was **not a significant difference** between pre- and post-visitors mentioning the **main message** of the exhibit—that you can't see some things in your peripheral vision until they move— when if they thought the exhibit showed them something about the human visual system.

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[6] *Note from Ray Wright, who coded and analyzed this data: "I calculated the Fisher Exact test for all 2x2 tables that had at least one cell with 5 or less counts. Where it yields a probability different than that of the Chi-Square calculation, I note the Fisher Pr in the row below the table. In no case did it change the conclusions that one might draw."*

Motion Detection

	Yes	No	Tot	% Yes		
Pre	18	31	49	37%	χ^2 =	0.000
Post	19	30	49	39%	d.f. =	1
Tot	37	61	98		Pr =	1.000

There was **not a significant difference** between pre- and post-visitors who talked about **peripheral vision,** when asked if they thought the exhibit showed them something about the human visual system.

	Yes	No	Tot	% Yes		
Pre	24	25	49	49%	χ^2 =	0.657
Post	29	20	49	59%	d.f. =	1
Tot	53	45	98		Pr =	0.417

There was **not a significant difference** between pre- and post-visitors who said something about **motion** but did *not* manage to articulate the main message— that you can't see some things in your peripheral vision until they move.

	Yes	No	Tot	% Yes		
Pre	21	28	49	43%	χ^2 =	2.001
Post	29	20	49	59%	d.f. =	1
Tot	50	48	98		Pr =	0.157

4. Does this exhibit seem relevant to your life in any way?

More pre-visitors said that the exhibit seemed **relevant to their lives.** This was not a significant difference, but it did **indicate a trend.** This reduction of post-visitors saying the exhibit is relevant to their lives might be explained by the fact that so many of the new *Seeing* collection exhibits make a direct connection to everyday life that this exhibit seems less relevant in the post-collection context than it did in the pre-collection.

	Yes	No	Tot	% Yes		
Pre	40	9	49	82%	χ^2 =	3.272
Post	31	18	49	63%	d.f. =	1
Tot	71	27	98		Pr =	0.070

There was **not a significant difference** between pre- and post-visitors who articulated the **main message** of the exhibit—that you can't see some things in your peripheral vision until they move—when asked if the exhibit was relevant to their life. In both cases the numbers were pretty low.

	Yes	No	Tot	% Yes		
Pre	11	38	49	22%	χ^2 =	0.055
Post	13	36	49	27%	d.f. =	1
Tot	24	74	98		Pr =	0.814

There was **not a significant difference** between pre- and post-visitors who mentioned **peripheral vision** when asked if the exhibit was relevant to their life.

	Yes	No	Tot	% Yes		
Pre	21	28	49	43%	χ^2 =	1.098
Post	15	34	49	31%	d.f. =	1
Tot	36	62	98		Pr =	0.295

There was **not a significant difference** between pre- and post-visitors who mentioned **driving** when asked if the exhibit was relevant to their life.

	Yes	No	Tot	% Yes		
Pre	20	29	49	41%	χ^2 =	0.042
Post	22	27	49	45%	d.f. =	1
Tot	42	56	98		Pr =	0.838

5. Is there anything about this exhibit that other visitors might find confusing?

There was **not a significant difference** between pre- and post-visitors who thought the exhibit might be **confusing to other visitors.**

	Yes	No	Tot	% Yes		
Pre	30	19	49	61%	χ^2 =	2.617

Post	21	28	49	43%	d.f. =	1
Tot	51	47	98		Pr =	0.106

There was **not a significant difference** between pre- and post-visitors who commented that they had to **read the directions** before they could understand the exhibit.

	Yes	No	Tot	% Yes		
Pre	11	38	49	22%	χ^2 =	0.613
Post	7	42	49	14%	d.f. =	1
Tot	18	80	98		Pr =	0.434

Significantly fewer post-visitors found the **directions confusing.**

	Yes	No	Tot	% Yes		
Pre	22	27	49	45%	χ^2 =	4.569
Post	11	38	49	22%	d.f. =	1
Tot	33	65	98		Pr =	0.033

There was **not a significant difference** between pre- and post-visitors who commented that they did not know **where to look** when using the exhibit.

	Yes	No	Tot	% Yes		
Pre	4	45	49	8%	χ^2 =	0.136
Post	4	45	49	8%	d.f. =	1
Tot	8	90	98		Pr =	0.712
					FishEx	1.000

There was **not a significant difference** between pre- and post-visitors who **articulated the main message** at any time during the interview.

	Yes	No	Tot	% Yes		
Pre	32	17	49	65%	χ^2 =	0.784
Post	37	12	49	76%	d.f. =	1
Tot	69	29	98		Pr =	0.376

PERIPHERAL VISION - Coded Responses by Question

1. What did you try with the exhibit and what did you notice?

There were **significantly more post-visitors** who articulated the **main message** of the exhibit—that you can see different kinds of information in different parts of your field of view.

	Yes	No	Tot	% Yes		
Pre	12	36	48	25%	χ^2 =	13.521
Post	32	18	50	64%	d.f. =	1
Tot	44	54	98		Pr =	0.000

Vision clearest in center

There were **significantly more post-visitors** who took the next step and articulated that they can **see most clearly in their central vision.**

	Yes	No	Tot	% Yes		
Pre	7	41	48	15%	χ^2 =	3.998
Post	17	33	50	34%	d.f. =	1
Tot	24	74	98		Pr =	0.046

2. What do you think this exhibit is trying to show?

Main message

There was **no significant difference** between pre- and post-visitors who said that the exhibit was trying to show they can **see differently in different parts of their field of view.**

	Yes	No	Tot	% Yes		
Pre	19	29	48	40%	χ^2 =	0.694
Post	25	25	50	50%	d.f. =	1
Tot	44	54	98		Pr =	0.405

There was **no significant difference** between pre- and post-visitors who said that the exhibit was trying to show they can see **most clearly in their central vision.**

	Yes	No	Tot	% Yes		
Pre	11	37	48	23%	χ^2 =	0.018
Post	11	39	50	22%	d.f. =	1
Tot	22	76	98		Pr =	0.894

There was **no significant difference** between pre- and post-visitors who mentioned **special cells** in their eyes, when asked what the exhibit was trying to show.

	Yes	No	Tot	% Yes		
Pre	2	46	48	4%	χ^2 =	1.096
Post	6	44	50	12%	d.f. =	1
Tot	8	90	98		Pr =	0.295
					FishEx.	0.269

3. Do you think this exhibit shows you anything about the human visual system?

There was **no significant difference** between pre- and post-visitors who thought the exhibit showed them **something about the human visual system.** Almost everyone answered affirmatively. This was not surprising given the context of the exhibit.

	Yes	No	Tot	% Yes		
Pre	47	1	48	98%	χ^2 =	0.511
Post	47	1	48	98%	d.f. =	1
Tot	94	2	96		Pr =	0.475
					FishEx.	1.000

There was **no significant difference** between pre- and post-visitors who **articulated the main message** - that they can see differently in different parts of their field of view - when asked if the exhibit showed them anything about the human visual system.

	Yes	No	Tot	% Yes		
Pre	18	30	48	38%	χ^2 =	0.000
Post	17	31	48	35%	d.f. =	1
Tot	35	61	96		Pr =	1.000

There was **no significant difference** between pre- and post-visitors who talked about how they can see more **clearly in their central vision,** when asked if the exhibit showed them anything about the human visual system.

	Yes	No	Tot	% Yes		
Pre	7	41	48	15%	χ^2 =	0.000
Post	8	40	48	17%	d.f. =	1
Tot	15	81	96		Pr =	1.000

4. Does this exhibit seem relevant to your life in any way?

There was **no significant difference** between pre- and post-visitors who thought the exhibit seemed relevant to their lives. Most visitors answered in the affirmative. Given that 88% of the pre-visitors said yes, we did not expect to see a big difference here.

	Yes	No	Tot	% Yes		
Pre	42	6	48	88%	χ^2 =	0.005
Post	45	5	50	90%	d.f. =	1
Tot	87	11	98		Pr =	0.943

There was **no significant difference** between pre- and post-visitors who thought that the exhibit was relevant to their lives in a way that related to **driving.**

	Yes	No	Tot	% Yes		
Pre	29	19	48	60%	χ^2 =	0.694
Post	25	25	50	50%	d.f. =	1
Tot	54	44	98		Pr =	0.405

5. Is there anything about this exhibit that other visitors might find confusing?

There was **no significant difference** between pre- and post-visitors who thought other visitors might find the exhibit **confusing.**

	Yes	No	Tot	% Yes		
Pre	14	34	48	29%	χ^2 =	0.088
Post	17	33	50	34%	d.f. =	1
Tot	31	67	98		Pr =	0.766

There was **no significant difference** between pre- and post-visitors who specifically mentioned the **directions being confusing.**

	Yes	No	Tot	% Yes		
Pre	14	34	48	29%	χ^2 =	0.088
Post	17	33	50	34%	d.f. =	1
Tot	31	67	98		Pr =	0.766

There was **no significant difference** between pre- and post-visitors who said they weren't sure **where to look** when using the exhibit.

