A Participatory Model for Integrating Cognitive Research into Exhibits for Children

Discovery Center
Museum of Science, Boston

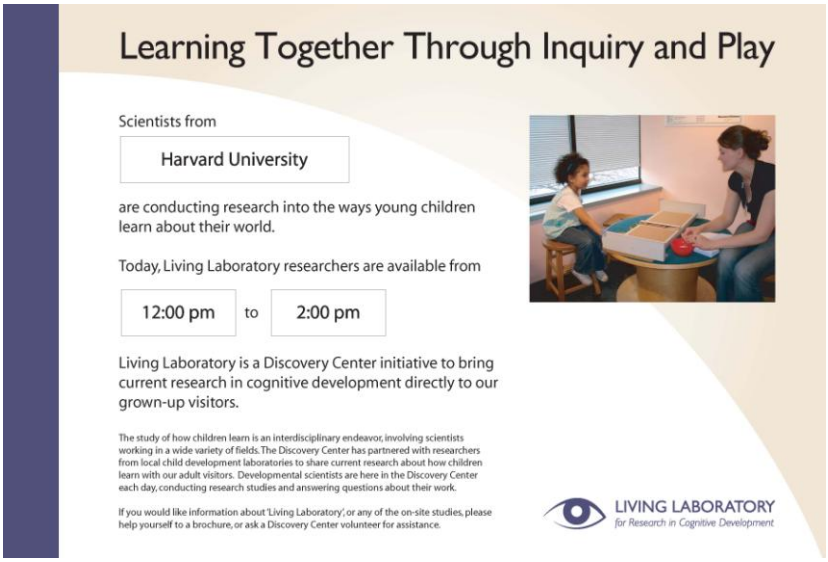

Figure 1: Discovery Center, Living Laboratory wall sign
August 2009

Summative Evaluation
Final Report
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Museum of Science, Boston

Summative Evaluation Report
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Some visitors and volunteers still look to the Museum of Science and to our researcher collaborators for authoritative, didactic answers to questions about child rearing while our programming strives to foster understanding through evidence, not authority. We want adults to wonder about "how children learn" and about "how to discover how children learn" and not about "how should children learn" or about "what parents should do to make their children learn 'faster' or 'better.'" We believe that it will be an understanding and appreciation of the scientific process that will shape adults' behavior most, impacting how they play with their own children, encouraging observation, healthy skepticism in the face of related decisions, and trust in sharing their children's natural curiosity. ... we are trying to emphasize inquiry over authority.

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Part 1. Introduction

A Participatory Model for Integrating Cognitive Research into Exhibits for Children was a model that the Museum of Science proposed to the National Science Foundation's Informal Science Education Program (NSF-ISE) in the Fall of 2006. The Model was to further develop, test, and refine an innovative program that engages adult visitors in a deeper understanding of how children learn and expand understanding of cognitive development. Researchers from cognitive and child development laboratories at the Massachusetts Institute of Technology (MIT), Harvard University, and Children's Hospital Boston, have been studying children and educating adult visitors in a Living Laboratory within the Discovery Center at the Museum.

The focus of both the Formative and Summative evaluations were on investigating how Discovery Center educators could best achieve their goals for the *Participatory Model for Integrating Cognitive Research into Exhibits for Children* by shaping several strategies for interpreting the research conducted daily in the Discovery Center's Living Laboratory. The evaluation team investigated interpretation strategies that help adult visitors (i.e., caregivers 18 years and older) become interested in and better understand the science of cognitive research.[1]

The results of the Formative evaluation indicated that the interpretive strategies were 'stimulating interest' in cognitive research. A critical question for the Summative evaluation was to identify and record "adult behaviors and comments that demonstrate 'understanding' of cognitive science … whether adults understand the *process* of the research rather than whether

[1] In this report we are using the term, 'interpretive strategies,' as the key 'deliverables' for the project. In the NSF ISE proposal information, selected 'deliverables,' or for this project interpretive strategies, are to be "integrated to achieve the greatest project impacts" and the project should "creatively 'push the envelope' in enhancing informal science learning" (http://www.nsf.gov/pubs/2004/nsf04579/nsf04579.htm). Excerpts from five reports to NSF funders throughout 2007-2008, written by Lucy Kirshner, Project Manager for *A Participatory Model for Integrating Cognitive Research into Exhibits for Children*, provide introductions to the interpretive strategies throughout the Summative evaluation report.

they can recall or articulate particular findings" (Formative Evaluation Report, September 2008, p. 47). The plan for the Summative evaluation was not only to evaluate if the interpretive strategies were meeting their goals and achieving their desired outcomes. We also hoped to build a knowledge base that could inform future Museum of Science products.

1.1 Impacts on the Discovery Center's public and professional audiences

The impacts and goals of the project for public and professional audiences during the Summative evaluation year of the project included:

Impacts on public adult audiences

1. Participating adults will increase their interest in the science of cognitive development.
2. Participating adults will increase their understanding of the science of cognitive development.
3. Adult visitors will increase their capacity to be active learners alongside their children.

Impacts on research and professional collaborators

1. Research collaborators, those who conduct studies in the Living Laboratory, will find a value in the conversations they have with Museum visitors.
2. Professional collaborators, colleagues from other ISE institutions nationally, will consider instituting similar programs at their institutions.

1.2 Summative Evaluation Key Findings (see also Appendix 1)

The summative evaluation highlighted that across the sample of adult visitors, individuals:

- Described research questions both specifically and broadly, and identified the 'skills' of children that the researchers were studying
- Indicated that they understood the 'process' of the research by identifying the procedure and stimuli used
- Outlined research-related observations they would make at home as a result of their interactions with interpretive strategies
- Identified further research questions to find out more about cognitive research and children's learning.

Researchers who were conducting studies in the Living Laboratory felt that they:

- Improved in their ability to communicate their research questions and process to adult visitors and volunteers as they conducted studies in the Discovery Center
- Became more comfortable articulating what they do as a researcher in personal conversations
- Fostered adult understanding and educated communities who visit the Discovery Center
- Determined optimal conditions for conducting a study in a public space, in spite of distractions and having to discard data when there is too much noise for children to focus
- Learned to talk to adult visitors throughout the Discovery Center about their research as they are attempting to recruit children for their study

- Developed 'real world application' and examples as they help adult visitors understand their studies, rather than talk with adult visitors about 'pure science,' which is helpful for writing grant applications and other educational opportunities in which they are engaged
- Evolved new directions for a research study as they observe children in the Discovery Center
- Learned about how to be effective communicators by observing volunteers in the Discovery with families and interns.

1.3 Summative evaluation strategy, 2008 to 2009

During the Summative evaluation, we attempted to generate knowledge about adult visitor 'understanding' of cognitive science and whether adults understand the *process* of the research. We also hoped to better understand what cognitive science researchers are learning about how to conduct experiments in public spaces, and how conducting research in the Discovery Center has impacted their research study(ies) and the process of conducting studies.

Evaluation of adult visitors' responses to interpretive strategies: Indicators of 'understanding' included evidence that adult visitors:

- Recognize the hypothesis or question that the scientists are asking or what they are trying to find out (*vs*. the researcher as all knowing and the answers already known)
- Wonder about what goes into setting up a research study, for example how scientists have chosen methods to find answers to their question, an appropriate and large enough subject pool, and/or how they created a situation that isolates a particular learner's behavior (i.e., appreciate the challenges that researchers have *vs*. personal questions about their own children)
- Try to predict an outcome for the study but want to check that prediction with data gathered (a sense of the confirmation of prediction *vs*. one child's response to a study)
- Think of other questions they wish that research would address and try to imagine how to conduct the research
- Use Science, Technology, Engineering and Mathematics (STEM) skills that are helpful in understanding scientific process, such as graphical literacy or an ability to recognize statistical significance, appropriately in the context of a study (i.e., thinking like a researcher).

We evaluated the following five interpretive strategies to study adult visitor understanding during the summative evaluation.

1. *Researcher conversations* (Figure 2): In evaluating the impact of researchers' conversations on adult visitors whose child participated in a research study in the Living Laboratory, we looked for how parents begin a conversation and questions they asked researchers.

   We observed whether researchers encouraged questions from parents after they have had time to hear about a study, and whether visitors took a flyer or insert included in a Discovery Center brochure. The insert described the research study, as well as related activities to try in the Discovery Center and at home. For adult visitors whose child had participated in a study during a

Figure 2: Do young children know that property can change owners? http://www.mos.org/discoverycenter/livinglab/csr/ownerdolls

previous visit and took home an insert we wanted to know if parents tried activities they read about at home and observations they made about their children.

2. *Standalone exhibits and activity cards*: We evaluated adult visitors' interactions with three standalone exhibits Discovery Center staff had created during the formative evaluation year. The three research-related standalone exhibits included Legs & Wheels, and a Mobile and Causal Boxes in the Infant area. Each exhibit had activity cards with information that an adult should be able to absorb very quickly before either the child or the adult loses interest. In addition, graphical representations of findings indicated how researchers attempt to predict, for instance, how many children of what age might respond to the study in a particular way.

Figure 3: Legs & Wheels toys

- Legs & Wheels (Figure 3) is a standalone exhibit, which includes two activity cards and a graphical display of research findings.
- The two standalone exhibits in the Infant area (Figure 4) are the Mobile and Causal Boxes (Figure 5), which also include activity cards and graphical displays of research findings.

Figure 4: Infant area with Mobile and Causal Boxes exhibits

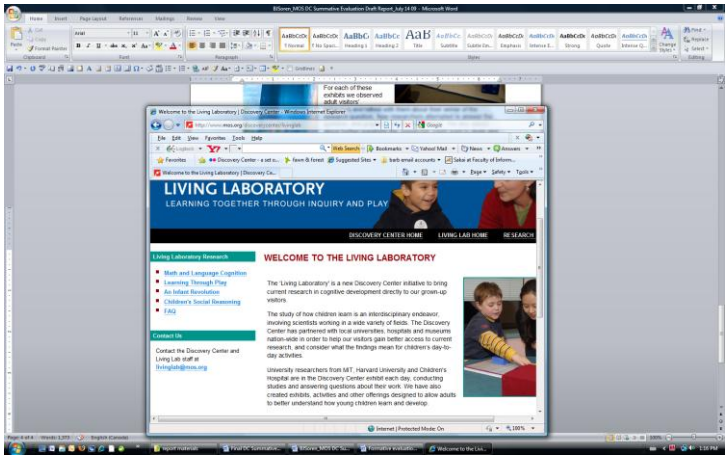
Figure 5: Causal Boxes

For each of these exhibits we observed adult visitors' behaviors and talked with them about their sense of the research question, how researchers attempted to answer the question, and graphical displays of findings. We also asked about further questions the researcher might want to study and how visitors might further explore the research by observing their child or children at home.

3. *Science of Kids Workshop with Researchers* (Figure 6): Evaluators observed attendees at a Science of Kids Workshop in March 2009 as researchers demonstrated and discussed their research studies. We noted questions individuals asked researchers and understanding of the research studies. Attendees completed a survey with questions related to their interest in the research, research questions and methods, new insights about cognitive research, and further questions they may have about research studies.

Figure 6: Science of Kids Workshop March 14, 2009

4. *Living Laboratory website* (http://www.mos.org/discoverycenter/livinglab) (Figure 7):



We analyzed monthly Web traffic reports from the launch of the Living Laboratory section of the Discovery Center website in January through to the end of December 2008. Content on the site included pages with specific study descriptions, videos, podcasts, and online activities.

Figure 7: Homepage, *The Discovery Center's Living Laboratory: Learning Together Through Inquiry and Play*

Evaluation of project impacts on researchers: We compared a small sample of 'novice' graduate researchers from MIT and Harvard who were conducting studies in the Living Laboratory with 'expert' researchers who had been conducting research in the Discovery Center for a longer period of time. We evaluated two 'novice' researchers' conversations two times throughout the year (when they first began in the Living Laboratory and later in the year), and two 'expert' researchers once during the Summative evaluation year.

Instruments for evaluating project impact on researchers included:

1. *Audio-recoding a conversation about a research study with volunteer interpreters*: Through content analysis we assessed researchers' skills and confidence in communicating their research question, methods they are using, and research findings to a group of volunteer interpreters.

2. *Feedback forms completed by volunteers*: Volunteers who participated in the audio-recorded conversation wrote comments on what they learned about researchers' studies, what they thought researchers were trying to find out, and how they were trying to answer their research question. Volunteers provided important feedback about ways researchers might improve how they communicate their research studies to adult visitors.

3. *Focus Groups with researchers*: During the Summative evaluation we conducted two focus groups with more and less experienced researchers from MIT and Harvard research labs, during the weekend of the Science of Kids Workshop in March 2009. Questions for researchers included:

   - What they thought had been working well about helping adult visitors understand their research in the Discovery Center
   - What were challenges in explaining their research to adult visitors
   - What they were learning about how to conduct experiments in public spaces
   - What they found effective in helping adult visitors understand their primary research question and methods they were using to try to answer their question
   - How conducting research in the Discovery Center might impact their research study(ies) and the process of conducting studies
   - How they felt about their skills in communicating their work to adult visitors and volunteer interpreters in the Discovery Center.

Through these evaluation instruments we were able to determine:

- What researchers had learned about how to conduct experiments in public spaces
- How conducting research in the Discovery Center impacted their research study(ies) and the process of conducting studies
- How, if at all, researchers' skills in communicating their work to adult visitors with whom they interact changed since working in the Discovery Center. We hoped to find out if their confidence in communicating their research study to publics changed (e.g., different age groups, ethnic groups, outreach groups, and visitors more or less knowledgeable about research)? If so, in what way(s)?

1.4 Summative evaluation data collection and analysis

Dr. Barbara Soren, external evaluator for this project, and Museum of Science, Boston evaluator, Anna Lindgren-Streicher, were responsible for the Formative and Summative evaluation data collection and analysis from November 2007 to July 2009. We collected and analyzed data using multiple data collection methods and participants in order to develop as complete a picture as possible of visitors' experiences with the interpretive strategies.

Overall, 289 people participated in the Summative evaluation, including adult visitors, researchers conducting studies in the Discovery Center, as well as staff and volunteer interpreters interacting with visitors as they used interpretive strategies.

Multiple evaluation methods: As adult visitors experienced one or more interpretive strategies we used multiple methods, allowing us to triangulate data and strengthen the conclusions we were able to draw from the data.[2] See also Appendix 2 for a summary of Summative evaluation methods and Appendix 3 for a profile of adult visitors who participated in the Summative evaluation.

[2] Triangulation ensures that evaluators can avoid the problems of a one-method study, such as biased or untrue responses from self-reporting, and reduce the likelihood that the evaluator will draw a false conclusion based on the limits of any one instrument [e.g., Patton, 2002 - *Qualitative research and evaluation methods,* Thousand Oaks, CA: Sage Publications, Inc.; Soren, 1995 - Triangulation Strategies and Images of Museums as Sites for Lifelong Learning, with G. Lord & J. Nicks, in *Museum Management and Curatorship*, *14*(1), 31-46].

During the Summative Evaluation, data collected included:

1. *Participant observation* of 112 adult visitors in the Discovery Center interacting with specific interpretive strategies.

    - We tracked adult visitors focusing on their behaviors and interactions, including if and when adult visitors interact with researchers and/or staff/volunteer interpreters.
    - For standalone exhibits, we noted group interactions, child and adult initiatives in playing with the exhibit, whether adults read activity cards and interpretive panels, whether they took a Discovery Center brochure, as well as interactions with staff or volunteers.
    - For visitor conversations with researchers, we observed questions adult visitors asked researchers prior to and immediately after a child's participation in a research study, or a little later after the child completed the study (within 10 minutes). We also looked for whether they took a flyer or insert about the research study, talked with others in their group, or talked with a staff member or volunteer.

2. *Interviews* with 89 of the visitors observed. We asked people the following questions:
    - Their awareness that researchers were conducting studies in a Living Laboratory on how children learn
    - If a child they were with had participated in a research study in the Living Laboratory prior to the current visit, and if so, if they took home a flyer about the study and read it
    - What they thought the researcher was trying to find out
    - How the researcher was trying to find out answers
    - How they felt about the information on activity cards
    - If they were to write a headline for a story about the research, what the headline for their story would be
    - Further questions the researcher might want to study
    - Things they might want to look for while playing alongside their child at home.

    We observed and interviewed adult visitors from the beginning of mid-December 2008 through to the beginning of May 2009. This sample of visitors included:
    - 37 adult visitors whose children participated in a study with a researcher (37 observations and 31 interviews)
    - 44 visitors who interacted with the Legs & Wheels exhibit (44 observations and 32 interviews)
    - 31 visitors with very young children who experienced the Mobile and Causal Boxes exhibits in the Infant Area (4 observations and interviews at the Mobile; 27 observations and 22 interviews at Causal Boxes).

3. *Observation of a Science of Kids Workshop with researchers and a pre- post-survey that 19 attendees filled out*. Three evaluators noted interactions with researchers and questions about their research studies throughout the Workshop. Professor Paul L. Harris, Victor S. Thomas Professor of Education, Harvard Graduate School of Education, whose research interest is the early development of cognition, emotion, and imagination, gave an introductory lecture. Attendees participated in demonstrations by three researchers from the Graduate School who have been working in the Discovery Center's Living Laboratory for two to four years. The survey asked about key reasons for attending, changes in understanding of cognitive development research and how children learn, impressions of the Workshop, what the attendees most valued about the Workshop, further questions individuals had, and what could be improved the next time Discovery Center staff offer the Workshop.

4. *Visitor Surveys* or written exit questionnaires. 127 adult visitors responded to the interpretive strategies and potential outcomes of their experiences by completing a Visitor Survey. Questions related to, for instance, use of and experiences with the interpretive strategies, feelings about the research related to how children learn in the Discovery Center after their visit, the potential for return visits, use of the Discovery Center website at home to learn more about cognitive research after a visit, and interest in getting involved in the Discovery Center's Living Laboratory for cognitive research. Half of the visitors (47%) completed exit questionnaires during vacation week, 28% during weekdays, and 25% on weekends (see Table 1). Eighteen of the weekday visitors attended 'Family Fun Night,' an outreach evening, on January 23, 2009.

Table 1: Exit Survey data collection times (N=127)

Time of data collection	No. (%) completed
Vacation Week	60 (47%)
Weekday	35 (28%)
Weekend	32 (25%)

The Visitor Survey indicated that this sample of visitors came to the Discovery Center to have a fun, educational experience as a family. Top reasons for visiting were 'It is fun,' 'Family time,' and 'Educational experience for children' (see Table 2). The top two categories, 'It is fun, and 'Family time' had the same percentage frequency of responses as they did in the Formative evaluation, and 'Educational experience' was very similar in the two studies (49% in the Formative evaluation).

Table 2: Reasons for visiting (N=127)
multiple responses were possible

	No. of visitors	% of visitors
It is fun	70	55%
Family time	69	54%
Educational experience for children	55	43%
Recommended by a friend or family member	9	7%
Play date	8	6%
Other reasons	6	5%
Waiting for people who are exploring other parts of the Museum	4	3%
Recommended by a Museum staff person	3	2%
Saw it on the map	0	0%

- Forty of the Visitor Survey visitors (31%) were aware of the Living Laboratory prior to their visit, 16 visitors (13%) had a child participate in a research study during a previous visit, and nine of these (7% of the Visitor Survey sample) had taken a flyer to read at home; only four visitors (3%) had read about the Living Laboratory research on the website.

- Half of the visitors who completed the Visitor Survey (53%) were aware of the Living Laboratory research after their visit to the Discovery Center (an increase of 22%).

- Interpretive strategies that this sample of adult visitors interacted with during their Discovery Center were the Legs & Wheels exhibit (26%), the Infant area (18%), and a talk with a researcher from MIT, Harvard, or the Children's Hospital (11%); 20 of the visitors (16%) played with other research toys in the Discovery Center, 16 visitors (13%) talked with a staff member or volunteer interpreter about the research or related exhibits, and 11 visitors (9%) took Living Laboratory brochures.

- Two-thirds of the Visitor Survey sample (64%) responded that they would be interested in trying to learn more about the research in the Discovery Center by visiting the Discovery Center website.

- 18 of the visitors (14%) would read the Discovery Center e-newsletter to learn more - 36 visitors (28%) wanted to get more involved in the Discovery Center's Living Laboratory on cognitive research by receiving the newsletter; 11 of the visitors (9%) would attend a parents' roundtable led by the researchers.

5. W*ebsite-related methods*. Web metrics and analysis of hits and unique visitors for each page of the Living Laboratory section of the Discovery Center website helped to determine Web traffic to sections of the site. We hoped this would provide indicators that after a Discovery Center visit adult visitors who had experienced the Living Laboratory research and interacted with the interpretive strategies during a visit might learn more online and expose their children to learning situations that challenge and support new understandings. We analyzed Web traffic to http://www.mos.org/discoverycenter/livinglab from January through to December 2008.

6. *Researchers and volunteer interpreters-related methods*. We gained insight from 'insiders' – researchers and volunteer interpreters – who interact and have conversations with visitors in the Discovery Center. The written and verbal reflections of two 'novice' researchers and two 'expert' researchers as they talked with 17 volunteer interpreters about the research study they were currently conducting in the Living Laboratory provided indicators of changes in researchers over time in the Discovery Center as they communicate their research study to adult visitors.

7. *Researcher insights methods*. Two focus groups with 10 of the researchers conducting studies in the Discovery Center from the MIT and Harvard research labs provided insights into:

   - What they thought had been working well about helping adult visitors understand their research in the Discovery Center
   - Challenges in explaining their research
   - What they have learned about how to conduct experiments in public spaces
   - What they have been finding effective in helping adult visitors understand their primary research question and methods they are using to try to answer their question
   - How conducting research in the Discovery Center might impact their research study(ies) and the process of conducting studies
   - How they felt about their skills in communicating their work to DC volunteer interpreters and adult visitors in the Discovery Center.

Data analysis: We entered quantitative data into databases and analyzed the data using descriptive statistics (e.g., frequency of responses), as well as inferential statistics to compare responses across groups.

For qualitative data we used inductive coding methods in which we looked for patterns, themes, and interrelationships that emerged from the data for each interpretive strategy, as well as across interpretive strategies, to evaluate the impact of the Living Laboratory experience on adult visitors and researchers.

- We developed a Codebook for the analysis of each interview question across interpretive strategies, using common themes such as ability to describe research question, identification of 'skills' of children examined by researcher, and identification of procedure(s) or stimuli used in exhibit/research study. Codebooks were very helpful in demonstrating 'understanding' of cognitive science, and whether adults understand the *process* of the research (rather than whether they could recall or articulate particular findings) – the primary goals of the summative evaluation.

- A comparison of 'novice' and 'expert' researchers' conversations with volunteers, and responses of researchers during focus groups provided indications of improved ability to communicate research questions and process to adult visitors and volunteers as researchers conducted studies in the Discovery Center – the secondary goal of the summative evaluation.

Profile of adult visitors across interpretive strategies: Across interpretive strategies we collected common demographics about adult visitors' last visit to the Discovery Center (i.e., sex, age, race/ethnicity, and highest level of education), and whether they would want to learn more by receiving the Discovery Center's e-newsletter and/or participate in a parents' roundtable led by researchers.

For the adult visitors who completed a Visitor Survey, had an interview after a child participated in a study with a researcher, or participated in an interview after they interacted with one of the standalone exhibits (i.e., Legs & Wheels, the Mobile, or Causal Boxes) the following were the most common demographics (see also Demographic Comparisons in Appendix 3):

- This visit was either their first time in the Discovery Center (31%), or their last visit was within the past three months (30%).
- 65% were female
- 37% were 30-34 years, and 31% were 35-44 years
- Just over half (54%) had completed a Graduate degree (49%) or some graduate work (5%); 37% had completed a College degree (31%) or some college (6%)
- Three-quarters were White (73%); other ethnic/racial group represented were Asian-American (6%), Hispanic-Latino (5%), African-American (3%), and American Indian or Alaskan Native (1%).

1.5 Overview of changed thinking about how children learn during a visit to the Discovery Center

On the Exit Survey and the Science of Kids Workshop Survey, we asked adult visitors whether their thinking about how children learn changed during their visit to the Discovery Center. We asked people to indicate if they 'Strongly Disagreed,' 'Disagreed, 'Agreed,' or 'Strongly Agreed' with the following statements:

- I feel more informed about how children learn
- I feel more informed about how researchers conduct cognitive development research
- My visit to the Discovery Center changed how I think about how children learn.

For the Visitor Survey sample:

- 69% of the 127 visitors felt more informed about how children learn – 9% 'Strongly Agreed,' 60% 'Agreed'
- 49% responded that they felt more informed about how researchers conduct cognitive development research – 9% 'Strongly Agreed' and 40% 'Agreed'
- 37% believed that their visit to the Discovery Center changed how they thought about how children learn – 6% 'Strongly Agreed' and 31% 'Agreed.'

Statistical tests with the full exit survey data set for the three questions - Feel more informed about how children learned; Feel more informed about how research is conducted; and Changed how I think about how children learn - indicated no statistically significant difference in the responses across the adult visitors' in the following categories:

- Last visit (within past year; more than one year ago)
- Educational level (College degree or some college; Graduate degree or some graduate school)
- Sex (Male; Female)
- Race (White; Non-White)
- Income (Under $50,000/year; Over $100,000/year).

These comparisons showed that there was no difference (based on these three questions) in how the different demographics groups responded to the Living Laboratory.

