

FINAL SUMMARY EVALUATION REPORT

For:

Traits of Life

**A Collection of Life Science
Exhibits**

**The Exploratorium,
San Francisco, CA**

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THE TRAITS OF LIFE EXHIBITION

In 1998, the Exploratorium staff submitted a proposal to the National Science Foundation to develop a collection of life science exhibits "to offer science center visitors new ways to explore characteristics shared by all living things."

The intention was to combine existing Exploratorium components as well as new exhibits and emphasize in the exhibit collection "that all life, no matter how diverse, shares common essential traits." This proposal was one of a series planned to develop permanent exhibits at the Exploratorium. To quote from the proposal:

Traits of Life is the second exhibit development project in a multiyear initiative in progress at the Exploratorium that represents a transformation in how we conceive of exhibits and programs, and how we create experiences with visitors. The goal is to create an enhanced public learning environment that will be accessible and engaging to adult and child, student and teacher, novice and expert. . .

Our visitor-directed goals are to create experiences that:

- Encourage visitors, through experimentation, observation, and comparison to recognize a variety of traits shared by living organisms and living systems
- Help visitors find ways of thinking about the commonality of traits among a diversity of life
- Help visitors understand the interconnectedness of organisms and their adaptations over time.

(NSF Proposal Summary, p. C-1, 2)

The full proposal included plans for artist-in-residence projects, publications, links to formal education, a wide variety of public programs as well as a travelling exhibit derived from the main, permanent exhibition at the Exploratorium.

Work on this project began in 1999. Exploratorium staff carried out front-end evaluation on potential visitors and extensive formative evaluation work as new exhibit components were developed and tested on the floor.

By 2001, a number of existing components had been brought together in one area and new ones in various stages of development put out on the floor and tested with visitors. By the end of that year, the components were grouped together on the balcony section of the Exploratorium and design of the space was begun.

The exhibit opened in October 2002. The goals of the project, as far as the exhibition was concerned, were reemphasized in a brochure prepared for visitors at that time.

Variety is the spice of life—or is it?

Earth hosts millions of species in myriad forms—a fraction of all that have gone before—but this riotous diversity masks an underlying unity.

Woodpecker and tree, and elephant, bacterium and human—deep down, we're all alike. Our methods may vary, but we all use energy and reproduce. As species, we all evolve. And we're all made of the same ingredients—cells.

The TRAITS OF LIFE collection is broken up into four sections organized around defining features of living things. We've designed these sections to help visitors explore these signature traits and appreciate their significance. We have chosen four categories: The Stuff of Life, Making More Life, Change Over Time and Life Uses Energy. Each section comprises four to ten exhibits and activities.

EVALUATION

Overview

The Exploratorium contracted with George Hein, Professor Emeritus, Lesley University, to carry out the summative evaluation of the exhibition itself.

Prof. Hein met with the advisory committee during the development of the exhibition, and talked with in-house evaluation staff and exhibit developers on several occasions. He visited the newly grouped exhibits early in 2002. The evaluation plan was developed in collaboration with Kathy McLean, Charles Carlson and Sue Allen of the Exploratorium staff.

The evaluation was intended to document several aspects of visitors' response to the exhibition. These included:

1. What do visitors actually do in the exhibition (their behavior)?
2. Does it lead them to new ways of thinking about traits of life?
3. Are they intrigued by individual exhibit components?
4. Do they appreciate the commonalities of life forms?
5. Do they practice and enhance observation skills?
6. Does it encourage conversations related to life sciences?

An additional evaluation goal, added later in the process, was:

7. Did visitors recognize this group of exhibits as different in design from other Exploratorium exhibits?

The evaluation plan consisted of three separate methods for collecting data, a tracking study, intensive, interactive observations at selected components and exit interviews. The three components were intended to gather overlapping data on the seven evaluation goals. The proposed relationship between the methods and the evaluation goals is illustrated in Table 1 below. All the qualitative data were read and reread to elicit the themes that might be contain using standard methods. Quantitative analysis was applied as appropriate.

Table 1
Evaluation Components and Data

	Tracking	Observation	Interviews
Behavior	X	X	
New Thinking			X
Intrigued (Interested)	X	X	X
Commonalities			X
Observation skills		X	
Conversations		X	X
Exhibit design			X

The evaluation team consisted of George Hein, consultant, lead evaluator; Elsa Bailey, Ph. D. candidate, Lesley University; Kerry Bronnenkant, exhibit evaluator at the New England Aquarium (at the time of the evaluation); and two interviewers from the San Francisco area, Mary Kidwell and Jackie Wong. The Boston area evaluation group had worked together on several previous evaluations.

The original plan called for all the work to be carried out in October-November 2002. Because the complete exhibition was not ready for summative evaluation, the work was divided and carried out over a longer time period. Some of the observations were carried out on components that had already been installed at the end of October 2002. The tracking, additional observations and interviews were conducted in January 2003.

Tracking

Tracking was conducted on consecutive days, January 4-12, every day except Monday, 1/6/03 (the Exploratorium is not open on Mondays) and Wednesday, 1/8/03. Approximately 75% of visitors were tracked on the four weekend days; the rest were tracked on the three weekdays. Obvious school groups or other large parties were not included, although individuals or small groups sometimes were actually part of larger group, but looking at the exhibits independently of any teacher or group leader and not engaged in an obvious school task. Groups of visitors were selected as they entered the designated area from either side of the exhibition. Forty-five groups who entered from the left side (facing the balcony) and 55 groups entering from the right side (facing the balcony) were tracked. The first person to stop long enough to be noted (minimum 5 seconds) was the person in the group designated to be followed and tracked.

Interactive Observations

Selected components of the whole collection were chosen for more detailed study by the Exploratorium staff. For each, an observer (either Elsa Bailey or

George Hein) watched approximately 20 visitor groups as they interacted with that component and attempted to record both behavior and conversation. Elsa Bailey carried out a majority of these observations in late October 2002. She frequently asked visitors to describe their experience and conducted informal interviews to get a better sense of what the visitors were experiencing as they engaged with the component. George Hein carried out some more observations in January 2003. His work was simultaneous with the tracking study, so in order not to compromise the tracking study, since it was possible that the visitors observed were being tracked, he seldom engaged visitors in conversation.

Exit Interviews

Exit interviews were conducted as visitor groups left either side of the exhibition. The second person to cross an invisible line was asked if he or she could be interviewed. If this person was part of a group, the interviewer suggested that the group pick some place to meet, so that the interview could be carried out with just the chosen respondent. Children under the age of 10 were not interviewed. The interviewer and subject sat on a bench near the group of exhibits.

The following statement preceded the interview:

Excuse me, my name is _____ and I'm talking to visitors today to get some feedback about this group of exhibits. We are trying to improve the visitor experience at the Exploratorium and your assistance will help everyone that comes to the museum. Would you give about 10 minutes of your time to answer some questions?

Interviews occasionally lasted significantly longer than 10 minutes—a few took over half an hour—but most were completed in 8-15 minutes. As much as possible interviewers asked subjects to expand on short answers with prompts such as “Could you say a little more about that?” or other encouraging comments. The complete interview protocol is included in an appendix.

Seventy visitors, chosen after they had visited the exhibits, were interviewed. In an effort to see whether “cued” visitors might have a deeper and richer experience visiting the exhibits, an additional 40 visitors were interviewed who had been approached before they went to the exhibits and asked whether they would be willing to answer some questions after they had visited “this group of exhibits for as long or short a time as they wished.”

The Report

The data gathered from tracking, interactive observations and interviews were read and reread in order both to summarize the results of each method and to be able to present the best possible summary of information for each set of

interactive observations and each interview question. Where feasible, the categories of answers to questions have been presented in tables, indicating frequency of responses for each type of answer. Like all qualitative analysis, these summaries represent the best judgement of the evaluator. Full transcripts of all the data have been made available to the Exploratorium research staff.

In addition, selected samples of individual observations or individual interview responses are provided. Unless noted otherwise, the quotations are intended to be representative — both in relative quantity and in quality — of observed visitor activities, comments and responses. In a few instances, in order to illustrate a point, selections are not representative and are so indicated.

FINDINGS

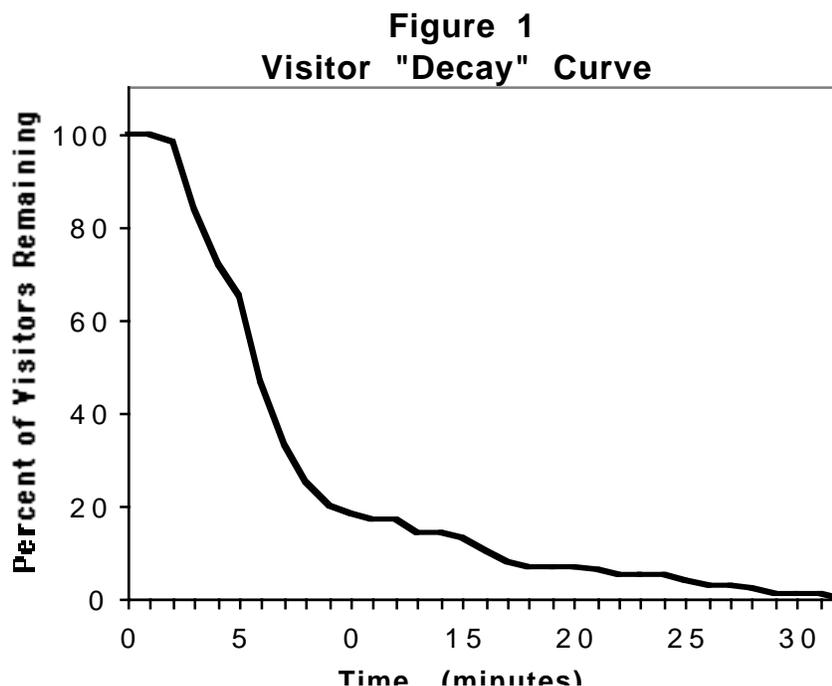
Tracking Study

The tracking study consisted of 100 visitors tracked through the exhibition from either entrance, using the components designated as a part of *Traits of Life*.

