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LEARNING ABOUT SCIENCE AND SELF

A Partnership Between the Children's Museum of Manhattan and the Psychology Department at New York University

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The Team

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The Museum Setting

CMOM has been serving families across New York City for over 40 years and is a nationally recognized leader in the field of informal education. Over 350,000 people visit CMOM every year, with 50,000 free visits per year for low-income families. CMOM is at the forefront of improving early learning for children and families in New York City and beyond. Through its interactive exhibitions and educational outreach programs at the museum and in the community, CMOM combines early childhood education, health education, arts and science education, and cultural awareness to stimulate children's learning from an early age, providing a foundation to support formal education. It serves as a trusted resource to parents, educators, and caregivers, and as a key collaborator for public and private initiatives.

Children's museums provide powerful contexts for children to learn about the world around them. Museums excel at creating places where children can learn about physics, biology, literacy, art, and math through their own creative actions. By providing spaces where parents and children come together to learn, museums also create opportunities for children to learn about themselves and their families. For example, by spending an afternoon with their parents at the museum, children might learn that their parents value science—or find art exciting—and therefore that these are activities that they should value as well. Through a research partnership between New York University and CMOM, we have been developing new approaches to support the potential of children's museums to provide experiences that leave children not only with new understanding, but also with increased enthusiasm for learning and stronger beliefs in their own capacities to succeed.

CMOM—A Long History of Commitment to Research

CMOM, located on the upper west side of Manhattan, is at the forefront of improving early learning for children and families in New York City and beyond. In its efforts to develop new, creative programming to support early learning, CMOM has built strong partnerships with New York University (NYU), Barnard College, Hunter College School of Public Health, and the National Institutes of Health. These partnerships have enabled CMOM to develop exhibits and programming based on the latest research on how children learn. To illustrate, *PlayWorks* is one of CMOM's major exhibit spaces for young children (ages 0–5) and is designed to facilitate the development of children's physical, social, math, art, science, literacy, and problem-solving abilities via play. *PlayWorks* was developed with leading experts in child development, including Kathy Hirsch-Pasek (Temple University), Dorothy Singer (Yale University), and Lois Bloom (Columbia University). Key goals of *PlayWorks* are to provide experiences that allow parents and children to engage together in learning, to make visible to parents and caregivers how children learn through play, to motivate parents and caregivers to seek and find everyday opportunities that nurture play and a love of learning, and to create an environment that supports the skills needed for school readiness. By working with research partners, CMOM designed *PlayWorks* to meet these goals in an effective, evidence-based manner.

As further illustration of CMOM's commitment to research, as part of its three year, *EatSleepPlay Health Initiative*, CMOM partnered with the National Institutes of Health and a national advisory board of medical and health experts to develop and test *EatPlayGrow*—the first ever federally approved early childhood health curriculum for use with children five years and younger. As part of this initiative, CMOM also worked with its advisory board to translate the latest research on health and early childhood obesity into family-friendly activities and educational experiences as part of a new health exhibit at the museum: *EatSleepPlay: Building Health Every Day!*

As an organization dedicated to improving early childhood learning and health, CMOM also provides a vital link between leading researchers and families most in need. It has become a sought-after partner for researchers and academic institutions looking to study children and families in informal learning settings. As a result, CMOM is in a unique position to bring the pressing needs and challenges facing families today to the attention of researchers through its on-the-ground "feedback loop" with community partners, to develop new programs and resources that directly respond to these needs, and to bring the latest research affecting children and families directly to the community.

Although CMOM has a long history of involvement with research, CMOM's commitment to research took on a more central and visible role within the daily life of the museum in 2010, when CMOM partnered with Dr. Marjorie Rhodes, associate professor of psychology at New York University, to establish an active child development research laboratory within the museum. This laboratory is located in classroom space adjacent to the *PlayWorks* exhibit and provides families visiting the museum with an opportunity to take part in and learn about current research on early cognitive and social development.

The laboratory is open four days per week at CMOM. During these times, undergraduate and graduate student researchers from Rhodes's lab approach families within the *PlayWorks* exhibit and invite them to participate in research. Interested families are brought to the private testing space and are given detailed information about the research so that they can decide whether or not to participate. To date, over 5,000 families have participated in research via this onsite laboratory. Due to CMOM's extensive outreach activities, and because CMOM serves a diverse audience daily, the sample of participating families reflects the diversity of New York City. Opening this lab at CMOM had two immediate positive consequences for the research process—it increased the efficiency of research and allowed researchers to include a more diverse sample of families than would otherwise visit a laboratory at a research university. Studies conducted via this lab at CMOM have composed the basis of 15 academic publications, two grants from the National Science Foundation, and over 25 conference and colloquia presentations. In this chapter, we will discuss several of the key findings from this research program that have been particularly important to growing the NYU–CMOM partnership.