For the Science of Kids Workshop group, in comparison to the Visitor Survey sample, responses of adults who attended were:

- 100% felt more informed about how children learn - 58% 'Strongly Agreed' and 42% 'Agreed.'
- 100% were more informed about how researchers conduct cognitive development research - 58% 'Strongly Agreed' and 42% 'Agreed.'
- 83% believed that their visit to the Discovery Center changed how they thought about how children learn - 50% 'Agreed' and 33% 'Strongly Agreed.'

As we found in the Formative evaluation, a workshop in which attendees can learn from researchers through demonstrations, questions, and discussions about their studies in cognitive research is clearly an excellent approach for helping individuals feel informed about how children learn and how researchers conduct cognitive development research. But by the end of the Summative evaluation, responses to questions were continuing to indicate that interpretive strategies also were helping visitors in the Discovery Center feel more informed about the research and the process researchers use, as well as changing some visitors' thinking about how children learn.

The next sections of the report: The remaining sections of the Summative Evaluation report include:

- Detailed findings for the three standalone exhibits in Part 2.

- Findings related to researchers' interactions with visitors and volunteers, researchers' reflections on conducting studies in the Discovery Center during focus groups, and an analysis of the number of users who browse the Living Laboratory website in Part 3.

  Both Parts 2 and 3 focus on 'understanding' of cognitive science - whether adults understand the *process* of the research, and researchers' improved ability to communicate their research questions and process to adult visitors and volunteers in the Discovery Center.

- A Project Associates Report with progress Associates have been making during 2008-2009 toward integrating cognitive research into their museums in Part 4. This final report provides evidence that the Museum of Science's evolving Model for their project, *A Participatory Model for Integrating Cognitive Research into Exhibits for Children*, is continuing to move forward and influence the practice of other museum professionals across the country.

Part 2. Standalone Exhibits: Legs & Wheels, the Infant Area Mobile and Causal Boxes

Three standalone exhibits in the Discovery Center enable visitors to interact with an actual experiment and come up with their own questions they want to explore. Interpretive panels for each exhibit tell adult visitors, "You can be a Cognitive Scientist!" The hypothesis was that because the toys are novel and intriguing, parents who watch their children playing with them will gravitate toward information available about related research.

2.1 Legs & Wheels

'Legs & Wheels' is an example of a 'toy' that mimics tools from research studies in the Discovery Center. Cognitive researcher, Dr. David Rakison at Carnegie Mellon University, studies how children's classification skills develop during early childhood. Dr. Rakison found that children as young as five months classify objects based on the object's observable properties. Discovery Center staff have recreated his experiments at the Museum in order to understand how children in the Discovery Center use classification (a scientific reasoning skill) in their everyday interactions with objects.

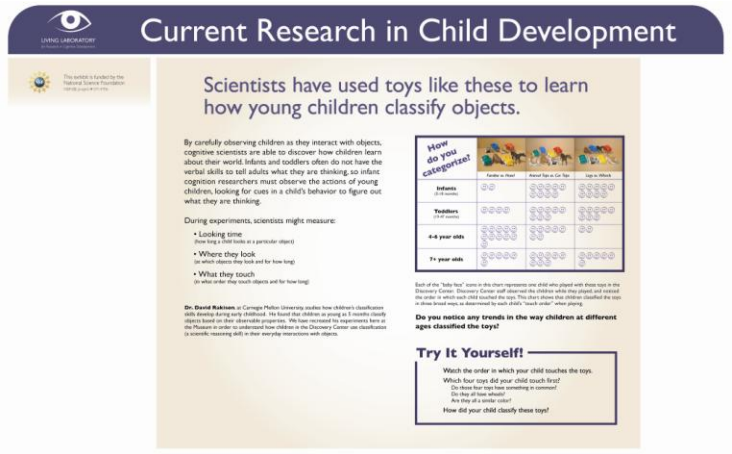


Figure 8: Legs & Wheels Interpretive Panel

As described on the interpretive panel in Figure 8, by carefully observing children as they interact with objects, cognitive scientists are able to discover how children learn about their world. Infants and toddlers often do not have the verbal skills to tell adults what they are thinking, so infant cognition researchers must observe the actions of young children, looking for cues in a child's behavior to figure out what they are thinking.

The graphic on the panel uses 'baby face' icons to represent one child who played with these toys in the Discovery Center. Discovery Center staff observed children while they played, and noticed the order in which each child touched the toys. This chart shows that children classified the toys in three broad ways, as determined by each child's 'touch order' when playing. The panel encourages adult visitors to watch the order in which their child touches the toys, and asks if they notice any trends in the way children at different ages classify the toys. Adults as researchers can observe:

- Which four toys did your child touch first?
- Do those four toys have something in common?
- Do they all have wheels?
- Are they all a similar color?
- How did your child classify these toys?
- Do you notice any trends in the way children at different ages classified the toys?

Two activity cards tell adult visitors: "You can use these toys to learn how your child classifies objects." One activity card suggests that parents ask their child how a toy like the one in the image on the card moves (zebra legs with a car seat on the top of the body). The second card

suggests they ask their child what **noise** a toy like the one in the image on the card makes (a horse on wheels).

Legs & Wheels Key Findings (32 interviews completed)

Across the sample of adult visitors who interacted with Legs & Wheels:

- 59% of the visitors were able to describe research questions, either the particulars of the question (22%) or the researcher's broad area of research (37%); 16% were able to identify the 'skills' of children that the researchers were studying.
- 25% indicated that they understood the 'process' of the research, by identifying the procedure (16%) or stimuli used (9%).
- 31% outlined research-related observations they would make at home, while playing alongside their child, as a result of their interactions with interpretive strategies (17% of the other visitors described observations related to research generally, and not research from the exhibit).
- 61% identified further research questions to find out more about cognitive research and children's learning (51% a specific question, data point, or measure; 7% a broad or general query; and 3% questions related to children).
- 36% were able to write a headline for a story about the Legs & Wheels research based on what they saw in the picture on the interpretive panel.

Observations of interactions at Legs & Wheels (N=44)

Most of the groups at Legs & Wheels had one adult; four groups had two adults.

As Table 3 indicates:

- Most often a child played with the toys on his/her own (88% of the groups); 58% of the interactions were an adult and child playing together, and 42% were the child playing with the toys after adult encouragement.
- Most of the adults (89%) read the panel about Current Research in Child Development (56%), and/or the activity card related to Legs & Wheels (33%).
- One person took a Discovery Center brochure, and one talked to staff or a volunteer.

Table 3: Behaviors at Legs & Wheels: N=43
Note: There were no checked observations for one visitor

Behavior	Number of visitors
Child plays with the Legs & Wheels toys	**Yes: N=38 (88%)** No: N=5 (12%)
Adult and child play with the toys	**Yes: N=25 (58%)** No: N=17 (39%); NR (2%)
Child plays with the toys after adult encouragement / instruction	**Yes: N=18 (42%)** No: N=25 (58%)
Adult reads the panel about Current Research in Child Development	**Yes: N=24 (56%)** No: N=19 (44%)
Adult reads the activity card	**Yes: N=14 (33%)** No: N=29 (67%)
Adult takes a brochure	**Yes: N=1 (2%)** No: N=41 (95%); NR (2%)
Adult talks with staff/volunteer interpreter about the study	**Yes: N=1 (2%)** No: N=41 (95%); NR (2%)

Children or fathers tended to initiate playing with the Legs & Wheels toys (children initiated 34% of the interactions observed, and fathers 25% of the interactions). Keeping young children focused on the sorting and classifying activity, and engaged, tended to be a challenge. For example:

- A two year-old came to the table to begin play. The father joined child shortly after. The father read the activity card, then proceeded to engage the child actively, questioning the child about what sound each toy made. The father attempted to refocus the child when the child had lost interest.
  [30-34 years, visited past 6 months-1 year, college degree]

- Another two year-old played with the Legs & Wheels toys. The mother appeared, observed the child, and asked the child about the toy's color and the name of the animal. The mother and child appeared to play with the toys in a manner unrelated to way they are meant to be used. The mother spoke Polish to her child. The child lost interest in Legs & Wheels and attempted to walk away, but the mother placed him back in the chair at the Legs & Wheels exhibit.
  [30-34 years, visited past 3 months, graduate degree; also took a brochure, played with other research toys, and talked with the researcher and staff]

- After reading the panel about the research, a father engaged his 4½ year-old child in the activity by asking the child to classify each object. He instructed the child to group the Leg & Wheels pieces. He encouraged his child by saying, "Good job." He also had a one year-old playing at the box station who occasionally walked over to show her father things from her box, otherwise the father would have read the activity card with his older child.
  [35-44 years, visited past 3 months, graduate degree; also went to the Infant area with an 8 month-old child, talked with staff, and was interested in receiving the e-newsletter]

Legs & Wheels exhibit demographics (see also Appendix 3): One-third of the group of visitors (32%) who interacted with the Legs & Wheels exhibit was aware of the Living Laboratory research in the Discovery Center after their visit. Only four of the visitors' children had participated in a research study (none had taken home a flyer to read more about the research study). Half of the adults had visited the Discovery Center in the past six months (44% in the past three months and 6% in the last 3 to 6 months), while 16% had never been to the Discovery Center before. Of those who responded to demographic questions 15 of the visitors were females (47%) and 11 were males. Most adults were White (63%), but three were Asian American and two were Hispanic-Latino.

Interviews with Adult Visitors who interacted with the Legs & Wheels exhibit (N=32)

What the researcher was trying to find out: (59% were able to describe the research question; 16% could identify 'skills of children examined by the researcher; 25% were unable to describe the research question)

When they were told that an original experiment by a researcher was the basis for the Legs & Wheels exhibit and asked what they thought the researcher was trying to find out, more than half of these visitors (59%) were able to describe the research question. Most responses related to categorizing, grouping, classifying, or sorting, such as "How children classify" or "How kids categorize things." Two responses were:

- Assorting toys with their function. How kids group toys?
  [Female, 35-44 years, visited past 3 months, with a 3 year-old, graduate degree, Asian-American; also talked with a researcher and previously participated in research study]

- What part of toy child connects to. How they classify: vehicle *vs*. animal.
  [Female, 30-34 years, visited past 3 months, with a 3 year-old, college degree; also talked with a researcher and staff]

Five visitors (16%) described specific 'skills' of children that were somewhat related to the research, such as, "to see if the child makes associations with animals and cars" and whether they "recognize" a car or horse first. The remaining eight visitors gave cursory or tentative descriptions (e.g., "Different ways to move for locomotion" or "I think questions about different toys").

How the researcher was trying to find out answers: (47% gave tentative guesses at research methods; 16% identified the procedure used and 9% the stimuli used in the exhibit or research study; 28% guessed or had unrelated responses)

The second question was to see if visitors knew the 'process' of doing the research or how the researcher was trying to find out answers. Almost half of the sample of adult visitors (47%) who interacted with Legs & Wheels expressed ideas about 'methods,' and in particular 'observation.' But they did not add any detail particular to exhibit or research study. Some responses were:

- By watching kids watching research. The material.
  [A grandmother with a 3 year-old who was aware of the research]
- Observation and questioning.
  [Male, 35-44, visited past 3 months, with 4 and 6 year-olds, graduate degree; also took a brochure and talked with staff]
- By watching how child plays with toy. Like a car or animal. What sound does the child make?
  [Female, 30-34, visited past 3 months, with a 3 year-old, college degree; also talked with a researcher and staff]

Five visitors (16%) identified the specific procedure used with some detail about the nature of the classification. One mother with an 18 month-old said,

- Asking child to pick out particular groups, the ones with wheels, the ones with legs, etc.
  [55-64, visited 3-6 months ago, college degree; also went into the Infant area and played with other research toys]

Three other visitors (9%) talked about specific stimuli used related to how children think the toys move or sound, or comparing different ways of moving.

Information on the activity card: After these first two questions, the interviewer asked visitors to read the activity cards, and to comment on the information on the cards. Most visitors felt the content and vocabulary were 'just right' (74% for each), and that the information provided was 'just right' (58%). The remaining visitors had a range of opinions about the information provided on the activity cards. Three visitors said the content was 'simple' or 'too simple' and one that it was 'complex.' Four visitors found the vocabulary 'easy' and one person that it was 'too easy.' Seven visitors commented that there was 'too little information,' and one said that there was 'too much information.'

To probe visitor understanding more deeply, the final three questions asked about writing a headline for *The Boston Globe* about the Legs & Wheels research, further questions the researcher might want to study, and things parents might want to look for while playing alongside their child at home.

A headline for *The Boston Globe* about the Legs & Wheels research: (36% had an idea for a headline related to the research question, 18% for a headline related to cognitive science, and 11% a statement about babies; 36% did not have an idea)

Ten of the adult visitors (36% who responded to this question) attempted a headline about, for instance, different ways to move animals *vs*. cars or sorting natural and unnatural objects. One father whose three year-old child had previously participated in a research study suggested that a more general headline for a story might be: "How kids see things, which category do they recognize first?" Five visitors (18%) thought of headlines related to cognitive research, such as discovering "thinking patterns that can then be used to make lesson plans" or "interactive ability."

Further questions the researcher might want to study: (58% suggested questions related to the research or results – 51% specific to the research and 7% more general questions; 3% of the questions related to observing their own child; 39% could not think of further questions)

Half of the Legs & Wheels visitors (51%) were able to think of questions the researcher might want to study, related to the research or results for the Legs & Wheels study. Questions were about:

- Different colors, patterns, shapes, or ways of moving – slow *vs*. fast
- Visual and auditory discrimination, and creativity
- Sharing with another child
- Comparing results with those of children with autism
- How to physically connect the toys
- The same and different categories of toys
- Preferences for animals or cars
- Age differences in classifying objects.

Observations while playing alongside a child at home: (48% suggested things they may look for at home related to the research - 31% were research-related and 17% related to research generally; 41% might observe things unrelated to the research, and 10% did not have observation ideas)

Finally, nine of these adult visitors (31%) at the Legs and Wheels exhibit thought of things related to the research that they might want to observe while playing alongside their child at home. They suggested observing why children grouped toys as they did, their ability to classify animals, how they deal with different shapes, and language used to describe things like size, volume, and height. Five other people thought about observing more general areas, such as: what interests child and exploring from there; questions asked regarding toys and nature; classifying shells and rocks collection; imaginative play; and learning how a child learns - physical and cognitive development.

The responses of the adult visitors who spent time with the Legs & Wheels exhibit indicated that the toys, interpretive panel, and activity cards, were engaging and helped them think more about research related to children classifying, categorizing, sorting, and grouping objects.

2.2 Infant Area: Mobile and Causal Boxes exhibits (26 interviews completed)

Two exhibit components in the Infant Area allow adults to re-create infant studies with their young children (i.e. pre-walkers).

One component is **a Mobile** that features a variety of pillows (in pairs of different colors or patterns) that adults can hang on the Mobile, or hold in front of their infant, to determine whether their baby prefers certain colors or patterns over others.

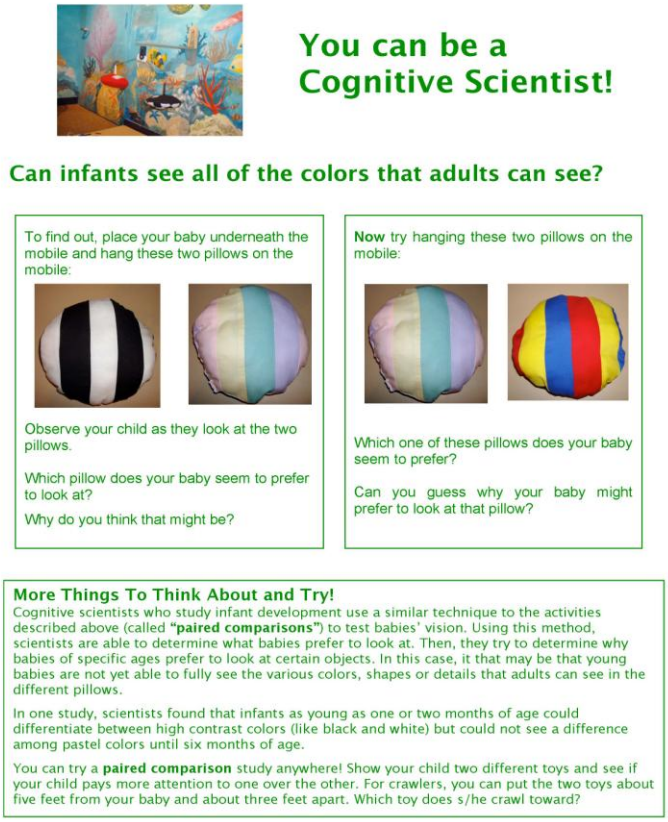


Figure 9: Mobile Interpretive Panel on colors

One interpretive panel invites adult visitors to explore if infants can see all of the colors that adults can see. To find out, they can place their baby underneath the Mobile and hang two different colored pillows on the Mobile's bracket. Then they can observe their child as the baby looks at the two pillows, and see which pillow the baby seems to prefer to look at, and why they think that might be (Figure 9).

A second interpretive panel about visual acuity helps parents think about how clear their child's vision is. To find out, the instructions are to place their baby underneath the mobile, and hang two pillows, for example with different sized black-and-white stripes on the Mobile. Then they can observe their infant's reaction to the two pillows. They can see if their baby seems to prefer to look at one of the pillows over the other, and think about why that might be. A graphic on visual acuity (Figure 10) describes how Discovery Center staff showed three different pillows (one at a time) to babies in the Discovery Center, and recorded how much time they spent looking at each pillow. Each of the 'baby-face' icons represents one baby. The pictures indicate which pillow each baby in the sample looked at the longest.

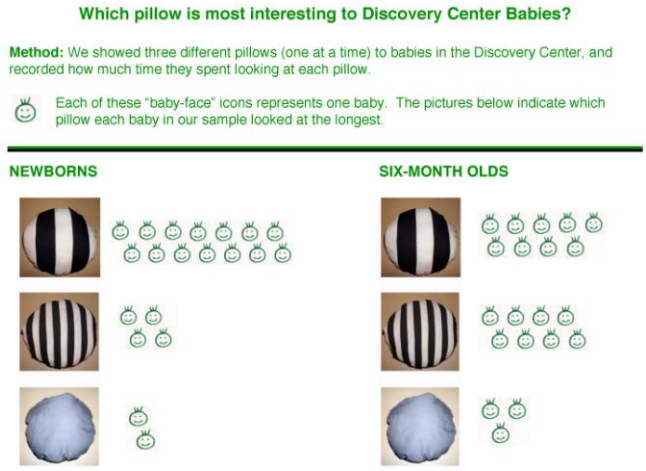


Figure 10: Mobile Interpretive Panel on visual acuity

The second standalone exhibit is a colorful **Causal Boxes** display, with buttons to press, lights that come on, and objects that move around behind plexiglass when an infant presses the buttons. The inspiration for this exhibit is research Cognitive Scientists from the Early Childhood

Cognition Lab at MIT are conducting in the Discovery Center, in order to better understand how young children learn through play. In one research project, they found that older children (4-6 years-old) will continue exploring a toy if it is unclear which cause, among multiple possible causes, creates a particular effect in the toy. Although MIT researchers did not look at infants in their research, Discovery Center staff have invited adult visitors in the Infant area to think about what infants might know about cause & effect relationships. The interpretive panel for the exhibit (Figure 11) explains that the 'fish tanks' or Causal Boxes exhibit is a toy that has multiple causes (different colored paddle-buttons) and multiple effects (fish, seahorses, seaweed and lights).

Figure 11: Causal Boxes exhibit interpretive panel

As the panel for Causal Boxes describes, the exhibit helps adult visitors better understand what infants know about cause & effect. The panel explains that adults should sit facing the 'fish-tank' exhibit and place their baby on their lap. Using both of their hands, they can press the blue and red paddle-buttons on the 'fish tank' at the same time. As they press the paddle-buttons, they can describe what happens in the 'fish-tank' to their baby, saying, "Look! The light comes on and the fish swim!" The panel suggests that they repeat this sequence a few times, always while pressing the same two paddle-buttons, until they are sure that they have captured their baby's attention. Then they can let their baby explore the paddle-buttons on his/her own, and observe: Does s/he try one paddle-button at a time? Or two paddle-buttons at once? Does their baby try to press the paddle-buttons that the adult had not shown them? Or does the baby focus only on the two paddle-buttons the adult pressed? Did their baby try to figure out which of the two paddle-buttons the adult pressed turns the light on? How did the adult know the baby was trying to figure it out?

A pictogram (Figure 12) describes the method Discovery Center staff used to show babies two of the buttons on the 'fish-tank' being pressed simultaneously (one that controls the light and one that controls the seaweed), and recorded their subsequent behavior exploring the buttons. Each of the 'baby-face' icons, again, represent one baby, and indicate which behavior each baby performed after being shown two buttons pressed at the same time.

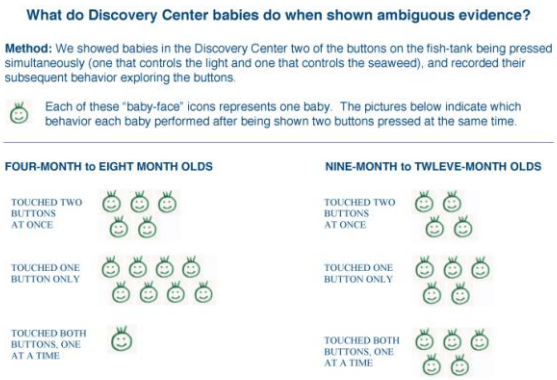


Figure 12: Pictogram for Causal Boxes exhibit

Infant area demographics (see also Appendix 3): In the Infant area, no one who interacted with the Mobile or Causal Boxes exhibits was aware of the Living Laboratory research in the Discovery Center after their visit, and their children being very young, none of them had children who had participated in a research study. Almost half of the adults had never visited the Discovery Center (46%), and 31% had visited in the past six months (all of these visitors in the past three months). Two had visited six months before, two had visited one to two years before, and one person had visited two to five years before. One group did not complete a demographic profile. Of the other 25 visitors, 16 of the visitors were females (61%) and 9 were males. Most adults were White (81%), but two were Asian American and one was Hispanic-Latino.

Information on the activity card: After the visitors in the Infant area read the activity cards either for the Mobile or Causal Boxes exhibit with the interviewer, most visitors felt the content, vocabulary, and information were 'just right' (77% for the content and information, and 81% for the vocabulary). The other visitors had mixed feelings about the information on the activity cards.

- Two visitors said the content was 'simple,' and nine visitors that it was 'complex.'
- One mother with a 6 month-old at the Mobile exhibit who had a graduate degree, talked with a researcher, and was interested in receiving the e-newsletter found the content and vocabulary 'complex.'
- At the Causal Boxes exhibit, one mother with a 6 month-old who also had a graduate degree, and interacted with Legs & Wheels thought the content and vocabulary was 'complex' and that there was too much information.
- An Hispanic-Latino mother who spoke with a staff member and had a college degree said the content was 'simple'
- A mother with an 11 month-old who talked with staff and had a college degree felt the content and vocabulary was 'too complex' and there was too much information ('5' on a scale 1 to 5).

Mobile Exhibit Key Findings (4 interviews completed)

A small sample of the adult visitors interacted with the Mobile during the Summative evaluation period. Of those interviewed:

- 100% of the visitors were able to describe research questions, either the particulars of the question (25%) or the researcher's broad area of research (75%).
- 100% gave a tentative guess at the research methods.
- 25% outlined research-related observations they would make at home, while playing alongside their child, as a result of their interactions with interpretive strategies (75% of the other visitors described observations related to research generally, and not research from the exhibit).
- 50% identified further research questions to find out more about cognitive research and children's learning.
- 75% were able to write a headline for a story about the Mobile research based on what visitors saw in the picture on the activity card.

Observations of interactions at the Mobile (N=3)

Note: There were no observations reported for one of the groups.

Although the data collectors spent large amounts of time in the Infant area, they found that very few adult visitors used the Mobile exhibit with their young babies. One group at the Mobile had two adults and a six month-old, and three groups included one adult and a child (two three month-olds and a four month-old).

As Table 4 indicates three of the four adults positioned their infant under the Mobile, and two adults held pillows for their child to look at, two changed pillows displayed, two read the activity card, and two read labels that are on pillows on the floor about babies' preferences (i.e., stripes/solid colors, red/yellow, yellow/blue, faces/other patterns, patterns/solid colors, black-and-white stripes/solid grey, black-and-white/colored patterns).

Table 4: Behaviors at the Mobile: N=4

Behavior	Number of visitors
Adult positions the infant under Mobile	N=3 (75%)
Adult holds pillows up for child	N=2 (50%) One father was arbitrarily selecting pillows
Adult changes pillows displayed	N=2 (50%)
Adult reads the activity card	N=2 (50%)
Adult reads labels on pillow	N=2 (50%)

- No one in this small group of adult visitors talked with a staff person or volunteer interpreter about the study because they were not stationed in the Infant area during the time period of the Summative evaluation.
- Also, no one looked at a very informative infant vision display on the wall across from a rocking chair to the left of the entrance to the Infant area, where mothers often sit to nurse or hold their babies.
- Two mothers and one father initiated having an infant look at the Mobile. Both mothers laid their infants down on the pillow and placed their child under the Mobile and began reading the cards on the backs of the pillows. The father set his baby under the Mobile and then had a conversation on his phone for about five minutes. He sat in the rocking chair and changed pillows after his conversation. He did not seem interested in which pillows he chose.