To qualify for the study one member of the designated visitor group had to pause at an exhibit component. This became the group member tracked. Thus, the most casual visitor groups were excluded.

The area tracked was defined as a group of 50 components identified separately for purposes of tracking, containing various life science exhibits. A few additional components in the general area were excluded from the tracking because they were older exhibits that were not part of the *Traits of Life* collection (for example, an exhibit of glowing photobacteria and *Hide and Seek*, an animal camouflage exhibit). Visitors sometimes mentioned these in interviews. The area through which visitors were tracked was approximately 2,900 sq. ft. Approximately 40 of the 50 components were "exhibits" in the sense that they included something more than words and pictures. The other ten were title signs or explanatory panels mounted sufficiently independently from the remaining components to be considered separate potential stops during the tracking. Most of the 40 "exhibit" components also included some text.

The average time recorded was 8.11 ± 6.12 minutes, V_{50} (the time when half of the visitors tracked had exited the gallery) of just under 6 minutes. A visitor decay curve, Figure 1 showing the number of visitors remaining at increasing times is



provided on the preceding page. . Eighteen visitors (18%) remained ten 10 minutes or longer. The tracking data can be compared to other exhibitions of similar size with roughly similar types of content. Table 2 below lists all exhibitions contained in Serrell's (1998) compilation for non-diorama exhibitions in science museums that are 2,500-3,000 sq. ft. and contain at least 25 components.

Table 2
Comparative Visitor Statistics

Title	Institution	Area (Sq. ft.)	# of components	Av. Time (min)
HBDS	Bos.Sci.	2500	58	12
Tunnel	OrlanSC	2800	23	10
Sun	VirSC	2500	25	7
Symmet	RubFleSC	3000	26	16
Turbland	Explora	3000	34	11
Signals	RubFleSC	3000	31	23
Traits	Explor	2900	~40	8

Comparison data from Serrell, B. (1998). *Paying Attention: Visitors and Museum Exhibitions*. Washington DC: American Association of Museums

A demonstration was in progress while 29 of the groups were tracked, and 12 of the individuals tracked stopped at this component. The data suggests that the influence of a demonstration on the visitors' behavior is minimal. Less than half of the visitors tracked while a demonstration was in progress stopped to observe any or all of it; and the average time for the demonstration stop was only 1.34 minutes (relatively long for an exhibit component, but indicating that most did not observe an entire demonstration) and the average total times in the exhibition for visitors who did stop was 9.1 minutes, with a median time of 7 minutes, not a dramatic change from the overall averages.

Including all tracked elements, visitors stopped at anywhere from 2 to 21 components, with an average of 8 stops/visitor. The data are not easily comparable to other recorded tracking data since, for the purposes of this study, some of the signs and labels were recorded separately from the exhibit components. The ten signs and labels appear among the components with the lowest attracting power (number of stops) and holding time (average time). Table 3 on the next page provides detailed information for each element.

Attracting Power and Holding Time

During the tracking, the time for stops at any component was recorded for each tracked visitor. This leads to two separate conclusions, the relative attracting power of the components, recorded as the percentage of visitors that stopped at each, and the relative length of time that those who stopped stayed there, expressed as the average length of stay.

Table 3
Attracting Power and Holding Time of Components

Attracting Power		Holding Time	
Component name	% of visitors stopping	Component name	Average times
Goldfish Evolution	58%	Genetic Inheritance	01:49
Chick Embryos	43%	Zoom in on Cells	01:45
Energy From Death	43%	Demo Station	01:34
Lesson from the Labs	38%	Rotifer	01:30
Energy from Wood	38%	Energy from Wood	01:09
Jarred In	36%	Trading Materials	01:09
Termite gut	33%	Unnatural Selection	01:08
Hot Pile	33%	Chick Embryos	01:08
Glowing Worms	32%	Develop. Chick Embryo Film	00:54
Living Color 1 (with flaps)	31%	Lesson from the Labs	00:49
Trading Materials	30%	Energy from Light	00:48
Hydra	29%	Making more w/out Sex Panel	00:46
Tricks of Love	29%	Mutant Flies	00:45
Mutant Flies	28%	Look inside Zebra fish	00:45
Oxygen Pollution	26%	Which embryo is human	00:45
Genetic Inheritance	25%	Energy From Death	00:45
Look inside Zebra fish	25%	Energy from Death Computer	00:44
Zoom in on Cells	25%	Termite gut	00:43
Energy from Light	24%	Cell Explorer	00:42
Rotifer	20%	Jarred in Text	00:40
Living Color 2	19%	Hydra	00:39
Dance of Development	17%	Glowing Worms	00:39
Unnatural Selection	15%	Dance of Development	00:34
Cell Explorer	15%	Goldfish Evolution	00:33
Energy from Death Computer	15%	Tricks of Love	00:31
Energy from Death skeletons	13%	Telltale Breath	00:30
Kalanchoe	12%	Time Lapse	00:28
Demo Station	12%	Hot Pile	00:28
Oxygen Bubbles	11%	Grass Portrait	00:27
Jarred in Text	10%	Energy from Death skeletons	00:27
Telltale Breath	8%	Jarred In	00:25
Which embryo is human	7%	Kalanchoe	00:24
Title Sign	4%	Oxygen Pollution	00:24
Tiger Skin	4%	Living Color 1 (with flaps)	00:23
Develop. Chick Embryo Film	4%	Animal Cell	00:22
Making more w/out Sex Panel	3%	Living Color 2	00:15
Time Lapse	3%	Oxygen Bubbles	00:13
Using the glow gene text	3%	Tiger Skin	00:12
Feather Panel	2%	Using the glow gene text	00:11
Grass Portrait	2%	Life Needs Energy Panel	00:10
Life Needs Energy Panel	2%	Leaf Panel	00:08
Leaf Panel	2%	Title Sign	00:07
Animal Cell	1%	Feather Panel	00:05
Snake Skin Panel	0%	Snake Skin Panel	00:00
Change Over Time Panel	0%	Change Over Time Panel	00:00
Making More Life Panel	0%	Making More Life Panel	00:00
Making more w/ sex Panel	0%	Making more w/ sex Panel	00:00
The Stuff of Life Panel	0%	The Stuff of Life Panel	00:00
Plant Cell	0%	Plant Cell	00:00
Title Sign (2)	0%	Title Sign (2)	00:00

Visitors who entered from the left side (facing the balcony) of the exhibition stayed longer than visitors who entered from the right side (facing the balcony) did. The averages were left side entry 9.7 ± 7.7 minutes (N=45), compared to right side entry 6.8 ± 4.0 minutes (N=55).

Interactive Observations

Note: Elsa Bailey spent time talking with people she observed. Since George Hein's observations were carried out at the same time the tracking study was conducted, he did not interact with those he observed. Sample observations provided below are representative of the visitor interactions unless noted otherwise.

Cell Explorer

When approached, people compare this with *Zoom in on Cells*. Most appear to prefer viewing the cells themselves. But for a sizeable minority of visitors, the program is engaging. N=18. Average time = 1:09 minutes

16:11:35 – 16:11:37

F~25

F~25 stops to look at *Cell Explorer*. Stands for a moment looking at it and then moves on. I ask her what her reaction to it was. She says, "There is nothing living next to it. I don't like computers. I work with computers. I especially don't like high tech looking things." She points toward *Zoom in on Cells*. "That's alive, that's exciting."

14:28:57 – 14:30:30

F~37; F~10

[14:26:01 F~37 sits down at *Zoom in on Cells*. F~10 and F~8 stand next to her. They leave. She remains and continues to choose cells and scan them while moving the lever.] While at *Zoom in on Cells*, she appears to be looking at corn cells. She leans over toward *Cell Explorer* and peers at the poster. She returns to *Zoom in on Cells*. 14:28:57 She gets up from *Zoom in on Cells* and moves to computer screen of *Cell Explorer*. She touches screen. There isn't a stool in front of the computer screen. She gets down on her knees and studies the screen. Her elbow rests on screen. She touches parts of the screen. F~10 comes back over to F~37. The exchange some words and then F~10 leaves. F~37 continues to work on the *Cell Explorer* screen. When she gets up and moves away, I approach her. I introduce myself and ask for her reactions. She says that the *Zoom in on Cells* was terrific. She tells me she is a nurse, therefore this is stuff with which she is familiar. I tell her we also would like to know her impressions of the *Cell Explorer*. She says she liked it. I ask her what drew her to it. She says that it was "proximity." I ask her if she saw a connection between the two exhibits (*Zoom In* and *Cell Explorer*). She says, "No, it was just proximity. [*Cell Explorer*] was the closest one to [*Zoom in on Cells*]." I ask her if she found the computer program easy to use. "Very," she says. I ask about the text. She says she read it all. I ask if she found it useful. She said it was a good review of things she studied a long time ago.

