Falling for Science

Objects in Mind

edited and with an introduction
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INTRODUCTION: FALLING FOR SCIENCE

Sherry Turkle

This is a book about science, technology, and love.

An eight-year-old sits braiding the hair on the tail of her My Little Pony doll, completely absorbed in the job. The shining plasticized hair is long and resilient; she plays with it for hours.

She starts by taking the tail and dividing it into three strands, which she braids together. Beginning again, she undoes that braid and divides the tail into nine strands. Then she braids groups of three until she has three plaits, which she braids together into one. Undoing this braid, the girl now begins with twenty-seven strands, braiding them first into nine, then into three, then into one. The girl is playing with My Little Pony but she is thinking about recursion.

This eight-year-old is one of my MIT students who, in this collection, write stories of their childhoods. What they have to say testifies to the importance of objects in the development of a love for science—a truth that is simple, intuitive, and easily overlooked.

There are many paths into science. This collection explores one of them, a path in which imagination is sparked by an object. It is about young people discovering objects that can "make a mind": a puzzle, a toy pony, a broken radio, a set of gears, origami. Here, three generations of distinguished scientists, engineers, and designers, and twenty-five years of MIT students in the course of their university training write about an object they met in childhood or adolescence that became part of the fabric of their scientific selves.[1] And since, for each of us, the many aspects of self are deeply enmeshed, these narratives about objects and science also explore themes of family, friendship, home, love, and loss.

In an ongoing national conversation about science education in America, there is a new consensus that we have entered a time of crisis in our relationship to the international scientific and engineering community.[2] For generations we have led; now Americans wonder why our students are turning away from science and mathematics—at best content to be the world's brokers, broadcasters, and lawyers, and at worst simply dropping out—while foreign students press forward on a playing field newly leveled by the resources of the World Wide Web. Leaders in science and technology express dismay. On this theme, Bill Gates stated flatly: "In the international competition to have the biggest and best supply of knowledge workers, America is falling behind." He also said, "In math and science, our 4th graders are among the top students in the world. By 8th grade, they're in the middle of the pack. By 12th grade, U.S. students are scoring near the bottom of all industrialized nations."[3]

When the Science Committee of the House of Representatives asked the National Academies, the nation's leading scientific advisory group, for ten recommendations to strengthen America's scientific competitiveness, the Academies offered twice that number.[4] There were recommendations to support early-career scientists and those who plan to become science teachers. There were recommendations to create a new government agency to sponsor energy research and to use tax policy to encourage research and development in corporate settings.

As sensible as these recommendations may be, they deal largely with financial incentives and big institutions. This collection suggests a different tack.

From my very first days at MIT in 1976, I found passion for objects everywhere. I had students and colleagues who spoke about how they were drawn into science by the mesmerizing power of a crystal radio, by the physics of sand castles, by playing with marbles, by childhood explorations of air-conditioning units. They also spoke of new objects. I came to MIT in the early days of the computer culture. My students were beginning to talk about how they identified with their computers, how they experienced these machines as extensions of themselves. For some, computers were "objects-to-think-with" for thinking about larger questions, questions about determinism and free will, mind and mechanism.[5]

Trained as a humanist and social scientist, I began to ask, what is the role of objects in the creative life of the scientist? What makes certain objects good-to-think-with? What part do objects take in the development of a young scientific mind?

The Collection

In the early 1980s, an MIT colleague, the mathematician and computer scientist Seymour Papert, wrote about how the gears on a childhood toy car had brought him into science. Fascination with those first gears made way for fascination with other gears. With practice, Papert learned to play with gears in his mind: "I became adept at turning wheels in my head and at making chains of cause and effect. . . . I remember quite vividly my excitement at discovering that a system could be lawful and completely comprehensible without being rigidly deterministic."[6]

The gears on the toy car brought Papert to mathematics, but more than an intimation of mathematics had brought Papert to the gears. They might have symbolized a connection to his entomologist father, a romantic but distant figure, who spent much of his time doing fieldwork in the South African bush. Seymour Papert's facility with gears might have been the first thing his father took pride in, and once this connection was made, Papert's object choice was overdetermined. We cannot know. What is certain in Papert's narrative is that thinking with and about things is not a cold, intellectual enterprise but is charged with eros. Papert says: "I fell in love with the gears."[7]

For over twenty-five years of teaching at MIT, I have made my first class assignment a question in the spirit of Papert's essay on gears: "Was there an object you met during childhood or adolescence that had an influence on your path into science?" Over the years, assigning my students a paper on childhood objects has sometimes provoked surprise from them, even anxiety. Students ask: "Why write about an object? Will I be able to find one?" I reassure these students that if they have trouble fixing on an early object, together we will find something appropriate for them to write about. No one will do poorly on this assignment. But then, once students begin to work, there are calls to parents to check their memories. There are conversations with siblings. My students go home for vacation and return to MIT with an object in tow. I typically devote one or two class sessions to reports on the objects of childhood; students have trouble keeping to their allotted times so we schedule extra meetings. Over the years, it has become clear that this assignment stirs something deep.

Here, I have chosen fifty-one essays from my collection of over 250 student essays gathered from 1979 to 2007 and followed them with essays on childhood objects by eight senior scientists, engineers, and designers—mentors who range in age from their forties to their seventies. Although the essayists' fields of interest cut across science, engineering, and design, the collection's title and my remarks refer to them together as *science.* My focus is on what these fields have in common: a passion for the technical, for formal analysis, for discovery, and for understanding how things work.

In the mentor essays one sees the arc of a life that takes a child from engagement with an object to scientific maturity. A boy is fascinated with the 173 steps of a hill in his hometown, by the stone terraces in his backyard, and by the wax hexagons of his beehives. He becomes an architect whose buildings celebrate the beauty of geometry. A hip high-school freshman in Atlanta has no interest in science until she discovers that it includes lasers, skydiving, and purple haze chemistry, their combined glamour drawing her toward a career in engineering. A child curious about the inside of a radio wonders what connects the circuits he can see and the broadcasts he can hear—concerns that will lead him to computational networks and questions about what links body and mind, brain and thought.

The mentor essays place us on a higher ground from which we can imagine where students may be heading, a prescience about pre-science. The mentor scientists were not given the student essays to read. Yet there are many connections across generations. Times have changed, certain objects have changed, but curiosity and a grammar of things and thinking have remained constant.

To illustrate something of that grammar, I ask the question, "What makes a scientist?" Activities with objects provide some answers: building and sorting, play and vision, the way we use objects to model the world. Finally, there are the ways we take in the digital and the natural, what we program and what we sense. In the section on "building," I use one object, LEGO bricks, in a special way. Over the years, so many students have chosen them as the key object on their path to science that I am able to take them as a constant to demonstrate the wide range of thinking and learning styles that constitute a scientific mindset.

Thinking about scientists and their objects raises the question of how to best exploit the power of things to improve science education. Neither physical nor digital objects can be taken out of the equation; nor should either be fetishized. Over the past decades, we have seen an ongoing temptation to turn to computers to try to solve our educational crisis. It is natural, in a time of crisis, to avidly pursue the next new thing, but we need not lose sight of the things that have already worked. Awash as we are in new teaching materials (from smartboards to simulated science laboratories) object-play is not something to which today's teachers are necessarily attuned, although as early as third grade, young people interested in science can identify the objects that preoccupy them. Theirs are the minds we want to cultivate, but these students are often isolated, strangely alone with their thoughts.

One reason we don't pay enough attention to things and thinking is that we are distracted by our digital dreams; another is that traditionally, scientists have been reticent to talk about their object passions or, one might say, about passions of any kind. There was a canonical story about the objectivity and dispassion of scientific work and scientists stuck to it. In 1856, the essayist Walter Bagehot described the young scientist as an aficionado of the object world, yet Bagehot was ready to declare that scientists' involvement with "minerals, vegetables, and animals" spoke to an absence within their constitutions of an "intense and vivid nature." Scientists, he wrote, "are by nature dull and frigid and calm. An aloofness, an abstractedness cleave to their greatness."[8] In their autobiographical writings, scientists reinforced the idea that theirs was a discipline that faced nature with cool composure; lives in science were recounted in ways that separated reason and passion and saw objects through abstractions.[9]

But there has always been another story in which scientists' attachments to objects are red-hot. In recent years, this story is starting to be told.

Nobel laureate Richard Feynman begins his autobiography, *Surely You're Joking, Mr. Feynman!,* with a loving description of the "lamp bank" that he built when he was ten, a collection of sockets, bell wire, and serial and parallel switches, screwed down to a wooden base. Feynman plays with the lamp bank to get different voltages by setting switches up in different combinations, serial or parallel. He joyfully recounts his electronic universe: the radios he bought at rummage sales, his homemade burglar alarms and fuses. The fuses, made from tin foil, offer spectacle as well as intellectual excitement. Feynman sets them up with light bulbs across them so that he can see when a fuse has been blown. And he puts brown candy wrappers in front of the light bulbs so that a blown fuse translates into a beautiful red spot on his switchboard. "[T]hey would glooooooooooow, very pretty—it was great!"[10]

It was the Great Depression, and Feynman's neighbors started to call upon the ten-year-old to fix their broken radios. In one case, Feynman figures out what is wrong with a radio that starts up noisily and then quiets down by asking himself the question, "How can that happen?" He lets his imagination move around the elements of the radio—thinking through the tubes, amplifiers, heat, RF circuit, grid voltages—and he comes up with a solution. The tubes are heating up in the wrong order. His neighbor's formulation: This child "fixes radios by thinking!"[11] In terms that Seymour Papert uses in his writing on education in the computer culture, the radios provided a "microworld" for learning.[12]

Feynman fell in love with electronics and, in the process, with thinking like a scientist. Like Donald Norman, who writes so movingly about radios in this volume, Feynman developed more than curiosity; he found a language for expressing it. He learned a certain way of asking questions and testing theories. For Feynman, radios carried ideas and made him famous in his neighborhood, an association of ideas and identity that is common to all of the essays in this collection.

Generations of Connection

Seymour Papert met his gears in 1930. The architect Moshe Safdie writes about a boyhood in Jerusalem later in that same decade; the cognitive scientist Donald Norman describes growing up with radios during the 1940s. Geologist Selby Cull met her chocolate meringue in the 1980s; computer scientist Andrew Sempere discovered the Holga Camera in the mid-1990s. This collection documents objects on the path to science, technology, and design over a seventy-five-year time span.

Over that time, there have been dramatic changes in the kinds of objects children have had presented to them. Yet in reviewing twenty-five years of science students' writing on their favored childhood objects, certain trends are apparent. One is an interest in transparency. Through the mid-1980s, MIT students who grew up in the 1960s wrote about radios, vacuum cleaners, wooden blocks, and broken air conditioners. These are things to take apart and put back together again. Students describe childhoods in which they fix what is broken or at least try to. They write about the frustration of not getting things to work but learning from their furious efforts.

By the end of the 1980s, my students begin to write about growing up with electronic games, lasers, video games, and "home computers," objects that are investigated through the manipulation of program and code. Yet even with the passage from mechanical to electronic, and from analog to digital, students express a desire to get close to the inner workings of their machines. The early personal computers made it relatively easy to do so. Machines such as the TRS-80, the Atari

2600, and the Apple II came bundled with programming languages and beyond this, gave users access to assembly languages that spoke directly to their hardware. Students write fondly about programming in assembler and of the pleasures of debugging complex programs. Metaphorically speaking, an early personal computer was like an old car in your garage. You could still "open up the hood and look inside."

However, by the 1990s the industry trend was clear: digital technology was to become increasingly opaque, reshaped as consumer products for a mass market. The new opacity was cast as transparency, redefined as the ability to make something work without knowing how it works. By the 1990s personal computer users were not given access to underlying machine process; computers no longer arrived with programming languages as a standard feature. Beyond this, programming itself was no longer taught in most schools. Even so, young people with a scientific bent continued to approach technology looking for at least a metaphorical understanding of the mechanism behind the magic.

Beyond seeking a way to make any object transparent, young people across generations extol the pleasure of materials, of texture, of what one might call the resistance of the "real." In the early 1990s, computer scientist Timothy Bickmore's experiments with lasers, "passing the laser through every substance that I could think of (Vaseline on slowly rotating glass was one of the best)," recall the physical exuberance of Richard Feynman's candy-wrapped light bulbs of a half-century before. For Selby Cull in 2006, geology becomes real through her childhood experience of baking a chocolate meringue: "Basic ingredients, heated, separated, and cooled equals planet. To add an atmospheric glaze, add gases from volcanoes and volatile liquids from comets and wait until they react. