MIND, BRAIN, AND EDUCATION

Common Content, Philosophy, and Programming Support Thriving Collaborations Between Cognitive Science Labs and Museums

Moira R. Dillon[1] and **Cindy R. Lawrence**[2]

ABSTRACT— University research labs focusing on education, psychology, and cognitive development have been collaborating with museums more and more over the past decade. Nevertheless, cognitive science labs that primarily engage in basic as opposed to applied research may find it difficult to entice museums to collaborate, and existing collaborations may fall short of their full potential to garner benefits to labs and museums alike. Here, we focus on a kind of lab and museum collaboration that has common content, philosophy, and programming and impacts both scientific theory development and museum practice. By illustrating one example of a collaboration between the Lab for the Developing Mind at New York University and the National Museum of Mathematics in New York City, we offer practical tips and suggestions for other cognitive science labs aiming to achieve strong lab-museum synergy.

Successful collaborations between university research labs and museums often rely on shared goals, equal and reciprocal engagement, and practical benefit in terms of research output and financial support (see Callanan, 2012; Sobel & Jipson, 2016 for reviews). The aims of many collaborations have included, for example, evaluating children's knowledge growth in informal learning environments (Ash, 2002), examining parent–child pedagogical interactions (see Callanan et al., 2020 for a review), measuring the effectiveness of museum exhibits or educational materials (Ash, 2003; Van Schijndel, Franse, & Raijmakers, 2010), enriching the public's knowledge about scientific research (Osberg, 1998), and expanding the quantity and diversity of participant pools who engage in research (Frank, Vul, & Saxe, 2011; Tenenbaum & Callanan, 2008).

The depth and breadth of these collaborations and their possible benefits to labs and museums may nevertheless differ based on the lab's primary focus and methodology. In particular, labs focusing on education, some areas of cognitive development, and informal learning may have the interest, tools, and expertise to directly inform the educational practices of a museum, and findings from studies conducted in the museum may further the lab's own research program. Labs focusing on cognitive science that conduct mostly basic as opposed to applied research and whose research programs are less directly related to education may nevertheless generate different benefits to both themselves and their partner museums. Sometimes these benefits are initally hard to identify, leading to unique challenges for such cognitive science labs looking to foster lab-museum partnerships.

Many cognitive science labs have nevertheless developed rich and successful collaborations with museums (Callanan, 2012; Corriveau, Kipling, Biarnes, Ronfard, & Harris, 2016). Such collaborations are mutually beneficial. For example, labs have access to a greater quantity and diversity of research participants, labs test the generalizability of their findings to out-of-lab contexts, and lab trainees gain experience with science communication; museums demonstrate a commitment to scientific research with their visitors being able to access cutting-edge science

[1]Department of Psychology, New York University,
[2]National Museum of Mathematics,

Address correspondence to Moira R. Dillon, Department of Psychology, New York University, New York, NY; e-mail: moira.dillon@nyu.edu

directly, and, if there is space rental involved, the museum's income may help them meet their financial goals. In many cases, especially when the lab's research content is already closely related to the museum's content, other significant benefits arise. For example, cognitive science labs focusing on children's metacognition, reasoning, learning, and play can use their findings to inform the creation or refinement of museum exhibits to better engage children's informal learning in general (Sobel, Letourneau, & Meisner, 2016) or intuitions about the subjects and methods of science in particular (Rhodes & Bushara, 2016; Schulz & Bonawitz, 2007). Despite these apparent benefits, the investment and motivation required for cognitive science labs and museums to collaborate may make it difficult for either party to entice the other to initiate the partnership. For example, the lab's experimental designs may not account for visitor satisfaction, and the museum may have to prioritize room rentals to non-academic but more consistent (or deeper pocketed) parties.

The present work thus describes benefits of collaborations between cognitive science labs and museums where testing at the museum informs both theories in cognitive science and practice at the museum. Rather than either lab or museum engaging the other as a beneficial supplement, the lab and museum find each other at the intersection of their existing content, philosophy, and programming. We illustrate one example of such a thriving collaboration between the Lab for the Developing Mind at New York University and the National Museum of Mathematics in New York City and suggest it as an inspiration for future collaborations aiming to achieve strong lab-museum synergy.