Embryo area

I focused on the *Chick Embryo* table. This was the only place where I timed visitor interactions. The table with the chick embryos is popular and easy to use. Even very small children, who have to climb on a stool to use magnifiers, do so and immediately know what to do. Many are excited by being able to see the beating heart and a considerable number of visitors both look for quite long times through the magnifiers and go back and forth between the different samples. Few visitors go to lift the flaps on the embryo comparison on the wall, and few look up at the video.

1:34:25 – 1:35:30

F28, M4, M2

F28 “. . .when chicken lays an egg, go ahead and look at it.” M4 can't see well, F28 “go get a chair” he does and kneels on it F28 “See, this here is day 2.” Boy moves stool over and looks. F28 “That's how baby chicks get started.”

18:05 – 3:20:02

MF, 20,20

M “look at the forming brain and heart.” He's quoting as he looks. They look hard, talk, She takes ma. To #4 to look. “Oh yeah, you can see it.”

Energy from Death

People stop and pay attention. Comments like “gross” are common, as is one member of a group calling the others over to observe the phenomena. Not many conversations include comments about the use of energy and the cycle of life. N=27. Average time, 1:34 minutes

14:49:25 – 14:52:04

M~9; F~45

F~45 and M~9 approach tank. F~45 stands and M~9 sits on stool. 14:49:25 F~45 says, “Bull frog, a bird, a rat and a mouse I didn't see.” M~9 appears to ask F~45 a question (inaud). F~45 says, “Looks like they have beetles and common house fly. It's not really fresh. It's the end of decomposition. F~45 walks away from the component. M~9 continues to look at screen. 14:50:05 M~9 calls “Mom get over here.” F~45 walks back toward component. M~9 says, “They just split open his head.” F~45 says “They do it on nature shows.” M~9 sits on stool and looks into tank. He says something (inaud). F~45 says, “No they are scavengers.” F~45 walks away and return to the component she'd been looking at (Living Color). M~9 gets up and follows her over to Living Color.

12:14:58 – 12:16:52

F~27; M~5, also M~25; F~55

F~27 and M~5 approach the tank. F~27 crouches down and talks with M~5 who is asking her (inaud) questions. F~27 says, “They're getting nutrients from the dead animals. They put it back in the soil so new things can grow.” M~5 responds (inaud). M~25 and F~55 come over. F~27 points to upper sign and says to F~55 and M~25, “They're getting nutrients from the dead animals. They add different dead animals and then watch the decomposition.” I approach her, and introduce myself. She says that she was explaining to her little brother what was happening in the tank because little kids don't always understand what is

happening in exhibits. She says that it's a great exhibit because people don't always understand what maggots and all the creepy crawlies are here for.

Glowing worms

A lot depends on the state of the screen when visitors approach. Sometimes it is in focus and the worms are visible, sometimes there's little to be seen and the visitors push buttons vigorously and frequently and hope something will happen. If they succeed there are some nice interactions, although for a limited fraction of visitors. One mother patiently showed her son (age ~3) what was going on and tried to convince him that the blue light shining on the worms was the cause of the green glow to be seen in the screen. They spent 5+ minutes. Average time, 1:08 minute, with 7/20 at a minute or more. Below are two successful interactions.

12:06:06 – 12:07:30

F55

Sits, Pushes green (gets clear image) and reads. 12:07:10 (approx.) M10 (no connection, I think) comes over and says, "What are you trying to do, play a game?" He moves focus buttons.

F55 to boy, "that's a UV light, when you push that it turns green. M10 "Wow".

M40 comes over, says to boy, "Let's go, Scott . . . Come on Scott, let's go over here." (M10, although engaged, gets up and leaves.)

1:25:56 – 1:28:18

F3, F35, F20

F35, "Here's glowworms" to child. "Why don't you get a chair so you can see. Push this, that's making them green." They're this way so that we can see them." F20, F3 leave, older woman stays. She pushes focus, looks at screen, manipulates to focus and reads.

She turns to F20 who is at mice, "Do you know why these worms glow? Because they have a gene from a jellyfish. She joins others at neighboring component.

Jarred In

Responses are varied. The component is a resting place, a bright spot in a darker area and receives a range of reactions from treating it as background to trying to "figure it out." Some visitors read the label intently.

N=21. Average time 1:01 minute

16:11:58 – 16:12:56

F~28

F~28 approaches piece. She appears to watch the activity in the tubes. She looks up. She notices sign and moves toward it. She appears to read sign. I ask her for her impressions. She pauses for a moment and then says, "It's pretty cool. I like the hydroponics. I can see the roots if I look up. That's good for big people. The kids can look at the low parts." {Afterwards I learn she is a H.S. Biology teacher.}

14:46:01 – 14:46:09

F~34

F~34 stands for a few moments with arms folded looking up at the component. Then she turns and leaves. I approach her and ask for her reactions to the exhibit. She tells me, "We came by it twice." We were trying to figure it out, and

also what part of it we were supposed to be looking at. It looks like energy trying to flow through it. It takes a little time to understand that there are plants in there.”

15:40:45 – 15:41:18

M~17; F~18

M~17 and F~18 approach component. They are involved in a conversation [apparently unrelated to component, - something about parking and cars.] Each sits down on a separate bench adjacent to the other. They both face the piece. They continue to speak to one another, and their conversation still seems to be in the same vein, however their gaze is on the piece. F~18 gets up and M~17 rises as well. They walk away together still conversing, and their topic still is maintained.

Pollination Partners

Most visitors don't stop long (if at all) and there's considerable pushing the light buttons alternately to make the screen flicker. A very small fraction of visitors use both controls, both moving from plant to plant and switching lights. Average time, 16 seconds, with 2/20 over 30 seconds and none at a minute or more. The engagement described below is the best engagement of the 20+ observed.

1:57:43 – 1:58:15

M23, F20, M2

M23 moves in and is engaged, turning platform and switching light. Other two join. Adults leave and child pushes buttons back and forth until mother calls her away.

Six additional observations of “cued” visitors, who were asked to look at the component for as long as they wished and then provide the observer with comments on it, yielded more successful interactions and considerably longer ones. Most of these visitors read a majority of the text and explored the component thoroughly.

1:34:30-11:40:45

M35, F8 (also F 30 but she goes off, comes back at end)

He starts to read on right, F8 switches lights “how do you get it to the next flower?” M35 (Without looking down to her) “I don't know” continues to read. F8 “Oh,” she's found the rotate sign and does so. He lifts flaps, looks at them “Look at that, a honey possum.” [to observer] “Is it a mammal?”

11:35:40 girl flips listlessly, (can't get his attention) she leaves

M35 “Oh, here's an error, it's not that birds have a poor sense of smell, they don't smell at all.”

He switches to reading on the left “I don't understand. Something I've never understood. Why is it that plants, they have both male and female parts, it explains that, but not why they need other plants. If they explained that, that would be great.”

11:38:05 he continue to read carefully, back on the right,

He looks at center, reads the sign at top, turns, flips, turns pushes back and forth turns.

Interview: “It's interesting, I never think about different ways, connections. I only think of pollination with bees.

It might be interesting to have a cross reference to somewhere else where there is use of UV light. I wonder, do birds see UV light? This is interesting.

11:49:42-11:54:50

F28, M30, F14

F28 Comes up to it, starts to read, takes out glasses, reads entire left panel, followed by middle panel, reads on right (so far all reading, doesn't lift anything.) Finally (about 3 minutes) lifts one flap. she turns. F14 comes up briefly, then leaves

M30 also arrives he turns, then looks a lot, he leaves.

She pushes one, then the other button, looks

Looks up at screen

Pushes, turns looks at screen

Pushes, turns looks, looks, looks

M30 comes up at end

Interview: "Well, maybe it's just me, but I don't know what you're supposed to be seeing. There's good information here. I don't know how to look for what they're telling you to look for.

Man joins conversation, he explains, "They see veins in the plant see, more detail now." (under UV light) F28 "There's definitely a difference. But I expected more difference. It's a little complicated."

Termitarium (Energy from Wood)

People easily engage with it, some read the explanatory material, but almost everyone spends considerable time looking through the wonderful magnifiers with the lights on them. Reference to termites in their own houses are common. N=19. Average time = 2: 54

15:55:30 – 15:57:10

F~35; M~36; M~6; M~3, F~ 8

F~8 runs to *Termitarium*. She picks up the magnifier. F~35, M~36, M~6, and M~3 run over to examine the case. F~8 says, "Eeeeeuuuu." The whole group is investigating the component, piling on top of it and around it. Then, {with what seems like doing so almost on cue}, all of them dash off toward *Energy from Death* component.