Interviews with Adult Visitors who interacted with the Mobile exhibit (N=4)

What the researcher was trying to find out: (25% were able to describe the research question with particulars of the question the exhibit presents; 75% were able to describe the research question more broadly)

When they were told that an original experiment by a researcher was the basis for the Mobile exhibit and asked what they thought the researcher was trying to find out, one of the adult visitors with a six month-old said that she saw the activity cards the last time they visited:

- [the cards] explained a great deal. They are seeing which pillow children like best.
  [25-29 years, visited past 3 months, 2 adults, graduate degree]

The three other visitors were in agreement that the research question was about "how babies see," "what are babies looking at," and "Seeing how babies see, or what they look at."

How the researcher was trying to find out answers: (100% gave tentative guesses at research methods)

In response to the question about the 'process' of doing the research or how the researcher was trying to find out answers, three of the adult visitors said the research talked about observation or "watching what the babies are watching." The mother with her six-month-old had read exhibit material. Her response related to the research question:

- If I read [the] signs, I think that they are studying visual stimulation in children.

Responses to the final three questions, which asked about writing a headline for a story about the Mobile research based on what visitors saw in the picture on the activity card, further questions the researcher might want to study, and things parents might want to look for while playing alongside their child at home, indicated some understanding of the Mobile research.

A headline for a story about the Mobile research: The headline three of the visitors suggested was about "seeing things" and "we can know what babies see."

Further questions the researcher might want to study: A further question for one mother with a 3 month-old was "more sight studies." The mother with her 6 month-old commented:

- …the research results were what I was most interested [in]. I guess that I would do something with the commonality of results."

Observations while playing alongside a child at home: A mother visiting the Discovery Center for the first time with a 3 month-old son would observe "whose face he recognizes" while she is playing alongside her child. The other three responses were unrelated to the research (e.g., "we are working on crawling" and "we are working on learning where sounds come from").

In summary, this component was not well-utilized, and a larger sample of visitors at the Mobile exhibit with their babies would provide more evidence of ways in which the interpretative panel and activity cards help parents better understand an infant's visual acuity at different ages, as well as their baby's preference for certain colors or patterns over others. Continued observations and interviews with adults who interact with the Mobile exhibit might give Discovery Center staff insight into ways to attract more adult visitors to this exhibit.

Causal Boxes Exhibit Key Findings (22 interviews completed)

Across the sample of adult visitors who interacted with the Causal Boxes:

- 18% of the visitors were able to describe research questions, either the particulars of the question (4%) or the researcher's broad area of research (14%); 77% were able to identify the 'skills' of children that the researchers were studying.
- 27% indicated that they understood the 'process' of the research, by identifying the procedure (4%) or stimuli used (23%).
- 45% outlined research-related observations they would make at home, while playing alongside their child, as a result of their interactions with interpretive strategies (23% of the other visitors described observations related to research generally, and not research from the exhibit).
- 68% identified further research questions to find out more about cognitive research and children's learning (36% a specific question, data point, or measure; 18% a broad or general query; 14% everyday observations of their young children).
- 45% were able to write a headline for a story about the Causal Boxes research based on what visitors saw in the picture on the activity card (36% related to the research question, and 9% related to cognitive science).

Observations of interactions at the Causal Boxes (N=27)

Sixteen of the groups at the Causal Boxes exhibit had one adult, and 11 groups had two adults, most with one child. Only four groups had two children.

Table 5 highlights behaviours at the Causal Boxes:

- Most often adult visitors (85%) or a child (67%) pressed the colorful buttons, or the child pressed buttons after an adult's encouragement or instruction (63%).
- One-third of the adult visitors (33%) read the activity card about the Causal Boxes exhibit, similar to visitors reading the activity cards related to Legs & Wheels.
- Two people talked with others in their group about the exhibit and two people talked with a staff member or volunteer about the research study.

Table 5: Behaviors at Causal Boxes: N=27

Behavior	Number of visitors
Adult visitors presses button	N=23 (85%)
Child presses button	N=18 (67%)
Child presses buttons after adult encouragement/instruction	N=17 (63%)
Adult reads the activity card	N=9 (33%)
Adult talks with others in the group about the exhibit	N=2 (7%)
Adult talks with staff/volunteer interpreter about the study	N=2 (7%)

Different than at the Legs & Wheels exhibit, mothers tended to initiate playing with the Causal Boxes (mothers initiated 48% of the interactions observed, a child 22% of the interactions, both parents 13% of the interactions, and a father 9% of the interactions). The following are some examples of observations:

- A mother was interested in the boxes, and read the card, her child was less interested. They stayed in the infant area for approx. 45 minutes, (parent) intermittently pushing the boxes; the child pushed one button but was generally apathetic to the boxes.
  [35-44, visited past 6 mos-1 yr, 2 adults, 11 month-old and 3 year-old, graduate degree]
- A child crawled over to the boxes, and began pressing buttons; the mother pressed buttons as she was reading the card.
  [35-44, visited 2-5 years ago, 1 adult, 9 month-old, graduate degree; also talked with staff]
- A father took child #1 over to boxes immediately; brought them to the attention of the mother, who proceeded to bring child #2 over to the boxes.
  [45-54, 1st visit, 2 adults, 1 year-old twins, graduate degree; also talked with staff]

Interviews with Adult Visitors who interacted with the Causal Boxes exhibit (N=22)

What the researcher was trying to find out: (18% were able to describe the research question; 77% could identify 'skills' of children examined by the researcher; 4% were unable to describe the research question)

When they were told that an original experiment by a researcher was the basis for the Causal Boxes exhibit and asked what they thought the researcher was trying to find out, most of these visitors (77%) were able to identify 'skills' of children examined by the researcher. Most responses related to 'cause & effect,' particularly after they had read the sign for the exhibit. The sign over the Causal Boxes exhibit had the title, "Cause & Effect Learning takes place all the time! Watch your baby play with this interactive aquarium! Even toys allow babies to explore cause and effect relationships." The sign also showed three images of a baby crying and getting a bottle, a black cat chasing its tail, and a child pushing a toy car. One mother with an 11 month-old responded:

- I read the sign and the card and so I think it is about cause & effect. I don't know if I would have known without the cues.
  [35-44, 1st visit, 1 adult, college degree]

Four of the adults (18%) were able to describe the research question, again as related to cause & effect or causal relationships. The father with 1 year-old twins said:

- Cause & effect: to see if actions - environmental concepts - are working and if they connect the button with the action.
  [45-54, 1st visit, 2 adults, graduate degree; also talked with staff]

Another father with an 8 month-old suggested:

- Once they start touching the buttons, to see if they understand that the certain colors and shapes mean certain reactions.
  [30-34, 1st visit, 2 adults, some college; also went to Legs & Wheels, other research toys, and talked with a researcher and staff]

How the researcher was trying to find out answers: (41% gave tentative guesses at research methods; 4% identified the procedure used and 23% the stimuli used in the exhibit or research study; 32% guessed or had unrelated responses)

The second question, to see if visitors knew the 'process' of doing the research or how the researcher was trying to find out answers, resulted in more tentative guesses than specific procedures. As with Legs & Wheels, most adults talked about observation – one 25-29 year-old woman with an 11 month-old elaborated, "Observation of basic reaction, trying it out with

different babies and seeing what they do." A mother with an 11 month-old and 3 year-old described the research method as, "Watching babies and seeing where they make the connections -- non-verbal cues."

The father with twins identified the procedures more specifically:

- Direct stimulus response connection: buttons, drawing attention to boxes with color and size.

And the father with an 8 month-old talked about specific stimuli used related to how his child used the Causal Boxes:

- Inside the boxes, the colors kind of correspond to the buttons and the squares are movement and octagon does light. Which does child respond to more, light or movement? I think that is what they are asking.

Cause & effect also dominated in responses to the final three questions asked about writing a headline for a story about the Causal Boxes research based on what visitors saw in the picture on the activity card, further questions the researcher might want to study, and things parents might want to look for while playing alongside their child at home.

A headline for a story about the Causal Boxes research: (similar to responses for Legs & Wheels, 36% had an idea for a headline related to the research question. Also 9% had an idea for a headline related to cognitive science, and 18% a statement about babies; 36% did not have an idea)

Eight of the adult visitors (36%) attempted a headline about "the idea of cause & effect," "the idea of babies understanding cause & effect," or "the lights and movement exhibit." Two visitors (9%) thought of headlines related to cognitive research, such as "how the brain of children works." Others suggested a headline specific to babies (e.g., "babies like sound and light").

Further questions the researcher might want to study: [similar to responses for the Legs & Wheels exhibit, 68% thought of further questions to study - 54% suggested questions related to the research or results (36% of these visitors offered a specific question and 18% a broad or general inquiry), and 14% thought of questions related to observing their own child; 32% could not think of further questions]

Similar to the Legs & Wheels sample, half of the Causal Boxes visitors (54%) were able to think of questions the researcher might want to study that were related to the research study. Questions were about:

- Reaction time of babies
- Anticipation behaviours such as tickling and giggling and pattern-finding
- Length of time looking at the movement and the lights
- Changing shapes or colors to see if children understand or simply memorize
- Watching to see how they would react if nothing happened when they pressed the buttons
- Other toys that have "this cause & effect thing"
- Adding noise and light (kids like anything that lights up and makes noise)
- Changing the shapes – the triangle and circle are shapes that infants like and know
- Age differences in responding to light and color.

Observations while playing alongside a child at home: (45% suggested things they may look for at home related to the research. Also, 23% might observe things related to research generally. 32% did not have observation ideas)

Ten of the adult visitors at the Causal Boxes (45%) thought of things they might want to observe while playing alongside their child at home. Early ages of cause & effect, and toys that do cause & effect more than the parent realizes were two options for parents. The father with twins proposed:

- Object permanence; uncovering and discovering objects. We do stacking/restacking to see if mechanical cognition is there (sign language; gender consciousness; clapping-babies recognize sound/action relation).

A group with parents and a 1 year-old felt they "have a good routine of teaching cause & effect, with lights, stove, etc." And a mother with a 9 month-old said that they "do cause & effect studies with language development." Five other visitors at the Causal Boxes exhibit (23%) mentioned observations at home that were related to research, but not to cause & effect. For instance, one mother with a 9 month-old talked about her son learning that a stool is "structurally unsound" and that "different sounds get different reactions from parents."

To conclude this section of the Summative evaluation report, although the research areas were different, adult visitors who spent time with the Legs & Wheels and Causal Boxes exhibits had good ideas about further questions to ask, and observations they might make playing alongside their children. Whereas Legs & Wheels focused visitors on classification and classifying and categorizing of objects, the interactions with the Causal Boxes exhibit resulted in visitors thinking about questions and observations related to cause & effect. Because of the under-utilization of the Mobile during the Summative evaluation period, our findings for the third standalone exhibit were inconclusive.

Part 3. Living Laboratory Researchers

The focus of this section of the Summative Evaluation report is the Living Laboratory researchers. We used several approaches to find out the impacts of the *Participatory Model for Integrating Cognitive Research into Exhibits for Children* project for the research collaborators who conduct studies in the Living Laboratory, as well as the value of the conversations they have with Museum visitors.

- Similar to the observations and interviews we used for the three standalone exhibits in the Discovery Center, we observed and interviewed adult visitors who had conversations with researchers after their child participated in a research study.
- Four of the researchers from Harvard Graduate School of Education also facilitated a Science of Kids Workshop for adult visitors during the morning of March 14, 2009. Three of the evaluation team members observed and wrote notes on roundtable discussions with the researchers, and participants completed a pre- post-survey. In order to compare responses, some of the questions were the same as questions asked on the Visitor Survey and during interviews with visitors after their child participated in a research study in the Discovery Center.
- Two 'novice' researchers had conversations with volunteer interpreters at the beginning of their time in the Discovery Center (November 2008 and February 2009), and several months later (in May 2009). We compared these conversations with talks that two 'expert' researchers who have been conducting studies in the Living Laboratory for several years had with volunteers (in April 2009). Audiotapes of these conversations provided a sense of the impacts of conducting studies in the Discovery Center's Living Laboratory, as researchers described their research study and answered questions.
- Dr. Soren moderated focus groups with two groups of researchers March 13 and 14, 2009, some of whom were more 'novice' and others more experienced, to learn more about the personal and professional value of the conversations they were having with Museum visitors.
- Finally, we analyzed the number of hits and unique visitors for pages of the Discovery Center's Living Laboratory website, http://www.mos.org/discoverycenter/livinglab, throughout 2008. The website provides opportunities for adult visitors to learn more about research projects they may have experienced with a child, or prepare them for a research study they might experience during a visit to the Discovery Center.

3.1 Researcher Conversations with Visitors

Researchers from cognitive and child development laboratories at both Harvard and MIT were conducting studies daily, morning and afternoon, in the Discovery Center throughout the Summative evaluation data collection.[3] Behind the scenes, Discovery Center staff work with university scientists to ensure that conversations with parents communicate the aims and methods of each research study in a language that has meaning and impact. Discovery Center staff and lab managers from the universities have instituted training and 'tip sheets' for both researchers and volunteers in order to make their dialogs with each other and with visitors most effective and helpful for all.

[3] The *Laboratory for Cognitive Neuroscience* at Children's Hospital Boston, became a new partner during the Formative evaluation in 2008, but researchers were not conducting studies in the Living Laboratory during the times evaluators were collecting data in the Discovery Center during 2008-2009.

To encourage more meaningful conversations about the value of the research and why it is being conducted, Discovery Center staff instituted additional training for researchers, and increased the frequency of opportunities for researcher conversations with the staff and volunteers. The intention of this two-way communication is to allow staff and volunteer interpreters to understand the research in the context of daily life, and provide opportunities for researchers to practice conversing with a 'lay audience' about their work.

Researcher Conversations with Visitors Key Findings (31 interviews completed)

Across the sample of adult visitors who had conversations with researchers after their child participated in a research study in the Living Laboratory:

- 48.5% of the visitors were able to describe research questions, either the particulars of the question (35.5%) or the researcher's broad area of research (13%); 45.5% were able to identify the 'skills' of children that the researchers were studying.
- 62% indicated that they understood the 'process' of the research, by identifying the procedure (39%) or stimuli used (23%).
- 42% outlined research-related observations they would make at home, while playing alongside their child, as a result of their interactions with interpretive strategies (10% of the other visitors described observations related to research generally, and not research from the exhibit).
- 29% identified further research questions to find out more about cognitive research and children's learning (16% a specific question, data point, or measure; 13% a broad or general query).

Observations of adult visitors watching a child participating a researcher's study (N=37)

Researchers tended to be proactive in engaging visitors after a child participated in a study, offering a flyer as well as verbally communicating more information about their research. Most of the groups who participated in a research study in the Living Laboratory had one adult (27 groups); nine groups had two adults, and one group had three adults.

Table 6 shows that the majority of the 37 visitors observed (32 visitors, 86.5%) consented to having a child participate after a researcher approached the child's parent. The remaining five visitors did not give consent because their children were not in the target range for a particular research project, or children were not with a parent or guardian who could sign the consent form (e.g., grandparents were not legal guardians). Children whose accompanying adults were not able to sign consent forms may have worked through the study with the researcher, but the researcher would not have recorded the child as being a subject for the research study.

Interaction	Number of visitors
Consents to have child participate in the study	**Yes: N=32 (86.5%)** No: N=5 (13.5%)
Asks researcher questions prior to child`s participation	**Yes: N=4 (11%)** No: N=32 (86%); NR (3%)
Talks with researcher immediately after child`s participation	**Yes: N=29 (78%)** No: N=8 (22%)
Takes a flyer about the research study	**Yes: N=20 (54%)** No: N=17 (46%)
Talks with others on the group about the study	**Yes: N=1 (3%)** No: N=36 (97%)
Talks with staff/volunteer interpreter about the study	**Yes: N=1 (3%)** No: N=36 (97%)
Asks the researcher more questions later during their visit (within 10 min.)	**Yes: N=3 (8%)** No: N=34 (92%)

Table 6: Adult visitors` interactions with researchers: N=37

- Four visitors (11%) asked the researcher a question before a study (e.g., ages of children who could participate, the reason for the study, and how long it would take).
- 86% of the adult visitors talked with the researcher after the conclusion of the study - 78% immediately after, and three visitors (8%) asked the researcher more questions a little later (e.g., inquiring about a child's answers, and how to explain the study to the child who participated).
- 54% took flyers or inserts for a Discovery Center brochure that describe the research study; four of the visitors who did not take flyers had a child participate in a study during a previous visit.
- Only one person appeared to talk to a staff member or volunteer at the time a child participated in a research study. However, during their visit to the Discovery Center, 42% of this group of adult visitors reported that they talked with staff or a volunteer on their demographic questionnaire.

Researchers often recruit children by looking around the Discovery Center for a child of the appropriate age for their study in the Living Laboratory. For the sample of visitors who had conversations with researchers, the researchers most often approached the adult visitors about a child participating in a research study in the Living Laboratory area in a corner by the windows in the Discovery Center, which is next to an experiment table (35% of the adult visitors), or at the entrance to the Discovery Center (23%).

While their child participated in a study, adult visitors most often sat on a stool or chair next to the Living Laboratory corner (44%), positioned themselves immediately behind or next to their child (18%), or stood near the corner where the researcher conducted the study (15%). Others sat on a bench at the nearby experiment table (12%), on the window`s ledge, or on a step at the window (3%).

Figure 13: Does imitating an adult's actions limit children's spontaneous exploration during play? http://www.mos.org/discoverycenter/livinglab/ltp/imitation

A few observations were:

- A mother of a 5 year-old sat on the stool next to her child, read papers next to the table while the experiment began, and became more attentive as the experiment continued. The child attempted to interact, but the parent discouraged this.
  [35-44, 1st visit, some college, also talked with staff]

- Another mother with 1, 2, and 3 year-olds walked around with her other children but mostly watched her child at the lab bench, then on the stool next to the experiment corner. She had three young girls with her - two participated in the research. The girls were active and running, and their mother was busy keeping up with them.
  [25-29, visited past 3 months, 1 adult, some college; also took a brochure, went to the Infant Area, and used other research toys]

- A father sat on window ledge, very interested. The mother observed from right behind their 3½ year-old child, also interested.
  [Female, 35-44, 1st visit, grad degree. did not receive the flyer or insert for the research study]

- A mother who explained the researcher's questions to her child, aided her child with hints and prompts to study questions, and made facial expressions of approval or not to the child's answers. She inquired about her child's answers.
  [35-44, visited past 3 months, 1 adult, 2½ & 5 year-olds, college degree; also went to Legs & Wheels, talked with staff, and wanted to receive the e-newsletter]

- A mother with a 2½ year-old child was on her knees beside her child. She prompted the child to "Pay attention," "Watch the ball," encouraged the child, and smiled and applauded when the child was right, saying "Good job."
  [25-29, visited past 6 months-1 year, 1 adult, college degree]

- Both parents read literature while the experiment was running. The father perused other flyers as well; the mother watched more closely. The evaluator gave the mother a flyer, after the interview. Later, she noticed the mother was reading it in the Infant area.
  [Female, 30-34, visited past 3-6 months, 1, 3, & 5 year-olds, graduate degree; also took a brochure]

Demographics of visitors who had conversations with researchers (see also Appendix 3): Six of the visitors' children (19%) had participated in a research study during a previous visit to the Discovery Center. Half of the adults had visited the Discovery Center in the past six months (39% in the past three months and 10% in the last 3 to 6 months), while 32% had never been to the Discovery Center before. Others had visited 6 months before (6%) and 1-2 years previously (13%). Of those who responded to demographic questions, 22 of the visitors were females (71%) and 7 were males. Most adults were White (87%), but three were Asian American (10%).

Interviews with Adult Visitors after a child participated in a researcher's study (N=31)

What the researcher was trying to find out: (48.5% were able to describe the research question – 35.5% the specifics of the research, and 13% the researcher's broad area of interest; 45.5% could identify 'skills' of children examined by the researcher; 6% were unable to describe the research question)

When asked what they thought the researcher was trying to find out, half of the visitors whose child participated in a research study (48.5%) were able to describe the research question. Most of these visitors described specifics about the question of the day (35.5%), which varied depending on the researcher who had conducted the study. Individual parents said the research question for their child was:

- How children play and reason
- Cues that affect comprehension
- Sharing and fairness
- Instructions needed to complete a task
- A child's perception of things that are real and not real
- Prejudices and what a child does, or does not, have against people
- Understanding different groups

One example of a response to what the researcher was trying to find out was:

- How they play and reason when they have some but not all information, and how they use it in a systematic way.
  [35-44, visited 1-2 years ago, 1 adult, graduate degree; also took a brochure]

A father whose child had previously participated in a research study and had taken home a flyer said the study was:

- All about seeing how she shared. It was about sharing and fairness - how she gauged what to do.
  [35-44, visited past 3 months, 1 adult, 2½ & 4½ year-old, graduate degree, Asian-American]

For a mother whose child also had previously participated in a research study and had taken home a flyer, the study for her child was about:

- Cognitive development for 2-5 year-olds, what instructions they need to complete a task. For him, verbally, what information they need to understand an activity. For this activity out of a tube, watching where he thought the ball would fall.
  [30-34, visited 3-6 months ago, 1 adult, 1 and 2 year-olds, graduate degree; also went to the Infant Area]

Four parents (13%) described the research study their child had experienced in terms of the researcher's broad area of interest, such as a mother with a 3 year-old who thought the researcher was looking at "children's ability and how they share, and if it is imported by having an older sibling."

Almost half of the visitors who interacted with researchers (45.5%) identified specific skills examined by the researcher, either related to 'children' generally (35.5%) or related to 'my child' (10%). Individuals spoke about, for instance, "problem solving skills," "how children learn ... and how they follow visual information," and "developmental differences between ages." One mother with 2 and 4 year-olds who spoke about her own child observed "her ability to solve problems or reason."

Feelings about the information the researcher was communicating: One of the first interview questions was how the parent felt about the information the researcher was communicating (ranked on a scale of '1' to '5'). Most of the sample of visitors who talked with a researcher after their child participated in a study thought the content was 'just right' (81%), and the vocabulary was 'just right' (90%). Fewer felt that the information was 'just right' (74%) – eight visitors thought there was too little information, particularly two visitors with graduate degrees who ranked the information at '1.'

A question later in the interview asked how the researcher could improve how s/he communicated the research study. Eight parents (25%) suggested ways the researcher could clarify the study for children (e.g., doing an example first, speaking louder, eye contact, and more reinforcement). Seven parents (22%) wanted more information about the research study, such as "a simple handout, if parents wanted it," "what they have found so far," "parental involvement – should parents stay back?" and "having a visual so I could read it while my child did the experiment."

How the researcher was trying to find out answers: (62% understood the 'process' of the research - 39% identified the procedure used and 23% the stimuli used in the exhibit or research study; 32% gave tentative guesses at research methods; 6% guessed or had unrelated responses)

Over a third of the parents (39%) had a good sense of the methods the researcher used to find out answers to the research question. Some talked about specific procedures with key details of methods (23%). Some examples were:

- Dropping a ball in a tube and seeing where it went
- Giving a child stickers, some of which they could keep and others they could give away; dividing stickers "between oneself and imaginary others – it was in her control"
- Using different colors and stories, trying to find out what prejudices a child had against people.

Others talked about procedures in more general terms (16%), such as the researcher leading and the child following, or "providing examples of things that work and don't work." A third group identified stimuli used in the study of the day (23%), describing stickers as "props to measure the level of fairness," "interactive games with beads and a turntable," pictures and stories. Some parents made tentative guesses at research methods (32%) – "Categories, I guess. They ask the children to put people and things into categories," suggested one Asian-American mother with 3 and 4 year-olds. Eight parents thought 'observation' was the method used.

As with the interviews for the standalone exhibits, the final two questions asked about further questions the researcher might want to study, and things parents might want to look for while playing alongside their child at home.

Further questions the researcher might want to study: (29% suggested questions related to the research or results; 71% could not think of further questions)

Nine of the parents (29%) thought of questions related to the research - five visitors (16%) specifically related to the research or results, and four visitors (13%) related more generally to the research. For example, for a father with a 3 year-old who had previously participated in a research study a procedural change might be:

- The younger the child, the more literal the child takes you. They didn't understand that. Maybe use a colored glove instead of a sticker. Graphically the red was too dark and the faces were hard to see.
  [45-54, visited past 3 months, 1 adult, graduate degree]

A suggestion unrelated to the research study of the day by a mother with 2½ and 5 year-olds was:

- Maybe more images of things on TV (e.g. Barney), real age appropriate.
  [35-44, visited past 3 months, 1 adult, college degree; also went to Legs & Wheels, talked with staff, and had an interest in the e-newsletter]

Observations while playing alongside a child at home: (similar to responses for the Causal Boxes exhibit, 42% suggested things they may look for at home related to the research (10% might observe things related to the research their child participated in, and 32% generally related to research). Three other visitors (10%) suggested things they might observe, but not the research of the day. Seven visitors (22%) described observations unrelated to the research, and 26% did not have observation ideas)

Finally, 13 of the parents involved in conversations with researchers (42%) thought of things they might want to observe while playing alongside their child at home – three parents (10%) talked about things specific to the research, and 10 others (32%) would observe things generally related to the research.

