Journal of Cognition and Development

Conducting Cognitive Developmental Research in Museums: Theoretical Issues and Practical Considerations

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TOOLS OF THE TRADE

Conducting Cognitive Developmental Research in Museums: Theoretical Issues and Practical Considerations

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Increasingly, cognitive developmental researchers are forming partnerships with museums as a way to achieve both overlapping and distinctive goals. Such partnerships can further our understanding of cognitive development by providing opportunities to study children's learning within social contexts. At the same time, these collaborations can support the design of effective informal learning experiences for children and families. This article presents three distinct models for doing research in museums; they are presented in the context of both theoretical and practical concerns. Examples of research–museum partnerships are described, practical problems and potential solutions are discussed, and suggestions are provided for developmental researchers with an interest in developing museum partnerships.

Despite their beginnings as private collections of curiosities accessible only to the elite, museums have become part of daily life for many families in the United States and around the world. Given museums' role in everyday life for many children, Knutson and Crowley (2005a, 2005b) called museums an untapped resource for developmental psychology research, with potential to serve as "learning laboratories" valuable both to researchers and to the museums themselves. Indeed, recent years have seen a

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sharp increase in collaborations between university researchers and museums (mostly children's museums and hands-on science centers), with several distinct partnership models. In this article, I discuss theoretical and practical reasons for studying development in museum contexts, outline three distinct models for doing research in museums, describe some practical problems and their solutions, and provide suggestions for developmental researchers hoping to develop museum partnerships.[1]

WHY CONDUCT RESEARCH IN MUSEUMS?

Theoretically speaking, increased impact of sociocultural perspectives on development has arguably broadened the focus of developmental research from the individual child to the child in social context (Cole, 1996; Rogoff, 2003). As is true for schools (Alibali & Nathan, 2010), museums are important social contexts where children interact with and reason about people and materials. Studying children in these natural contexts can support new insights about development. Particularly in light of our society's increasing emphasis on the need to improve Science, Technology, Engineering, Mathematics (STEM) education, research in museums has the potential to have both theoretical and practical impact.

Importantly for the sociocultural approach, children's activity in museums is usually more open ended, flexible, and child driven than is possible in school contexts (or laboratories). The growing field of informal science learning provides evidence of how children's STEM learning can be best supported outside of school (National Research Council [NRC], 2007, 2009, 2010). At the same time, developmental research on how children learn through family conversation has yielded essential new information (Callanan & Jipson, 2001; Callanan & Valle, 2008; Gelman, Coley, Rosengren, Hartman, & Pappas, 1998). This focus has intensified thanks to two recent theoretical constructs highlighting the importance of children's social experiences for cognitive development. Csibra and Gergely's (2009) notion of "natural pedagogy" argues that children are biased to learn quickly and generalize broadly when learning from an adult whose intention is to teach. Harris and Koenig (2006) argue that children need to rely on the "testimony" of others for many things that cannot be learned through direct observation. Both ideas are generating new insights and research findings;

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[1]This article focuses specifically on cognitive developmental research with children in museum settings; other bodies of research pursue educationally relevant questions regarding evaluation of workshops and programs designed by museum staff to be used by teachers, students, and families.

museums are valuable settings to explore the ways that parents actually talk to children about science and other important topics.

As Haden (2010) has argued, museums provide unique settings to observe spontaneous family conversation and activity, potentially changing our views of learning. In particular, new insights have emerged from studies of children's developing understanding of science through family conversations (Callanan & Jipson, 2001; Callanan, Jipson, & Soennichsen, 2002; Crowley, Callanan, Tenenbaum, & Allen, 2001; Eberbach & Crowley, 2009; Luce, Callanan, & Smilovic, 2012; Palmquist & Crowley, 2007; Rigney & Callanan, 2011). A combination of naturalistic and experimental findings show that children who engage in explanatory talk with parents at exhibits are likely to explore more deeply and gain better conceptual understanding of relevant concepts (Crowley, Callanan, Jipson, et al., 2001; Fender & Crowley, 2007). Variation in children's experiences at exhibits has also been demonstrated in studies exploring gender (Crowley, Callanan, Tenenbaum, et al., 2001), cultural background (Gaskins, 2008a; Tenenbaum & Callanan, 2008), and parents' epistemologies (Luce et al., 2012). In museums, researchers can observe naturally occurring conversations within the guiding structure provided by exhibits. Studying how families talk about particular domains supports analysis of diversity in children's thinking and families' reasoning.

Beyond theoretical benefits of museum research, there are also practical benefits. Museum research can offer extremely productive environments for training students. In our museum work, undergraduate students are enthusiastic about connections between psychology and education, and between scientific and practical impact. Graduate students gain breadth by recognizing connections from their work in developmental psychology to the field of STEM learning and gain experience in an organization structured very differently from a university.

Increasingly, researchers see museums as productive settings even for research that does not focus on family conversation or museum learning. New models for research partnerships (see next section) harken back to Knutson and Crowley's (2005a, 2005b) notion of museums as "learning laboratories," where research typically conducted in university labs can take place in a museum context, allowing access to research for families who might not usually be involved. In a new model at the Museum of Science in Boston, for example, researchers work with museum staff to provide opportunities for visitors to learn about research as part of their museum visit. One advantage is that this model allows researchers to map development across a wide age span, potentially establishing norms with large samples (Frank, Vul, & Saxe, 2011).

Despite the advantages of studying museums as a context for development, however, using the lens of sociocultural theory also highlights one

problem. Families who attend museums are self-selected and potentially biased toward certain communities (Allen, 2007; Gaskins, 2008a; Stein, Garibay, & Wilson, 2008). One obvious factor is socioeconomic status, given that admission fees can be expensive. Museums have addressed this issue using sliding scales, free days, and community outreach. In our work, we have invited families to participate who have never been to museums before (Tenenbaum & Callanan, 2008). Ironically, families living in museums' urban communities may be less likely to visit than families who drive from the suburbs. Still, some argue that the population of visitors to museums may be more diverse than those who respond to invitations to participate in research in university settings. I return to the issue of diversity after reviewing various models for conducting cognitive developmental research in museums.

WAYS OF CONDUCTING RESEARCH IN MUSEUMS

Three distinct models for doing research in museums have emerged: museums as 1) contexts for studying cognitive development, 2) places for families to participate in and learn about research, and 3) settings for conceptualizing, designing, and evaluating interventions. As I discuss each of the three models, variations will be identified, and individual examples will serve as case studies.

Museum Conversations as Contexts for Studying Developmental Change

University–museum partnerships. The model in which researchers partner with museum staff is the one with which I am most familiar, because of my 16-year partnership with Children's Discovery Museum of San Jose (CDM). Another example of this type is the partnership linking Kevin Crowley's UPCLOSE group at University of Pittsburgh, the Pittsburgh Children's Museum, and the Carnegie Museum of Natural History. Other examples include Leona Schauble's work with Children's Museum of Indianapolis (Schauble & Bartlett, 1997), Suzanne Gaskins's and Catherine Haden's work with Chicago Children's Museum (Benjamin, Haden, & Wilkerson, 2010; Gaskins, 2008a, 2008b), and Lisa Szechter's work with LIGO in Baton Rouge (Szechter & Carey, 2009).

To illustrate this type of model, I describe our partnership with CDM, which began in the mid 1990s. Kevin Crowley (a postdoctoral researcher in my lab at the time) and I were interested in studying children's engagement in explanatory family conversation. We approached CDM asking to do unobtrusive research and were surprised at our warm welcome from

the director at the time, Sally Osberg (Osberg, 1998). The main reason that the partnership became successful is that the goals of the researchers over-lapped with those of the museum staff. CDM was in the midst of submitting a National Science Foundation (NSF) proposal to build a new exhibition called "Take Another Look." Osberg and her staff saw our research on family conversation as a valuable way to meet NSF's requirement for evalu-ation of their exhibition. We developed a method for obtaining consent as families entered the museum (see "Practical Problems"). We came up with a procedure to provide quick feedback to the team (which Crowley dubbed "blitz coding"), while using the same videotapes to conduct longer-term and more meticulous coding for basic research in developmental psychology.

One example of how research and museum goals intersected began with our finding a strong gender difference in parents' explanatory talk at science-related exhibits. Parents provided many more explanations to boys than to girls (Crowley, Callanan, Tenenbaum, et al., 2001), despite the fact that girls and boys were equally likely to ask questions and to approach and engage with exhibits. We hypothesized that parents may unknowingly talk differently to girls because they do not expect their daughters to be inter-ested in science domains. CDM's staff responded to this unwelcome finding with a new grant proposal for the exhibit "Alice's Wonderland," presenting STEM content in the context of an exhibit clearly intended to be relevant to girls. Alice, the main character, was not only a girl, but a beloved character from literature. Coding as in the original study, analyses of talk in the Alice exhibit revealed no gender differences (Callanan, Frazier, & Gorchoff, 2012). The research goals were met because this finding helped clarify the contexts of parents' explanatory talk to children. At the same time, the research worked hand in hand with the museum's goals of creating exhibi-tions that promote both STEM learning and gender equity.

This partnership model has evolved through two subsequent NSF-funded projects at CDM and Crowley's move to Pittsburgh and development of UPCLOSE, which integrated research in the redesign of the Pittsburgh Children's Museum (Knutson & Crowley, 2005a, 2005b) and developed links with other museums (Eberbach & Crowley, 2009; Palmquist & Crowley, 2007). My most recent CDM collaboration ("Mammoth Discovery!") focused on fossilized mammoth bones found in San Jose and paired exhibit develop-ment with research on parents' support of children's evidence-based reasoning (Luce et al., 2012), with an interdisciplinary team of exhibit designers, devel-opers, science educators, museum educators, and paleontologists.

Content-based partnerships. A related model for museum research involves researchers in developing particular exhibits focused on content about which they have expertise. One excellent example is Margaret Evans's

collaborations with the consortium of museums that developed ''Explore Evolution'' (e.g., Evans et al., 2010) and then with New York Hall of Science in creating ''Charlie and Kiwi's Evolutionary Adventure.'' Evans's research on children's understanding of evolution (e.g., Evans, 2000) provided a foundation guiding exhibit designers in choosing developmentally appropriate content and presentation styles and in avoiding language that might contribute to common misconceptions (Evans, Lane, & Weiss, 2011).

Another example is a map exhibition at Children's Museum of Indianapolis, building on Lynn Liben's research on children's spatial understanding (Liben, Szechter, & Myers, 2009). These content-based collaborations provide opportunities for researchers' expertise to inform exhibit content, while researchers gain new kinds of data, broadening their investigations to include children's thinking in naturalistic settings.

Museums as Places for Families to Participate in and Learn About Research

Newer models build on Knutson and Crowley's (2005a, 2005b) suggestion regarding museums' potentially rich source of research participants. Collaborations are appearing in which museums make space available for research that has little to do with the development of museum exhibits or programs. This model for research in museums is best exemplified by the ''Living Laboratory'' at the Museum of Science in Boston, in partnership with cognitive developmental researchers at Harvard University, Massachusetts Institute of Technology, and several other universities. In this model, museums develop a dedicated space for researchers to conduct developmental studies. For example, in the ''Living Laboratory,'' Schulz and colleagues have conducted basic research studies of children's causal understanding (e.g., Schulz & Bonawitz, 2007). In a similar arrangement at Boston Children's Museum, Frank and colleagues have conducted basic research on infants' social attention using eye tracking (Frank et al., 2011).

Cognitive developmental researchers may wonder why museums would agree to what may sound, at first, like a one-sided arrangement. Researchers gain access to families, but what do the museums gain in return? In the places where this model is working well, museums see clear benefits. Perhaps most obviously, nonprofit museums need to balance their finances, and some museums may charge researchers to use their research space. Another important point, however, is that hosting researchers from prestigious universities provides credibility, showing that museums are learning institutions and not playgrounds. Also, many museums aim to improve public understanding of science, and the Boston project team argues their project

informs the public about an underrepresented branch of science: cognitive science. This growing model is expanding to museums across the country. Its continued success likely depends on researchers supporting museums' goals and finding ways for their research findings to inform future exhibit development. One promising example in the Boston collaboration involves the research of Schulz and her colleagues on children's causal understanding through play, which is inspiring development of new museum exhibits. An important future research goal is to test the idea that participating in cognitive research in museums may change visitors' ideas about the nature of science.

Museums as Settings for Conceptualizing, Designing, and Evaluating Interventions

A final model was alluded to earlier and sometimes overlaps with other models. Museum exhibit designers often collaborate with researchers to conceptualize, design, and evaluate the effectiveness of exhibits.

Research focused on educational goals.   Other researchers focus on museums themselves as informal educational institutions, asking questions about effectiveness of exhibits or programs and hoping to build a knowledge base for the practice of informal science education. Some museums have in-house research departments, such as the Exploratorium in San Francisco. While assessing the effectiveness of exhibits and programs, these researchers also produce original learning research published in journals and books (Allen & Gutwill, 2009; Gutwill & Allen, 2010). An impressive example is the project on "Active Prolonged Engagement" in which different versions of exhibits were designed and tested, leading to a clearer understanding of the elements that encourage visitors to engage in open-ended exploration (Humphrey & Gutwill, 2005). Other educational researchers based in universities or museums explore similar questions regarding effectiveness of museums and capture variation in how parents guide and children learn (e.g., Ash, 2003; Ellenbogen, 2002; Van Schijndel, Franse, & Raijmakers, 2010).

Evaluation studies.   Because funders require evaluation of exhibits and programs, a number of researchers have developed companies specializing in museum research. Often these evaluation studies are difficult to distinguish from other types of learning research, and the fuzziness of these boundaries seems to increase over time. One distinction is that most evaluation reports do not end up in published form, though there are exceptions (e.g., Falk & Dierking, 1992; Stein et al., 2008).

PRACTICAL PROBLEMS AND POSSIBLE SOLUTIONS

As with any research with children and families, research in museums requires prior approval by a university institutional review board (IRB), including approved procedures for gaining informed consent. Practical issues regarding data collection vary a great deal depending on the type of research. Based on previous research (especially related to the first model discussed in the previous section), mention of a range of methods that have been successful may be helpful to future researchers.

Regarding informed consent, questions arise about how and where to ask families to participate. In our early work, we quickly learned that inviting families to participate in a study as they were about to engage with a particular exhibit often seemed intrusive and off putting. When we moved to inviting families near the admission area of the museum, we found them to be much more open to considering participating. We developed a consent form that families could read and sign on a clipboard, and we offer business cards providing relevant contact information for our lab as well as our campus IRB. To identify those children who have permission, we designed stickers for children to wear, coded for age, that signal to our video camera operators that the child has consent to be videotaped. Other methods for informed consent have been developed; for example, see Gutwill's (2002, 2003) analysis of different methods of gaining visitor consent.

With regard to data collection, there are again diverse methods that depend on the research questions and goals. Many studies of family visits to a particular exhibition have used video recordings of interactions, often paired with brief interviews or tasks given either before or after the visit (or both). We use small digital cameras. Attaching remote wireless microphones to the exhibit allows the camera position to be less imposing than would be necessary otherwise; we also discourage our camera operators from looking into the viewfinder while filming. Alternatively, in studies where an individual family is videotaped as they move through an exhibit space, having family members wear lavalier microphones works well. Sometimes experimental designs are even possible within museum settings and compare different conditions by varying wording of a sign or design of an exhibit.

The newer model of creating a lab space within a museum opens up additional possibilities regarding consent. One of the strengths of the model used by the Boston Museum of Science project, as well as a growing number of other museums, is the explicit focus on research participation as an opportunity visitors can choose as part of their museum experience. Increasing awareness about developmental research has the potential to help research partnerships continue to grow.

ADVICE FOR RESEARCHERS WISHING TO CONDUCT RESEARCH IN MUSEUMS

The advice of Alibali and Nathan (2010) for research in schools applies to museums as well: Be patient, be flexible, follow up with results, and give something back. Those considering a partnership with a museum might also consider the following advice.

Find Overlapping Goals

As mentioned, successful research–museum partnerships are mutually beneficial and support both museums' and researchers' goals (Osberg, 1998). Regardless of your research focus, find ways to work with a museum that meet your research goals, but be cognizant of the museum's goals as well. You might even inquire about the museum's goals before proposing your own. Obviously, joint grant funding is advantageous to both research and exhibit development, and working together on grant proposals can foster clear articulation of each partner's role. Collaborations also may open up new sources for funding including NSF's program on Informal Science Education, the Institute of Museum and Library Services, and private foundations.

Get to Know the Organization

Science museums are different from children's museums, natural history museums, and marine science centers, but even museums in the same category differ. Learn about the museum's mission, philosophy, and hierarchical structure. Some museums have in-house design and development teams, while others rely on leasing traveling exhibits. Some museums emphasize programs, such as family workshops, field trips, and teacher professional development. Before proposing something, know how the museum works and build relationships with the staff; learn about their views on research and build common ground. Once collaborating, stay actively engaged with staff. Participating in biweekly team meetings has been a major reason for the success of my partnership with CDM. Finally, recognize how research influences visitors' experience. The research presence must be comfortable and engaging and should add to visitors' experience rather than disrupt it. We need to learn more about which models of research are most appropriate for which visitors, so families from diverse backgrounds are comfortable participating. As new types of research partnerships emerge, so will better ways to involve families as partners in research. Much can be learned from museum practitioners already developing successful community partnerships

with families, such as the Philadelphia/Camden Informal Science Education Collaborative (PISEC) project (http://www.fi.edu/case/projects.html).

Recognize Museum Staff Members as Professionals

The museum field is in the midst of a widespread effort to increase recognition of practitioners' professional background and expertise. Museum professionals may have background in education, design, specific STEM content, marketing, or fundraising. These different roles often link to different philosophies about work and collaboration. Exhibit designers may think of their work as artistic creation of unique experiences, whereas education staff may use their extensive knowledge of children to create activities that engage multiple developmental levels. Take the time to learn about individuals and what they bring to the team. Discover how their expertise informs their practice before you begin to offer advice, and recognize potential reciprocal benefits. One example that may surprise researchers is that Boston Museum of Science staff members have helped researchers to better explain their findings to visitors. Museum professionals know how to communicate clearly with their audiences and can help researchers remove jargon that we hardly notice when we talk to colleagues.

Recognize That Your Outsider Status has Both Benefits and Drawbacks

As an outsider to the institution, your feedback, especially when backed with objective data, may help to defuse and resolve disagreements within the organization. At the same time, decisions will be made that are not consistent with research recommendations. Remember that museums are juggling many demands, and their priority must be to keep the place running every day. Try to support that goal, while knowing that at times it may make things difficult for your data collection and that your carefully reasoned recommendations may be difficult to implement.

Give Something Back

Even if your research is not directly connected with museum practice, there are many ways to contribute to the museum's goals. Presenting your research findings may inspire the staff as they develop new programs or exhibits. It has been extremely rewarding to see our research contribute to the impetus for new projects and shared funding opportunities. Researchers can also help in more mundane ways; finding citations is easy for university researchers but difficult and expensive for others; writing brief summaries of

relevant research can assist museum staff as they write grant proposals, final reports, or presentations to boards or funders. Collaborations can also provide access to the university IRB approval process; alternatives for nonuniversity researchers are extremely expensive.

Keep an Open Mind

Researchers should enter museums with an open mind about what they might find. Going in with eyes open to the complexity of the real setting, rather than trying to control everything as you would if still working in the university lab, K. Crowley (personal communication, October 28, 2011) argues, is likely to be healthy for the field as well as for developmental theory.

CONCLUSIONS

Museums are indeed unique and valuable learning laboratories, with much to offer to researchers of cognitive development. As more researchers and museums find ways to collaborate, no doubt new and innovative models will arise. Just as in school settings, the invitation for researchers to collaborate is likely to remain open only as long as museums find the outlay of resources (space, staff time, and visitor interest) is balanced by clear benefit in meeting their goals.

One goal that researchers and museums have in common relates to issues of diversity. Both in research and in museum experiences, many of us are aiming to increase the diversity of the participants or visitors we reach. Researchers may assume that collecting data in a museum automatically increases the diversity of their sample, but this might not be the case. Working with museum staff who are reaching out to community partners and helping them to expand those efforts will benefit all parties. Just as museum audiences may help to diversify research participation, through their findings, researchers may help museums better understand their diverse audiences (Allen, 2007; Gaskins, 2008a, 2008b; Siegel, Esterly, Callanan, Wright, & Navarro, 2007).

There are challenges involved in developing partnerships with museums, but most researchers will find it well worth the effort. As we move forward, these partnerships are likely to be good for the field in a variety of ways. The more we learn about the nuances of family interactions in different everyday settings, the more we learn about development.

ADDITIONAL RESOURCES

Two recent volumes by the National Academies (NRC, 2009, 2010) are excellent starting points for learning about research in museums and other

informal learning settings. In addition to the citations in this article, other valuable sources are Leinhardt, Crowley, & Knutson's (2002) volume, *Learning Conversations in Museums*, and Paris's (2002) volume, *Perspectives on Object-Centered Learning in Museums*. Haden (2010) wrote an informative recent overview in the journal *Child Development Perspectives*.

Informative Web-based sources focus on museum–research partnerships, especially the Web site informalscience.org (where evaluation reports and published papers are made available) and the resources connected with the Center for Advancement of Informal Science Education. Interested researchers are encouraged to explore the Web sites of the museums mentioned, especially the work of Sue Allen and Josh Gutwill conducted at the Exploratorium in San Francisco, as well as the collaborative work of the Center for Informal Learning and Schools. Other relevant professional groups include the Association of Science and Technology Centers, the Association of Children's Museums, and the Visitor Studies Association (visitorstudies.org).

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