	Yes	No	Tot	% Yes		
Pre	3	45	48	6%	χ^2 =	0.305
Post	1	49	50	2%	d.f. =	1
Tot	4	94	98		Pr =	0.581
					FishEx	0.357

Peripheral Vision

6. Articulates main message at some point in interview?

There was **no significant difference** between pre- and post-visitors who **articulated the main message**—that you can see different kinds of information in different parts of your field of view— at some point during the interview.

	Yes	No	Tot	% Yes		
Pre	32	16	48	67%	χ^2 =	0.638
Post	38	12	50	76%	d.f. =	1
Tot	70	28	98		Pr =	0.424

7. Articulates that vision is clearest in central vision at some point during the interview?

There was **no significant difference** between pre- and post-visitors who commented that they **see most clearly in their central vision.**

	Yes	No	Tot	% Yes		
Pre	20	28	48	42%	χ^2 =	0.001
Post	22	28	50	44%	d.f. =	1
Tot	42	56	98		Pr =	0.977

Appendix B

Interviewing Methods

Seeing 3-Exhibit Pre-Post Study

Katherine Whitney & Associates
1/9/03

General Methods

1. Every third *eligible* person to cross an imaginary line was selected for an interview. Eligible candidates were defined as adult visitors and children 10 years and older. That meant if a child under 10, or a person wearing a black dot (indicating that they'd already been interviewed) or an Exploratorium employee or any other ineligible person crossed the line, they weren't counted. The interviewer picked up the counting sequence with next eligible person to cross the line.

2. The interviewer introduced themselves to the candidate according to a script (See Appendix D - Evaluation Instruments)

3. The interviewer encouraged the candidate to use the exhibit, and observed for particular behaviors. The interviewer made notes about the candidate's behavior on the evaluation instrument.

4. The interview began when the candidate determined they were done interacting with the exhibit. The interviews were taped.

5. After the interview, the candidate was asked to sign an Exploratorium consent form and to complete a brief demographic form.

6. At the end of the interview, the candidates were thanked for their time and given a black dot to put on their Exploratorium sticker, to indicate that they had been interviewed.

7. The candidates were not given gifts.

Details

1. When asking candidates "What did you do and what did you notice?" interviewers found it helpful to interrupt them as they listed their steps ("First I did this, then this, then this...") and ask "What did you notice?" rather than wait until they had described everything they did at the exhibit. What they noticed at each particular point in the exhibit is as important as what they did.

2. When asking the question "Does this exhibit seem relevant to your life?" some interviewers found that visitors did not understand the question. They found it helpful to add the following probes (to those already in the script): "Is this something you've experienced before? Does this remind you of anything out in the world? Can you give me an example?

3. Interviewers sometimes reassured candidates up front and throughout the interview that the interview was not a test, and that the exhibit was the thing on trial. We felt it was important that the visitor feel comfortable and not on the spot.

4. Interviewers found it helpful sometimes to tell visitors up front that they would be happy to answer any questions after the interview was completed.

5. Candidates were selected as usual for the exhibit "Peripheral Vision." (The third eligible person to cross an imaginary line.) They were then asked to find a friend to help them with the exhibit. Only the initial candidate was interviewed, however. The friend usually stuck around, but the interview was strongly directed toward the initial candidate.

6. "Peripheral Vision" observation and interviews took a little longer than the other two exhibits. The two people usually switched off and did both the looking and the "helping." And there was a lot for them to read before they could understand what to do with this exhibit.

7. Interviewers found it helpful to hide the two stools that usually sat in front of the exhibit "Seeing Yellow" to discourage non-candidate visitors from sitting down and using the exhibit. They found it awkward to recruit a candidate and then have to wait for another visitor to finish using the exhibit. The interviewers pulled out the stools once they'd selected and cued the candidate.

8. Interviewers found it helpful to conduct interviews sitting right in front of "Seeing Yellow" so that candidates could refer to the exhibit labels and components

as they described their experience. This was also helpful at the other exhibits.