For example, a father with 2 and 7 year-olds suggested that "Parents as researcher" is "an interesting idea." A mother with a 5 year-old who has "all of these multicultural friends" thought there would be "lots of questions at home" about the child's preferences in the study. A mother with a 5 year-old was interested in children's reasoning – "how they decide to put things together or not." Another mother with a 3 year-old wanted to observe "how well certain activities help them develop, regarding their sharing."

Three other visitors (10%) thought of things they would look for that were not related to the research of the day. One father with 4, 5, and 7 year-olds would look for "cognitive breakthrough." An Asian researcher who "does not look at kids" wanted to see how to "encourage logical thinking." A mother with 3 and 4 year-olds would compare stages and gender differences. "I guess I am always thinking about why they do what they do," she concluded.

To summarize, the responses of the adult visitors who spent time with a researcher in the Living Laboratory indicated that the research study stimulated their thinking about research questions and the process of conducting research studies, both specific to the study in which their child participated and about research more generally. Many parents seemed to have a good sense of the research in which their child participated and some had suggestions for further research questions and things they might observe at home while playing alongside their children.

The next section describes a Science of Kids Workshop that provided an opportunity for adults to watch demonstrations and discuss research projects with three of the most experienced researchers who conduct studies in the Living Laboratory.

3.2 Science of Kids Workshop at the Museum of Science, March 2009

The first Parents as Scientists Workshop in March 2008 was an opportunity for 26 interested adults to meet and talk in more depth than possible during a Museum visit with MIT researchers working with Dr. Laura Schulz at the Early Childhood Cognition Lab.

The follow-up March 14, 2009 Science of Kids Workshop featured researchers from Harvard Graduate School of Education. The speaker for the Workshop was Professor Paul L. Harris, Victor S. Thomas Professor of Education in the Graduate School. His primary research interests are early development of cognition, emotion, and imagination. Professor Harris talked about research related to whether a child is "socio-cognitive" with historical evidence from studies in the 1920s by Piaget and Vygotsky, research from the 1970s to the present, and current social cognition investigations looking at a balance between how sensitive *vs*. how egocentric a child is.

Figure 14: 2009 Workshop with Researchers

Accompanying Professor Harris were three graduate students, all of whom were conducting their own research studies, and very experienced working in the Living Laboratory at the Discovery Center. At the Workshop, attendees had an opportunity to watch and discuss 20-minute demonstrations of each of their research studies in the Living Laboratory, while their children worked on science activities in an adjoining room. The focus of each research study was:

- *S*ensitivity to another child's distress, when the child caused the distress, and whether an apology ameliorates distress
- *C*hildren's sensitivity to fair shares and resources distributed equally *vs*. their own preferences for sharing resources
- Hyper-social sensitivities, the category to which a child belongs, such as cultural and racial groups, and in-group *vs*. out-group sensitivities.

Science of Kids Workshop Key Findings (19 surveys completed)

Across the sample of adult visitors who attended the Science of Kids Workshop:

- 100% of the group attended to find out more about how children learn, and 79% had an interest in the subject. Other reasons for attending were because it sounded like fun (58%), there was free childcare during the event (32%), and free event admission (32%); or they wanted to get involved in the Museum of Science (42%), meet people and socialize (26%), and network with professionals (21%).[4]

- Prior to the Workshop, more than half of the Workshop attendees (63%) felt that they an understanding of cognitive development research and most of the Workshop attendees (84%) felt that they had an understanding of how children learn.

[4] Since participants could select more than one reason for attending, totals add up to more than 100%.

- After the Science of Kids Workshop:
  - 100% agreed that they enjoyed the Workshop experience (95% 'Strongly Agreed," one attendee 'Agreed')
  - 100% agreed that they felt more informed about how children learn (58% 'Strongly Agreed,' 42% 'Agreed')
  - 100% agreed that they felt more informed about how researchers conduct development research (74% 'Strongly Agreed,' 26% 'Agreed')
  - 79% agreed that the Workshop changed how they think about how children learn (47% 'Agreed,' 32% 'Strongly Agreed')
  - 89% agreed that they could relate the research presented to their own lives (47% 'Strongly Agreed' and 42% 'Agreed').

Science of Kids Workshop Demographics (see also Appendix 3): 19 of the adults who attended the Science of Kids Workshop filled out a pre- and post-Workshop questionnaire. Three people (16%) had attended the 2008 Workshop and one person attended because friends of hers who attended the first Workshop "highly recommended" attending. One of the women came for "intellectual stimulation and to support efforts by Museum of Science to talk to like-minded people [and] discuss race + racism." Discovery Center staff were successful in their attempts to have attendees represent a broader demographic than those who attended the 2008 Workshop, although they were still highly educated and predominantly female. Of those who responded to demographic questions on the survey, 13 were females (72%) and four were males (22%; 65% of the 2008 attendees were females). 61% of the attendees were White (compared to 90% in 2008), 22% were Hispanic-Latino, and an African-American and Ethiopian attended – a more diverse ethnic/racial group than attendees at the first Workshop.

Roundtable demonstrations and discussions*:* As parents worked with researchers at three roundtables following Professor Harris' talk, three evaluators observed and took notes. The sections below reflect evaluators' observation notes. The summary of roundtable discussions provides a sense of how the researchers initially described their research studies to participants, and participants' engagement and understanding based on their comments and questions. Some attendees also suggested further questions researchers might ask.

Figure 15: Roundtable discussion with Researcher

Researcher 1: *How do children learn stereotypes about groups of people?*
This study asks if stereotypes are learned, or are an inevitable consequence of the way our minds are wired. The study explores the conditions that affect children's formation of stereotypes.

Children 3-8 years-old hear a story about two groups of people, the Lups and the Nifs (represented with cartoon images) engaging in either pro-social or anti-social behavior (i.e., practicing good manners *vs*. cheating). The researcher then asks children to make judgments about whether new members from each group will perform similar or different behaviors in the future.

Questions some of the participants asked as the researcher presented his findings were related to in-group/out-group behaviours, identity *vs*. egocentrism, making connections to stories told, and the influence of color on the results:

- What do you think would happen if the in-group/ out-group does good/bad things?
- Do children feel they belong to a group, play together in competitive game?

- What do you think about how children react, what group they want to be in?
- How do you know that it has to do with their group identity, and not their own egocentrism?
- Do you see kids making connections to stories, like the story of the Sneeches?

An African-American attendee suggested removing color "so you are not influencing results" and using "gender-neutral images." The researcher responded that a further question was to ask if different characters – male or female – steal, play loud music (attributed to males), or make a pie (attributed to a female).

Researcher 2: *Do children know that property can change owners?*
This study examines how children - aged 2½ to 5 years - learn the rules of ownership.

Children hear two stories about a 'toy transfer' between two characters. In one story, a child receives a present at a birthday party. In another story, a child in the park takes a toy when the owner is not looking. In both stories, the researcher establishes the first character who possesses the toy as the owner. After each story, the researcher asks questions to see if children believe that ownership has transferred to the second character: "Can the thief take the toy home?" or "Does the birthday girl need to give the toy back?" He was using stickers with stars, smiley faces, and goofy pink dinosaurs.

Some of the attendees' questions at these roundtables were about the effects of colors *vs*. types of stickers, gender preferences, sample size, age-related and birth order differences, and something earned *vs*. given:

- Is it the stickers or the colors? You said real vs. funny, but the one you showed was pink. There might be some gender preferences in there.
- How big was the research panel? How many kids did you do this with? Who was willing to give anything at all? You expected the younger kids to be more selfish.
- Did you collect other data, like siblings, birth order?
- Is there a difference, if it is perceived as something that is earned *vs*. something that is just given?
- Was there also the sense that the observer was not going to know, was not going to see?
- Were the findings the same for boys and girls?

Suggestions for further research were:

- It would be interesting to combine this with [Researcher 1's] study to see whether how they share is different if they are in the same group, or in an out-group.
- I would be very interested in seeing this experiment with food. With little cookies, or M&Ms, or chocolate. Something they normally would not be able to have. Would that make it less likely for them to give it away?
- What about if they get something (e.g., an envelope of someone else's stickers) before they give away their own stickers?
- What do you think would happen, if they do have siblings? Would they share more or less? And what if they are giving their sticker away to the other gender, what do you think would happen? Would that affect things?

One attendee asked: "What if the child knows the other person?" The researcher responded that was a further research question: "the more the child relates to a person as a human being, the more generous they are." He is working on three possibilities with 2 year-olds – how many stickers they have; if a parent gives some to friend; and kids being told to share (i.e., social pressure).

Researcher 3: *What does "I'm sorry" mean to your child? How do apologies affect children's feelings and behavior?*
This study examines whether children feel and behave differently in the presence - versus absence - of an apology.

Children, aged 4-10 years, receive stickers in an envelope from 'a child in a different city.' The researcher asks how the stickers make them feel and think. However, the study involves deception: the experimenter actually prepares the envelope; it contains no stickers, but rather a note from the fictional gift-giver saying that s/he used all of the stickers. Some notes offer an apology (i.e., "I'm really sorry"), while others do not. After opening the envelope, the researcher asks children questions about their feelings, the traits of the gift-giver, and how the gift-giver might have felt. Children then have an opportunity to share some new stickers with the gift-giver.

The researcher is finding that labels and colors are very clear for younger children, and that 'good' *vs*.' bad' is a binary question, but there might be 'a little good' or 'a little bad.' Some of the questions at Researcher 3's roundtables included culture and gender differences, creation of hypothetical stories, and researcher bias:

- Are there culture or gender differences (e.g., related to language acquisition)?
- If a child received stickers, it would be how many *vs*. how cool.
- Did they create hypothetical stories (e.g., a push on playground apologies related to a minor transgression)?
- Do you as a researcher have bias with your own kids?

After the Workshop one of the attendees wrote Discovery Center staff a thoughtful email explaining some of her responses from her teacher's perspective:

> ... the English language seems to have an insufficient variety of vocabulary words to express the diverse reasons and circumstances [in which] we feel the need to apologize to others. We use sorry too much and risk devaluing it. We are "sorry" when we accidentally bump into someone and even killers are often "sorry" (perhaps deeply sorry or some other combination of adverbs) when they face sentencing. In contemporary American we rarely hear "pardon me" and words and phrases such as I regret, I am contrite, I am remorseful are out-of-vogue. It would probably be beneficial if "forgive" and "excuse me" were revived so that we can teach children the range of situations and emotions which are improved with an apology as well as the nuances of language.

Another attendee's post-Workshop written feedback was:

> I'm looking forward to further Science for Kids Workshops. I find many cognitive psychologists are unaware of the emotional conflicts that are the basis for or that determine cognition such as the security satisfaction of using words as abstract icons rather than as concrete signals. Even Piaget denied this. Your organizing skill is appreciated.

Science of Kids Workshop Survey Responses

The Science of Kids Workshop survey asked attendees about:

- Understanding of cognitive development research and how children learn prior to the Workshop
- Feelings after the Workshop with a series of statements using a "Strongly Disagree' to 'Strongly Agree' scale
- What they valued most about the Workshop
- If they found out something they did not before
- Questions they still had about how their child learns
- Ways to improve the Workshop
- For people who attended the 2008 Workshop, if participating in the first Workshop changed their thinking about how children learn, or their interactions with their children.

Pre-Workshop Understandings (see Table 7)

Understanding of cognitive development research and how children learn: The Science of Kids Workshop group was quite well informed about cognitive science and how children learn prior to the Workshop.

Table 7: Pre-Workshop Understanding (N=19)

Understanding of Cognitive Development Research	
Strongly_Disagree	2 (11%)
Disagree	3 (16%)
Agree	9 (47%)
Strongly_Agree	3 (16%)
No_Response	2 (11%)

Understanding of How Children Learn	
Strongly_Disagree	1 (5%)
Disagree	1 (5%)
Agree	12 (63%)
Strongly_Agree	4 (21%)
No_Response	1 (5%)

- More than half of the Workshop attendees (63%) felt that they an understanding of cognitive development research prior to the Workshop (47% 'Agreed' and three attendees, 16%, 'Strongly Agreed'). In contrast, five people (27%) did not feel they understood cognitive development research.
- Most of the Workshop attendees (84%) felt that they had an understanding of how children learn prior to the Workshop (63% 'Agreed' and four attendees, 21%, 'Strongly Agreed'). Only two people (10%) did not feel they understood how children learn.

Table 8: Post-Workshop Feelings (N=19)

Enjoyed the experience	
Strongly_Disagree	0
Disagree	0
Agree	1 (5%)
Strongly_Agree	18 (95%)
No_Response	0

Feel more informed about how children learn	
Strongly_Disagree	0
Disagree	0
Agree	8 (42%)
Strongly_Agree	11 (58%)
No_Response	0

Feel more informed about how researchers conduct cognitive development research	
Strongly_Disagree	0
Disagree	0
Agree	5 (26%)
Strongly_Agree	14 (74%)
No_Response	0

This Workshop changed how I think about how children learn	
Strongly_Disagree	1 (5%)
Disagree	2 (11%)
Agree	9 (47%)
Strongly_Agree	6 (32%)
No_Response	1 (5%)

I can relate the research presented today to my own life	
Strongly_Disagree	0
Disagree	1 (5%)
Agree	8 (42%)
Strongly_Agree	9 (47%)
No_Response	1 (5%)

Post-Workshop Feelings (see Table 8): The Science of Kids Workshop was very effective for helping attendees better understand cognitive development research and how children learn.

After the Science of Kids Workshop:

- 100% of the attendees agreed that they enjoyed the Workshop experience (95% 'Strongly Agreed," one attendee 'Agreed')
- 100% agreed that they felt more informed about how children learn (58% 'Strongly Agreed,' 42% 'Agreed')
- 100% agreed that they felt more informed about how researchers conduct development research (74% 'Strongly Agreed,' 26% 'Agreed')
- 79% agreed that the Workshop changed how they think about how children learn (47% 'Agreed,' 32% 'Strongly Agreed')
- 89% agreed that they could relate the research presented to their own lives (47% 'Strongly Agreed' and 42% 'Agreed').

What attendees most valued, did not know before, and further questions: Attendees described aspects of the Science of Kids Workshop that they most valued, what they had learned, and what they would now like to know.

Three people who also attended the first Workshop in 2008 indicated that they most valued hearing the researchers, learning about each study, and "seeing the level of current research" after the Science of Kids Workshop:

- 'Hearing each of the researchers and hearing the wrap up and connections by Paul!" At this year's Workshop she learned "That children are capable of such complex thoughts and acting."
  [Female, 35-44, visited 3-6 months ago, 1 year-old, graduate degree, attended the first year's Parents as Scientists workshop]

- "The opportunity to learn about each study and see the connections between them." She felt there were "Good concrete examples about the idea of perspective taking and developmental stages."
  [Female, 30-34, visited past 6 months-1 year, no children, graduate degree, attended the first year's Parents as Scientists workshop]

- "Seeing the level of current research." He found out about being "rewarded for naïve experiments."
  [Male, 75-84, visited 3-6 months ago, mature children 46 and 50 years, graduate degree, attended the first year's Parents as Scientists workshop; 'Strongly Disagreed' that the Workshop had changed how he thought about how children learn; checked between 'Disagreed' and 'Agreed" that he would recommend the Workshop to others]

A few first-time attendees who seemed more confident about their responses wrote about stereotyping, apology, being part of a group with a negative image, and feeling sorry:

- The Workshop "presented three issues that are very appealing and quotidian. It also made me realize how important stereotype-building, sharing and apologizing are." She found out more about "stereotype information" and wanted to know more about how she should help her son to share, and when to share. She wondered about enrolling him in a more heterogeneous school. She would have liked more experts' advice on parents' behavior.
  [Female, 30-34, visited past 3 months, 2 year-old, some graduate work, Hispanic-Latino]

- "The amazing value of an apology." Her children were 9 years and older. "I can use this to sensitize them to how younger children think."
  [Female, 45-54, visited past 3 months, 9, 11, and 15 year-olds, graduate degree; reason for attending – "Intellectual stimulation + to support efforts by Museum of Science to talk to like-minded people - discuss race + racism"]

- "The examples - implications to learning behaviors." She found out "That a group with negative image of itself would not think of a good thing beyond neutral." She questioned, "If you force your children to be part of a negative group do they eventually accept it as good?"
  [Female, 35-44, visited past 3 months, 5, 7, and 16 year-olds, graduate degree, African-American]

- "Current research in child development." The attendee better understood that "Kids are not that egocentric; they are influence[d] by circumstance." A question related to a child's feeling sorry, "Do I need to enforce it whenever children do wrong?"
  [visited past 3 months, 4 year-old twins, graduate degree]

Parents who were more tentative commented on age-related responses, teaching about sincere apologies, and children's sharing:

- At this point it is a little difficult to evaluate based on my lack of reference. My child is 1½, so it is interesting to look forward and see what may happen." She had found out more about "the similar responses regardless of age."
  [Male, 45-54, visited 3-6 months ago, 1 year-old, college degree; he checked between 'Disagreed' and 'Agreed' that the Workshop changed how he thought about how children learn]

- "How to teach my child on how to give sincere apology when he does wrong and also teach him how to share with other kids." She had discovered, "The age difference on making decision[s]" and wanted to know how to teach her child.
  [Female, 35-44, visited 1-2 years ago, 1 year-old, college degree, Ethiopian]

- "I would like to know more about how to learn [how] children share, or the best way to teach how the children share."
  [Female, 30-34, visited 2-5 years ago, 2 year-old, graduate degree, Hispanic-Latino]

- **"**The increase[d] sensitivity it gave us in the way we look at our kids and interact with them." She learned that "When it comes to sharing kids tend ultimately to think of themselves first."
  [visited past 3 months, no children, college degree]

A few general comments related to the field of research, current research studies, and the Museum conducting research studies.

- "Seeing three related fields of research in one room." He suggested running a series – "time went fast."
  [Male, 35-44, visited past 3 months, 10 year-old, graduate degree; "Disagreed' that he had changed how I thought about how children learn]

- "Kid free. Opportunity to learn and explore." She had discovered that "the museum conducts these studies."
  [Female, 35-44, visited past 3 months, 1, 3, and 5 year-olds, graduate degree; reason for attending - "Highly recommended by friends who attended last year."]

- "Hearing current research is very interesting." She wanted to know more about the "shift of group importance after 7 yrs [to] 8-12 years and beyond." She found that there was "too much information presented at once, [which was] hard to digest." She suggested having "more time to talk; less information at once."
  [Female, 35-44, visited past 3 months, 5 and 8 year-olds, graduate degree]

For one Hispanic-Latino attendee with a graduate degree and 4 and 5 year-olds, the Workshop "was great" and increased her "point of view." Another Hispanic-Latino participant with a graduate degree and a 3 year-old learned how researchers "make research with kids, how this research is conducted, [and] differences between kids and adults." She suggested that it would be helpful to inform parents about the way to teach children about sharing and how to apologize. Specific aspects of the Workshop that three people appreciated were the question-and-answer period and the "opportunity to ask questions in an interactive setting," as well as small group discussions.

Success indicators for the Science of Kids Workshop were that 84% of the attendees found the speaker easy to understand (68% 'Strongly Agreed' and 16% 'Agreed;' two attendees disagreed). Everyone who attended found the experiments easy to understand (63% 'Strongly Agreed' and 37% 'Agreed'), and 95% would recommend the Workshop to others (79% 'Strongly Agreed' and 16% 'Agreed'). More time for talk and discussion, question time, and free time between roundtable demonstrations and discussions were the primary recommendations for improving the next Workshop (by 42% of the attendees). In the next section, both 'novice' and 'experienced' researchers had opportunities to communicate their research questions and methods to another group, volunteer interpreters who work in the Discovery Center.

3.3 Researcher conversation with volunteers: 'Novice' and 'Expert' Researchers

A comparison of conversations volunteers had with researchers from MIT and Harvard was informative of impacts for researchers conducting studies in the Discovery Center's Living Laboratory. From June 2008 to June 2009, Living Laboratory researchers provided 60 hours of formal professional development for Museum staff and volunteers through small group 30-minute briefings. Conversations reported in this section were with two 'novice' undergraduate researchers, and two 'expert' graduate researchers who had been conducting research in the Discovery Center for a period of time.

We evaluated two 'novice' researchers' conversations two times throughout the year (when they first begin in the Living Laboratory in November 2008 and February 2009, and in May 2009), and two 'expert' researchers in April 2009. Nine volunteers had one-on-one conversations with the 'novice' researchers, and eight volunteers had conversations with the 'expert' researchers. These conversations were an opportunity to assess:

- What have researchers learned about how to conduct experiments in public spaces?
- How has conducting research in the Discovery Center impacted their research study(ies) and the process of conducting studies?
- How, if at all, have the researchers' skills in communicating their work to adult visitors with whom they interact changed since working in the Discovery Center?
- Has their confidence in communicating to different publics about their work changed (e.g., adult visitors from different age groups, ethnic groups, outreach groups, and visitors more or less knowledgeable about research)? If so, in what way(s)?

Two focus groups with researchers who were more 'novice' and more 'experienced,' reported on in the next section, also were very informative of the personal and professional impacts of conducting research studies in the Discovery Center.

Methods for evaluating researcher conversations with volunteers: The methods we used for the researcher-volunteer conversations were to:

- Audio-record a brief conversation (about 12 minutes) in which researchers described their research question, design of the study, ages of children in the study, materials and method used, and findings. Through content analysis of transcriptions, it was possible to look at the 'novice' researchers' skills and confidence in communicating their research studies over several months working in the Living Laboratory, and to compare the skills of 'novice' and 'expert' researchers in describing their studies. Themes discussed during conversations related to researchers:

  - Primary research question
  - Methods to find answers
  - Helping adult visitors understand the research
  - Challenges in explaining their research to adult visitors in the Discovery Center.

  The questions volunteers asked during interviews gave a very good sense of their interest and engagement, what they understood, and areas in which they needed clarification or wanted to know more.

- Volunteers completed feedback forms after the conversation on which they responded to:

  - The content, vocabulary, and amount of information the researcher was communicating
  - What they learned about a researcher's study
  - What the researcher was trying to find out
  - How the researcher was trying to answer her/his research question
  - Suggestions for improving how the researcher communicated the research study.

  As we had included on the Visitor Survey and Science of Kids Workshop Survey, after the conversation with a researcher, volunteers also rated how informed they felt about how children learn, how researchers conduct cognitive development research, and if the conversation changed how they thought about how children learn.

Researcher Conversation with Volunteers Key Findings (17 conversations)

- After the second group of conversations with the first 'novice' researcher later in May, there was some improvement in understanding. One volunteer 'Agreed' that he felt more informed about how children learn and more informed about how researchers conduct cognitive development research, while the second volunteer 'Strongly Agreed' with these statements. The second volunteer 'Agreed' that that her conversation with the researcher changed how she thought about how children learn, but the first volunteer 'Disagreed.'

- In conversations with the second 'novice researcher, one volunteer in the May conversation commented, the researcher "did a much better job explaining her study than when she first began." The second volunteer who participated in this conversation found the study interesting and that it was important for adult visitors "to be aware of this type of research." After the May conversation, both volunteers found the content and vocabulary 'just right' (3), but that there was too little information.

- At the end of the conversations with both 'expert' researchers, the volunteers generally 'Strongly Agreed' that they had increased in their understanding about how children learn and how researchers conduct cognitive development research, and that they changed in how they thought about how children learn. After the first 'expert' researcher's conversation, the researcher's interest and enthusiasm about her research study impressed volunteers. She had developed some great ways of involving participants in her study, as well as explaining her study to the parents of these children. Comments about the second 'expert' researcher were that he does a great job communicating his study to the children, parents, staff, interns and volunteers. He is thorough, makes it interesting and informative and provides the parents with links to how the study might apply to real life situations."

- Comparisons across conversations the two 'novice' and two 'expert' researchers had with volunteers highlighted that experience in the Discovery Center helps to improve communication about research questions, design, methods, findings, and implications with volunteers. The more experienced the researchers were, the more engagement and curiosity the volunteers seemed to have.

'Novice' researchers

The first 'novice' researcher talked with two volunteers in November 2008 and two volunteers at the end of May 2009. His research study was about how toddlers conceptualize words that indicate spatial relationships, a study on which he was a co-investigator at Harvard University (http://www.mos.org/discoverycenter/livinglab/csr/spatialreasoning).

The second 'novice' researcher spoke with three volunteers in February and two volunteers in mid-May 2009. Her research study was on whether imitating an adult's actions limit children's spontaneous exploration during play. The primary investigator for this study was Dr. Laura Schulz at the Early Childhood Cognition Lab at MIT. Dr. Schulz and some of her researchers were the focus of the 2008 Parents as Scientists Workshop.

Primary research question:

First 'novice' researcher: In his first conversation, the first 'novice' researcher's description of his research was detailed, elaborated, and somewhat confusing. Volunteers seemed unsure of the research question, hypothesis, and why the researcher was conducting the study. One of the descriptions of his research question was:

> What we're looking at today is how children think about words and language. … we might think that little kids find it easier to think about words like front and back. … that might be the way they tend to think about spatial words. Or they might tend to think about spatial words to be more like north and south where it doesn't change if you turn the doll around. … in different languages, they actually use different terms to describe where things are. … in some languages they use words like uphill/downhill, so they say that this giraffe is uphill and this giraffe is downhill. And those words don't change when the doll turns. But in English we use front and back, which does change when the doll turns. So what we're interested in is what children, who haven't really mastered front and back and left and right, think about spatial words.