LAB FOR THE DEVELOPING MIND AT NEW YORK UNIVERSITY (LDM)

Established in 2017 by Dr. Moira R. Dillon, the Lab for the Developing Mind at New York University (LDM) conducts basic research on the origins and development of humans' capacity for abstract thought. The lab uses cognitive, developmental, computational, and cross-cultural approaches to gain insight from the full range of human encounters with geometry, from the basic spatial sensitivities of infants to the untutored use of spatial symbols and language by children to the high-level spatial concepts of adults. In addition, the lab asks how our basic mechanisms of perception and cognition about places, objects, agents, and social partners might influence the products of our diverse cultures, like our use of pictures, and underlie our everyday commonsense human intelligence in a way that might be directly compared with—and perhaps built into—machine intelligence.

NATIONAL MUSEUM OF MATHEMATICS (MOMATH)

The National Museum of Mathematics (MoMath) is a unique educational resource devoted to the wonders of math and its many connections to the world around us. Established in 2012 by a small group of math enthusiasts—including current Executive Director and CEO Cindy Lawrence—MoMath is Manhattan's only hands-on science center and the nation's only museum focused on math. MoMath's 19,000-square-foot space is home to more than 40 interactive, engaging, and playful exhibits that showcase the fascinating world of math and that allow visitors to slip naturally into the world of patterns, shapes, and numbers. In the more than 10 years since it opened, MoMath has become a model for public math engagement around the world.

COMMON CONTENT

The LDM's research content and methodologies are diverse, but many studies focus on perception, cognition, or reasoning about geometry. Similarly, MoMath engages many disciplines and traditions within math, but some exhibits incorporate concepts from intuitive and formal geometry. Through the dialogue at the foundation of the collaboration, the lab and Museum have been able to find significant content overlap, not just through a broad focus on math but also on particulars that touch equally on the lab's studies and the Museum's exhibits. For example, while the lab had had a focus on reasoning about geometry, it had not focused on physical reasoning until recognizing that a combination of geometric and physical reasoning is captured by one of the Museum's exhibits (as described later).

Once the content overlap is found, figuring out how to translate it into research that benefits the lab and museum alike remains challenging. We suggest that a study might exploit content overlap so that: (1) its methods take advantage of the unique resources the museum provides; and (2) its findings inform both the development of the lab's scientific theory and the museum's pedagogy. One experiment conducted by the LDM at MoMath, for example, aimed to determine whether children and adults have early emerging intuitions about the shortest distance between two points—among the most fundamental elements of formal geometries—on spherical surfaces (Figure 1). This study revealed that not only adults' but also children's intuitions about the shortest path between two points are more flexible—to spherical surfaces—than initially thought, at least when judgments are couched in judgments about the efficient actions of others (Huey et al., 2023).

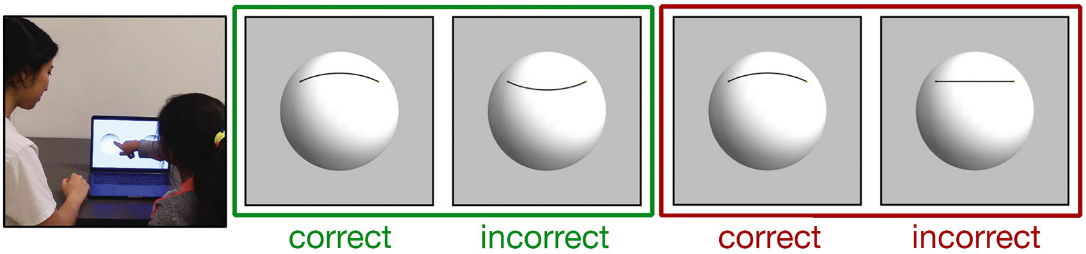

Fig. 1. In Huey, Jordan, Hart, and Dillon (2023), 6- to 8-year-old children and adults chose which one of two paths in pairs of pictures of spheres was the most efficient (shortest) path. Different trials compared pairs of paths that both looked curved in the pictures of the spheres (left, green outline) and pairs in which only the most efficient path looked curved (right, red outline). Children and adults were surprisingly successful at identifying the correct, most efficient paths, especially when comparing two curved paths.