Another key benefit of the research lab at CMOM is that it provides training for student researchers in communicating with parents and the broader community. Students are trained to treat each research session as an opportunity to provide educational outreach to families. Student researchers explain the purpose of the study that the family participated in and its implications for child development, and also answer parents' questions about related areas of cognitive and social development. Students also provide a newsletter detailing other recent research findings and their implications. Thus, another key benefit of conducting basic research within CMOM is the potential for rapid dissemination of important research findings to the public.

Research Overview

The research conducted via the lab at CMOM examines basic questions in early cognitive and social development. Consistent with CMOM's educational approach, Rhodes's research takes the perspective that children are active explorers of their environments who build *theories* to try to make sense of the world around them. Children's theories are not as detailed or elaborate as scientific theories, but their beliefs are theory-like in that they provide children with a conceptual framework for understanding and predicting events in their daily lives. A major goal of much cognitive development research is to determine how children construct these theories, how theories change across development, and the implications of children's theories for their beliefs and behavior. In turn, CMOM is interested in designing environments that optimally support the development of children's theories.

Much of the research in the lab at CMOM integrates theories and methods from developmental, cognitive, and social psychology to examine how children develop theories of the ***social world*** (e.g., Rhodes, 2013). Young children have the task of making sense of a rich and complicated social environment. During the early childhood years, children's conceptual and social development is focused on trying to understand questions such as: "What kinds of people are there in the world?," "What kind of person am I?," "What sorts of behaviors do people 'like me' do?," and "What are we good at?" How children answer these questions has broad implications for their development—including for their tendencies to engage in social stereotyping, for their interests and persistence in various subjects at school, and for their friendships and pro-social behaviors. Thus, an important goal of Rhodes's research has been to examine how these beliefs—or theories—about the social world develop. In particular, we test how children's intuitive conceptual biases (Rhodes, 2012; Rhodes, Gelman, & Karuza, 2014) interact with cultural input (Chalik & Rhodes, 2014; Diesendruck, Goldfein-Elbaz, Rhodes, Gelman, & Neumark, 2013) to shape the development of their understanding of the social world (Rhodes, 2013).

Our recent research has revealed that subtle features of the language that children hear powerfully shape children's understandings of the social world. Through Rhodes's conversations with Bushara and other educators at CMOM, we have discovered that these findings have clear implications for educational practice. Thus, a major focus of our current partnership is developing and testing new applications based on this research. We will next describe our research framework, questions, and findings in some detail, before moving on to describe current and future plans to build on this research to develop and evaluate new educational practices.

Rhodes's previous research has focused on ***psychological essentialism***—a pervasive conceptual bias to construe some categories (e.g., *tigers*, *girls*, *scientists*) as reflecting highly coherent and distinct kinds whose members are fundamentally similar to each other and different from nonmembers (Medin & Ortony, 1989). Psychological essentialism entails thinking that membership in these categories is determined by a stable, intrinsic property, which causally constrains observable behaviors. For example, essentialist beliefs about *tigers* entail thinking that whether an animal is a tiger is determined by birth and stable, that tigers are fundamentally similar to each other and different from non-tigers, and that an animal—once born a tiger—will inevitably grow up to be ferocious (Gelman, 2003). In this way, category membership is viewed as a natural and unchangeable part of an individual's identity that fundamentally shapes who they are and what they can grow up to be.

In the case of animal categories—like tigers—psychological essentialism may facilitate conceptual development and knowledge acquisition by allowing children to overlook superficial differences (e.g., between orange and white tigers) and focus on the properties that category members share. Yet essentialism reflects a biased, inaccurate picture of the world; most categories—even biological species—have no real essences (Leslie, 2013), species change over time in ways that essentialist thinking does not allow (Gelman & Rhodes, 2012; Shtulman & Schulz, 2008), and category members often vary more widely from each other than essentialism implies. Indeed, essentialist thought—particularly its emphasis on within-category homogeneity and stability over time—interferes with people's understanding of the mechanisms that drive evolutionary change (Shtulman & Schulz, 2008) as well as with normative reasoning regarding how properties are distributed across categories (Rhodes & Brickman, 2010).