- One volunteer asked, "Why does it matter?" In her written feedback, her description of the research question was, "Is it easier for children to think in terms of north and south vs. left or right – and what happens when the labels are changed?"
  [Female, 18-24, some college]
- The second volunteer wanted to know quite late in a conversation, "What is your hypothesis going into this?" She wrote that the research question was, "How children figure out where things are. Then, how language affects this.
  [Female, 18-24, some college]

A segment of an elaborated response to one of the volunteer's questions was:

> ... there are two ways of thinking about it. We want to see what children, when they are presented with that kind of ambiguous dis-relation, which way they go. ... So what we are looking at is trying to find out which one it is. Whether they start off with these ideas, which are more like front and back, even though they don't have those words, or they start off with ideas more like north and south, even though they don't have those words either. ...we think that when we do the left and right trials with the giraffe on the left and the giraffe on the right, and we say that this one is on the 'ziv' and this one is on the 'kern,' children almost always think of something like north and south. ... it doesn't matter which way [the doll] is facing. But we think that when one is in front and one is behind, it might be easier for them, or they might tend to think that it actually changes when the doll turns.

His description of the research question was more succinct in the second conversation:

> ... what we are looking at is how children learn about spatial words. Spatial words can be everything from front and back, left and right, north and south, east and west. And we want to see how children think about those words and how, at different ages, what they understand. ... what we do for the experiment is introduce some kind of made up words, ...'ziv' and 'kern.' We make them up so that we know exactly what children know about these words, so we can teach them the words. And that way … they haven't had some experience with those words before, which might be changing their process. ... we use a doll ... and we teach the kids new words using [the doll].

Neither volunteer had questions about the research question in May.

- One volunteer described the research question in written feedback as: "How children learn and are they able to make correct responses when the object has turned." [Male, 55-64, Graduate degree]
- The other volunteer understood the research question more clearly as: "At what age do children learn left / right or front / back and how do they use them *vs*. directional cues like East / West or North / South." [F, 18-24, College degree]

Second 'novice' researcher: The second 'novice' researcher was increasingly clear about the research question, two conditions during the first conversations, and a further two conditions during the second conversations.

During her first conversation she described her research study as:

> The study that I'm running has to do with pedagogy, which is the art and science of teaching children how to learn. So what this study investigates is whether or not the cues that a teacher will give a child would direct them to exploratory play.

One volunteer asked: "But, why? I understand what you're trying to figure out, but why are you trying to figure that out? What are you going to do with the research? Why are you doing it?" The researcher explained further:

> ...the point is to work out which system of spatial thinking children start off with and then how that system is changed with language. So you might have two competing theories. You might say that children start off with this system of left and right ... Or you might think that they have this idea about north and south and then they have to develop this idea of left and right, or front and back, which changes with development." ...some research we do in the lab is very practically applied, but some of the other research we just do to find out more about how children think and the methods they use for thinking about the world. ... In this case, that would be something where we didn't necessarily have an application."

Written responses about the research question were somewhat similar:

- "Is it better to direct a child's exploratory play or not?" [F, 18-24, College degree]
- "Do children explore a toy the same way if they are shown an aspect *vs*. allowed to just explore?" [F, 18-24, some college]
- "The researcher is trying to determine if showing a child only one part of a toy causes them to focus only on that part or if they will explore the entire toy." [F, 25-29, some graduate work]

Methods to find answers:

First 'novice' researcher: The first 'novice' researcher offered very detailed descriptions and demonstrations of his research process, resulting in clarification questions by volunteers. He did not mention age groups he was working with in either conversation. Most volunteers were vague in their written responses to research methods used after both conversations.

In his first conversation, he demonstrated and described the method he was using:

> [Condition 1] What we say is things like, 'The giraffe is on the 'ziv' side, and this one is on the 'kern' side, and this is the 'ziv' side of [the doll's] head, and this is the 'kern' side of [the doll's] head.' And then, we give them that information and we introduce these terms, and then we turn the doll. And we say, 'now which one do you think is on the 'ziv' side; now which one do you think is on the 'kern' side?' And sometimes they say, 'Oh, I still think that one's on the 'ziv' side, it's the same one.' And sometimes they say, 'No, now the other one's on the 'ziv' side.'
> [Condition 2] ... we hide a penny in [the doll's] little sac. She has a sac on her front and on her back. And if you let the child keep their eyes open they just like focus on the penny... And the minute you say 'Okay, can you find the penny?' ... they just follow their eyes to the penny. We don't really know if they understand where the penny is. So what we do is we get them to close their eyes ... and count to 5, [and ask], 'And now, where do you think the penny is?'"

Volunteers wanted to know:

- "Why are you using a doll and not something else?"
- "What else do you do with the studies, besides the front and back…?"
- "What age groups are you working with?"
- "How many conditions do you have?"
- "What sample size are you hoping to get with this?"

In their written feedback, one volunteer seemed to accurately describe the research method as:

- "two conditions – using a doll as a prop – along with a penny + 2 giraffes, and renaming directions as 'giv' and 'kern.' Asking where the penny / giraffe are in respect to the doll (north / south / front / back / giv / kern, etc.)."
- The second volunteer did not seem at all sure, suggesting, "Working with kids."

Second 'novice' researcher: The second 'novice' researcher provided clear explanations of the two conditions the researcher runs for this research study. During the first conversation, one of the volunteers asked for clarification; the other two seemed to understand the methods used based on their written feedback following the conversation. The researcher also did not introduce age groups for the study in either conversation.

During her first conversations, she described the method she was using quite consistently:

> I run two conditions – [Condition 1] I have a 'no demo' condition, which is where I say, 'This is my toy, isn't it cool? I'm going to let you play with it,' and I walk away. … we tape everything the child does, and we go back and look at it. When they are done playing they tell me, 'Okay, I'm finished,' and I come back and I ask them questions about it. The toy does a variety of different things, … and I give them one chance to show me how to do it and then I take it back. … there are four things - it tweets, it makes noise; there's a light; and … there's a mirror. We're just trying to see, without any instruction, whether they explore about the toy.
> [Condition 2] the 'demo' condition, … I say, 'This is my toy. I'm going to show you something about it.' Then I tweet, and say 'Oh, that was really cool, I'm going to let you play with it.' [Then] I leave. We want to see - did they explore other parts of the toy or did they just really figure the tweeter out?"

Only one volunteer asked questions about the methods used: "For the demonstration one, do you always just show them one? What do you think would happen if you showed them all aspects of it? Do you think they would then play with all of it?"

Written descriptions of the methods indicated that two of the three volunteers had a sense of the methods used:

- "A toy with a few different sensory functions"
- "Showing child[ren] the toy and letting them explore it on their own with no demonstration or after they are shown one aspect"
- "The researcher has a toy that does four things. The researcher will either allow the child to explore the toy by themselves or will demonstrate one part of the toy. They then ask the child to show them how the different parts work."

During the second conversation, the researcher described her methods in much more detail, introducing a 3rd condition with a parent and 4th condition with an unrelated 2-5 year-old:

> We have read a lot of different conditions but the two main ones are:
> [Condition 1] a control where we just give the children the toy and we don't show them anything about it, we don't tell them anything about it. We just let them play with it until they get bored. And then at the very end, we occlude the toy behind the Styrofoam occluder and we ask questions to see if the children figured out the functions of the toy.
> [Condition 2] ... in the other condition, which has a lot of variations, we show the children something about the toy. In most cases, we show them the speaker part of the toy. Then we let them play with the toy for however long until they get bored, and we ask them the same four questions when they are done playing. We want to see the difference between the children that were shown nothing and the children that were shown a demonstration of how the toy works.
> [Condition 3] We moved on in that same condition to show the parent in front of the child without involving the child at all. We take the parent aside and say, 'Please don't make eye contact with your child when I show you these,' ... as we would with a four year-old to the parent. We just want the child to observe. It is like a separate thing when they are not being involved or they are not being taught, but they are paying attention. We want to see if those children are able to answer the four questions in a way similar to the demonstration children from the previous study and the non demo children.

Volunteers' questions tended to focus on the new 3rd condition with parents:

- "I'm not quite understanding what the purpose of the parent – ? You are letting the child observe you instruct the parent – that this is a function of the toy?"
- "When you were showing it to the parents, did you have any way of knowing where the child's attention is? Are you paying attention to whether they are looking at you, or do you think they are listening to you? You are only using the children that are watching?"
- "Do you tell them at all how many things it does?"

In written responses, one volunteer was less precise than the other:

- "Using two (not related) children – one to use the toy, one to teach the toy to"
- "In the new experiment they demonstrate part of the toy to an older child, then give the toy to a younger child to play with. They'll compare this to a group given no instruction. Then they test to see if the child knows how to make the toy do certain things."

Helping adult visitors understand the research:

First 'novice' researcher: The first 'novice' researcher's explanations about implications of his current study for further research projects, and cultural differences related to thinking about space, were of particular interest to some of the volunteers.

As he explained in his first conversations:

> We have three ideas about how children can think about space. They can think about space in terms of things that don't change, like north and south. Things always change when you turn, like my left and my right. And then the third category is things that change when other people turn, like his left and his right. .. if you move around then your left and your right will change. But if we are talking about the doll's left and right, that won't change.

- One volunteer wondered about implications of the research study: "since you have already found something new about it, where are you going…?" and wrote, "I was very surprised to learn that children are more likely to develop concepts of north and south before front and back."
- The other volunteer asked: "What implications do you think this is going to have on cognitive or language development?"; "They think that they develop the idea of north and south before they develop the idea of front and back? Weird. I would think it would be the other way around," and, "the study is focusing on American culture, right?" This volunteer responded that the research was helping visitors understand, "Directional associations for children."

At the end of the first conversation:

- Both volunteers 'Agreed' that they felt more informed about how children learn, and more informed about how researchers conduct cognitive development research.
- Volunteer #2 'Agreed' that that her conversation with the researcher changed how she thought about how children, but Volunteer #1 'Disagreed.'

At the end of the second conversation, there was some improvement in understanding.

- Volunteer #1 'Agreed' that he felt more informed about how children learn and more informed about how researchers conduct cognitive development research. Volunteer #2 'Strongly Agreed' with these statements.
- Volunteer #2 'Agreed' that that her conversation with the researcher changed how she thought about how children learn, but Volunteer #1 'Disagreed.'

Second 'novice' researcher: Volunteers attempted to understand implications of the second 'novice' researcher's study for teachers, similarities with conditioning, and the design of the novelty toy.

The researcher explained current thinking about the research study, and a new condition in her second conversation:

> ... we just finished all the kids in that condition and it looks very interesting because it seems ... as if they are not instructed. They have the same answers to the questions as the kids who had not heard anything about the toy ... We are trying to figure out if it is because we instructed their parents and they are used to having their parents shown things that they don't really ever have to think about again, or if it is something else, like ... an adult.
> [Condition 4] What I am trying to do today, which I have never done before, is to put two subjects at the same time. They can't be siblings because there is a special relationship between siblings, which might mess up the data. But I am going to have one child watching me instruct another child and then give the toy back.

- One volunteer immediately asked, "So we have two children who aren't siblings?" "What are you anticipating is the reason that they tested more like the ones that didn't get any instructions?" In her feedback, the volunteer wrote: "I learned that as they had expected, informing the child about an isolated function of the toy exhibits their exploratory play."
- The second volunteer asked about research design: ""I was just noticing that ... when you designed it ... there is this part that looks like it might do something, but it doesn't. Did you purposely do that?" She wrote about understanding after the session: "They are trying to learn how demonstrations affect a child's exploratory play. They had interesting results and I learned about the next step they're taking to address the question."

At the end of the first conversation:

- The three volunteers 'Agreed' that they felt more informed about how children learn, and more informed about how researchers conduct cognitive development research.
- Volunteer #1 'Agreed' that that her conversation with the researcher changed how she thought about how children, but Volunteers #2 and #3 'Disagreed.'

At the end of the second conversation, there was improvement in understanding:

- Both volunteers 'Agreed' that they felt more informed about how children learn, and that their conversation with the researcher changed how they thought about how children learn.
- Volunteer #1 'Agreed' that she felt more informed about how researchers conduct cognitive development research, while Volunteer #2 'Strongly Agreed.'

Challenges in explaining their research to adult visitors in the Discovery Center:

First 'novice' researcher: One of the volunteers in each conversation found the content too complex. After the first conversation, one of the volunteers suggested that it would have been helpful to communicate with more confidence, and less jargon with answers. She found the vocabulary 'just right' (3), but the content too complex (4) and that there was too much information (4). The other volunteer found the content, vocabulary, and information 'just right' (3), but imagined "parents would find it easier if the explanation was a bit shorter." She asked, "Why is he playing on the floor *vs*. the table?"

After the second conversation, one of the volunteers suggested a slower-paced introduction, and found the vocabulary and information 'just right' (3), but the content too complex (4). The other volunteer found the content, vocabulary, and information 'just right' (3), and wondered if it would "make a difference using a doll?"

Second 'novice' researcher: A broader, more detailed explanation of the research – a little more background - were suggestions from most volunteers who participated in the two conversations. Asking volunteers to do the study, themselves, also was a suggestion in both groups. Some of the volunteers in both groups felt that there too little information (three of the five volunteers).

In the first group:

- One volunteer found the content and vocabulary 'just right' (3), but that there was too little information (2)
- Another found the content and information 'just right' (3), but the vocabulary too difficult (4).
- The third volunteer found the content, vocabulary, and information 'just right' (3) and thought "the researcher did a good job explaining the study verbally. I would suggest asking [people] to do the study themselves (to play with the toy) in order to get an understanding of how that works and what exactly the child is seeing / hearing."

One volunteer in the second conversation commented, the researcher "did a much better job explaining her study than when she first began." The second volunteer who participated in this conversation found the study interesting and that it was important for adult visitors "to be aware of this type of research." After the second conversation, both volunteers now found the content and vocabulary 'just right' (3), but that there was too little information.

'Expert' researchers

Each of the 'expert' researchers talked with four volunteers in April 2009. The first 'expert' researcher was studying whether imitating an adult's actions limit children's spontaneous exploration during play (http://www.mos.org/discoverycenter/livinglab/mlc/randomness). The primary investigator for this study was Dr. Laura Schulz at the Early Childhood Cognition Lab at MIT. The researcher had been working with the Living Laboratory since September 2008.

The second 'expert' researcher was a PhD candidate at the Harvard Graduate School of Education, who also participated in the 2009 Science of Kids Workshop and one of the focus groups with researchers. He had been conducting research studies in the Discovery Center for three years. His research was on whether children know that property can change owners (http://www.mos.org/discoverycenter/livinglab/csr/ownerdolls).

Primary research question:

First 'expert' researcher: In her conversation, the first 'expert' researcher' provided a consistent, clear introduction to her research study, including the age of the children researched. The researcher's description of her research question was:

> I'm a researcher at MIT. What we look at here in the Living Lab is how children learn about cause &effect. ... how children learn about what's going on in the world. Today we have a fun game set up. It's called marbles and it is looking at how children look at randomness and perceive how randomness is supposed to look ... We run [the studies] with kids between the ages of three and eight.

She explained what she meant by "random sequence" in response to one of the volunteer's questions. When a volunteer asked, ""And what do you hope to find out in the overall study?" she further explained:

> This is … a study based on another researcher's work where he did a coin flip study with adults. We are … trying to see … how children think of randomness and how this relates to his coin flip study with adults. We are doing a bunch of different mediums with randomness – there is a spinner study where they guess where it is going to land on the spinner; there is more than one marble study; [and] there is a coin flip study. So we are trying to [gather] a lot of evidence to see how children think about 'random'."

This volunteer seemed to have a very good sense of the research question. She wrote on her feedback form: "She is looking to see if children of different ages view randomness in a similar or different way than adults do. [The researcher] also is looking for any shifts that she sees in the way 3 year-olds through to 8 year-olds view probability and randomness to see if younger children perceive it differently than older children. [F, 55-64, Graduate degree]

The other volunteers had no questions. In written feedback:

- One was vague and thought the research study was asking: "If age groups and answers to problems presented by decisions are related."
  [M, 65-74, Graduate degree]
- Another volunteer thought more precisely that her study was about: "How do children perceive randomness and how does their perception relate to how they think about cause and effect?"
  [F, 18-24, some college]
- The last volunteer suggested, "Does (any age) youngster understand what random means, and predict what the outcome will be?"
  [F, 55-64, Graduate degree]

Second 'expert' researcher: In the introduction to his conversation, the second 'expert' researcher clearly stated the research question, versions of the study they have used, and age considerations. Towards the end of their conversations, one volunteer had a question about the overall goal of the research study and another asked about the age groups for studies.

During his conversation, he described his research study as:

> What I look at in my research is how children start to understand ownership and property. … when you think about it, there are two ways kids can learn about who owns something. One is by seeing the person with the toy. … there can be this physical association of the object with a person. Or, you can learn about it by someone telling you. [A child] can be playing with the toy, but I can say, 'Well it's actually Billy's toy.' And that's how you would form this connection in your mind between the object and the person. ... I'm looking at this conflict between these two situations to see which association is stronger and when kids start to take my word for it over what they are seeing right in front of them. We will go through the study and then I will tell you a little bit about the bigger implications of this.

One volunteer asked: "What is the overall goal of the study? I know it is about ownership, but what is the main goal that you are talking about?" The researcher elaborated when he responded to this question:

> Let me take a step back and put it into a bigger picture. ... we are looking at ... two kinds of things. One is when kids are going to start to listen to what you are telling them, and that is particularly important in this kind of case where kids have no visual way to confirm that this is Billy's ball. When that ball is just sitting independently of these dolls, there is no way to tell whose ball it is. Ownership is this invisible information.

- The first volunteer wrote that the research question was: "The researcher is trying to figure out the shift that happens from 2 years to 3 years or older children in how they conceptualize ownership. [The researcher] is also trying to see how much the child picks up the verbal cues he gives such as that [it] is Susie's ball (even though Mike is playing with it)."
  [F, 55-64, Graduate degree]
- One volunteer seemed to have a good understanding of the research question: "When a particular group (for the most part) can distinguish ownership from possession."
  [M, 65-74, Graduate degree]
- Others were less specific and suggested that the research question was: "At what point do children listen and understand what you are telling them (take your word for something overriding their direct experience)?" [F, 18-24, some college]; and, "[The researchers] are seeing when they start to take the verbal information they're given when their visual images are contradicted." [F, 18-24, some college]

Methods to find answers:

First 'expert' researcher: The first 'expert' researcher described her methods very consistently and clearly. Two volunteers asked questions about colors used, one condition with marbles, and a child's understanding of the term 'random. As she demonstrated:

- First, can you tell me what color this is? ... Red? Awesome job.
- And what color is this one? ... Blue? Great job.
- Alright. I don't have any other marbles in my bag. I just have these two and I'm going to put these two marbles in my bag and I'm going to mix them up really [well]. And I'm going to pour one marble from this bag to this bucket. And without looking, I want you to tell me what color you think it is. What color do you think it is? ... Blue? Awesome.
- I'm not going to look and we're going to put it right back into this bag ok? I'm going to mix it up really [well] and do this 4 more times, OK? ... Blue?
- Shake it up... three more times. ... Red? Awesome.
- Mixing it up... Red.
- Alright last one. Mix it up really [well]. What color do you think it is? ... Red, awesome. Alright, well that's the end of my marble game, and you did a great job.

- One of the volunteers asked, "Do you let kids see what color they prefer before you do the study with them?; Do you think that the results would be different if you had more marble trials *vs*. five? With five it is sometimes easy for kids to do two blue, two red, and then one red, or one blue. Or do you think you might see a little bit more random if ... there are more trials? Have you tried the study with more than two marbles?" This volunteer had a good sense of methods used when she wrote: "The researcher is asking children to guess without looking what color marble fell out of the bag. She does five trials, and the child develops a sequence of what [s/he] think[s] is 'random.'"
- A second volunteer asked: *"Y*ou use the word 'random' even to a three year-old?; And you only use two marbles? That's it? So there is no other chance to have it be interpreted in another way, [or be] more confusing?; Was it easier to administer when you just got down to the two marbles as opposed to the ten?" After a lengthy response, the volunteer wrote that the methods used were: "The activity of using two different colored marbles in a bag, and the youngster tells what color the marble is."
- A third volunteer understood that the research methods were: "The researcher] is using a red marble and blue marble in a bag and pouring one marble into a container and asking the child what color the marble is that was poured into the container. She repeats this five times with no feedback to the child on which marble ended up in the container."
- The last volunteer did not respond.

Second 'expert' researcher: The second 'expert' researcher explained the basic story and four variations on the story about ownership in considerable detail. Most questions asked related to better understanding of the research study and how the researcher communicates the design of the study.

During his conversations, he described the method as:

…I have this whole collection of dolls here, four different dolls and each kid gets four stories. And the stories are pretty simple. They go like this. 'This is Sally and this is Billy. And right now Billy is playing with this ball and Sally is watching. Now let me tell you something – this ball is Billy's ball. And Sally is right here.' And I move the ball to the middle, and say 'So, can you tell me whose ball is it? Alright, cool, and can you tell me who can keep the ball? Alright, good.' ...

We have a couple of different versions of this story. In that case, Billy's playing with the ball but it is his. In another version, I would say Billy is playing with the ball but it is Sally's. And sometimes I'll keep the ball with the first person who had it, and sometimes I'll move it to the middle in between the characters to see if that makes a difference. Actually there are some studies that show that does make a difference, that small change.

The kids we are testing here are 2 and 3 year-olds, from 24 months all the way up to basically 48 months, right at four. How do you think kids react to this sort of situation? What do they rely on? The physical association or what I tell them?

- One volunteer described his research methods as: "Simple objects with dolls representing individuals and an object (i.e., a ball to establish ownership with, either by possessing it or verbal instruction denoting ownership)"
- Another volunteer wrote, "Telling stories with props and then asking children questions about what they just told them"
- A third volunteer suggested, "The researcher is telling stories and acting out the story at the same time. The researcher then asks the kids questions about the story such as "who can take this home?" The third volunteer explained in more detail: "The researcher is using dolls of different sizes, genders and colors in the study. He sets up two dolls in the park playing. He tells the child who the dolls are, who is playing with the toy, and whose toy it is. Then [the researcher] asks who gets to keep the toy and take it home, to check the child's conception of ownership."

Helping adult visitors understand the research:

First 'expert' researcher: This study seemed to interest volunteers most in the areas of data analysis, age-related findings, implications of the study, and follow-up studies. They asked many questions, and the researcher's responses were detailed, knowledgeable, and informative. Findings indicated that children think very similarly to children, or adults think very similarly to children. And that 'randomness' is different than the perception of what mathematics, statistics, and probability are supposed to be. For example:

"What we find here is young children between the ages of three and eight are performing just the same way that you do. ... If I flipped a quarter five times, what sequence do you think it would come out as? I doubt they would say something alternating like 'heads tails heads tails' or something that is 'heads tails heads heads tails.' Either there is a lot of alternating involved or a lot of runs. And this is not from what we have experienced with ... math or probability. We know it is just as likely [that] you get five heads as you get five tails. But nobody really says five heads or five tails when they are asked to come up with a random sequence because as adults, you really don't think that looks random. ... Now we are looking at children to ... get a baseline to ... see [if] it starts before we learn math. So let's look at how children think about random, and see if our perception starts from there. What we are seeing is that children, ... are behaving just the same as adults. Their sequences are just the same as you said 'red blue red blue red.' It's interesting to see how children think very similarly to adults, or adults think just like children as far as it comes to perceiving randomness. It's really exciting stuff."

Volunteers had many questions:

- "So do you see any changes with really young [children] like three year-olds *vs*. eight year-olds?; What types of questions do you get from parents about your study?" This volunteer wrote: "I learned that [the researcher] is looking at how children do with a study on randomness and probability compared to how adults do with similar studies."
- "Do you get many kids that just stick with one color, or anybody to just stick with one color? … like a 50-50 chance?; You don't keep track to see if anybody's right or wrong? I

did it just to see how many times I could get red; You are getting the same answer all the time then?; Other than the fact that I know it is unusual that you have just two. … 50% of the time you are supposed to be able to get it. So if you did 100, you should be able to get [it], [like] myogenics physics; You just get your statistics? – you statisticize each kid so you can figure out which ones will stick with a certain set, and which ones will stay steady, and which ones won't?; And you do with age groups, too? Statistical trends of an age group, three to four, four to five, three to five?" This volunteer's written response was: "Considering the age groups and the data compiled helps to indicate how children make decisions."

- "Do you see difference in children who are at the eight [year-old] end... [are 8 year-olds] more predictive ...for randomness?; This is an interesting study; do you have any results that you can discuss? Tentative results, preliminary results? Then will this translate into the workforce, as far as people making choices? Or is this something that is human condition, like we choose one or the other, or we are random by experiences?" This volunteer discovered "That young children can work / play with the term 'random.'" After the conversation, this volunteer better understood: "I learned that different ages of children depend on how they perceive randomness. I also learned that researchers need to [conduct] other studies if they don't effectively produce the data they are looking for."

At the end of the conversation, these volunteers generally 'Strongly Agreed' that they had increased in understanding:

- Volunteers #1 and #3 'Strongly Agreed' that they felt more informed about how children learn, more informed about how researchers conduct cognitive development research, and that the conversation with the researcher changed how they thought about how children learn.
- Volunteer #2 'Agreed' that that his conversation with the researcher changed how he thought about how children learn, and he felt more informed about how researchers conduct cognitive development research; he placed himself between 'Disagree' and 'Agree' on whether the conversation with the researcher changed how he thought about how children learn.
- Volunteer #4 'Agreed' that that her conversation with the researcher changed how she thought about how children learn, and that the conversation with the researcher changed how she thought about how children learn. She 'Strongly Agreed' that she felt more informed about how researchers conduct cognitive development research.