11:21:20 – 11:25:25

2F14 joined at 11:23:00 by two F 35

Oh, Oh, look they're eating, they both move mags. around at look, but are not very engaged, not very bent over. They start to leave, the two older F's come over "Wow that's really cool." F2 what is it? Oh, my God, Oh, my god!, they're termites. It's a nightmare for me, F1 Yea, like carpenter ants. F2 reads "they have soldier . . F2 Oh, here F1 does it have pinchers? (reads) reproductive ones have darker body. F1 Oh, I have one of those both look, Ok, here's one, ok. He's got the long pinchers. He's definitely a soldier. Both leave to follow the girls who are going out of the area.

Trading Material

People engage with this component and do push the button to stop the pump. Some think the termites will change behavior or even die as the CO₂/O₂ ratio

changes on the screen. My sense is that this is a wonderful illustration for those who already know the theory. N=20. Average time = 1:50 minutes

13:19:39 – 13:21:23

M~35; M~10

M~10 begins to talk about carbon dioxide. "So those guys [termites] might die. They are trying to get air." M~35 begins to explain that the termites make carbon dioxide and that the grass uses it. M~35 says, "The grass gets happy and the termites get happy." I approach M~35 and ask for his reactions. He says, "It's a neat illustration of the cycle of carbon dioxide and oxygen." He points to the grass and says, "It probably should say about how the grass is using the carbon dioxide and producing oxygen." He explains it is illustrating the transfer of the carbon dioxide to the grass. He says, "the transfer of carbon to the grass." He points to the computer screen and says, "Look at the graph. People are not used to seeing this kind of graph, that shows [output] over time."

13:42:30 – 13:44:02

F~28; M~4; M~10mos.

F~28 is standing behind M~4 who is seated at the component. F~28 says, "See, the termites use oxygen. When you push that and hold it, you can see that it starts to change. Those termites are breathing the oxygen. I ask her what she thought of the exhibit. She says that she thought it was a good way to see how things depend on one another. She tells me that M~4, who attends a Montessori Kindergarten is studying this in school, so she wanted to explain it to him. She says, "I didn't explain the graph - that was too complicated."

Interview Study

Exit interviews were conducted with 70 visitors exiting at either end of the exhibition. The second person to exit was approached and asked if he or she could be interviewed alone. Children were included if they appeared to be at least 10 years old. A protocol was used after it was piloted and modified.

In addition another 40 interviews were conducted, using the same protocol, with visitors who were approached before they entered the area (from both sides.) These visitors were asked to look at the exhibit for as long or short a time as they wished and then to be interviewed after their visit. They received a small gift if they returned for the interview. These "cued" visitors spent considerably more time in the gallery than was noted in the tracking study. Their average time was 18.9 ± 0.1 minutes, with a median time of 15.5 minutes. (By comparison, visitors in the tracking study spent an average of 8.11 ± 6.12 minutes with a median time of 7 minutes.)

Favorite components

A relatively large number of components were mentioned by both cued and uncued visitors in response to the interview question, "Where there some things in this group of exhibits that you really liked?" The responses are provided in Table 4 below.

Table 4
Response to question to name “exhibits that you really liked.”

Component	Number (and %) of Uncued Visitors who mention comp. N=70	Number (and %) of Cued Visitors who mention comp. N=40
Chick Embryos	12 (19%)	9 (23%)
Energy from Death (and computer)	11 (16)	12 (30)
Color Bacteria (both or either)	9 (16)	3 (8)
Termitarium and termite gut	9 (13)	9 (23)
Zebra fish embryo and film loop	9 (13)	4 (10)
Cow eye demo	6 (9)	6 (15)
Trading materials	6 (9)	2 (5)
Hide and Seek (not in tracking study)	5 (7)	2 (5)
Jarred In (Hydroponics)	5 (7)	3 (8)
Mutant flies	4 (6)	1 (3)
Zoom in on cells	4 (6)	4 (10)
Glowworms	4 (6)	2 (5)
Goldfish genetics (unnatural selection)	4 (6)	1 (3)
Goldfish	4 (6)	2 (5)
Grass portrait	4 (6)	2 (5)
Hot pile	3 (4)	0
Glowing bacteria (not in tracking study)	3 (4)	2 (5)
Leaf and feather panels	3 (4)	1 (3)
Genetic Inheritance	2 (3)	2 (5)
Tell tale breath	2 (3)	0
Magnetized Bacteria (not in tracking study)	2 (3)	0
Energy from Light	0	2 (5)
Flower Dissection	0	2 (5)
Tiger Skin	1 (1)	3 (8)
Rotifers	1 (1)	1 (3)
Oxygen Bubbles	1 (1)	0
DNA Demo	1 (1)	0
Grasshoppers (not in tracking study)	1 (1)	0
Kalanchoe	1 (1)	0
Hydra	0	1 (3)
Flip embryos	0	1 (3)

Many respondents listed more than one component.

Visitors also made general comments in response to this question. Cued visitors made more of these, relative to the total number interviewed than did uncued visitors—19 (27%) from uncued visitors and 16 (40%) from cued visitors. These are summarized and categorized in Table 5 on the next page.

Disappointment or Confusion

The interview protocol included two questions on visitors' possible dissatisfaction with the exhibition. Early in the interview, visitors were asked if anything in the exhibition disappointed them. The question was deliberately phrased to

Table 5
General comments about “exhibits that you really liked.”

Comment	Uncued visitors	Cued visitors
Living things, plants and animals, cells (many variations of this)	8 (11%)	6 (15%)
All embryos, embryo exhibits	4 (6)	5 (13)
Looking under microscopes, microscopes	3 (4)	4 (10)
That it's artistic, art panels	2 (3)	
Demos	1 (1)	
Time lapse films	1 (1)	
Watch staff fix hydroponics		1 (3)

encourage a substantive response. “Some visitors were disappointed with parts of this exhibit. Were there some things that disappointed you?” The responses from both cued and uncued visitors were mostly that nothing had disappointed them. Those that mentioned particular items had a range of specific concerns, none of which reached a level that would raise questions about any of the components. The responses are summarized in Table 6 below.

Table 6
Response to Question about Disappointment

	Number (and %) of Uncued Visitors who answer. N=70	Number (and %) of Cued Visitors who answer. N=40
No, nothing	50 (71%)	22 (55%)
Something broken or not available	3 (4)	5 (15)
Missed demonstration (not at scheduled time)	1 (1)	4 (10)
Hard to focus microscopes	2 (3)	2 (5)
Don't understand Jarred In	5 (7)	1 (3)
Don't understand hot pile	3 (4)	2 (5)
Don't understand bacteria wall	3 (4)	2 (5)
Other comments	8 (11)	4 (10)

Some visitors gave more than one response.

Later in the interview, they were asked, “Were there any activities or labels that didn't come across well, or were confusing in any way?” Again, the question produced mainly negative answers, with the substantive responses distributed as indicated in Table 7 on the next page.

Message

A majority of visitors thought that the exhibition had a specific message. When asked, “Do you think this group of exhibits has a message? If ‘yes’ what do you think is the main message?” only 5/70 (7%) and 4/40 (10%) replied in the negative or said they didn't know. The rest were able to provide some response, although another 6 (9%) of uncued visitors said it was about “science,” “research,” “science is cool” or similar non-specific answers. None of the cued visitors gave such general answers.

Table 7
Response to Question about Being Confused

	Number (and %) of Uncued Visitors who answer. N=70	Number (and %) of Cued Visitors who answer. N=40
No, nothing	41 (59%)	19 (48%)
Didn't see enough	6 (9)	2 (5)
Hydroponic was confusing, label not clear	8 (11)	1 (3)
Bacteria wall	6 (9)	1 (3)
Hot pile	3 (4)	
Title sign	2 (3)	
Trading materials		5 (13)
Glowing worms		4 (10)
Tricks of love		2 (5)
Zoom in on cells	1 (1)	1 (3)
One each: mice, decaying animals label, cell interactive, hydra, fabric panels, sex/non-sex, Carbon dioxide-blow on it, cow eye demo not on time, Oxygen bubbles, flowers/light, focusing microscopes, embryo labels, light and carbon dioxide	6 (9)	5 (13)

The rest, 59 (86%) of uncued visitors and 36 (90%) of cued visitors mentioned something about life. The answers can be subdivided as indicated in Table 8 on the next page. Most frequently, they referred to particular components of life—embryo development, energy use, death and decay, etc. Other major categories included life cycles, differences among living things or organisms, similarities among organisms, reference to environment, the importance of life, or the complexity of life.

A selection of responses provides a sense of the visitors' answers:

This [points to the general area with embryos] is the life part, and death part here [points to the decay area]. It's about where things come from, where stuff goes.

About plants and life.

There are tiny things that are a part of the world, like bacteria and other organisms. Cells - how much goes into creating a human or even a small animal.

[Cued]- About life, parts about the interconnection. I'm impressed by complexity of some of the displays, like the carbon dioxide chest for grass and termites. I couldn't understand the grass.

[Cued] - Life. Different things with energy. Mutation and evolution. The cow's eye... function of different parts of the eye.... That about body tools I suppose.

[Cued] - Yes, it's about life, apart from what you notice. There's life everywhere, and things are going on besides what we're doing.