Psychological essentialism underlies children's understanding not only of the biological world of animals and plants, but of certain components of the social world as well. For example, by age 4 years, essentialist biases shape how children understand gender categories. Thus, they expect girls to be fundamentally similar to each other and different from boys, and that being born a girl, for example, means that a baby will inevitably grow up to prefer tea sets to toy trucks (Taylor, Rhodes, & Gelman, 2009). In this way, essentialism leads children to overlook the role of culture and experience in contributing to gender differences and can contribute to social stereotyping. Further, as essentialism begins to shape how children understand social groupings—including those based on gender, race, ethnicity, or religion—essentialism can lead to the development of prejudice and discrimination (Allport, 1954). Finally, by shaping how children understand their own category memberships, essentialism influences children's beliefs about their own interests and capabilities (Dweck, 2006).

As Rhodes discussed research on essentialism with Bushara and other educators at CMOM, we began to consider that essentialism might shape not only how children understand animal species and social categories based on gender or race, but might also be relevant to how children and parents think about categories like *scientists*, *mathematicians*, or *artists*. For example, essentialist beliefs about scientists would entail thinking that scientists are deeply different from nonscientists, that scientists are born—not made, and that whether one is a scientist or not is stable across development. In our conversations, we thought that these types of beliefs might be quite prevalent among young children and their parents, as we informally observed that families often discuss these categories in essentialist terms—terms that imply that some children are scientists and others are artists, for example, and that imply that a child's true nature is something to discover (rather than something that develops over time).

We became very interested in the possibility that essentialism might shape how children understand achievement-relevant categories in particular, such as scientists or mathematicians, because it is easy to see how such beliefs could be problematic and maladaptive. Such essentialist beliefs imply that one's ability to succeed in science, for example, is determined not by the effort that one puts in, but by whether one is born with some necessary quality (e.g., something like innate talent). Further, these beliefs could lead children to interpret any setbacks—an inevitable part of science, in particular—as evidence that they are in the "nonscientist" group, leading to disengagement. Finally, such beliefs could be particularly problematic for girls, as these beliefs could combine with gender-stereotypes to yield the conclusion that *only boys are capable scientists* (e.g., Dweck, 2006; Leslie, Cimpian, Meyer, & Freeland, 2015). An essentialist conception of scientists can be contrasted with one in which scientists are viewed as being just like anyone else, but have chosen to put time and effort into the study of science.

We decided to study these issues directly in our child development research laboratory at CMOM. In particular, we wanted to address (a) whether children hold essentialist beliefs about science, (b) if such beliefs interfere with achievement-relevant behaviors, and (c) what might cause (or prevent) the development of these beliefs. We planned a series of studies to address these questions, with the goal of taking what we learned, along with other related work in the field (Dweck, 2006; Gelman & Heyman, 1999; Cimpian & Markman, 2011), to develop new educational strategies that might prevent the development of essentialist beliefs about science and increase children's achievement-relevant behaviors.

To begin to address these questions, we drew on Rhodes's and others' previous research examining the features that lead children to adopt essentialist beliefs about particular categories (Gelman, Ware, & Kleinberg, 2010; Rhodes, Leslie, & Tworek, 2012). Although psychological essentialism is a pervasive conceptual bias, children do not construe all categories in an essentialist manner. For example, children have more essentialist beliefs about animals (e.g., *dogs*) than artifacts (e.g., *tables*; Rhodes & Gelman, 2009a, 2009b; Rhodes et al., 2014) and they hold more essentialist beliefs about certain social categories (e.g., *gender*) than others (*sports teams*; Diesendruck et al., 2013; Rhodes & Gelman, 2009a). Rhodes's previous research at CMOM discovered that cultural input—in the form of language—guides **how children map** general essentialist beliefs onto particular categories they encounter in their environment.