9. Interviewers started recruiting visitors shortly after the museum opened. It usually took a while for visitors to get to the back of the museum, where the exhibits were located. The last recruit was at 4pm.

APPENDIX C

Evaluation Instruments

Seeing 3-Exhibit Pre-Post Study

Katherine Whitney & Associates
1/9/03

Seeing Evaluation Pilot Instrument – **SEEING YELLOW**

Date:_____ Time: :_____Interview #: :_____

Initials: ____

Hi, my name is _____ and I work here. We're trying to figure out who well these exhibits are working for people. Would you be willing to help us? It will take about 5-10 minutes.

Please use this exhibit. Take as long as you like. Read, play, get farther. And when you're finished, I'd like to ask you a few questions.

Group Size: 1 2 3 4 5+

Group: A A+K A+T T (13-17) K(<12)

ESL: N Y Yes, but fluent

Observations:

Turned knobs to adjust color? Y N

	At left	At right	Looked through
Used filter			
Used spectroscope			

Other observations:

Interview Questions: Seeing Yellow

1. Could you tell me what you tried with this exhibit and what you noticed? (Probe: Can you walk me through the steps you took?)

2. What do you think this exhibit is trying to show? (Could you say a bit more about what it shows?)

3. Do you think this exhibit shows you anything about the human visual system? (Could you say a bit more about what it shows?)

4. Do you think this exhibit shows you anything about how you see color? (Could you say a bit more about what it shows?)

5. Does this exhibit seem relevant to your life in any way?

6. Is there anything about this exhibit that other visitors might find confusing?

7. Anything else?

Seeing Evaluation Instrument - **MOTION DETECTION**

Date:_____ Time: :_____Interview #: :_____

Initials: ____

Hi, my name is _____ and I work here. We're trying to figure out who well these exhibits are working for people. Would you be willing to help us? It will take about 5-10 minutes.

Please use this exhibit. Take as long as you like. Read, play, get farther. And when you're finished, I'd like to ask you a few questions.

Group Size: 1 2 3 4 5+

Group: A A+K A+T T (13-17) K(<12) Cued

ESL: N Y Yes, but fluent

Observations:

Stands at center: Y N

chin on table? Y N

Had the critical experience?

(stopped cylinder AND pushed button) Y N

Moves cylinder?

Y N Unknown

Pushed button

Y N Unknown

Location of cylinder when stopped and button pushed

22 45° 68° 90°

other observations:

Interview Questions: Motion Detection

1. Could you tell me what you tried with this exhibit and what you noticed? (Probe: Can you walk me through the steps you took?)
(If they moved the cylinder out to the side: What did you notice when you had the white thing out to the side?)

2. What do you think this exhibit is trying to show? (Could you say a bit more about what it shows?)

3. Do you think this exhibit shows you anything about the human visual system? (Could you say a bit more about what it shows?)

4. Does this exhibit seem relevant to your life in any way?

5. Is there anything about this exhibit that other visitors might find confusing?

6. Anything else?

Seeing Evaluation Pilot Instrument - **PERIPHERAL VISION**

Date:_____ Time: :_____Interview #: :_____

Initials: ____

Hi, my name is _____ and I work here. We're trying to figure out who well these exhibits are working for people. Would you be willing to help us? It will take about 5-10 minutes.

Please use this exhibit. Take as long as you like. Read, play, get farther. And when you're finished, I'd like to ask you a few questions.

Group Size: 1 2 3 4 5+

Group: A A+K A+T T (13-17) K(<12) Cued

ESL: N Y Yes, but fluent

Observations:

Head positioned correctly Y N

Helper starts block at outer edge of semi-circle Y N

Helper moves block slowly Y N

User identifies spot where they first see block Y N

Other observations:

Interview Questions: Peripheral Vision

1. Could you tell me what you tried with this exhibit and what you noticed? (Probe: Can you walk me through the steps you took?)
(If they moved the cylinder out to the side: What did you notice when you had the white thing out to the side?)

2. What do you think this exhibit is trying to show? (Could you say a bit more about what it shows?)

3. Do you think this exhibit shows you anything about the human visual system? (Could you say a bit more about what it shows?)

4. Does this exhibit seem relevant to your life in any way?

5. Is there anything about this exhibit that other visitors might find confusing?

6. Anything else?