Table 8
Response to Question about the Exhibition's Message

	Number (and %) of Uncued Visitors who answer. N=70	Number (and %) of cued Visitors who answer. N=40
About life, or specifically about some aspect of living things	24 (34%)	12 (30%)
The importance of life	11 (16%)	1 (3)
The life cycle/ ecology or pollution	9 (13)	11 (28)
Similarities among living things	9 (13)	4 (10)
Life exists in odd places, differences/complexity of life, diversity	6 (9)	8 (20)
Science research, everything is gross, science is cool	6 (9)	
Don't know, no idea	5 (7)	4 (10)

Answers that the message was about life "cycles," the continuous biological cycle from birth to death are illustrated by the following:

Oh yeah, absolutely a message. This right here [points to the energy area], everything is like a big circle, always go back to ether [sic] no matter what.

Shows how balanced the environment is, and how easy it is to become unbalanced, with global warming, or an excess of CO₂. The exhibition captures the part played by plants and animals in maintaining a balance in the atmosphere.

The way the things live off other things - and how it's all a big circle.

[Cued] - The message is of how things evolve, how one thing affects another, like a chain: oxygen, reproduction, how things feed off one another to produce an end product.

The idea of a cycle was frequently associated with an ecological message, about the importance of life and/ or the need to preserve it.

I would have to say it's impossible for anything not to have a message. Here it's probably about the importance of the biosphere around us.

[Cued] - Message about the environment - take care of it, or this stuff won't be around.

[Cued] - I don't take a message away - I guess it teaches you about the complexity of life - how everything is interconnected. I guess also the sensitivity of the ecosystem.

Another group of answers focused on the difference among living species and life processes.

Everything is different for different kinds of life.

Life (at least biology) is amazing and very complex, and has pockets of strangeness I never anticipated.

To teach kids differences in different ways things develop, stages things go through.

[Cued] - To illustrate the diversity of life. Show it in a way that is clear, an actual [motion to the exhibits area, indicating he meant actual as in real/physical] for biology.

[Cued] - Yes. Magnifications especially, looking at different living things. Kids don't get that in school, comparing cell types. This is unique.

[Cued] - How diverse life on this planet is. If I were building up this exhibit, I'd be more explicit about the message, though the concept of life is very clear.

The theme of commonality among living things was emphasized by some, as distinct from just saying that the commonality was that the exhibition was about life or about preserving life. Some of these responses were partial, in the sense that they mentioned the commonality of one or more trait of life, while others stressed several commonalities among all living forms.

To introduce the idea that humans are very similar to plants.

Yes. Just that there's life, something might die, but it still supplies energy, still part of life.

It's great for adults and children to understand how life is formed, how similar between different species.

Yeah. Things that all life have in common.

[Cued] - Yes. It's important to learn about life. That we share a lot in common with other living things.

[Cued] - Traits of Life. [looking up at intro panel]. From the beginning to end, energy, circle of life.

[Cued] - Broad message of interconnectedness of all living things. How much we're all alike. Profound message in the Oxygen Bubbles, which could have been said more firmly, how each part of life is interdependent.

New Information

Visitors were asked, "Was there anything in this group of exhibits that you didn't know before, or that got you thinking in a different way?" Many, especially uncued visitors (36%) said they didn't learn anything new. Those that did respond mentioned specific components or some facts about living things they didn't know. There were essentially no answers that indicated that the exhibition had inspired visitors to think about nature differently.

Table 9
Responses to question about new information

	Number (and %) of Uncued Visitors who answer. N=70	Number (and %) of Cued Visitors who answer. N=40
No, not really; I already know this; I learned it in biology	25 (36%)	6 (15%)
Yes, everything, or most was new, Or sections (e.g. "about plants") was new	6 (9%)	7 (18%)
Cow's eye dissection	5 (7%)	2 (5%)
Hot pile	5 (7%)	2 (5%)
O ₂ /CO ₂ balance, that plants produce O ₂ , O ₂ pollution	5 (7%)	2 (5%)
Bacteria produce light	4 (6%)	
Termites, wood	4 (6%)	4 (10%)
Energy from death	4 (6%)	1 (3%)
Similarity of embryos	3 (4%)	3 (8%)
Goldfish mutations	2 (3%)	2 (5%)
Hydroponics	2 (3%)	
Blocking light with hands	2 (3%)	1 (3%)
Fruit flies	2 (3%)	
Glowing worms	1 (1%)	2 (5%)
One each, either cued or uncued: Genetic traits, DNA demo, Magnetic Bacteria, Aquaria, lizards, grass makes art Brain cells in Zoom, worms glow, zebra fish embryos	9 (13%)	3 (8%)

Recognition of "Traits" Title and Its Meaning

Several questions were intended to elicit the visitors' recognition of the title of the exhibition and the meaning of that title.

First visitors were asked whether they had "noticed the name of this group of exhibits." Since the title label was displayed twice, visible when entering from either side of the exhibition, the question was appropriate for all visitors except the relatively small number entering from the back, that is, near the balcony. A minority of both uncued 31/70 (44%) and cued 15/40 (38%) visitors had noticed the title. Some, who came into the exhibition close to the balcony may never have passed either of the title panel. Some visitors looked up at the title panel when asked.

All were told the title and asked, "Why do you think it has that name?" Answers from cued and uncued visitors were not significantly different and covered a range of topics, as summarized in table 10 below. Some visitors, 11 (16%) of uncued and 8 (20%) of cued, referred to "characteristics" or commonalities among life forms. Others, 13 (19%) of uncued and 9 (23%) of cued visitors, recognized that it was about life in general. A third set of responses, 14 (20%) of uncued and 10 (25%) of cued visitors, referred to components of life such as embryos, genes, oxygen balance, etc.

Table 10
Responses to Question about the Exhibition Title

	Number (and %) of Uncued Visitors who answer. N=70	Number (and %) of Cued Visitors who answer. N=40
No idea, not sure	3 (4%)	1 (3)
characteristics, commonalities	11 (16)	8 (20)
Elements of life	14 (20)	10 (25)
Tells about life	13 (19)	9 (23)
About differences	11 (16)	8 (20)
Genetics	2 (3)	
Life cycle	2 (3)	1 (3)
Other	5 (7)	4 (10)

A selection of answers from the *cued* visitors illustrates the extent to which they were able to describe the significance of the title of the exhibition. Answers from uncued visitors were similar.

Don't know why "traits," that word doesn't give me a clear idea of what they're talking about.

I suppose it's about life.

Because it's about the different things in life.

Just the many qualities that can be found in life, like embryos, reproduction.

It's living, study of living things at a basic level. Genes, DNA, cells, photosynthesis.

It's about life, the different things that happen in life of different organisms.

All about life, characteristics of life.

Well, someone dreamed up a catchy phrase. Different kinds of life?

Definitely has lots of life, different stages of life. Reproduction, even has death. From embryo to death.

Showing all the traits of life, different things that life has, traits basically.

To give an idea of how other organisms live.

Clearly, because of the essential processes for life on this planet, like reproduction, cell division, and the balance of oxygen and CO₂.

Because it's showing you the different aspects of life: the beginning, the middle, and the end of life.

There are so many more living things on earth than just humans. It talks about all life, not just humans. How living things started, reproduced, grow.

Now that I read the sign - it's trying to show things that all have in common, like the genetic testing.

Next visitors were told that “The people who built this group of exhibits were trying to show what’s common among living things, instead of what makes them different from each other.” and asked, “How clearly did this come across?” They were given three choices with the responses listed below.

Table 11
Responses to Question about Clarity of Theme

	Number (and %) of Uncued Visitors who answered. N=70	Number (and %) of Cued Visitors who answered. N=40
Very Clear	21 (30%)	17 (43%)
Somewhat clear	34 (49)	14 (35)
Not at all clear	15 (21)	9 (23)

Many respondents, 22 (31%) uncued and 15 (38%) cued, commented on their answers. These comments are illuminating. Below are the comments from the cued visitors. There were relatively fewer comments from the uncued visitors, many of whom had said at the beginning of the interview that they had not observed a great deal, but the general tone from both groups of visitors was similar.

Comments from cued visitors who said that the theme was “very clear”

With the embryos and decomposition.

Especially in the embryo exhibit. Wasn't so clear in grass/termite exhibit. Plants produce oxygen, but the message wasn't clear enough for younger kids.

From the embryos, definitely.

Everything has to eat, live and avoid being eaten.

Interwoven nature, everything is dependent on other things.

Comments from cued visitors who said that the theme was “Somewhat clear.”

Showed it well with the embryos.

If that's their only goal, it wasn't too clear. Shows lots of differences.

I focused on each exhibit, might have missed larger context. Maybe there needs to be something to more explicitly tie it together with similarities rather than differences.

Comments from cued visitors who said that the theme was “Not at all clear.”

Not specifically clear, but still interesting.

Didn't really notice that things were more the same than different
I thought it was about differences.

Clear theme was there, but I didn't see that that was the point. I thought the
point was essential life events..

I see now that you say that, but didn't while going through the exhibit.
I saw lots of differences.

Visitors were also asked, "Can you give an example of any Trait of Life that you saw in this group of exhibits?" and "Do you think [*the one you said*] is true for every living thing, or only some kinds?" The examples provided are summarized in Table 12 below.