In particular, Rhodes' research at CMOM indicated that *generic language*—language that refers to abstract kinds (e.g., "tigers have stripes")—guides children to apply essentialist beliefs to particular categories (Rhodes et al., 2012; also Gelman et al., 2010). On this account, generic language does not *create* essentialist thought. Essentialist beliefs reflect basic conceptual biases, and go far beyond the content of generic language itself. For example, there is no explicit content in the sentence "tigers have stripes" that communicates that being a tiger is a matter of innate and immutable category membership. Yet children conclude that new categories have those features after fairly limited exposure to such generics, as described below. Thus, children seem to have abstract expectations that *certain* categories in their environment reflect essential kinds and then rely on linguistic cues to determine *which* categories have this structure. Because generic language communicates regularities regarding abstract kinds, children assume that categories described with generic language are the kinds of categories that are coherent and causally powerful enough to support such generalizations (Cimpian & Markman, 2011; Gelman et al., 2010; Gelman & Heyman, 1999; Leslie, 2008; Rhodes et al., 2012).

To illustrate how we came to these conclusions—which provided the direction for our current work on how children think about achievement categories—we will briefly describe the methods and findings of Rhodes et al., 2012. In that project, we introduced children to an entirely new, arbitrary grouping of people called "Zarpies." First, an experimenter read an illustrated book that presented the novel category via 16 individual pictures of Zarpies, one per page, each displaying a unique property. The 16 Zarpies were diverse with respect to race, sex, and age, so that children could not map the category onto any group for which they might already hold essentialist beliefs. By condition, children heard the property on each page described either with generic language (e.g., "Look at this Zarpie! Zarpies climb fences") or nongeneric language (e.g., "Look at this Zarpie! This Zarpie climbs fences"). None of the properties involved any negative qualities. The experimenter read the book two times to the child and then assessed children's essentialist beliefs about Zarpies.

Rhodes et al. (2012) found that, in the nongeneric condition, children did not hold essentialist beliefs about Zarpies after exposure to the book. That is, although they learned the category "Zarpie," they did not expect Zarpie properties to be determined by birth, they did not expect individuals to do certain behaviors *because* they are Zarpies, and they did not expect all Zarpies to share either the properties mentioned in the book or other new properties. In contrast, the generic condition significantly increased the likelihood of these essentialist beliefs

among preschool-age children. This study thus revealed that a small amount of generic language led children to apply essentialist beliefs to a new category, when they would not otherwise do so, confirming that subtle linguistic cues have powerful consequences on conceptual development.

Current Research Direction: Essentialist Beliefs about Scientists

Building on this previous research, as well as Rhodes's and Bushara's conversations, we considered that hearing certain forms of language about scientists, such as "Let's be scientists!," "Scientists explore the world!," "Scientists conduct experiments"—language that our informal observations suggested was quite common in input to children—might elicit maladaptive essentialist beliefs about science (and likewise, "Mathematicians solve problems" would elicit essentialist beliefs about math, for example). For example, during a review of museum messaging, CMOM discovered it was communicating to the public using generic language, and that museum staff routinely used generics when speaking to children and families. For example, CMOM offered programs titled "Little Scientists" or "Little Artists," which, as described above, inadvertently implies to children that there are categories of scientists and nonscientists or artists and nonartists. These informal observations are also consistent with the findings of more formal child development research, which has revealed that parents and educators often use generics when communicating with young children (Gelman, Coley, Rosengren, Hartman, & Pappas, 1998; Gelman, Goetz, Sarnecka, & Flukes, 2008; Gelman, Taylor, & Nguyen, 2004; Pappas & Gelman, 1998).

Whereas Rhodes's previous research, observations within the museum, and conversations between NYU researchers and CMOM educators all supported these hypotheses, no study had specifically tested whether hearing generic language about scientists elicits essentialist beliefs about science or undermines children's achievement behavior. Thus, to test if this is the case, we conducted a new study in our laboratory at CMOM. This new study was inspired directly by our observation that generics about science are commonly used in early childhood education programs—an observation that resulted from our research taking place onsite at CMOM. If Rhodes had been conducting the research on generic language only via an on-campus laboratory at NYU, the possibility of examining essentialist beliefs about categories such as "scientist," "artist," or "mathematician"—or the role of generic language in the development of these beliefs—would not have come up as an important research direction. Further, the design of the study and the research protocol were inspired by discussions with CMOM educators about how generic language might be used—or avoided—in actual science lessons with children and their caregivers.

To test whether generic language about science elicits essentialist beliefs and interferes with children's achievement behaviors, we conducted a study to examine children's responses to generic vs. nongeneric language about science. First, children (ages 4–5) were randomly assigned to hear one of two introductions to science. One introduction began, "Today we are going to *be scientists* and play a science game!" and continued with language such as "Scientists explore the world and discover new things!" The other introduction began, "Today we are going to *do science* and play a science game!" and continued with language such as, "Doing science means exploring the world and discovering new things." The content of the two introductions was identical; what varied was the type of language used to describe science.

After hearing one of the two introductions, children were asked to complete a science game. For this game, children were asked to sniff covered cups and predict the contents from a range of alternatives. Children completed two easy trials that presented obvious smells and only two possible answer choices. For example, children would smell a covered cup that contained an orange slice, and were asked to guess whether the cup contained an orange or some chocolate. Children then completed two challenging trials intended to elicit incorrect guesses, so that children would experience setbacks. This part of the design was very important because it is particularly upon the receipt of negative feedback that essentialist beliefs become problematic (see Bryan, Master, & Walton, 2014; Cimpian, Arce, Markman, & Dweck, 2007). It is straightforward to see why this is the case—if children have the essentialist perspective that people either are scientists or nonscientists, then they may happily believe they are in the scientist group (perhaps even receiving a boost in motivation from seeing the world this way; Bryan et al., 2014) until they encounter a setback. A setback, however, provides some evidence that they may not be in the scientist group after all (Cimpian et al., 2007; Cimpian & Markman, 2011), a possibility that is particularly problematic if one holds essentialist beliefs, as essentialism implies that whether one is a scientist or not is fixed—not something that can be changed by effort. In contrast, if one does not hold essentialist beliefs about scientists, but instead views science as involving activities and skills that one can build over time, then setbacks are not nearly as threatening. Thus, it is after setbacks—an inevitable part of learning to do science or developing any new skill—that we would expect essentialist beliefs to become problematic.

For this reason, we presented children with two cups to make guesses about for which the smells were misleading. For example, children sniffed a cup that contained a sponge that had been soaked in lemon juice, and were asked to guess whether it contained a lemon, a sponge, or one of three other possible options. For each trial, the experimenter marked whether the child's guess was right or wrong with either a green check or a red "x"—to make the fact that a setback had occurred clear to children. After these four trials, children were asked if they wanted to keep playing the science game or if they wanted to do something else. If children chose to continue, they were given a new cup to smell and asked to make a guess, and then once again, they were asked if they would like to continue playing or do something else. Children could choose to complete up to 10 additional rounds of the science game. How many rounds the children chose to complete serves as a measure of their persistence. After they finished the science game, children were asked to complete a measure of their essentialist beliefs about science, a measure assessing their beliefs about their own performance during the "science game," and a measure of their more general attitudes about science. These questions were completed via a standardized interview with an experimenter.

We found that the generic language increased essentialist beliefs about science among both boys and girls. For example, children in this condition were more likely to say that someone who is good at science has always been good at science and will always be good at science, and less likely to say that someone who has difficulty with science can improve their abilities. Yet, these essentialist beliefs undermined only girls' (not boys') persistence, self-evaluations, and attitudes toward science. Girls in the "be a scientist" condition chose to complete fewer subsequent rounds of the science game (showing less persistence) than girls in the "do science" condition. They also evaluated their own performance more negatively and reported relatively more negative attitudes toward science. The language condition did not interfere with boys' performance or attitudes. Thus, we found that small and subtle differences in language can interfere with female students' achievement in science.

Building on This Research to Develop New Educational Approaches

We believe that our research on the role of generic language in shaping the development of essentialist beliefs about scientists has the potential to address a critical social problem. The persistent underrepresentation of girls and women in science limits their opportunities for cognitive development as well as for economic attainment (Beede et al., 2011). Prior work has extensively documented that girls' beliefs about their own capacity for success in science critically contribute to this problem (Dweck, 2006; Eccles & Wigfield, 2002). For example, girls who view success as determined by stable, innate talent are more likely to withdraw following setbacks and refrain from taking on challenging problems (Cain & Dweck, 1995; Smiley & Dweck, 1994). These beliefs are often better predictors of children's success than their own actual preparation or ability level. For example, across the transition to junior high school, as coursework becomes more challenging, girls who believe that success depends on effort do better in math than those with similar previous grades who view success as dependent on talent (Blackwell, Trzesniewski, & Dweck, 2007). Similar effects have been found at the college-level; controlling for SAT scores, female students who view success as dependent on innate ability begin to underperform relative to their male peers in challenging classes, yet female students who view success as dependent on effort do not (Dweck, 2006).

Further, recent work suggests that gender gaps at the Ph.D. level are predicted by the extent to which a discipline is perceived as requiring raw, innate talent, with women attaining a smaller percentage of Ph.D.s in such fields—many of which are in STEM (Leslie, Cimpian, Meyer, & Freeland, 2015). Notably, these effects emerge already in early elementary school-aged girls (6- and 7-year-olds): when a new activity was described as being "for hardworking kids," girls and boys showed an equal level of interest in it, however, when it was described as being "for smart kids," girls showed significantly less interest in it than boys (Leslie, Cimpian, & Meyer, 2013). Thus, beliefs that success in some disciplines requires innate talent—and assumptions that such disciplines are "for boys"—emerge in early childhood and persist to the Ph.D. level, and perhaps beyond. Considerable stability has been found in children's beliefs about the role of talent in determining success beginning in early childhood (Cain & Dweck, 1995; Eccles, Wigfield, Harold, & Blumenfeld, 1993; Smiley & Dweck, 1994; Wigfield et al., 1997; Wigfield & Eccles, 2002); given the pernicious consequences of these beliefs, it is important to identify the processes that lead to their formation.

With our research, we have identified an underlying conceptual bias—psychological essentialism—that gives rise to the belief that talent determines success. Suppose that one believes that scientists form a highly distinctive category of person, such that their common outward properties are grounded in their shared, inherent natures. Since scientists as a category are marked by their common ability to do science, it makes sense (from an essentialist perspective) to suppose that this ability must be grounded in something underlying, stable, and inherent—in something like *innate, unchangeable talent.* Viewed from this perspective, the belief that science (or math, etc.) requires a special innate gift is a natural corollary of psychological essentialism. Even more importantly, we have identified a modifiable feature of cultural input—generic vs. nongeneric language—that shapes whether children develop these beliefs.

Building on the basic research described above, as well as other related research in the field (Cimpian et al., 2007; Cimpian & Markman, 2011; Dweck, 2006; Gelman et al., 2010; Leslie et al., 2015), NYU and CMOM are currently working together to launch a national project—*The Language Effect*—to test whether training educators to avoid generic language can increase children's—and especially girls'—engagement and achievement in science. The goal of this project is to translate the latest research on the power of language to support the development of more adaptive beliefs during early childhood into practical applications for museums. To do this, we plan to adapt selected existing science lessons to include strategies for communicating more effectively with children and families in museum settings. For this new project, CMOM builds on a strong track record of success adapting existing curricula to new audiences and for new purposes. For example, CMOM adapted the National Institutes of Health's (NIH) *We Can!* obesity prevention curriculum (originally designed for children ages 8 and older) for use with children ages 5 and younger. Through five studies with low-income families in New York and New Orleans, CMOM evaluated and confirmed the efficacy of this *EatPlayGrow* curriculum, and the NIH recently approved it as an obesity prevention curriculum for use with young children. Additionally, CMOM established a network of federal agencies and community-based organizations to disseminate its curricula, including the NIH, *Let's Move!*, Association of Children's Museums, First Book, Family Place Libraries, National Head Start Association, and New York City Department of Health, all of whom are now distributing *EatPlayGrow* at no cost.

Building on these previous experiences, we plan to create *The Language Effect Resource Manual*, which will combine STEM lessons with a comprehensive research report and training materials. We plan to evaluate and refine the manual through a series of pilot programs that will engage educators in specialized training and test for the effectiveness of this training on educational practices—and ultimately on child engagement and achievement. Through these evaluations, we will test whether the manual's materials are successful in training museum educators in how to use language to support child development effectively. After this pilot and evaluation research, we hope to disseminate the manual to museums and libraries across the country through our national network of dissemination partners.

A key component of the *Language Effect Resource Manual* will include ten STEM lessons that have been modified to avoid generic language about science or math. Each lesson will begin with an introduction for educators, which reminds them about the importance of avoiding generic language. For a sample introduction, see Table 6.1.

TABLE 6.1 Sample introduction for educators.