Second 'expert' researcher: Thoughtful and knowledgeable elaborations on reasons for choices his group has made in their studies about ownership, and research in the area characterized his conversation with volunteers. He was very effective at making decisions about the research design transparent, and respectful of the importance of questions the volunteers asked. Volunteers generally 'Agreed' or 'Strongly Agreed' that they felt more informed about how children learn, more informed about how researchers conduct cognitive development research, and that the conversation with the researcher changed how they thought about how children learn. Only one volunteer who participated in conversations with both researchers was less sure if he had changed in how he thought about how children learn.

The researcher used analogies effectively to explain the implications of his research and to respond to volunteer's questions. For instance:

> … what we are finding so far is that there is this tendency for younger kids, the 2 year-olds, to favor whoever is playing with the ball, regardless of who I say is the owner. The older kids ... are actually a little more confused than I expected them to be for 3 year-olds. Part of it is ... maybe

they are at school and someone else is allowed to play with [the ball] but "I don't know whose it is," and you can't really tell based on this situation. We deliberately are restricting the information that they have to work with so we can zero in on exactly what they are picking up on, what they are using to make that judgment.

So I think the bigger implications of this are that once you learn about information like ownership from what I tell you, you can track that information and know that Sally has certain rights … in relation to this ball even though Billy is playing with it. She can ask for it back and get it back and take it home, and she can keep it at the end. But it is also interesting because even when I tell you that, you know something about that ball that you can't see, it's a fact, it's a piece of information about that ball that's invisible.

Again, volunteers asked many questions:

- Volunteer #1: "So what does this mean about my kid? What does it tell me about my own kid? Like, don't touch it, it's hot, kind of thing?" He wrote in response to the conversation: "The concept of ownership is one that obviously is different in most individuals of a given age depending on that individuals' tool development."
- Volunteer #2: "I guess I'm interested in … why you have different sets of dolls?; Have you seen any trends in your studies in data collection? Or have you gotten to that point where you are working up the data?; And it also is hard because a 2 year-old is not necessarily a 2 year-old, in terms of another 2 year-old being at another level of understanding. There is so much range in that age range; What kind of questions do you find parents are asking when they are finished with the study?; And what does their child do with it…? How [does] it reflect what they are doing at home? Do they carry it out here as well?" In her written notes, she better understood that "Kids at a younger age tend to rely on what they see to formulate opinions / understanding of their world."
- Volunteer #3: "Do boys and girls have different preferences – if there is a boy child playing the game do they usually say it is the boys' ball?; And what about the toys? [Are they] girls' toys or boys' toys?; Instead of a boy doll and a girl doll – do you ever use two boy dolls or two girl dolls?; If there is a younger kid … even if they choose the wrong thing, are they consistent in choosing the wrong thing? OR do you get some kids that just say, 'Oh, Sally's,' or 'Oh, Dave's'…?; What kinds of results have you seen?; You said before how the younger kids have a mental image of what's going on. Do you ever try it where you start off with the ball in the middle and you say 'this is Sally and this is Dave, and Dave's playing with the ball' even though the ball is still in the centre?; Have you ever seen if the kids have siblings, does that make a difference if they're more willing to share it…?" After a lengthy conversation, this volunteer wrote that she learned: "[The researcher] is studying the concept of ownership of an object and seeing how 2 and 3 year-olds deal with the issue of ownership. Younger children tend to say the puppet who is in possession of the toy or playing with the toy owns it even if it is the other puppet's toy. However, 3 year-olds generally pick up more easily on the verbal cues of whom it belongs to even when someone else is playing with the toy."
- Volunteer #4: "Do you [know] anything about kids - like if they have siblings? ... if they have to learn how to share? This fourth and final volunteer's feedback was: "I learned at what ages children learn about ownership. I also learned that this study can help show at what ages kids take in the information they're given when it conflicts [with] their mental image or previous conceptions."

At the end of the conversation, similar to responses for the first 'expert' researcher most of these volunteers 'Strongly Agreed' that they had increased in understanding:

- Volunteers #3 and #4 'Strongly Agreed' that they felt more informed about how children learn, more informed about how researchers conduct cognitive development research, and that the conversation with the researcher changed how they thought about how children learn.
- Volunteer #1 (the same volunteer as Volunteer #2 for Expert Researcher #1) 'Agreed' that that his conversation with the researcher changed how he thought about how children learn, and he felt more informed about how researchers conduct cognitive development research; he placed himself between 'Disagree' and 'Agree' on whether the conversation with the researcher changed how he thought about how children learn.
- Volunteer #2 'Agreed' that that she felt more informed about how researchers conduct cognitive development research and that her conversation with the researcher changed how she thought about how children learn; she 'Strongly Agreed' that she felt more informed about how children learn.

Challenges in explaining their research to adult visitors in the Discovery Center:

First 'expert' researcher: The influence of parents and parents' questions were the only potential challenges and communication issues volunteers wondered about in conversations with this 'expert' researcher.

- One volunteer asked, "And what do you find with kids? Do you find any influencing from parents that are with the kids when you are doing the study?" She felt that the researcher "did an excellent job presenting her Research Study. She was very clear and informative, able to respond to questions and provided very interesting information about her study and other similar ones." She found the content, vocabulary, and information 'just right' (3).
- A second volunteer thought the researcher explained "the presentation of the problem and the request for an answer was communicated reasonably well."
- A third volunteer wrote, "She actually explained what this study was seeking to discover very well" and found the content, vocabulary used, and information 'just right' (3).
- The fourth volunteer asked further: "Do you ever explain to kids, who might be a little bit older, what probability is? Or do you just do – this is my game of marbles, see which one it is?; And what if a parent comes up to you and says, 'I don't understand, how does this relate to cause and effect? This is about randomness. I don't get what my kid is doing.' How would you tell them?" In her written response, this volunteer felt, "a little confused how the study related to cause & effect. At the beginning of the study we're told that this study is about cause & effect and how it relates to randomness. But at the end the researcher just talks about randomness. Maybe a little explanation about the cause & effect." Nonetheless, she found the content, vocabulary used, and information 'just right' (3).

One volunteer commented at the end of her feedback form, "I love the study. It's fun stuff. Especially when you ... run a bunch of younger kids all day and then you run older kids throughout the rest of the day to see that shift a little bit. It's a great study." She was impressed with [the researcher's] interest and enthusiasm about her research study. "She has definitely developed some great ways of involving participants in her study and also explaining her study to the parents of these children. Great Job!" Another volunteer wrote, "I thought [the researcher] did a great job executing the study and answering my questions. Aside from the cause & effect explanation, everything was very clear and I definitely learned about kids' perceptions of randomness."

Second 'expert' researcher: As one of the volunteers wrote, the research question and methods used by the second 'expert' researcher seemed to be clear and accessible. Communication of the design of the research study was very effectively explained through several everyday analogies, such as germs on toys and the earth being round *vs.* flat. Volunteers found the content, vocabulary used, and information 'just right' (3), as they had for the first 'expert' researcher.

The researcher further discussed his perspectives on and interest in 'ownership:'

> And so there are certain things about the world that we can only learn about by people telling us. … ownership has this dual thing where you can learn about it two different ways. But there is also stuff like germs. I can tell you 'don't touch that ball, there are germs on it,' and you can't see the germs. You just have to take my word for it that there is something bad about that ball and you don't touch it. You change your behavior based on that information.
>
> I'm interested in … these properties of objects that are invisible, and germs might as well be like ownership because you can't tell that they are physical property. As scientists we know they are. But there are other things we learn about through verbal testimony, ... like historical figures. We have no direct experience of George Washington, we learn about him through other people. A lot of scientific information, too, we have to override our direct experience. So a direct experience of seeing Billy playing with the ball, you have to take my word for it that it is Sally. In a kind of similar and analogous way, your direct experience of the world is that it is flat. You have to learn that it is round. So there are bigger implications for this kind of research, looking at how do we learn to take information from other people that conflicts with our direct experience of the world?

Volunteers continued to ask questions:

- "Do you see any difference in the 2 year-olds because of the language 'this is Sally's ball?' What does Sally's ball mean?"
- "Are you seeing differences in families that might have only one child, where it would affect these things? Whereas in a family that has 6 or 7 kids, this might be Billy's, that might be Sally's, that might be John's, and they have some idea of ownership within the family."
- "Is that a similar situation to 'Dave is playing with the ball but the ball is Sally's,' and then whose ball is it?"

Volunteers concluded that this 'expert' researcher's "method seems to be as direct and easily understood as can be with participants."

- "[The researcher] does a great job communicating his study to the children, parents, staff, interns and volunteers. He is thorough, makes it interesting and informative and provides the parents with links to how the study might apply to real life situations. This is an interesting study to participate in and discuss."
- "I thought it was great, but maybe see if the child has any preferences to gender or specific toys." This last volunteer wrote, PERFECT! across the three areas of communication. "Really great explanations! Very interesting goal for this study."
- The researcher "explained everything very clearly for a parent to understand and for a child to understand (stories told are very clear and simple)."

'Expert' researchers' enthusiasm, explanations, and clarity clearly impressed and interested the volunteers who had conversations with them about their research studies in the Living Laboratory. Comparisons across conversations the two 'novice' and two 'expert' researchers had with volunteers highlighted that experience in the Discovery Center helps to improve communication about research questions, design, methods, findings, and implications with volunteers. The more experienced the researchers were, the more engagement and curiosity the volunteers seemed to have. In the next section, two focus groups with researchers gave a better sense of the researchers' feelings about the impact of the Discovery Center on public understanding of their research.

3.4 Researcher Focus Groups

During the weekend of the Science of Kids Workshop, Barbara Soren moderated two focus groups with more and less experienced researchers. Ten researchers from research labs at MIT and Harvard Graduate School of Education participated. The intention of the focus groups was to discuss researchers' perspectives on adult visitor understanding of the *process* of conducting their research studies.

As explained in the introduction to each group, one of the goals of the evaluation of interpretive strategies related to the Living Laboratory throughout 2008-2009 was to determine the impact of this model on researchers' interest and behaviors in educating adult visitors. We were attempting to evaluate researchers' interest and behaviors by interviewing visitors after their child had participated in a research study in the Living Laboratory, audio-recording conversations of researchers with volunteers, and conducting the focus groups with researchers.

Focus group questions included:

1. What do you think has been working well about helping adult visitors understand your research in the Discovery Center?

2. What have been challenges in explaining your research to adult visitors?

3. What have you learned about how to conduct experiments in public spaces?

4. How much time do you spend talking to parents whose children are not subjects?

5. What have you been finding effective in helping adult visitors understand your primary research question and methods you are using to try to answer your question?

6. How might conducting research in the Discovery Center impact your research study(ies) and the process of conducting studies?

7. How do you feel about your skills in communicating your work to volunteer interpreters and adult visitors in the Discovery Center (e.g., your confidence in communicating to people different more or less knowledgeable about research, different age and ethnic groups)?

Five researchers and one observer attended the first focus group. Three were Laboratory Managers and three were Research Assistants (RAs). One of the RAs and one of the Lab Managers had been conducting research in the Discovery Center since August 2008. Two of the RAs and another Lab Manager who began in the Discovery Center in February 2009 were more 'novice' researchers.

Researchers from Harvard Graduate School of Education who participated in the Science of Kids Workshop were in the second focus group. Three of the researchers had been conducting studies in the Discovery Center for "a couple of years," 3 years, and 4½ years.

Researcher Focus Groups Key Findings (10 researchers)

- Researchers felt they help adult visitors to understand their research by learning to explain studies simply, through Discovery Center staff training, and by articulating what they do as researchers and fostering adult understanding.

- The biggest challenges for the researchers tend to be deciding whether or not to include data for a study when a parent is with groups of children, parents' time, recruiting with the help of volunteer interpreters, and accessibility of research studies.

- Researchers had learned about: how to approach adult visitors in the Discovery Center; how to manage distractions in the Discovery Center; repeat visitors who also have had children participate in studies in their labs; turning down children who do not have consent; their own prior expectations about running studies in the Museum; determining whether to include or discard data; and observations by adult visitors.

- Researchers found that personal conversations, inserts or flyers about their research studies, real world applications and personal examples are particularly effective for helping adult visitors understand their research question and methods. Positive outcomes have been spin-offs or new directions for a study.

- One researcher's final comment was, it has been a "fantastic experience, and a model to be adopted by other museums. I hope it gets increased funding."

<u>Helping adult visitors understand their research in the Discovery Center</u>

Researchers felt they help adult visitors to understand their research by learning to explain studies simply, through Discovery Center staff training, and by articulating what they do as researchers and fostering adult understanding.

- *Explaining research studies in a simple way*. Learning to explain their research studies to visitors in a simple way is important during researchers' training. *"*Once you get talking to parents, they are really excited" about the research study.

- *Training by Discovery Center staff*. During training sessions in the Discovery Center, staff help "to get researchers to a place where the research isn't an intimidating thing to the parents." The researcher has to be "comfortable sharing with the parents."

- *Articulating what they do as a researcher*. Researchers "gain valuable insight in articulating" what they do. It has helped graduate students to be more comfortable and confident teaching and working with undergraduate students.

- *Fostering adult understanding and educating the community*. For one of the experienced researchers, "fostering understanding" depends on how invested adults are. If adult visitors become invested in a research study, and stay around for a few minutes and talk, "they grasp the study when they walk away." If adults are with other children in other areas of the Discovery Center, they do not tend to be able to watch the full experiment. Adults with graduate education "grill you on methods" Adults with college education "are at a more sensory level" or "ask questions unrelated to research." One

researcher said that she has had numerous parents who are turned off by seeing the camera. "The people that turn down a study are less educated." She thinks that it is a matter of trust – "they don't trust you because you are a researcher."

Challenges in explaining their research to adult visitors

The biggest challenges for the researchers tend to be deciding whether or not to count or include data for a study when a parent is with groups of children, parents' time, recruiting with the help of volunteer interpreters, and accessibility of research studies.

- *Including or discarding data*. It is difficult for researchers to count or include the data for a child when they have a group of children sitting around and "helping out the kid being run, but giving them hints," and then to sit the other children down "when they already know what is going on." It is hard to know where one child should be while the other child is going through. "We allow kids to go through, but then we can't count the data."

- *The amount of time parents have*. If parents have other children, they do not have time to talk and focus on the study you are conducting. One researcher has found that "a one-line pitch" is helpful (e.g., "this is a study about fairness"). Another researcher solicits with "a 10-second pitch - I don't tell more about the study." After he asks, "Did you get what this is about?" He finds that an effective way to engage parents. A good question from an adult was "a great opportunity to discuss random assignment" for another researcher. Being able to "jump on comments" can result in "rich conversation with parents" (e.g., the design of a study, individual differences entering the study with their own children, and their children's personalities). Also, "parents are happy to have someone do an activity with their kid; they can rest."

- *Recruiting children for studies in the Living Laboratory*. Researchers have found volunteer interpreters in the Discovery Center helpful for recruiting and helping parents understand what they are doing. As one researcher explained, "If I start then I can get on a roll, but I can't go out there and talk to parents." Another added, volunteers who know and can talk about the research "could direct people to the experiment corner at the end of their engagement with visitors." However, to be a helpful resource, volunteers have to "know the specific protocol" and send the right aged children for a study. The researchers are "able to recognize particular ages much more accurately than volunteers not as experienced with discerning ages." A sign stating the age range volunteers are looking for would be helpful for recruitment, but one of the Lab Managers advised that a sign also would be "exclusive." Having two people from the researcher's lab is helpful. Then one researcher can recruit and the other can "run the subjects." Recruiting can be a way of "leading into other information."

- *Accessibility of studies*. The experienced researchers find that it is easy for adult visitors to understand "the set-up" or "what you are doing." But it is "challenging to understand the results." "The set-up is deceptively simple – they don't get the whole story; [they] have to dig deeper. We are still struggling with answers." One researcher commented, "It is different today than it was the first day – how much information to give, and how to have a more helpful conversation. There is a balance drawing on personal experience." He uses the same tools as when he was taught how to teach.

Researchers from MIT and Harvard labs use a manual that MIT has developed for researchers to go through with graduate students before they go into the Discovery Center. One of the research groups at Harvard also is developing a procedural manual on how to interact with people for research assistants. And the Discovery Center has developed a *Researcher Manual* to introduce researchers to the Discovery Center's history, educational philosophy, and mission statements, educational goals of the Living Laboratory, the role of the research interpreter, conducting research in the Discovery Center, Discovery Center volunteers, the protocol for introducing a new research study, and exhibit hours.

What they have learned about how to conduct experiments in public spaces

Researchers have learned about how to: approach adult visitors in the Discovery Center; manage distractions in the Discovery Center; work with repeat visitors who have had children participate in studies in their labs; turn down children who do not have consent; deal with researchers' prior expectations about running studies in the Museum; include and discard data; and help adult visitors become interested in their research studies through observation.

- *Comfort level in the Discovery Center*. Researchers in one group talked about not being "afraid of approaching people - rejection happens occasionally." They need to have a smile on their face. Two researchers commented that "The ability to speak with parents is very important" and "The more comfortable you are, the more comfortable the family with be." Researchers in the second group said they have gained "valuable skills in learning to articulate" what they do and feel more comfortable talking about their research.

- *Distractions and optimal conditions for conducting studies in the Discovery Center*. Researchers learn that they "have to keep the kids more engaged; there are distractions in the museum that are not in the lab." It is best not to make studies too long. Distractions depend on the day of the week. The more experienced researchers are careful who they hire for the public. If RAs are not appropriate, they do the study in the lab. One of these researchers said, "I am more able to work in distracting environments."

- *Repeat visitors who have had children participate in studies in their labs*. Researchers have found that they are "always excited about running experiments in the Museum of Science." One researcher said, "A lot of visitors have been at the website before" and "they are excited - they say that they have done this before."

- *Turning down children who do not have consent*. "Having to turn down kids that don't have their parents there happens surprisingly often." One researcher commented, "You can still run the study; you just can't use the data." Another researcher said that Discovery Center staff had told her that they "can't run them without parent signature."

- *Prior expectations about conducting studies in the Discovery Center*. One person described her initial expectations: "When you come to the museum you think that you will get children all the time. Half the parents I approach, I don't run. Even if I don't recruit them, if I educate them a little ... I feel good. I leave the option up to them; they might have a change of heart later." Staff suggest that researchers come in to see what to expect and what is going on in the Discovery Center.

- *Including or discarding data*. Researchers have found that on noisy days they have to discard data with 2-3 year-olds. "When there are too few in the Discovery Center, it is a drag. When there are too many, there are justifications for children responding, 'I don't know'." If they say 'I don't know,' researchers do not keep the data "because of a lack of focus." One experienced researcher has found it best to position himself to the right of the child. Another has had had to throw out 100 data points, but he was able to keep 400 data points. "Volume means I throw out some data, [but] I still have a good number." "He determines data to keep by asking, "Is there a noise impact on the findings?"

- *Helping adult visitors become interested in research studies through observation*. An 'expert' researcher likes "the idea of how people watch to increase interest. Part of the goal is to get people interested. ...The exhibit in the Museum is a way of giving back with parents."

How much time do you spend talking to parents whose children are not subjects?

When asked about how much time researchers spend talking to parents in the Discovery Center whose children are not subjects, one researcher said she spends "a significant part" of her shift talking to parents, depending on the day. Another thought she spent about "90 percent of my time outside of my corner." One of the newer researchers felt "weird" walking around all of the children and wants their parents to know that "I am not going to do anything wrong." A clipboard tends to make them feel more comfortable, particularly if it is difficult to see their name tags, One of the more 'novice' researchers finds that she has "to talk myself into talking to people. But then when I get talking to parents I find that it is not that bad, and I really like running subjects."

One of the lab managers in the first focus group mentioned "a clipboard tally." Discovery Center staff started tracking researcher contacts with visitors who were non-participants in studies in July 2008 (i.e., the clipboard tally).

- Of 318 'shifts' (between July 1, 2008 and March 3, 2009), researchers had participants on 281 of the 318 shifts (88% of the shifts)
- On 279 of the 318 shifts (88% of the shifts), they spoke with at least one visiting adult (often many more) whose child did not participate in the study. Sometimes they spoke with non-participants even when there were no subjects that day, and other times, *vice-versa*. On 10 shifts, researchers failed to record any data (most of these were the same researcher); on two shifts, there were no contacts of any kind.
- Overall, 39% of researcher contacts with visitors were with non-participants from July 2008 to March 2009.

What was effective in helping adult visitors understand their primary research question and methods they were using to try to answer their question

Researchers found that personal conversations, inserts or flyers about their research studies, real world applications and personal examples are particularly effective for helping adult visitors understand their research question and methods. Positive outcomes have been spin-offs or new directions for a study.

- *Personal conversations*. During personal conversations, visitors can be "really excited and responsive. They are eager to have their child participate. You bring out things about the tests you are running, and they are surprised at the games and what we can tell from them," reported one of the researchers.

- *The inserts or flyers researchers give to visitors*. In the first focus group, researchers talked about being "really excited" about the insert for their research study. "I feel like it does such a good job of explaining what we are looking for. It is so concise and clear." They find the inserts "a really good tool." Researchers tend to get two groups, suggested one researcher, "those parents that are excited about the study, and those that see us as something for their children to do. And even the second group can read this insert, and maybe they will read it at home."

- *Real world application vs. 'pure science.'* The 'expert' researchers talked about relating what they do in the Discovery Center "to the real world of grant applications. I am forced to think about research as if I am talking with an adult. I can't just say it's a research thing."

- *New directions or spin-off questions for a study*. In the second focus group, researchers talked about their Living Laboratory studies leading to "a new direction. Depending on responsiveness, we choose which direction, with one to three [that we have] in mind" (e.g., non-genuine apologies, or expressions of remorse). "It reinforces the desire to study that." "There are cases when people make comments about introducing ideas, as a natural follow-up and orthogonal to what I am doing. Suggestions are more a raw form. Ideas can be reinforced when I am working in the lab." One of these researchers has thought about "intuitions" (e.g., hetero *vs*. homogeneous populations). His time at the Discovery Center has impacted his research in that he is thinking about the educational component in museums and doing research in a museum "as a supplement to what I'm into, another facet to my research and interests" (e.g., an outcome of a visit to Science World in British Columbia, Canada). Other examples that have worked well with adult visitors for this group of researchers were: "Apologies with adults, reducing negative feelings about moral judgments, links with other species," and property studies (e.g., kibbutzim), which were brought up by a visitor interested in conversation. Visitors have asked one of the experienced researchers for references – "books to connect to my studies."

In the first focus group there was some discussion about negative connotations of the term "lab." One researcher described the term "lab" as "a hurdle." One mother, for example, thought that using a "lab" made her a bad mother. One researcher thought the term "Developmental Center" would be preferable to ''lab." Another researcher commented, "A good thing about doing this in public spaces [is that] you are not in some cold lab. People can see what you do out in the open." A third participant felt that "it is good that volunteers already break the ice. They are already talking and interacting with parents. It makes it easier to accept an invitation to a new location."

<u>How conducting research in the Discovery Center might impact their research study(ies) and the process of conducting studies</u>

Similar issues arose in response to this question that we had discussed earlier in the focus groups. Responses reinforced some key ideas, such as studies that keep attention, and inspiring new research directions.

Researchers need to develop studies that are short enough and engaging enough to keep attention. If a study "ran well in the Discovery Center it will run well in the lab. If you can be engaging in the Discovery Center, you can be in the lab." One research group extended their age range; it is "nice to have access to so many kids that you can extend the age range." Researchers in the first focus group discussed how "Once you are accustomed to doing

research out here, you understand what to say." Also, having to write the flyer or insert for a research study helps researchers "understand what is important to say."

For researchers in the first focus group, the experiment table in the Discovery Center, which is next to the corner where they conduct their studies, is an inspiration for further studies. One researcher has found, "When you are watching kids at the experiment bench and you look at them and think, 'Hey, they are doing something that I wouldn't do, why is that?' And then you can think of new questions." She wondered if the kids really understand an experiment, perhaps subconsciously. "It makes you think of broader aspects of children."

Experienced researchers felt they "have learned a lot" from the Living Laboratory experience. "It has spawned other talking opportunities. I feel more comfortable," and "This has been helpful for leading adult education workshops." They have learned from watching volunteers communicating Discovery Center exhibits (e.g., putting together an ostrich, and interactions of educators and interns watching)."It is helpful for "educating and interpreting." "It is a great experience – I am interested in the child." One of the researchers mentioned that he had unsuccessfully recruited a grandparent who cannot participate because grandparents are not considered legal guardians. This is "devaluing grandparents." Changing grandparents to legal guardians at the University's IRB (institutional review board) level was a recommendation from this group.

<u>How they felt about their skills in communicating their work to volunteer interpreters and adult visitors in the Discovery Center</u>

In the concluding moments of each focus group, researchers summed up their feelings about communicating their work to volunteer interpreters and adult visitors in the Discovery Center. Final comments were:

- "You have to have a lot of self-motivation ... parents just walk away and you need to make the initiative."

- "It gives you really good skills about talking about your research that you wouldn't get in a lab setting. ... You can run play studies on kids and find out so much."

- "A fair amount of parents have claimed to be doing similar things at home with their children" (e.g., a mother who related her parenting to our studies, especially the study about imitating). "Parents relate the child's activity in [one researcher's] study to activity at home." "Parents mention observation ... when conversation gets flowing" (e.g., when the researcher explains that she is doing research that has something to say that is contradictory to the usual teaching methods of teaching multiplication).

- There are "fun conversations that go longer, where there is an interest in the work" (e.g., with an uncle who was a relative of the child studied). "I have had a lot of parents ask about me and the lab and what I am doing."

- It has been a "fantastic experience, and a model to be adopted by other museums. I hope it gets increased funding."

Each focus group discussion was informative of ways in which the Living Laboratory and Discovery Center have impacted on researchers. They each ended with an important recommendation.

Researchers felt that the signage in the Discovery Center describing the studies as 'Just for grown-ups' affects the recruitment process. Adult visitors wonder if they should make an appointment. The sign does not indicate which lab is conducting the study, and should say instead, 'Please come on over.' More experienced researchers commented that the signage used to be more "aesthetically inviting" than it is now.[5]

A final recommendation was that the promotion of the Living Laboratory on the Discovery Center brochure and the home page of the website should include Harvard, MIT, and Boston Children's Hospital researchers and studies (i.e., *The Discovery Center's Living Laboratory for Research in Cognitive Development* brochure, and the homepage for WELCOME TO THE LIVING LABORATORY**,** http://www.mos.org/discoverycenter/livinglab). The Living Laboratory website, which features current and past research studies conducted in the Living Laboratory, is the topic of the final component of the researchers' section of this Summative evaluation report.

[5] As a result of this recommendation from one of the focus groups, Discovery Center staff created a new sign for the Living Laboratory research studies, featured on the cover page.

3.5 The Discovery Center's Living Laboratory Website
http://www.mos.org/discoverycenter/livinglab

The NSF grant funded the Discovery Center's own website with a major portion devoted to information about the Living Laboratory. The website allowed the Museum's Web team and Discovery Center staff to create and evaluate how effective the site is at reaching their audience and at communicating their science message.

During 2008, we collected metrics on users to the *Discovery Center's Living Laboratory*: *Learning Together Through Inquiry and Play* site (http://www.mos.org/discoverycenter/livinglab). From January, when Discovery Center staff launched the site, through to December the Museum of Science Web team helped to gather the number of participants using the Living Laboratory site, as well as the number of total hits and unique visitors spent on each page of the site. These measurements provide a baseline for continued evaluation of traffic to the site.

Living Laboratory Website Key Findings (January to December 2008)

- *Learning Through Play* with 10 study pages had the most hits during 2008. The pages feature cognitive scientists who have developed and are testing theories about how children might learn through play (total hits 3,124; total unique visitors 2,495). *What conditions allow toddlers to learn cause and effect relationships?* was the most popular study page (total hits 456, http://www.mos.org/discoverycenter/livinglab/ltp/tcw) *Learning Through Play* homepage: http://www.mos.org/discoverycenter/livinglab/ltp/list

- *Children's Social Reasoning* with 12 study pages had the next highest number of hits (total hits 3,087; total unique visitors 2,276). However, the studies that had the most hits in this section had later launch dates than studies most clicked on in the *Learning Through Play* section. Researchers include cognitive scientists who study children in order to develop a better sense of how children perceive other people and how this might affect their interactions in the social world. *Moral stories* was the most popular study page (total hits 467, http://www.mos.org/discoverycenter/livinglab/csr/moralstories) *Children's Social Reasoning* homepage: http://www.mos.org/discoverycenter/livinglab/csr/list

The three sections of the Living Laboratory website in 2008

An Infant Revolution highlighted research that utilizes innovative methods for developing a better understanding of infants' cognitive abilities, even before they can speak. The most popular section of the site was *How do children classify objects?*, the Legs & Wheels study by Dr. David Rakison, and his students at Carnegie Mellon University (519 hits, launched in January). They study how children group objects and form categories. This study examined how infants - aged 14, 18, and 22 months - develop the ability to classify, an essential scientific reasoning skill (http://www.mos.org/discoverycenter/livinglab/air/rakison).

Learning Through Play describes how observation of children's play activities indicates that the process of 'playing' is inherently unsystematic. This contradiction has made the question of how children learn during play of particular interest to parents, teachers and researchers. To find out what play is all about, cognitive scientists at The Early Childhood Cognitions Lab at MIT have developed and are testing theories about how children might learn through play. (http://web.mit.edu/eccl/)

The three most used *Learning Through Play* sections were:

What conditions allow toddlers to learn cause and effect relationships?
(456 hits in 2008, launched in January)

Toddlers may be able to learn two events are associated, but toddlers may not understand that they can act on objects to produce an effect. This study considers whether toddlers use cues from adults to understand cause and effect relationships.

Figure 16: Cause & effect relationships
http://www.mos.org/discoverycenter/livinglab/ltp/tcw

Does competition affect children's reasoning?
(391 hits in 2008, launched in January)

Previous research indicates that until around age 8, children typically do not control variables in experiments as scientists do. This study investigates whether children have the ability to control variables at a younger age (5-6 years), if given the proper context.

Figure 17: Children' reasoning
http://www.mos.org/discoverycenter/livinglab/ltp/ramps\

Do children play more when evidence is not clear?
(354 hits in 2008, launched in January)

It is widely believed that children learn by playing, but how does this happen? This study asks: do children play in more diverse ways with a toy when it is not clear which cause, among several possible causes, makes the toy 'go.'

Figure 18: Play when evidence is not clear
http://www.mos.org/discoverycenter/livinglab/ltp/mats

Children's Social Reasoning describes research studies by cognitive scientists who are attempting to develop a better sense of how children perceive other people and how this might affect their interactions in the social world. The Paul Harris Lab at Harvard University has studies in this section, such as demonstrations during the Science of Kids Workshop. (http://isites.harvard.edu/icb/icb.do?keyword=k32581).

The three most hit sections of *Children's Social Reasoning* were:

How do kids tell right from wrong?
(467 hits in 2008, launched in March)
Harvard University's Laboratory for Developmental Studies

Have you ever reprimanded your child, only to hear them say, "But I didn't mean to!"? Understanding when we are responsible for accidents, and when we are not, is an important part of child development. This study asks: How do children judge accidental behavior? Researchers read stories to kids aged 4-8 and ask them what they think about the characters.

Figure 19: Children' reasoning
http://www.mos.org/discoverycenter/livinglab/csr/moralstories

How do children learn to be face-recognition 'specialists'?
(397 hits in 2008, launched in May)
Children's Hospital Boston

During the first year of life, infants seem to lose the ability to tell the difference between faces they see frequently (i.e., primary caregivers) and less frequently (i.e., animal faces). This study asks: How do children develop the ability to recognize faces, and how might being exposed to one face type more than another affect children's face processing abilities?

Figure 20: Children' reasoning
http://www.mos.org/discoverycenter/livinglab/csr/facerecognition

How do children learn stereotypes about groups of people?
(387 hits in 2008, launched in February)
Social Psychology Laboratory at Harvard University

This study asks: Are stereotypes learned, or an inevitable consequence of the way our minds are wired? This study explores the conditions that affect children's formation of stereotypes. Children 3-8 years-old hear a story about two groups of people, the Zips and the Zaps (represented with cartoon images) engaging in either pro-social or anti-social behavior (i.e., practicing good manners *vs*. cheating).

Figure 21: Children' reasoning
http://www.mos.org/discoverycenter/livinglab/csr/socialgroups

In 2009, a new addition to the Living Laboratory website was a fourth section, *Math and Language Cognition*, which highlights cognitive scientists with an interest in learning more about how children develop language skills and conceptions about mathematical principles.
Math and Language Cognition homepage: http://www.mos.org/discoverycenter/livinglab/mlc/list

Website traffic reports from January through to the end of December 2008 indicated that the number of users to sections of the Living Laboratory site steadily increased throughout the year. For instance, the *Learning through Play* section began with 24 hits in January and had 457 hits in November and 414 in December. The *Children's Social Reasoning* section began with 7 hits in January and ended with 576 hits in November and 565 in December.

eNews: The first Discovery Center eNews for February/March 2008 went to 69 recipients March 13. The number of subscribers steadily increased throughout the year. A total of 718 received eNews throughout 2008. Discovery Center staff tracked the number of eNews that users received and opened (326 or 45% of those who received it), as well as the number of click throughs (138, 19% of those who received it).

Visitor Survey (N=127): Three visitors (3% of the Visitor Survey sample) whose children had participated in a research study during a previous visit to the Discovery Center had browsed the Discovery Center website prior to their visit. At the end of their visit, 81 of the 127 visitors (64%) expressed interest in learning about the Living Laboratory research through the Discovery Center website, as well as the eNewsletter (18, 14%). Thirty-six visitors (28%) left contact information in order that they could receive the Discovery Center eNews.

A Web code section of the site: Discovery Center staff posted an option on the Discovery Center homepage (in April 2008) for visitors who had received a brochure or a paper newsletter with a code. The online message was: "Have a Discovery Center or Living Lab code? Enter it here!". Twenty-seven website users entered a code from the beginning of May 2008 until the middle of April 2009. This group of users could potentially help with ongoing evaluation of the Living Laboratory initiative, on-site in the Discovery Center, and online on the Living Laboratory website.

At the end of the Formative evaluation report, Discovery Center staff indicated a commitment to continue to evaluate Living Laboratory section of the Discovery Center website. Ongoing evaluation requires ongoing coordination with the Museum's Web team and resources in order to ensure better metrics as a measure of the website's effectiveness. The website is a very important online interpretive strategy for extending understanding about cognitive science research to adult visitors and potential visitors. The website also is critical to giving a global audience an opportunity to experience the Discovery Center's Living Laboratory initiative at the Museum of Science, Boston.

The final section of the Summative evaluation highlights how Project Associates have been integrating cognitive research into their programming, which is another way of extending the reach of the *Participatory Model for Integrating Cognitive Research into Exhibits for Children* into other museums.

Part 4. Project Associates and Future Plans

Project Associates Report: Progress toward Integrating Cognitive Research

(a report based on discussion at AAM April 2009, and email correspondence in June/July 2009, prepared by Becki Kipling, Museum of Science (MoS), Program Manager- Discovery Center)

Overview

- Project Associates at all four sites have prototyped using research toys with their visitors and staff. Each of the institutions now regularly offers "Legs & Wheels" (L/W) research toys in the exhibit spaces.
- Project associates at all four sites indicate that bringing research toys to their institutions impacted their staff's interest in sharing, and ability to share cognitive research with visitors to their exhibits.
- All Project Associates indicate that parental "interest in the research" is probably a more important and appropriate goal for them than "understanding of methods" or "understanding of results." They question whether "parents becoming researchers" is an appropriate goal for their audiences, but feel that "parents becoming more informed consumers of child development information" is fully appropriate to their missions, and this is the angle all four sites have adopted as they work to further develop adult programming initiatives around cognitive science.

Boston Children's Museum, BCM (Jeri Robinson)

- *Play Space/Play Lab* is now collaborating with both MIT and Harvard labs to bring live research to the exhibit floor- more than 1,000 children participated in research during 2008. *Play Lab* will be on a several month hiatus in Spring/Summer '09, while the early learner galleries undergo construction, but research will continue at BCM in alternate locations.

Figure 22:
Play Lab waiting room

- *Play Space* staff were trained to use the L/W toys by MoS's Discovery Center Fellow Christina Gonzalez (Christina also worked as an intern in BCM's *Play Lab* in Fall '08 and Spring '09). Sharing this staff member between the two Boston museums has had a big impact on the ways *Play Space* staff view and support research activities in the space, and has allowed the Discovery Center to reach out to new audiences, especially in underserved communities in and around Boston.
- *Play Space* staff set up the L/W toys and activity cards at the 'story kiosk' and began collecting data about kids/parents interactions with, and reactions to, the research toys.
- During a pilot evaluation, using tools developed at MoS, BCM visitors who interacted with the research toys on their own seem evenly split on whether they feel "more informed about how scientists conduct research" and on whether they feel the experience "changed how they think about their own child's learning" (with 50% agreeing in

Figure 23: "Leg and Wheel" research toys at *Play Space's* Story Kiosk at BCM

both cases, N=10). Within this small sample of visitors at BCM, there was less agreement that the experience changed how they understand "children's learning" generally (with only 20% agreeing).

- Parents who played with L/W toys were "surprised that kids could sort that young" and that "kids have opinions about how to sort" - conversations around the Legs & Wheels toys are helping BCM staff talk with parents about kids' exploration of, and learning in, *Play Space* (e.g., all kids being "different" rather than some being "wrong")
- Parents in *Play Space* regularly ask after the *Play Lab* researchers, wondering when they will be in, and expecting to have the opportunity to participate in the research.

Maryland Science Center (Stacey Prinzing)

- Stacey wanted her staff to "own" the Legs & Wheels research toys project - she has been using the toys in *Kids Room* staff trainings ("running" staff in the study and discussing the "results" with each other) - at this point, the entire *Kids Room* staff "feels comfortable using and presenting them."
- Kids Room staff began by prototyping <u>where</u> they should present the L/W toys and activity cards to visitors (tried them in the main *Kids Room* exhibit, in a "back room" off exhibit, and in the Infant Room) – they decided to set up a station in the main *Kids Room* exhibition, where the toys and activity cards are displayed.
  - Stacey positioned this station near the entrance, where a staff member is always available - the research toys are giving her staff "something to talk about" related to child development (e.g., a concrete object they can use/refer to).
  - *Kids Room* staff have used the toys mostly with "regulars" and are thinking about how to use them with Head Start programming. Teachers visiting with their young students are very interested in "doing the experiment" with their kids.

Figure 24: "Leg & Wheel" research toys at *Kids Room* entrance

- *Kids Room* staff also have used the toys during "infant/toddler activity time." In April, the activity times centered around "things with legs and wheels" as a theme.
- *Kids Room* staff were slated to begin using the L/W evaluation tool just before Stacey came to AAM.
- Stacey has also replicated the DC's 'Infant Mobile' exhibit (using laminated cards as the stimuli for now) – they plan to build an actual Mobile soon.
- The best part for Stacey has been to "see the staff engaged" – her staff have thought of other ways to use the toys, including looking at and discussing "first reach" of both children and of parents (they've noticed that parents tend to "avoid" the modified toys).
- They have identified some potential collaborators for on-site research in *Kids Room*, but they are setting their own goals for that possibility, before making any partnerships.

Figure 25: "Leg & Wheel" research toys in the *Infant Room* at MD Science Center

Richmond Children's Museum (Claire Mehalick and Whitney Cardozo)

- Claire and Whitney explored the use of Legs & Wheels research toys with participants in their early childhood programs
  - They present the toys at a table in the gallery, and have been using the L/W observation tool developed at MoS to observe visitor reactions
  - They have been playing with the wording on the L/W activity cards to see if "group" is a better word than "classify" for their visitors.
- Richmond Children's Museum recently introduced signs/language throughout their exhibits for the purpose of educating parents about child development.
- For all their efforts, the Richmond staff report that "moms step back and are not involved - leaving their kids 'alone' is what they see as their role." The staff find challenges in engaging parents with the research toys – even story times and puppet shows don't seem to get the moms as involved as staff would hope. They think multiple exposures (e.g., in weekly/monthly "Toddler Time") will help get moms feeling more comfortable with "research" experiences – the remaining members of the Project Associates group echoed these ideas, and offered advice and their own observations around this issue.
- The staff at Richmond are still working to identify local researchers with whom they could partner.

The Children's Museum of Indianapolis, TCM (Barbara Wolf)

- Barbara took a very different approach to introducing the L/W toys to TCM - she prototyped on "Target First Thursdays," with exclusive focus on African American and Latino families in the *Play Scape* exhibition. They first wanted to see whether any of their families would be willing to sit down with a researcher and play with the toys. Barbara collected data on:

  1. Where in the exhibit it was easiest for parents to interact, and
  2. What parents said about the toys.

  - They used signs that said "Come Play with Me," also in Spanish (she noted, anecdotally, that when their sign said 'Harvard' or 'MIT,' parents "weren't interested," but didn't probe why this might be with parents).
  - Barbara found that their *Infant Area* was the most successful place for their visitors to experience the research toys - the *Fantasy Forest* was too distracting and the main exhibit area was "too chaotic for anything, really…"
  - She found parents, not children, overwhelmingly were the ones to terminate the activity (with many parents indicating a desire to "see it all," rather than allow a child to remain focused). She noted "very little engagement by fathers observed," versus mothers who were "more engaged."

Figure 26: 'Move Over' exhibit in *PlayScape* at TCM

- Biggest Impact for TCM: The NSF project has inspired the TCM staff to re-focus their *Play Scape* exhibition, with a new emphasis on children 0-3 years of age. Barbara indicates they would not be doing this without inspiration - from Living Laboratory - related to sharing research with parents in the exhibition.

APPENDICES

Appendix 1: Summative Evaluation Key Findings

Appendix 2: Summative evaluation methods with adult visitors and researchers

Appendix 3: Demographic Comparisons

Appendix 4: Indicators of having reached proposed impacts

Appendix 1: Summative Evaluation Key Findings

Goals One and Two: Visitors' increased 'understanding' of cognitive science and the process of conducting cognitive science

(*Notes*: Highlighted percentages represent the highest frequency of responses; 'I don't know' responses are not included)

Key Findings	Conversations with researchers (N=31)	Legs & Wheels (N=32)	Mobile (N=4)	Causal Boxes (N=22)
Described research questions	48.5% (particulars 35.5%; broadly 13%)	59% (particulars 22%; broadly 37%)	100% (particulars 25%; broadly 75%)	18% (particulars 4%; broadly 14%)
Identified the 'skills' of children that the researchers were studying	45.5%	16%		77%
Understood the 'process' of the research identifying the procedure used	39%	16%		4%
Understood the 'process' of the research identifying the stimuli used	23%	9%		23%
Tentative guess at the 'process' of the research	32%	47%	100%	41%
Outlined exhibit-related research observations they would make playing alongside their child at home	42%	31%	25%	45%
Described observations related to research generally	10%	17%	75%	23%
Identified further research questions to find out more about cognitive research and children	29%	61%	50%	68%

To summarize findings across interpretive strategies (not included, are the four visitors who interacted with the Mobile exhibit):

- 59% of the adult visitors could describe the research question at the standalone exhibit, Legs & Wheels, and 48.5% after a child participated in a research study in the Living Laboratory, compared to 18% at the Causal Boxes exhibit. However, 77% of the adult visitors could describe the 'skills' of children that the researchers were studying who interacted with the Causal Boxes (compared to 45.5% after a child participated in a research study and 16% at Legs & Wheels).
- 39% of the adult visitors whose child participated in a research study understood the 'process' of the research, identifying the procedure used. The frequency of visitors who could identify the stimuli used in conducting studies was the same for visitors who interacted with researchers and the Causal Boxes (23%). The most tentative guesses were at the Legs & Wheels exhibit (47%) followed by the Causal Boxes exhibit (41%).
- 45% of the adult visitors had ideas about exhibit-related observations they would make while playing alongside their children at home after they watched their child at the Causal Boxes, and 42% whose child participated in a study with a researcher.
- 68% of the adult visitors identified further research questions to continue to explore cognitive research and children after they interacted with the Causal Boxes exhibit, and 61% after interacting with the Legs & Wheels exhibit.

Visitors' increased 'understanding' of cognitive science and the process of conducting cognitive science at Standalone Exhibits: Summary of Findings

Legs & Wheels Key Findings (32 interviews completed): Across the sample of adult visitors who interacted with Legs & Wheels:

- 33% read an activity card about the Legs & Wheels exhibit and 56% read the interpretive panel about Current Research in Child Development.
- 59% of the visitors were able to describe research questions, either the particulars of the question (22%) or the researcher's broad area of research (37%); 16% were able to identify the 'skills' of children that the researchers were studying.
- 25% indicated that they understood the 'process' of the research, by identifying the procedure (16%) or stimuli used (9%).
- 31% outlined research-related observations they would make at home, while playing alongside their child, as a result of their interactions with interpretive strategies (17% of the other visitors described observations related to research generally, and not research from the exhibit).
- 61% identified further research questions to find out more about cognitive research and children's learning (51% a specific question, data point, or measure; 7% a broad or general query; and 3% questions related to children).
- 36% were able to write a headline for a story about the Legs & Wheels research based on what they saw in the picture on the interpretive panel.

Mobile Exhibit Key Findings (4 interviews completed): A small sample of the adult visitors interacted with the Mobile during the Summative evaluation period. Of those interviewed:

- 50% read an activity card about the Mobile exhibit.
- 100% of the visitors were able to describe research questions, either the particulars of the question (25%) or the researcher's broad area of research (75%).
- 100% gave a tentative guess at the research methods.
- 25% outlined research-related observations they would make at home, while playing alongside their child, as a result of their interactions with interpretive strategies (75% of the other visitors described observations related to research generally, and not research from the exhibit).
- 50% identified further research questions to find out more about cognitive research and children's learning.
- 75% were able to write a headline for a story about the Mobile research based on what visitors saw in the picture on the activity card.

Causal Boxes Exhibit Key Findings (22 interviews completed): Across the sample of adult visitors who interacted with the Causal Boxes:

- 33% read an activity card about the Causal Boxes exhibit.
- 18% of the visitors were able to describe research questions, either the particulars of the question (4%) or the researcher's broad area of research (14%); 77% were able to identify the 'skills' of children that the researchers were studying.
- 27% indicated that they understood the 'process' of the research, by identifying the procedure (4%) or stimuli used (23%).
- 45% outlined research-related observations they would make at home, while playing alongside their child, as a result of their interactions with interpretive strategies (23% of the other visitors described observations related to research generally, and not research from the exhibit).
- 68% identified further research questions to find out more about cognitive research and children's learning (36% a specific question, data point, or measure; 18% a broad or general query; 14% everyday observations of their young children).
- 45% were able to write a headline for a story about the Causal Boxes research based on what visitors saw in the picture on the activity card (36% related to the research question, and 9% related to cognitive science).

Visitors' increased 'understanding' of cognitive science and the process of conducting cognitive science after interactions with researchers: Summary of Findings

Researcher Conversations with Visitors Key Findings (32 interviews completed): Across the sample of adult visitors who had conversations with researchers after their child participated in a research study in the Living Laboratory:

- 48.5% of the visitors were able to describe research questions, either the particulars of the question (35.5%) or the researcher's broad area of research (13%); 45.5% were able to identify the 'skills' of children that the researchers were studying.
- 62% indicated that they understood the 'process' of the research, by identifying the procedure (39%) or stimuli used (23%).
- 42% outlined research-related observations they would make at home, while playing alongside their child, as a result of their interactions with interpretive strategies (10% of the other visitors described observations related to research generally, and not research from the exhibit).
- 29% identified further research questions to find out more about cognitive research and children's learning (16% a specific question, data point, or measure; 13% a broad or general query).

Science of Kids Workshop Key Findings (19 surveys completed): Across the sample of adult visitors who attended the Science of Kids Workshop:

- 100% of the group attended to find out more about how children learn, and 79% had an interest in the subject. Other reasons for attending were because it sounded like fun (58%), there was free childcare during the event (32%), and free event admission (32%); or they wanted to get involved in the Museum of Science (42%), meet people and socialize (26%), and network with professionals (21%).
- Prior to the Workshop, more than half of the Workshop attendees (63%) felt that they an understanding of cognitive development research and most of the Workshop attendees (84%) felt that they had an understanding of how children learn.
- After the Science of Kids Workshop:
  - 100% agreed that they enjoyed the Workshop experience (95% 'Strongly Agreed," one attendee 'Agreed')
  - 100% agreed that they felt more informed about how children learn (58% 'Strongly Agreed,' 42% 'Agreed')
  - 100% agreed that they felt more informed about how researchers conduct development research (74% 'Strongly Agreed,' 26% 'Agreed')
  - 79% agreed that the Workshop changed how they think about how children learn (47% 'Agreed,' 32% 'Strongly Agreed')
  - 89% agreed that they could relate the research presented to their own lives (47% 'Strongly Agreed' and 42% 'Agreed').

Goal Three: Better understanding of what cognitive science researchers are learning about how to conduct experiments in public spaces: Summary of Findings

Researcher Conversation with Volunteers Key Findings (17 conversations)

- After the second group of conversations with the first 'novice' researcher in May, there was some improvement in understanding. One volunteer 'Agreed' that he felt more informed about how children learn and more informed about how researchers conduct cognitive development research, while the second volunteer 'Strongly Agreed' with these statements. The second volunteer 'Agreed' that that her conversation with the researcher changed how she thought about how children learn, but the first volunteer 'Disagreed.'

- In conversations with the second 'novice researcher, one volunteer in the May conversation commented, the researcher "did a much better job explaining her study than when she first began." The second volunteer who participated in this conversation found the study interesting and that it was important for adult visitors "to be aware of this type of research." After the May conversation, both volunteers found the content and vocabulary 'just right' (3), but that there was too little information.

- At the end of the conversations with both 'expert' researchers, the volunteers generally 'Strongly Agreed' that they had increased in their understanding about how children learn and how researchers conduct cognitive development research, and that they changed in how they thought about how children learn. After the first 'expert' researcher's conversation, the researcher's interest and enthusiasm about her research study impressed volunteers. She had developed some great ways of involving participants in her study, as well as explaining her study to the parents of these children. Comments about the second 'expert' researcher were that he does a great job communicating his study to the children, parents, staff, interns and volunteers. He is thorough, makes it interesting and informative and provides the parents with links to how the study might apply to real life situations."