Table 12
Examples of Commonalities of Life

	Number (and %) of Uncued Visitors who answered. N=70	Number (and %) of Cued Visitors who answered. N=40
Don't know, don't remember	14 (20%)	3 (8%)
"What do you mean?"	1 (1)	5 (13)
Need for Oxygen/Carbon Dioxide cycle, Oxygen or sunlight	11 (16)	6 (15)
Reproduction	7 (10)	7 (18)
Cells/cell division	7 (10)	4 (10)
Mutation or evolution	5 (7)	2 (5)
Interdependence, ecosystem	5 (7)	1 (3)
Water	4 (6)	
Everything has to eat, consume	3 (4)	3 (8)
Genes, genetics, DNA	3 (4)	1 (3)
Being born or made	3 (4)	
Flies, normal and abnormal	2 (3)	1 (3)
Death, decay, decomposition	2 (3)	1 (3)
One each: reproduce without sex, biosphere, zebra fish develop, growth and development, eye color, plants, all move, ovum like embryo,	6 (9)	6 (15)

Most visitors said the trait they had chosen (if they could think of one) was true for all living things, but a few were not sure. They usually referred to its illustration in a specific exhibit component, but then were not always clear whether that applied to all living things.

Visitors were also asked, "Do you think it was a good idea to (try to) show the commonalities instead of the differences?" Responses are summarized in Table 13 below.

Table 13
Responses to, “Was it a good idea to show commonalities?”

	Number (and %) of Uncued Visitors who answered. N=70	Number (and %) of Cued Visitors who answered. N=40
Yes	60 (86%)	35 (88%)
No	1 (1)	1 (3)
No opinion or show both	10 (14)	4 (10)

Introductory Panel

Visitors were asked “Did you notice the introductory panel for the Traits of Life group of exhibits?” Their answers are summarized in Table 14 below.

Table 14
Noticing the Introductory Panel

	Number (and %) of Uncued Visitors who answered. N=70	Number (and %) of Cued Visitors who answered. N=40
Yes	25 (36%)	18 (45%)
No	1 (1)	1 (3)
Yes, but didn't read it	44 (63)	21 (53)

They were also asked, “Did you feel that there was enough introduction to the exhibits?” One set of visitors suggested more signs at the museum entrance, on the stairs or elsewhere. Others indicated that the theme was not clear enough. A few who felt they had enough information thought too many explanations were not necessary at the Exploratorium. Representative answers are provided below.

Nice to have more info, like, like what message you're trying to convey.

[Cued] - Elaborate your theme a bit more perhaps at the entrance. And I didn't see the entrance sign since I came in through the back.

You mention trying to show commonalities. Maybe give more info as I go through it [points to T of L entrance] so I know what we should be looking out for.

[Cued] - didn't get that this is about commonality in all the exhibits. Maybe if I've read this sign [points to intro panel]. Perhaps you want to state that more clearly.

The Exploratorium is about finding things out yourself. It's not necessary to have sequences and plans.

The most important thing when you're not forced to study, is that something catches your eye, then tells you a little bit more.

Comparisons

Visitors were asked whether they had made comparisons among or between components. The specific question was, “While you were in this group of exhibits, did you ever make comparisons between any of the kinds of living

things?” About half of the visitors said they had not, or couldn’t remember. The rest referred mainly to comparisons that already existed within exhibit components (such as the comparison of embryos from different species) or were inherent within individual components (such as *Zoom in on Cells*.) Few visitors made comparisons across exhibit components. Table 15 below itemizes those comparisons mentioned by more than one person.

Table 15
Comparisons Mentioned By More than One Visitor

	Number (and %) of Uncued Visitors who answered. N=70	Number (and %) of Cued Visitors who answered. N=40
No	33 (47%)	14 (35%)
Yes, but don't remember	4 (6%)	4 (10)
Embryos	11 (16%)	12 (30)
Termites vs. maggots	3 (4)	
Decaying animals	2 (3)	1 (3)
Zoom in on cells	2 (3)	1 (3)
Mutant flies	2 (3)	1 (3)
Camouflage tank	2 (3)	
Various animals	2 (3)	
Others	9 (13)	5 (13)

Comparing Traits to Other Exploratorium Components

The final section of the interview asked visitors for their impressions of the area and to compare it with the rest of the Exploratorium.

First they were asked, “Did it seem that the Traits of Life exhibit was one big area, or did it seem divided into smaller areas?” Responses were mixed, with a few visitors pointing out that both could be true. They are summarized in Table 16 below. The answers may reflect the perspective of the visitors’ interpretation of the question more than whether they noticed different sections within the exhibition. Some visitors stated that it was one area, since it was all about life. Others said it was divided because there were sub-categories of the main theme.

Table 16
Visitors’ Perception of the *Traits of Life* Area

	Number (and %) of Uncued Visitors who answered. N=70	Number (and %) of Cued Visitors who answered. N=40
One area	19 (27%)	16 (40%)
Divided into smaller areas	39 (56)	21 (53)
Both	10 (14)	3 (8)
Don't know	2 (3)	

TofL is definitely a cohesive whole, separate from the sound section. I saw the walls separating TofL into 3 parts.

It's like one big area. You can really tell it's different than sound or the other stuff up here.

Haven't seen 100% of it, but the way it's arranged, with the vertical panels, it seems divided in some way. But with the aquatic creatures throughout, that gives it some unity.

[Cued] - One big area. You can really tell when it began and ended very clearly.

[Cued] - Well, when we wandered to the sides of the exhibit, I wondered were we still in the exhibit. But between the leaf panel and the feather panel, it was very clear. And yes, it was divided into subjects.

[Cued] - Divided, but it does flow pretty well from one area to another.

Anyone who thought the area was divided was asked, "what different topics seem to be covered in the different areas?" A few visitors, 9 (13%) uncued and 4 (10%) cued, couldn't give a clear answer, but the others made differentiations that varied widely. A few described the areas as the exhibition designers envisioned them. The combinations of answers made it difficult to quantify them into categories. One general theme in a number of answers was the idea that there was a representation of stages of life in the different areas. The selection of responses below provides an overview of the range of answers.

Need to look closer to see if I got all three parts. Oh, yes, cells, path of creating life cycle with reproduction, and decomposition. [Note: This is from the same person as the first quote above].

[Cued] - Cell/microorganisms, eating/getting energy, live fish, energy, reproduction, etc.

[Cued] - Energy, that life needs it. Cells. The embryo section, I can't remember the name of that one. Cell division, first area is about when it's born, this area about living conditions, how living organisms get their energy, what they need to live.

Reproduction, genetic mutation, and energy

That one is all cells, beginning one [points to area with embryos] was all living animals, here you're got the end, like death and decay.

Human forms, insects, cells.

Internal changes, like genes, reproduction, carbon dioxide.

How things mutated, compost, termites.

[Cued] - Cell/microorganisms, eating/getting energy, live fish.

[Cued] - Animals, cell area, plant/bacteria/oxygen area. Or birth, midlife, sustenance.

Next, the visitors were asked to come to the edge of the balcony, look down and asked, "Could you look over the railing here, at a different area of the museum? So, looking at the area (downstairs) and comparing it with the *Traits of Life* group of exhibits we've been talking about, would you say there are differences between these two areas? " If they said that they could discern differences they were asked, "Do you personally have a preference for on or the other?"

Visitors were voluble and clear in their responses to the question about differences between the *Traits of Life* area and the downstairs below the balcony. (The latter is referred to as DS in the quotations below.) All but two thought there was a difference. Twenty seven respondents (27/70, 39%) referred specifically to the difference in content, describing upstairs as about live or living things, natural, biological, containing organisms, while the downstairs was described as physical, mechanical, geological, about electricity, science, climate and sand, minerals and science. Some just mentioned the difference in subject matter as an afterthought, as if that were obvious, while they discussed other characteristics of the differences.

They also mentioned other kinds of differences, mainly about the kind of visitor experience in each section or the design features of each. Many respondents, both cued and uncued, described several ways in which the areas differed from each other. A summary of the differences is provided in Table 17 below.

Table 17
Differences Between *Traits of Life* Area and Downstairs

	Number (and %) of Uncued Visitors who Answered. N=70	Number (and %) of Cued Visitors who Answered. N=40
No difference	2(3%)	
Content difference	27 (41)	20 (50)
Visitor experience difference	43 (61)	22 (55)
Exhibit design difference	17 (24)	14 (35)
ToL newer, more equipment	3 (4)	3 (8)

Note: Some answers included more than one different characteristic.

A few representative quotes, primarily about content difference are given below.

Looks like it doesn't have to do with life down there, more physical law, more interactive.

This [T of L] is quieter, less hands on to some extent. You can't mess with the plants and animals, would be mean wouldn't it. That's [downstairs] more industrial and mechanical.

Yeah, everything downstairs is physical, physical stuff happening. This [T of L] is natural. This [downstairs] is not, not at cellular level. It's life science up here. Very stark downstairs. Warmer up here. More close and warm.

[Cued] - More activities going on downstairs. A lot quieter here. The topic is different obviously. Less hands-on here [T of L]. You have exhibits that you can't play with.

As is evident from the short quotes above, visitors often also referred to the form of the exhibit areas. These comments could be divided roughly into two groups, with the same person often referring to both categories.