While this study tapped into a content area of interest to the Museum and was conducted in the Museum and with Museum visitors, it was run as it would have been in the lab: on a laptop; one-on-one with a researcher; and in a quiet room. It thus did not maximally merge the lab's research content with the Museum's content. The planned follow-up studies, however, do. These studies ask: What effect does couching geometry in a physical context (e.g., with gravity) have on children and adults' judgments about the *fastest* path between two points? Two planned studies thus explore how human intuitions about efficient paths are affected when we move from 2D pictures of geometric spaces like spheres to 3D physical spaces in the real world.

For these experiments, the lab will query visitors to the "Tracks of Galileo" exhibit at MoMath (Figure 2). Here, visitors are challenged to get a ball from one side of a track to the other as quickly as possible. To do so, they can adjust the height of the track at each of 10 posted locations and run a ball from the left side of the track to the right side, timing the run. Huey et al. (2023) measured participants' intuitions about the *shortest* paths on 3D spheres when participants looked at 2D pictures; this exhibit probes visitors' intuitions about the *fastest* paths subject to earth's gravity. In this exhibit, the *shortest* path is not the *fastest* path!

In one planned experiment lab researchers will stand in front of the "Tracks of Galileo" with a replica on a digital tablet and ask Museum visitors to participate in the experiment before interacting with the exhibit. Participants will be asked to adjust the figure on the tablet with their best guesses for the fastest path. Do most people start with the shortest, linear path? Do times get faster with successive guesses? Are final guesses close to the correct solution (a cycloid) in both shape and timing?

We will also passively collect data about the Museum visitors' interaction with the "Tracks of Galileo" over a 3-month period using eye-safe laser "measuring tape" attached to the 10 adjustable track points on the exhibit to record the position and time of the track every time a visitor sends the ball down it. This method will accumulate a large amount of data reflecting human intuitions about this problem, data otherwise impossible to collect in a lab setting. It will also provide the Museum with valuable data about the quantity and quality of visitors' interactions with its exhibit, potentially allowing them to evaluate whether the particular, complex mathematical ideas underlying the exhibit are being engaged by visitors (Evans, Weiss, Lane, & Palmquist, 2016). Finally, the protocols for the active and passive data collection in these two planned experiments without the request for personal identifiable information may streamline and reduce barriers to visitors' participation in scientific research.

Achieving a formal proof for the problem exemplified by the "Tracks of Galileo," the "Brachistochrone Problem," was hard won in math, and the lab experiments embedded in the Museum context probe what intuitions may have supported (or frustrated) this intellectual achievement, under what conditions those intuitions might be evoked, and what those intuitions might miss. The research findings are thus important to a scientific understanding of geometry as a central cognitive achievement of the human mind. Moreover, they may elucidate the role intuition and experimental play have in arriving at and understanding many of the formalisms we ask children to learn in math and physics classrooms. Indeed, such data may also lay the foundation for evidence-based Museum pedagogies. Common content shared by labs and museums may therefore foster experiments only possible through collaboration that both support the development of basic scientific theories and inform how to better design museum exhibits to spark curiosity and encourage active learning.

While the LDM and MoMath have found significant content overlap in their collaboration, cognitive science labs in general may face challenges when finding such overlap with museums because their local museum may specialize in content outside of their area of expertise or, in the case of many children's museums, may focus on discovery and learning more generally. This latter case can in fact turn out to be

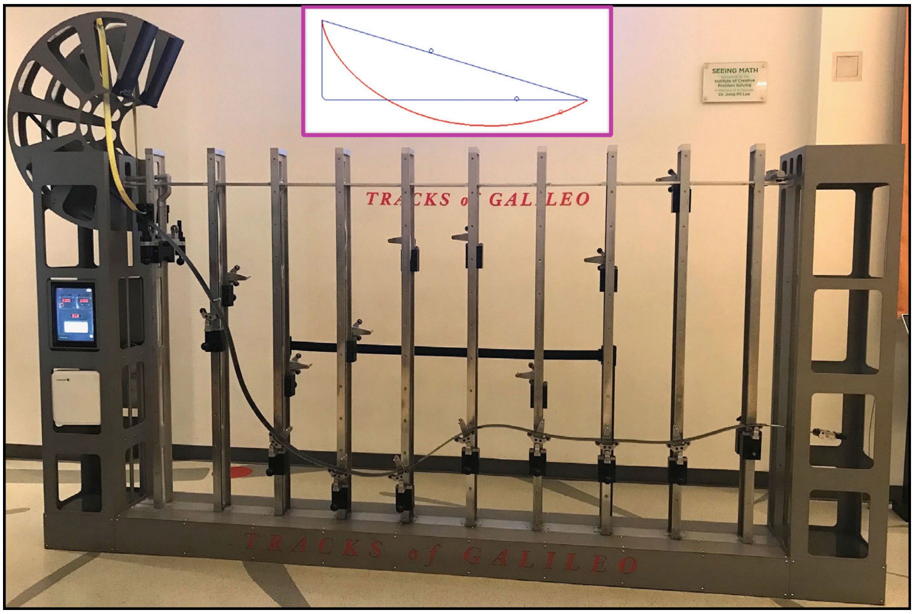

Fig. 2. The "Tracks of Galileo" exhibit at MoMath, focusing on the "Brachistochrone Problem." Visitors adjust the height of the track at each of the 10 posted locations. Then, they run a ball from the left side of the track to the right side and time the run. The inset (outlined in pink; image by Robert Ferréol [public domain], via Wikimedia Commons) displays 3 possible paths with the relative position of 3 different balls shown at the same time point. While the shortest path is linear (shown in blue), the fastest path is a cycloid (shown in red).

one of the best opportunities to find content overlap because the content in a children's museum is usually quite varied and diverse. For example, Long, Fan, Chai, and Frank (2019) aimed to understand children's knowledge about categories of objects by looking at their drawings. In their collaboration with the Children's Discovery Museum of San Jose, they installed a free-standing drawing station near the museum's existing art studio and gallery, identifying and capitalizing on this one area of overlap. If only a specialized museum is nearby, for example, an art museum, and a lab is not studying art but rather studying, for example, high-level vision, language, causality, or numerical reasoning, then the lab could look to the content of one of the museum's more well-known pieces whose theme reflects the lab's research focus. In short, working to find content overlap—whether at the museum level or only at the level of one exhibit—is the key.

COMMON PHILOSOPHY

The LDM and MoMath also share a philosophy when approaching mathematical thinking and engagement. This philosophy suggests that math is often best approached through the mathematical intuitions present across development and cultures rather than the formal mathematical instruction seen in schools with culturally specific symbols or curricula.

For the LDM, this philosophy has been exercised in studies both in and out of the Museum. For example, LDM researchers designed a school-readiness curriculum for math rooted in decades of lab-based research charting early emerging and universal sensitivities to number and geometry. By testing the efficacy of this curriculum with thousands of children in New Delhi, India, the research demonstrated that such intuitions can be effectively engaged and strengthened and that they form a foundation for later formal math learning in school (Dillon, Kannan, Dean, Spelke, & Duflo, 2017). Basic science researchers aiming to apply their findings to real-world learning may find that collaborating with practitioners in both formal, school settings and informal settings, like museums, will also be mutually reinforcing.

The LDM has exercised this philosophy through studies in the Museum. For example, in one study, children and adult Museum participants answered verbal questions about the general properties of planar triangles and visually extrapolated missing parts of fragmented planar triangles. Euclidean principles like the constant direction of a triangle's side guided all participants' visual extrapolations, but only older children and adults answered the verbal reasoning questions in ways that were conformal with Euclidean geometry (Hart, Mahadevan, & Dillon, 2022). Prior developmental and cross-cultural research—with children and adults from the United States, France, and a remote Amazonian village—had found very similar results using very similar tasks (Dillon & Spelke, 2018; Hart et al., 2018; Izard, Pica, Spelke, & Dehaene, 2011). While participants at MoMath may have specialized interest and more practice in math, their similar performance in the LDM's experiments to other populations suggests that at least some intuitive reasoning about geometry is largely unaffected by culture, education, or even expertise. Indeed, the universality of mathematical thinking has only rarely been tested in expert mathematicians or math enthusiasts (Amalric & Dehaene, 2016, 2018; Butterworth, 2006). Here again, we see how testing in a museum can be consequential to and help inform a lab's basic-science theory.

For MoMath, it has always been important to ensure that its exhibits are relevant and engaging for visitors of all ages and backgrounds and from all over the world, regardless of language and culture. Integral to its design process was a desire for exhibits to be intuitive and compelling to use without reference to printed signage—an innovation in the world of hands-on science centers. Accordingly, research that identifies mathematical reasoning that is independent of culture, education, or expertise can help inform the ongoing design process for new exhibits and programs and for improved visitor engagement.

While the LDM and MoMath have found significant philosophical overlap in their collaboration, cognitive science labs in general may nevertheless face challenges when finding such overlap with museums because lab and museum philosophies may be either tacit or framed for a specific audience, for example, scientific researchers or museum educators/visitors. One way that the LDM and MoMath have found ways to put their philosophies into dialogue is by having the lab members go to the Museum as visitors to engage with the Museum exhibitions and staff and having members of the Museum staff visit the lab space to see the lab's specialized spaces and try out some of the in-person experiments. These dedicated visits encourage dialogue not only about the content of any exhibit or experiment but also about the motivations for their design, their intended audience, and their goals. Such dialogue reveals broad philosophical themes—like the focus on probing natural intuition earlier—connecting the lab and Museum. Such themes, moreover, often supervene any particular content and may thus bring together labs and museums through common philosophy alone or encourage further dialogue to find shared content.

COMMON PROGRAMMING

Public outreach from labs and scientific outreach from museums is always to be encouraged. The LDM and MoMath have found ways to look within to figure out how they might look outward together. In doing so, they have created new programming, including talks, family events, and professional development days, which exemplify to the general public, to families, and to teachers both how cognitive science and math relate and how basic research and informal learning environments can inform one another.

The largest joint programming investment to date has been the LDM's sponsorship of a biannual *Minds on Math* talk series at MoMath. For each talk, the LDM invites an accomplished scholar in cognitive science who conducts basic research on how our minds work, especially in the context of mathematical reasoning. One talk takes place each academic semester starting in fall 2019 through spring 2024; admission is free and open to the general public. Each talk is announced through the lab's networks as well as through MoMath's email blasts, which reach more than 50,000 subscribers. Talks at the Museum typically attract between 40 and 200 registrants, but with the added, interdisciplinary appeal offered through the LDM, the talks that have taken place so far have seen around 300 registrants each. Moreover, MoMath has recently expanded its online offerings, allowing it now to engage with people from more than 100 different countries around the world—a platform from which *Minds on Math* talks were able to reach an even broader audience during the COIVD-19 pandemic and the pause of in-person events.

In coordination with the popular *Minds on Math* talks, which are aimed at adults, the LDM also sponsors complementary family events with free participation for MoMath visitors. These events focus not only on introducing parents and families to the content of the basic research presented at the talks, but also allow them to interact with example tasks and stimuli, playing games and activities inspired by the research in the talks. In addition to these events bringing basic research in cognitive science to populations who may not otherwise know about it, these events are also opportunities for lab trainees to practice scientific outreach and recruit families who may be interested in participating in future studies. The family events attract around 60 individuals.

Additional common programming is planned. For example, the LDM plans to host three free-admission Sundays at MoMath over the next 2 years. There are often significant barriers to participation in lab studies, including having the time and resources to make a special visit to the lab, but museums serve as hubs for families interested in a series of activities that foster growth and learning. These free days will boost the amount of data the lab is able to collect with Museum visitors, and free admission may attract families otherwise not able to pay for entry, supporting shared goals for diversity, equity, and inclusion in math and science outreach. Along similar lines, the lab plans to sponsor one professional development day per year for the next 2 years for New York City public school teachers at the Museum (~50 teachers per day). Lab researchers will provide teachers with presentations and activities from the lab's research conducted in the Museum. These days aim: to expose teachers to basic research in mathematical cognition; to teach them to be readers of basic science; and to spark their interest in testing findings in their classrooms. If teachers come away from the Museum experience with even more appreciation for the wonder and beauty of math, the benefits to their students in the current year and beyond will surely multiply.

While the LDM and MoMath have found significant programming overlap in their collaboration, cognitive science labs in general may nevertheless face challenges when finding such overlap because the ideal programming may be hard to envision initially and expectations about timelines, budgets, and resources may be different for the lab and museum. For example, holding a talk or event at a museum may require the museum to dedicate significant time, space, and staff to the event implementation. The LDM and MoMath have addressed challenges related to programming primarily in three ways. First, there are written agreements about the practicalities and logistics of any in-museum programming. In addition to reducing stress, these agreements can also be translated directly into the budgets and budget justifications in grant applications. Second, programming can take on various forms. The fall 2022 *Minds on Math* talk, for example, took place online with a speaker from Europe, which required a smaller budget, reached an even broader audience, and allowed the museum to try out a new event time slot. Third, lab members often attend events at the Museum, regardless of the direct connection to the lab. In addition to demonstrating engagement and learning about what kinds of programs the Museum can support more generally, this attendance has led to other opportunities for the lab, including the lab's presentation at a "math comedy night" in New York City, an outreach article on mathematical cognition through the *Society for Industrial and Applied Mathematics*, and an upcoming appearance on the popular math YouTube channel, "Stand-up Maths." While pinning down the perfect common programming off-the-bat may be out of reach, openness, creativity, and engagement often lead to new and exciting programming ideas and opportunities.

DISCUSSION

Shared content, philosophy, and programming have led to a rich and thriving collaboration between a cognitive science lab and a museum. Their imbrication is not only mutually beneficial but ignites further ideas for partnerships. For us, what started as a research project with a public outreach component has expanded to joint participation in diverse events and an ongoing generative process for new ideas and programs that benefit both organizations. LDM and MoMath are now joined in presenting at conferences, in writing grants, and even, as seen here, in authoring publications.

The symbol of our collaboration has been a Reuleaux Triangle, a shape of constant width that underlies one of the Museum's most popular exhibits, "Coaster Rollers." The lab gives participants in studies at the Museum a pocket-size version of such shapes, a tangible memory of their experience in the Museum with cutting-edge research on how the mind works. If we represent the intersection of content, philosophy, and programming described earlier as the intersection of an order-three Venn diagram, the resulting Reuleaux Triangle has indeed been the shape of our collaboration.

ACKNOWLEDGMENTS—This work was supported by a National Science Foundation CAREER Award (DRL-1845924; to Moira R. Dillon), a Jacobs Foundation Early Career Fellowship (to Moira R. Dillon), a SEED Award from The Institute of Human Development and Social Change at New York University (to Moira R. Dillon). We thank the Museum's participating visitors.

CONFLICT OF INTEREST

The authors have stated explicitly that there are no conflicts of interest in connection with this article.

INFORMED CONSENT

This manuscript does not involve human participants.

ANIMAL RIGHTS

This manuscript does not involve animal participants.

REFERENCES

Amalric, M., & Dehaene, S. (2016). Origins of the brain networks for advanced mathematics in expert mathematicians. *Proceedings of the National Academy of Sciences of the United States of America*, *113*, 4909–4917.

Amalric, M., & Dehaene, S. (2018). Cortical circuits for mathematical knowledge: Evidence for a major subdivision within the brain's semantic networks. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *373*, 20160515.

Ash, D. (2002). Negotiation of biological thematic conversations in informal learning settings. In G. Leinhardt, K. Crowley & K. Knutson (Eds.), *Learning conversations in museums*. (pp. 357–400). Mahwah, NJ: Erlbaum.

Ash, D. (2003). Dialogic inquiry in life science conversations of family groups in a museum. *Journal of Research in Science Teaching*, *40*, 138–162.

Butterworth, B. (2006). Mathematical expertise. In K. A. Ericsson, N. Charness, P. J. Feltovich & R. R. Hoffmann (Eds.), *Cambridge handbook of expertise and expert performance*. (pp. 553–568). Cambridge: Cambridge University Press.

Callanan, M. A. (2012). Conducting cognitive developmental research in museums: Theoretical issues and practical considerations. *Journal of Cognition and Development*, *13*, 137–151.

Callanan, M. A., Legare, C. H., Sobel, D. M., Jaeger, G. J., Letourneau, S., McHugh, S. R., … Watson, J. (2020). Exploration, explanation, and parent–child interaction in museums. *Monographs of the Society for Research in Child Development*, *85*, 7–137.

Corriveau, K. H., Kipling, R., Biarnes, M., Ronfard, S., & Harris, P. L. (2016). The living laboratory model: Bridging child development research and informal science education. In D. Sobel, & J. Jipson (Eds.), *Cognitive development in museum settings: Relating research and practice*. New York: Taylor and Francis.

Dillon, M. R., Kannan, H., Dean, J. T., Spelke, E. S., & Duflo, E. (2017). Cognitive science in the field: A preschool intervention durably enhances intuitive but not formal mathematics. *Science*, *357*, 47–55.

Dillon, M. R., & Spelke, E. S. (2018). From map reading to geometric intuitions. *Developmental Psychology*, *54*, 1304–1316.

Evans, E. M., Weiss, M., Lane, J. D., & Palmquist, S. (2016). Developing Mind Lab A University–Museum Partnership to explore the process of learning. In D. Sobel, & J. Jipson (Eds.), *Cognitive development in museum settings: Relating research and practice*. New York: Taylor and Francis.

Frank, M., Vul, E., & Saxe, R. (2011). Measuring the development of social attention using free viewing. *Infancy*, *110*, 1–21.

Hart, Y., Dillon, M. R., Marantan, A., Cardenas, A. L., Spelke, E., & Mahadevan, L. (2018). The statistical shape of geometric reasoning. *Scientific Reports*, *8*, 12906.

Hart, Y., Mahadevan, L., & Dillon, M. R. (2022). Euclid's random walk: Developmental changes in the use of simulation for geometric reasoning. *Cognitive Science*, *46*, e13070.

Huey, H., Jordan, M., Hart, Y., & Dillon, M. R. (2023). Mind-bending geometry: Children's and adults' intuitions about linearity on spheres. *Developmental Psychology*, *59*, 886–892.

Izard, V., Pica, P., Spelke, E. S., & Dehaene, S. (2011). Flexible intuitions of Euclidean geometry in an Amazonian indigene group. *Proceedings of the National Academy of Sciences of the United States of America*, *108*, 9782–9787.

Long, B., Fan, J., Chai, Z., & Frank, M. C. (2019). Developmental changes in the ability to draw distinctive features of object categories. In *Proceedings of the 41st Annual Conference of the Cognitive Science Society*.

Osberg, S. (1998). Shared lessons and self-discoveries: What research has taught Children's Discovery Museum. *Journal of Museum Education*, *23*, 19–20.

Rhodes, M., & Bushara, L. (2016). Learning about science and self: A partnership between the Children's Museum of Manhattan and the Psychology Department at New York University. In D. Sobel, & J. Jipson (Eds.), *Cognitive development in museum settings: Relating research and practice*. New York: Taylor and Francis Press.

Schulz, L. E., & Bonawitz, E. B. (2007). Serious fun: Preschoolers engage in more exploratory play when evidence is confounded. *Developmental Psychology*, *43*, 1045–1050.

Sobel, D., & Jipson, J. (2016) *Cognitive development in museum settings: Relating research and practice*. New York: Taylor and Francis Press.

Sobel, D., Letourneau, S., & Meisner, R. (2016). Developing Mind Lab A University–Museum Partnership to explore the process of learning. In D. Sobel, & J. Jipson (Eds.), *Cognitive development in museum settings: Relating research and practice*. New York: Taylor and Francis.

Tenenbaum, H., & Callanan, M. A. (2008). Parents' science talk to their children in Mexican descent families residing in the USA. *International Journal of Behavioral Development*, *32*, 1–12.

Van Schijndel, T. J. P., Franse, R. K., & Raijmakers, M. E. J. (2010). The exploratory behavior scale: Assessing young visitors' hands-on behavior in science museums. *Science Education*, *94*, 794–809.