Often, early science programming makes use of generic language, such as "Let's be scientists!," "Scientists discover things about the world!," "Let's be good scientists and make guesses about what we might find!" This language is intended to foster excitement about learning, yet recent research suggests that it has the opposite effect. Children interpret these examples of *generic language* as meaning that there is a group of people who are scientists, but also a group of people who are *not* scientists. This way of thinking about science—that some people do it and some people do not—is threatening because it suggests that whether someone is good at science or not is dependent on inherent abilities. Generic language makes children less willing to persist and try new things, out of concern that they might discover that they are in fact in the "nonscientist" category. Instead of using this kind of generic language, the following lesson uses *effort-focused* language. This *effort-focused* language describes science as something that everyone can learn to do, instead of as an identity-category in which some people are members. This *effort-focused* language is integrated into each component of the lessons and is intended to lead children to view doing science as something they can learn through practice and effort.

Additionally, for each activity in the lesson, there will be educator prompts alerting them to the subtleties of effort-based language and avoiding generic language. For an excerpt from a sample lesson, which is based on similar activities as we used in the scientist experiment described above, see Table 6.2.

To evaluate *The Language Effect Resource Manual*, we plan to conduct a series of studies with museum educators. Through these evaluations, we will test whether providing training in using effort-based—instead of generic—language effectively leads to changes in educators' language use, whether educators are able to

TABLE 6.2 Excerpt from the sample lesson, *The Nose Knows*.

In this lesson, *The Nose Knows*, children (ages 3–5) will learn about the sense of smell while engaging with the practices and vocabulary of science, most specifically: observe, predict, check, and discourse. This lesson will provide children with opportunities to use new vocabulary and engage with new science practices throughout the science activity, read aloud, and art extension.

Observe

Introduce the word "observe" to the children, ask the children if they know what the word means. Accept all answers, and then explain that to observe means to use the senses to get information about an object. Tell the children that they have five senses, ask them if they can name any of the senses, (sight, hearing, smell, taste, and touch). Tell the children that today they are going to observe using their noses, their sense of smell.

Generic language (not recommended)	Effort-focused language (recommended)
Today we are going to be scientists! Scientists explore the world and discover new things.	*Today we are going to do science. Doing science means exploring the world and discovering new things.*
An important part of being a scientist is observing what's around you. Do you know what observe means?	*An important part of doing science is observing what's around you. Do you know what observe means?*
Observing means using your senses to learn what's around you! What are the five senses?	*Observing means using your senses to learn what's around you! What are the five senses?*
Scientists can use their five senses to learn about the world. They can use their eyes to see; their ears to hear; their noses to smell; their mouths to taste; and their hands to touch!	*When people are doing science, they can use their five senses to learn about the world. They can use their eyes to see; their ears to hear; their noses to smell; their mouths to taste; and their hands to touch!*
Today we are going to be scientists by using our noses to smell what's around us.	*Today we are going to do science by using our noses to smell what's around us.*

Tell the children to breathe in through their nose and notice any smells in the room. Ask the children, "What do you smell when breathing in the air in the room?" (Accept all answers. Most children will note smelling the scent of the air freshener.) Point to where the air freshener is across the activity area and ask the children, "How were we able to smell something so far away?" (Accept all answers). Explain to the children that the scent from the air freshener traveled through the air and into their nose, the smelly item does not have to be right in front of us in order for our nose to smell it.

implement the lessons with the intended language, and whether these changes influence child engagement during the target lessons. To answer these questions, we plan to use multiple research methodologies, including surveys, observations, coding of natural language samples, and interviews. We are also developing ways to provide education for parents on language use via these new science lessons that will be offered through the *PlayWorks* exhibit, as well as through the development of new signage throughout the museum.

Long-Term Benefits of the CMOM–NYU Partnership

Research conducted by NYU in the lab at CMOM revealed that remarkably subtle features of language powerfully shape children's beliefs about the social world (Rhodes et al., 2012). Conducting this research within the museum inspired a new research direction, in which we discovered that these subtle linguistic cues also shape how children think about themselves and their own capacities for success in science. After four years of conducting lab-based studies on these research questions, we are now ready to translate our findings into practice by training educators on effective language use and evaluating our approach. We hope that this will provide a powerful new approach for addressing gender gaps in science achievement and interest, and that it will also provide a strong test of the power of language to shape child development outside of laboratory environments. What began as a partnership built on a shared goal—the goal of understanding how child development happens and how we can best support it—has turned into a research collaboration that is poised to advance both the fields of developmental psychology and informal education. Further, we hope that our approach will serve as a model for future collaborations between researchers and museums, and will be an important step toward bridging the gap between the latest research and direct implementation with children and families.

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