One set focuses on visitor processes and interaction with the areas. *Traits of Life* is described as less interactive, quieter, more reading, more visual, with more explanations and more learning, while the downstairs is described as more interactive, more active, with more playing, less explanations, but also seen by one visitor as "more educational."

The second set focuses more on design features of the areas. The upstairs is described as warmer, more colors, lighter, more intimate, more organized into areas, more museum-like, more arty, while the downstairs is described as starker, more spread out, less cohesive with more kids running around. There were at least 65 comments that mentioned one or more of these qualities.

Biggest difference I say is T of L has an introduction panel [points to exhibit signs] behind each exhibit and the area. Downstairs doesn't have that. You have to go up to it to see what it is. You don't group them [exhibits] with signs, not so obviously. You can imagine the groups, like weather and such, I guess. Signage is the biggest difference. These [T of L] take more thought, subtle thinking, nature. Downstairs is more push, turn, moving. Kids just go and have fun with them, sometimes not even doing it right.

This [T of L] seems more people friendly. That's [downstairs] more open. Sometimes down there is confusing. This [T of L] is more like an art gallery, more like museums. Downstairs it's like a playground, wide open.

[Cued] - Downstairs is more open, lots of room for running around playing with exhibits. More hands-on. This [T of L] is a smaller area, almost like a room with these walls. You have to read more to understand the exhibits.

That's [downstairs] more hands-on. This [T of L] is more like an art museum. There's some hands-on, but less so. The exhibits are closer together [in T of L]. Biggest difference, this [T of L] is more artistic, you need to think more.

DS, there is a central aisle with exhibits on either side. TofL, you can weave around the partitions, more free form. TofL seems more educational, which might be because of the difference in subject matter.

The environment DS feels like a workroom - hands on, under construction. TofL feels more structured, less hands on. More like "exhibits" and less like interactivity.

[Cued] - TofL is a little more intimate - easier to focus on subject. The lighting is more directed. DS is more like a playground, high energy.

DS, much more hands on, interactive. TofL requires utilizing facility and mind, while DS only shows and teaches. DS has no carpet, and a very open flow.

TofL more of a museum kind of thing. DS is more learning without processing, while in TofL, you must process the information. I do see them having a wonderful time DS.

Aside from the carpet upstairs and the concrete DS, in TofL, there are more interpretive signs, there are panels and walls, while DS it is open, as far as the eye can see. Some of the exhibits DS are harder to understand.

Yes, DS is more touching, getting inside things, hands on, and a different subject matter. TofL is not as much hands on, more restricted by topic, more looking and seeing. The DS is more fun, but it doesn't matter if you're interested in the topic upstairs. DS you don't need to understand it to have fun and enjoy it.

DS is fairly self-explanatory, while TofL has deeper information, but you need a tutorial on what to look for, what to see. DS doesn't need a lot of overview - you can just play with it. TofL is more learning things.

[Cued] - Seems more compact up here, more separated off. The physical space is different. The panels here make it more.... Just that the exhibits are attractively laid out, separated into sections.

[Cued] - DS the exhibits are more black and white, more pure science. TofL is more philosophical, more natural aspects of the world. I couldn't tell DS that there was a biology exhibit upstairs.

A few respondents felt that *Traits of Life* was newer, had more equipment or was more "up to date."

When asked whether they preferred one area to another, respondents were divided as indicated below. Perhaps more important was that the preferences shown were primarily based on the subject matter, not the style of the presentation. Visitors recognized the difference between the two areas, but appreciated the qualities of each. Very few visitors had extreme views in preferring one to another, and those views were always about subject matter, not the perceived differences in style of presentation.

Table 18
Visitor Preferences for *Traits of Life* Area or "Downstairs"

	Number (and %) of Uncued Visitors who answered. N=70	Number (and %) of Cued Visitors who answered. N=40
No preference, or like both	31 (44%)	17 (43%)
Prefer ToL, upstairs	18 (26)	15 (38)
Prefer downstairs	16 (23)	7 (18)
Don't know or no response	5 (7)	1 (3)

I like downstairs, I'm not a bio person.

I love biology best, so I'd have to say TofL, but I definitely have favorite activities DS, too.

[Cued] - DS, because of the subject matter. Lock me in DS for a month, and I'd be happy. Stuck here, I'd have to slit my wrists.

[Cued] - I like it in TofL, because of the colors, softer lights, not as metal as DS. It is cool DS, too, though.

[style?]: it depends on what theme and what you want to get across. You don't have to guide all that [points down] with walls. [You said this one takes longer to get to the hands-on aspect. Do you have a preference on one or the other when it comes to this?] With direct to hands on exhibits, people don't take time to figure out the theories sometimes. It's good to have a mixture of both. Sometimes it's good. Sometimes it's bad.

In TofL, I appreciate the design, and DS, I appreciate the functionality. I appreciate both areas. As an artist, I like the environment up here, but I also like to get "down & dirty" with the exhibits DS.

It's not a matter of preferring one over the other. But when we bring our grandkids, I'll do the upstairs first, because I want them to first do things we'll talk about later, and that will work better with the upstairs subjects, then finish DS.

[Cued] - No, I like them both. I've always thought of the Exploratorium as more about mechanics and physics, less zoological, so I was surprised to see this exhibit.

DISCUSSION

What Visitors Do In the Exhibition

Time in Exhibition

The tracking study demonstrated that the exhibit shows respectable visitor engagement. It compares favorably with data from other, similar exhibitions. The average times visitors spend are comparable with those recorded in exhibitions of similar size and content. And, as the visitor decay curve illustrates, *Traits of Life* has a significant “tail” of visitors who spend long times at the exhibition. This is not an unusual feature for many types of museum exhibitions: some fraction of visitors remain actively engaged for extended times.

The location of the exhibition in what is essentially an open hallway, a space that it's necessary to pass through when going from one end of the balcony at the Exploratorium to the other, means that there will be some visitors who wander through the exhibition with little intention to spend much time there. It is possible to avoid the exhibition completely, and some visitors were observed walking in one direction or the other on the balcony close to the wall behind which are offices and the imaging station. But many visitors who do not have a specific goal will wander through an open area and simply not be strongly attracted, but spend enough time to be counted. The way visitors were chosen for the study—the first person who stopped was tracked—assured that the most casual “window shopping” visitors, who never stopped at any component would not be counted. . It may also have produced a slight bias towards more diligent visitors, since the choice of groups to track was determined in part by a non-random characteristic. If this has any effect on the results it is to slightly overestimate time in the exhibition. But there were clearly some who looked at one or two components on their way through and didn't engage significantly with the exhibition.

Visitors who went through the exhibition from right to left (facing the balcony) may have been on their way out of the Exploratorium and therefore, less attentive and more eager to leave. Other exhibitions at the Exploratorium, such as *Frogs* or others at the far end of the ground floor, (as well as many exhibitions at other science museums) are more likely to exclude the most casual window shoppers that are just wandering through.

The tracking study shows in a crude, universal way that visitors interact with the exhibition. But it's important to recognize that attracting power and holding time are superficial measures and do not record the depth of interaction possible. The question in the interview study that asked visitors to state their favorite components does not yield a one-to-one correlation with the tracking data. For

example, *Lessons from the Lab*, which, with its live animals, attracted many visitors and held them for relatively long times, does not appear on the list of favorite components.

Demonstrations

The tracking data shows that demonstrations compete successfully for visitor attention with exhibition components, but do not overwhelm them. The demonstration station was right in the middle of the exhibition. Demonstrations were often announced in a loud voice and they included the popular cow's eye dissection. Yet, although average time at the demonstration "component" was among the highest recorded it was neither the highest average time, nor was it the component with the highest attracting power. Of the 29 groups tracked who went through while a demonstration was in progress, 12 (12/29 =41%) stopped to watch it.

Of the seventeen visitor groups tracked while the cow's eye demonstration was in progress, seven stopped to observe it for times ranging from 7 to 417 seconds, with an average of 125 seconds. Two groups stopped for the DNA demonstration of 7 that were tracked while it was in progress. Five groups were tracked during the flower dissection demonstration, but none stopped. Three groups stopped at the empty Demonstration Station.

I have no simple explanation to counter the traditional view that demonstrations, and especially the Cow's Eye Demonstration, are popular. Some visitors had clearly seen them before, and mentioned this. Sometimes, the demonstration did not take place when scheduled. Perhaps the fact that the museum was not particularly crowded in January during the tracking period made the exhibits themselves more accessible relative to the demonstrations.

Signs and Labels

In general, the signs and labels were among the components with the least number of stops and the lowest average times. This is no surprise, as repeated visitor studies have shown that visitors have an uncanny ability to ignore signs and labels. Placement of the title signs at above eye (and head) level may have contributed to this; visitors rarely look up. This conclusion is reinforced from the interviews, were only 44% (uncued) and 38% (cued) visitors reported noticing the title signs.

However, it must be acknowledged, as has been demonstrated in other studies, the interviews suggest that visitors don't have to come to a complete stop, as is required to be counted in a tracking study, to read material at an exhibition.

New Ways of Thinking

The evidence is not strong that the exhibition overtly resulted in new ways of thinking about biology for visitors. But this is a rather grandiose goal that would require visitors to be able to grasp *and articulate* new conceptual understanding after very short exposure to material, much of which can be incorporated into ideas they already have.

Visitors were able to clearly articulate strong views about the way content is presented in this group of exhibits and compare the design and “feel” of *Traits of Life* with other areas in the Exploratorium.

When asked whether they had learned anything new in the exhibition 25% of uncued and 15% of cued visitors responded “No,” as unlikely as that may be. The rest of the answers are mainly about new factual material, small bits of information that visitors had gleaned from the components.

Yet, the observations indicated that visitors were often excited about what they saw, calling over other members of their group, crying out in surprise, or just staying quite long times looking at the phenomena.

What the data suggest is that visitors don’t look at exhibition components intending to get new ways of thinking, and are comfortable being surprised and challenged in small ways, rather than in larger conceptual areas.

Intrigued By Individual Components

There is considerable data to suggest that many visitors were intrigued by individual components. For one thing, the tracking study shows a long “tail” of visitors who stayed a very long time. Also, individual components often have fairly wide variance in the tracking times, with a few individuals who stay long times. *Genetic Inheritance*, *Chick Embryos*, *Zoom in on Cells*, and *Energy from Death* (as well as the Demonstration Station) have individual visitors who remained more than 3 minutes. Some of these components require a long interaction in order to carry out the activity (*Genetic Inheritance* requires completing tasks and entering results into a sequence of computer screens in order to arrive at a conclusion), but there is no requirement that visitors actually spend sufficient time to complete the tasks. Not every visitor who stopped at these stations became intrigued enough to stay for relatively long times.

The observations, as mentioned above, demonstrate individual visitors' intense engagement with particular elements. In the cued observation of *Tricks of Love*, one visitor discussed at length the vision capabilities of birds and bees, whether they could see color, etc.

Finally, there are answers in the interviews that demonstrate visitors' interest in particular components or in the exhibition in general, as some of the quotations in the findings section illustrate.

Appreciate Commonalities

The goal of the collection of exhibits—to have visitors appreciate the commonalities of life—was only partially achieved. One or more of the four major Traits illustrated in the sections of the exhibition were recognized by a majority of the visitors, but few visitors noted all of them. The exhibition chose to illustrate commonalities by using components that showed the wide range of living creatures that illustrated these common traits in a variety of ways. So, in some sense the exhibition also illustrated the *differences* among life forms, and many visitors picked up this other “theme.”

When asked what the message of the exhibition was, visitors mentioned the four traits in their answers, but also mentioned that differences in living things was the message. When asked to name a trait, the four major traits in the exhibition were all mentioned, but only a small minority of visitors mentioned all four or *only* the ones stressed in the exhibition. When asked whether the title and its meaning were clear, not only did less than half of cued and uncued visitors say that the title was “very clear” but the added comments of those who thought it was “somewhat” or “not at all clear” frequently focused on the profusion of differences in life events or life forms depicted in the exhibits.

Two additional strong alternative themes that emerged in answers to many of the questions were the idea that the group of exhibits illustrated life cycles and that it somehow had an environmental message. The former of these is partly reinforced by the fact that some of the most powerful and popular components—*Embryos* and *Energy from Death*—could be interpreted as representing the beginning and end of life, and others clearly depicted intermediate stages of life.

But another reason that these two components were stressed so much may be that the concepts that life follows a cycle and that all life is interdependent (and that the environment is fragile) have been extensively emphasized in both formal education and in popular literature and life science museum displays. These are ideas that visitors brought with them and could apply to the components without needing to introduce a new concept.

Conceptual change is hard, and humans prefer to add new experiences, new data and new information to conceptual schemes they already have, rather than to accept new overarching ideas. Thus, the preference to see the group of exhibits as illustrating known concepts.

Practice and Enhance Observation Skills

It is difficult to determine whether visitors enhanced their observation skills, but there is considerable evidence that they practiced observation. The components with magnifiers and microscopes were all heavily used, and other components that had strong holding time, such as the *Energy from Death* also required observation. The major interactive style at this entire exhibition was observation, so the fact that components were used indicates that visitors observed.

This conclusion is supported by the comments that visitors made to each other about what they observed and urging others to come and look at what they had observed. Also, the evaluators noticed frequent characteristics associated with close observation: many visitors would go back and forth between the embryos, spend time looking at various areas of the *Termitarium*, stand in front of the stations that included carbon dioxide monitors or just watch the animals intently.

Engage In Conversations

Partly because the noise level at the Exploratorium made it difficult to overhear conversations, and partly because the interactive observations constituted only a small part of the data (and only covered eight components) it is difficult to draw any firm conclusions about the level of conversations stimulated by the exhibits.

People certainly talked to each other about what they saw. At the *Termitarium* they frequently discussed termites in their lives, recognizing them as the creatures that are constantly threatening their houses. The chick embryos also initiated considerable conversation, especially the fact that the heartbeat could be observed in a very young embryo. *Genetic Inheritance* stimulated conversation, even among strangers who were there at the same time.

Recognize This Group of Exhibits as Different in Design

When asked whether they saw this group of exhibits as different from others, many visitors chose to comment on the obvious difference in subject matter. But

a significant number of visitors also commented on the difference in the quality of *Traits of Life* from the downstairs or the other exhibit areas on the balcony.

As mentioned above in the Findings section, the recognition of the difference can be classified into two overlapping categories: the difference in quality of visitor experience and the difference in design. This dual acknowledgement of the differences is a powerful statement about the importance of design in affecting visitor experiences. The dividing walls, lighting and uniform labeling were noted and the *Traits of Life* area was described as warmer, more colorful and quieter than other Exploratorium areas. Perhaps equally important is that the visitors saw the area as more museum-like.

To summarize, the visitors clearly recognized the differences in design and stated emphatically that they were pleased to see both types of exhibit design in the Exploratorium.

Other Topics

Art Components

The Exploratorium has a long tradition of including artistic components along with the more scientific exhibits. The artistic ones usually do not have the same kind of explanatory labels attached. This tradition was continued in *Traits of Life*, but seemed to be a bit confusing for visitors. The feather and leaf panels, as well as the grass paintings, were noticed by some and appreciated. Unfortunately, the fragile leaves in the leaf panel were crumbled as far up as hands could reach, although at least some visitors thought this was intentional. *Jarred In* presented a difficult interpretation problem for many visitors because it appeared to be a “scientific” component, not too different from oxygen bubbles, for example, and certainly a display of biological organisms in an environment. But, because it is an art piece rather than a science exhibit, the explanatory label was not directly on the object but somewhat removed. The placement of the label would most likely not have caused any difficulty in an art museum, where visitors expect labels for sculptures in the middle of an area to be on a nearby wall or on the floor. But, since visitors were not sure of the nature of the display, they looked for an explanation and some were unsure of the component’s purpose.

Parents and Children

A frequent observation was parental teaching of children. The same educational focus was evident in the interviews. Parents were observed trying to explain components to their children or trying to engage them (with more or less success) in understanding causal relationships or conceptual models. In the interviews, adults frequently answered one way for themselves, but then commented that the response would be different from a child’s point of view. That family visitors use Exploratorium exhibits for overt educational purposes is not surprising, and is reinforced by the data from this evaluation.

Cued and Uncued Visitors

This summary evaluation is intended to assess the experiences of “normal” visitors to the *Traits of Life* exhibition. We believe this necessitated obtaining data from visitors who had no advance notice that they would be observed or interviewed. After discussions with Exploratorium staff, we decided also to interview visitors who had been told that they would be interviewed after they had seen *Traits of Life* because we were interested in their experience. The differences in responses between the two groups were surprisingly narrow.

The biggest difference was in the average times spent by the two groups and the level of engagement. Uncued visitors who were interviewed were not timed, but there is little reason to think that their time in the exhibit area would be different from that of the tracked visitors. The cued visitors, on average, spent more than two times as long in the exhibition. The cued visitors also had a smaller percentage of respondents, (22/70 (31%) of uncued and 5/40 (13%) of cued visitors) who said they hadn’t seen too much of the area because they were chasing children or taking care of toddlers. However, it is likely that visitors who were approached before they entered the area and then decided not to spend much time in the exhibits may not have returned for their interview.

But for all other questions, there was a striking similarity in the answers from both groups. Despite the longer time in the area, cued visitors did not notice the title signs to a greater extent. They responded similarly to questions about the theme and about the differences between this area and the rest of the Exploratorium. On the whole, they recalled aspects of the exhibition in similar terms.

Visitors Are Literal

The data reinforce the conclusion that, in general, visitors are literal. They respond directly to what they see and do and don’t make larger connections or look at the “big picture” aspect of the exhibits with which they interact. Visitors’ answers to questions about what the message of the exhibition was, or why it had that name, were often very specific, comprising the name or content of single components. When asked if they made comparisons between any living things, a majority of visitors spoke about comparisons *within* components, and primarily components where the comparison was explicitly included in the component design, such as *Zoom in on Cells* or *Which Embryo is Human*.

This emphasizes the need to be very explicit about the larger themes for any exhibition. Visitors, like audiences at a lecture, need to be told what the *Traits of Life* exhibition is about, reminded of what the exhibition is about and left with a final message reiterating the theme. Otherwise, they are likely to take in the content of the components and incorporate these into the concepts about nature with which they entered the exhibition.

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George E. Hein

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