- Comparisons across conversations the two 'novice' and two 'expert' researchers had with volunteers highlighted that experience in the Discovery Center helps to improve communication about research questions, design, methods, findings, and implications with volunteers. The more experienced the researchers were, the more engagement and curiosity the volunteers seemed to have.

Researcher Focus Groups Key Findings (10 researchers)

- Researchers felt they help adult visitors to understand their research by learning to explain studies simply, through Discovery Center staff training, and by articulating what they do as researchers and fostering adult understanding.
- The biggest challenges for the researchers tend to be deciding whether or not to include data for a study when a parent is with groups of children, parents' time, recruiting with the help of volunteer interpreters, and accessibility of research studies.
- Researchers had learned about: how to approach adult visitors in the Discovery Center; how to manage distractions in the Discovery Center; repeat visitors who also have had children participate in studies in their labs; turning down children who do not have consent; their own prior expectations about running studies in the Museum; determining whether to include or discard data; and observations by adult visitors.
- Researchers found that personal conversations, inserts or flyers about their research studies, real world applications and personal examples are particularly effective for helping adult visitors understand their research question and methods. Positive outcomes have been spin-offs or new directions for a study.
- One researcher's final comment was, it has been a "fantastic experience, and a model to be adopted by other museums. I hope it gets increased funding."

Living Laboratory Website Key Findings (http://www.mos.org/discoverycenter/livinglab/ltp/list, January to December 2008)

- *Learning Through Play* with 10 study pages had the most hits during 2008. The pages feature cognitive scientists who have developed and are testing theories about how children might learn through play (total hits 3,124; total unique visitors 2,495). *What conditions allow toddlers to learn cause and effect relationships?* was the most popular study page (total hits 456, http://www.mos.org/discoverycenter/livinglab/ltp/tcw)
  Learning Through Play homepage: http://www.mos.org/discoverycenter/livinglab/ltp/list
- *Children's Social Reasoning* with 12 study pages had the next highest number of hits (total hits 3,087; total unique visitors 2,276). However, the studies that had the most hits in this section had later launch dates than studies most clicked on in the *Learning Through Play* section. Researchers include cognitive scientists who study children in order to develop a better sense of how children perceive other people and how this might affect their interactions in the social world. *Moral stories* was the most popular study page (total hits 467, http://www.mos.org/discoverycenter/livinglab/csr/moralstories)
  Children's Social Reasoning homepage: http://www.mos.org/discoverycenter/livinglab/csr/list

Appendix 2: Summative evaluation methods with adult visitors and researchers

December 3, 2008 to May 3, 2009

Summative Evaluation Method	Data collected: Number of adult visitors, researchers, and volunteers (% of total sample, N=289)
Tracking/Observations of adult visitor use of interpretive strategy - Behaviors recorded of adult visitors in area and at interpretive strategy **Interviews after observing adult visitor interacting with interpretive strategy** - Follow-up interviews with adult visitors observed	**N=112** (39% of total sample) **We observed 112 adult visitors** (39% of total sample) - 37 conversations with a researcher (13% of total sample) - 44 with Legs & Wheels stand-alone exhibit (15% of total sample) - 31 in Infant area focusing on the Mobile/Causal Boxes stand-alone exhibits: 4 at Mobile and 27 at Causal Boxes (11% of total sample) **Of those observed, we interviewed 89 adult visitors** - 31 conversations with a researcher (11% of total sample) - 32 with Legs & Wheels stand-alone exhibit (11% of total sample) - 26 in Infant area focusing on the Mobile/Causal Boxes stand-alone exhibits: 4 at Mobile and 22 at Causal Boxes (9% of total sample)
Visitor Surveys / Exit Questionnaires - A random sample of adult visitors as they exit the Discovery Center	**N=127** (44% of total sample) Completed during vacation week (N=60, 47% of the Visitor Survey sample), weekdays (N=35, 28%), and weekends (N=32, 25%) During Family Fun Night, an outreach program Friday January 23, 2009 (one of the weekday data collection periods), 18 visitors completed Surveys (14% of the Visitor Survey sample)
Science of Kids Workshop March 14, 2009 - A workshop for adult visitors with researchers including a lecture and demonstrations	**N=19** (7% of total sample) - Pre- and post-surveys completed by 19 attendees
Researcher conversations with volunteers - Taped conversations with volunteers about the current study the researcher was conducting in the Living Laboratory	**Researchers: N=4** (1% of total sample) **Volunteers: N=17** (6% of total sample) - 2 'novice' researchers had conversations with 9 volunteers - 2 'expert' researchers had conversations with 8 volunteers
Two focus groups with researchers, March 14, 2009	**N=10** (3% of total sample) - Focus group included 'novice' and 'expert' researchers (N=5 + an observer) - Focus group included researchers who participated in the Science of Kids Workshop (N=4)

Appendix 3: Demographic Comparisons

Demographic Comparisons across interpretive strategies: The following tables provide comparisons of adult visitors who completed Visitor Surveys, and interviews after a child participated in a study with a researcher or they interacted with a standalone exhibits - Legs & Wheels, or the Mobile or Causal Boxes in the Infant area. Comparisons are by last visit to the Discovery Center, sex, completed education, race/ethnicity, and age (highlighted percentages represent the highest frequency of responses).

Visitors' Last Visit to the Discovery Center

Last Visit	Visitor Surveys N=127		Researcher Conversations N=31		Legs & Wheels N=32		Infant Area N=26		Total N=216	
Never	40	31%	10	32%	5	16%	12	46%	67	31%
Within the past three months	30	24%	12	39%	14	44%	8	31%	64	30%
3-6 months ago	9	7%	3	10%	2	6%	0	0%	14	6%
6 months to within the last year	9	7%	2	6%	1	3%	2	8%	14	6%
1-2 years ago	13	10%	4	13%	1	3%	2	8%	20	9%
2-5 years ago	12	9%	0	0%	1	3%	1	4%	14	6%
5-10 years ago	5	4%	0	0%	0	0%	0	0%	5	2%
More than 10 years ago	4	3%	0	0%	0	0%	0	0%	4	2%
Not sure	2	2%	0	0%	0	0%	0	0%	2	1%
No Response	3	2%	0	0%	8	25%	1	4%	12	6%

Visitor Sex

Sex	Visitor Surveys N=127		Researcher Conversations N=31		Legs & Wheels N=32		Infant Area N=26		Total N=216	
Male	34	27%	7	23%	11	34%	9	35%	61	28%
Female	88	69%	22	71%	15	47%	16	61%	141	65%
No Response	5	4%	2	6%	6	19%	1	4%	14	7%

Visitor Education

Education completed	Visitor Surveys N=127		Researcher Conversations N=31		Legs & Wheels N=32		Infant Area N=26		Total N=216	
Some high school	1	1%	0	0%	0	0%	0	0%	1	0%
High school degree	2	2%	1	3%	1	3%	1	3%	5	2%
Some college	8	6%	4	13%	1	3%	1	3%	14	6%
College degree	43	34%	6	19%	9	28%	9	35%	67	31%
Some graduate work	5	4%	1	3%	3	9%	3	11%	12	5%
Graduate degree	63	50%	17	55%	12	38%	10	39%	102	49%
Other	2	2%	2	6%	0	0%	0	0%	4	2%
No Response	3	2%	0	0%	6	19%	2	8%	11	5%

Visitor Race/Ethnicity

Race/Ethnicity	Visitor Surveys N=127		Researcher Conversations N=31		Legs & Wheels N=32		Infant Area N=26		Total N=216	
African-American	6	5%	0	0%	0	0%	0	0%	6	3%
American Indian or Alaskan Native	2	2%	0	0%	0	0%	0	0%	2	1%
Asian-American	6	5%	3	10%	3	9%	2	8%	14	6%
Hispanic/Latino	7	6%	0	0%	2	6%	1	4%	10	5%
White, not of Hispanic origin	90	71%	27	87%	20	63%	21	81%	158	73%
Other	3 (Asian, Asian Indian)	2%	1	3%	1	3%	0	0%	5	2%
No Response	13	10%	0	0%	6	19%	2	8%	21	10%

Visitor Age

Age	Visitor Surveys N=127		Researcher Conversations N=31		Legs & Wheels N=32		Infant Area N=26		Total N=216	
Younger than18	5	4%	0	0%	0	0%	0	0%	5	2%
18-24	7	6%	0	0%	1	3%	0	0%	8	4%
25-29	21	17%	3	10%	1	3%	2	8%	27	12%
30-34	64	50%	6	19%	8	25%	2	8%	80	37%
35-44	21	17%	19	61%	11	34%	16	61%	67	31%
45-54	4	3%	2	6%	2	6%	2	8%	10	5%
55-64	2	2%	0	0%	3	9%	2	8%	7	3%
65-74	3	2%	1	3%	0	0%	1	4%	5	2%
75-84	0	0%	0	0%	0	0%	0	0%	0	0%
85+	0	0%	0	0%	0	0%	0	0%	0	0%
No Response	0	0%	0	0%	6	19%	1	4%	7	3%

Summative Evaluation Visitor Demographics: Across the Visitor Survey and interpretive strategies, we also collected information about number and age of children visiting with, interactions with interpretive strategies, and whether adult visitors would want to learn more by receiving the Discovery Center's e-newsletter and/or participate in a parents' roundtable led by researchers. The following is a summary of responses to demographic questions, interactions with interpretive strategies, and learning more across the Visitor Survey and interpretive strategies.

Visitor Survey: Between December 3, 2008 and March 16, 2009, a random sample of 127 visitors completed a Visitor Survey before leaving the Discovery Center. Of those who responded to demographic questions:

- 31% never visited the Museum of Science before, with the next largest group (24%) consisting of visitors who had been to the Museum within the past three months; half of the visitors (50)%) were members
- 69% were female, while 27% were male
- The majority fell within the age range of 25-44 years (84%)
- Most were highly educated, 88% having completed either a College degree, some graduate work, or a Graduate degree

- 71% were White; other visitors were Hispanic-Latino (6%), African-American (5%), Asian-American (5%), American Indian or Alaskan Native (2%), and three people who were in another category (two described themselves as Asian and Asian Indian)
- Almost half (47%) earned a yearly household income of $100,000 or more, while 11% earned under $50,000 and 30% earned between $50,000 and 100,000.

Legs & Wheels standalone exhibit: Of those who responded to demographic questions:

- Half of the adults had visited the Discovery Center in the past six months (44% in the past three months and 6% in the last 3 to 6 months), while 16% had never been to the Discovery Center before
- 15 of the visitors were females (47%) and 11 were males (more males interacted with Legs & Wheels than the other interpretive strategies)
- Most visitors in the Legs & Wheels group were 35-44 years (34%) or 30-34 years (25%); three visitors were 55-64 years and two were 45-54 years
- Almost half of the visitors had completed a Graduate degree (38%) or some graduate work (9%); 28% had a College degree or done some college work (3%)
- Most adults were White (63%), but three were Asian American and two were Hispanic-Latino
- 45% of adults who interacted with Legs & Wheels during their visit to the Discovery Center also talked with staff or a volunteer; 19% talked with a researcher; 16% went into the Infant area; 16% took a brochure, and 6% used other research toys
- Five visitors wanted to receive an e-newsletter after their visit and one person was interested in participating in a parents' roundtable led by researchers
- A total of 38 children were visiting the Discovery Center with these adult visitors – 13 were 2 years and under; 10 were 3 years and under; 14 were between the ages of 4 and 6 years; one group had an 11 year-old.

Infant Area – Mobile and Causal Boxes standalone exhibits: One group did not complete a demographic profile.
Of the other 25 visitors:

- Half of the adults had never visited the Discovery Center (46%), and 31% had visited in the past six months (all of these visitors in the past three months); two had visited six months before, two had visited one to two years before, and one person had visited two to five years before
- 16 of the visitors were females (61%) and 9 were males
- Most visitors in the Infant area group were 35-44 years (61%) or 30-34 years (8%); two visitors were 25-29 years, two were 45-54 years, two were 55-64 years, and one was 65-74 years
- More than half of the visitors had completed a Graduate degree (39%) or some graduate work (11%); 35% had a College degree or done some college work (3%); High school was the highest level of education for one person
- Most adults were White (81%), but two were Asian American and one was Hispanic-Latino

- 44% of the adults observed and interviewed in the Infant area during their visit to the Discovery Center also talked with staff or a volunteer, and 20% with a researcher; three visitors (12%) also went to the Legs & Wheels exhibit; two people (8%) took a brochure, and four adults (16%) used other research toys
- Two visitors wanted to receive an e-newsletter after their visit and one person was interested in participating in a parents' roundtable led by researchers
- A total of 32 children under 4 years of age were visiting the Discovery Center with the adult visitors in the Infant area, most were 12 months and younger – two were 3 months, one was 4 months, three were 6 months, four were 8 months, six were 9 months, three were 10 months, four were 11 months, five were 12 months. Older children were 2 years, 3-3½ years (2), and 4 years.

Visitor conversations with researchers: Of the adult visitors whose child had participated in a research study:

- Half of the adults had visited the Discovery Center in the past six months (39% in the past three months and 10% in the last 3 to 6 months), while 32% had never been to the Discovery Center before
- 22 of the visitors were females (71%) and 7 were males
- Most visitors who had conversations with researchers related to a study were 35-44 years (61%) or 30-34 years (19%)
- More than half of the visitors had completed a Graduate degree (55%) or some graduate work (3%); 19% had a College degree or done some college work (13%); a High school degree was the highest level of education for one person
- Most adults were White (87%), but three were Asian American (10%) (adult visitors had more diverse ethnic/racial backgrounds at the standalone exhibits)
- 19% of adults whose child participated in a research study also interacted with Legs & Wheels during their visit to the Discovery Center, and 19% went into the Infant area. 42% talked with staff or a volunteer (similar to visitors who talked with staff or a volunteer at standalone exhibits). 29% took a brochure, and 10% used other research toys.
- Five visitors wanted to receive an e-newsletter after their visit and three people were interested in participating in a parents' roundtable led by researchers
- A total of 51 children were visiting the Discovery Center with these adult visitors – 12 were 4-4½ years (23%), 11 were 2-2½ years (21.5%), 11 were 3-3½ years (21.5%), and seven were 5-5½ years (14%). The remaining children were 1 year and under (5, 10%), 6-6½ years (3, 6%), and 7-7½ years (2, 4%).

Science of Kids Workshop: Of the 19 adults who attended the Workshop and responded to demographic questions on the survey:

- Most attendees (84%) had visited the Museum in the past six months (68% the last three months, and 16% 3-6 months before)
- 13 females (72%) and four males (22%) attended (65% of the 2008 attendees were female)
- 72% of the Workshop attendees were 30-44 years (similar to 74% in 2008); three attendees were 45-54 years, and one person who had attended the 2008 Workshop was 75-84 years
- 74% had competed some graduate work or a Graduate degree (similar to 78% of 2008 attendees), and 26% had completed some college or had a College degree.
- 61% of the attendees were White (compared to 90% in 2008), 22% were Hispanic-Latino, and an African-American and Ethiopian attended – a more diverse ethnic/racial group than attendees at the first Workshop.

Appendix 4: Indicators of having reached proposed impacts

The following were possible indicators that the Discovery Center group reached the impacts they proposed in their initial NSF proposal, and the impacts they have reached.

Impacts on the Discovery Center's Public Audience

Indicator	Proposed Indicator	Measures of Impact
1. Participating adults will increase their interest in the science of cognitive development (indicating a change in attitude)	▪ 70% say they would be interested in observing their child play during interviews	During interviews after interacting with an interpretive strategy (N=89): • 45% of the adult visitors had ideas about exhibit-related observations they would make while playing alongside their children at home after they watched their child at the Causal Boxes, and 42% whose child participated in a study with a researcher.
	▪ 70% interact with interpretive strategies and talk with a staff member or volunteer while observing a child interact with a research toy	On the Exit Survey (N=127): ▪ 55% interacted with interpretive strategies - 26% interacted with Legs & Wheels - 18% with the Infant area Causal Boxes or Mobile - 16% with other research toys - 13% talked to a staff person or volunteer about the research - 11% talked with a researcher - 9% checked the Discovery Center brochure.
	▪ 70% check that they want to learn more about Living Laboratory research, receive a Discovery Center e-newsletter and/or attend a Parent Roundtable	On the Exit Survey (N=127): ▪ 64% indicated interest in learning more about research in the Discovery Center after their visit. After their visit: - 64% planned to visit the Discovery Center website - 14% wanted to receive a Discovery Center e-newsletter - 9% wanted to attend a parents' roundtable led by the researchers.
	▪ 50% pick up and read or take away the informational brochure and insert about the research study of the day being conducted by researchers in the Living Laboratory	Observations with researchers (N=37) ▪ 54% of the adult visitors whose child participated in a research study took a flyer or insert about the study. On the Exit Survey (N=127): ▪ 13% whose child had participated in a research study during a previous visit, and 7% (nine visitors whose child had participated in a study) had taken home a flyer about the study and read it.

Indicator	Proposed Indicator	Measures of Impact
	▪ 50% log onto the website using the code on an informational brochure or e-newsletter	▪ Discovery Center staff posted an option on the Discovery Center homepage (in April 2008) for visitors who had received a brochure or a paper newsletter with a code to enter the code on the website. ▪ 27 website users entered a code from the beginning of May 2008 until the middle of April 2009. This group of users could potentially help with ongoing evaluation of the Living Laboratory initiative, on-site in the Discovery Center, and online on the Living Laboratory website.
2. Participating adults will increase their understanding of the science of cognitive development (indicating a change in understanding)	▪ 50% report that they found out something new about cognitive science after interacting with a researcher and/or research	On the Exit survey (N-127): ▪ 69% felt more informed about how children learn; 49% felt more informed about how researchers conduct cognitive research. On the Science of Kids Workshop Survey (N=19): ▪ 100% felt more informed about how children learn and more informed about how researchers conduct cognitive research. Across interpretive strategies: ▪ 59% of the adult visitors could describe the research question at the standalone exhibit, Legs & Wheels, and 48.5% after a child participated in a research study in the Living Laboratory, compared to 18% at the Causal Boxes exhibit. However, 77% of the adult visitors could describe the 'skills' of children that the researchers were studying who interacted with the Causal Boxes (compared to 45.5% after a child participated in a research study and 16% at Legs & Wheels).
	▪ 50% agreed they had changed how they thought about how children learn, and could tell us how they had changed	On the Exit survey (N-127): ▪ 69% felt more informed about how children learn (60% agreed; 9% strongly agreed) ▪ 49% felt more informed about how researchers conduct cognitive development research (40% agreed; 9% strongly agreed) ▪ 37% felt their visit to the Discovery Center changed how they thought about how children learn (31% agreed; 6% strongly agreed). On the Science of Kids Workshop Survey (N=19): ▪ 100% felt more informed about how children learn, and how researchers conduct cognitive development research ▪ 79% agreed that the Workshop changed how they thought about how children learn (47% agreed; 32% strongly agreed) ▪ 89% agreed that they could relate the research presented to their own lives (47% strongly agreed; 42% agreed).

Indicator	Proposed Indicator	Measures of Impact
	▪ 50% are able to read a chart in the research toys areas for infants or older children, or in the informational brochure, and know where their child / children would fit on the chart	Legs & Wheels exhibit observations (N=44) and interviews (N=32) ▪ 33% were observed to read the activity card and 56% read the interpretive panel about Current Research in Child Development ▪ 74% felt the content and vocabulary were 'just right,' and 58% that the information provided was 'just right'. Infant Area interviews (N=26): After the visitors in the Infant area read the activity cards either for the Mobile or Causal Boxes exhibit with the interviewer: ▪ 77% felt the content, vocabulary, and information were 'just right;' 81% felt the vocabulary was 'just right.' Causal Boxes exhibit observations (N=27); Mobile exhibit observations (N=4) ▪ 33% were observed to read the activity card at the Causal Boxes and 50% at the Mobile exhibit.
3. Adult visitors will increase their capacity to be active learners alongside their children (indicating a change in behavior)	▪ 50% agree when asked during an interview if there are things adult visitors might want to look for while playing alongside their child at home	Interviews across interpretive strategies (N=112) • 45% of the adult visitors interviewed at the Causal Boxes exhibit had ideas about exhibit-related observations they would make while playing alongside their children at home, and 42% after they watched their child with a researcher. • 31% interviewed at the Legs & Wheels exhibit offered exhibit-related observations they would make at home and 25% at the Mobile exhibit.
	▪ 50% use pages of the website with activities to be active learners alongside their children	On the Exit survey (N-127): ▪ 53% of the visitors who completed the Survey planned to visit the Discovery Center site after their visit.
	▪ 50% who attend a Parents as Scientists Roundtable discussion report that they have learned more about the research at the cognitive science lab and how they can use the research as they play alongside their children	After the Science of Kids Workshop: ▪ 100% agreed that they enjoyed the Workshop experience (95% 'Strongly Agreed," one attendee 'Agreed') ▪ 100% agreed that they felt more informed about how children learn (58% 'Strongly Agreed,' 42% 'Agreed') ▪ 100% agreed that they felt more informed about how researchers conduct development research (74% 'Strongly Agreed,' 26% 'Agreed') ▪ 79% agreed that the Workshop changed how think about how children learn (47% 'Agreed,' 32% 'Strongly Agreed') ▪ 89% agreed that they could relate the research presented to their own lives (47% 'Strongly Agreed' and 42% 'Agreed').

Impacts on the Discovery Center's Professional Audience – Researchers conducting studies in the Living Laboratory

Indicator	Proposed Indicator	Measures of Impact
1. Research collaborators those who conduct studies in the Museum, will find a value in the conversations they have with Museum visitors	▪ 50% of researchers spend time having conversations with caregivers in the Discovery Center whose children are not research subjects	Discovery Center staff started tracking researcher contacts with visitors who were non-participants in studies in July 2008: ▪ 39% of researcher contacts with visitors were with non-participants from July 2008 to March 2009. ▪ On 279 of the 318 shifts (88%) from July 2008 to March 2009, researchers spoke with at least one visiting adult (often many more) whose child did not participate in the study (on 10 shifts, researchers failed to record any data - most of these were the same researcher; on two shifts, there were no contacts). Sometimes they spoke with non-participants even when there were no subjects that day.
	▪ Researchers from MIT and Harvard labs who attend a researchers' focus group report on the value they find in interactions with museum visitors	Researchers have learned how to: ▪ Approach adult visitors in the Discovery Center ▪ Manage distractions in the Discovery Center ▪ Work with repeat visitors who have had children participate in studies in their labs ▪ Deal with researchers' prior expectations about running studies in the Museum ▪ Include or discard data ▪ Help adult visitors become interested in their research studies through observation.
	▪ Researchers develop a training manual to help train students in the lab to communicate effectively with children, caregivers, and staff/volunteers in the Discovery Center	▪ Researchers from MIT and Harvard labs use a manual that MIT has developed for researchers to go through with graduate students before they go into the Discovery Center. ▪ One of the research groups at Harvard also is developing a procedural manual on how to interact with people for research assistants. ▪ The Discovery Center has developed a Researcher Manual to introduce researchers to the Discovery Center's history, educational philosophy, and mission statements, educational goals of the Living Laboratory, the role of the research interpreter, conducting research in the Discovery Center, Discovery Center volunteers, the protocol for introducing a new research study, and exhibit hours.

Indicator	Proposed Indicator	Measures of Impact
2. Researchers from MIT and Harvard labs have conversations with volunteers about their research studies	▪ Researchers attend briefings with volunteers/staff to talk about current studies they are conducting in the Discovery Center	From June 2008 to June 2009, Living Laboratory researchers provided 60 hours of formal professional development for Museum staff and volunteers through small group 30-minute briefings. During the Summative evaluation, 17 volunteers had one-on-one conversations with one of two 'novice' researchers at the beginning of their time in the Living Laboratory and several months later, or one of two 'expert' researchers about their research studies in the Living Laboratory. Key findings were: ▪ 'Expert' researchers' enthusiasm, explanations, and clarity clearly impressed and interested volunteers ▪ Comparisons across conversations the two 'novice' and two 'expert' researchers had with volunteers highlighted that experience in the Discovery Center helps to improve communication about research questions, design, methods, findings, and implications with volunteers ▪ The more experienced the researchers were, the more engagement and curiosity the volunteers seemed to have.

Impacts on the Discovery Center's Professional Audience – Professional collaborators, colleagues from other ISE institutions nationally

Indicator	Proposed Indicator	Measures of Impact
Professional collaborators, colleagues from other ISE institutions nationally, will consider instituting similar programs at their institutions	▪ 50% report planning to institute something similar to an aspect of the Living Laboratory at their institution	▪ Project Associates at all four sites have prototyped using research toys with their visitors and staff. Each of the institutions now regularly offers "Legs & Wheels" (L/W) research toys in the exhibit spaces. ▪ Project associates at all four sites indicate that bringing research toys to their institutions impacted their staff's interest in sharing, and ability to share cognitive research with visitors to their exhibits.
	▪ 70% use similar evaluation methods to assess interest of caregivers in the science of cognitive development	▪ All Project Associates indicate that parental "interest in the research" is probably a more important and appropriate goal for them than "understanding of methods" or "understanding of results." They question whether "parents becoming researchers" is an appropriate goal for their audiences, but feel that "parents becoming more informed consumers of child development information" is fully appropriate to their missions, and this is the angle all four sites have adopted as they work to further develop adult programming initiatives around cognitive science.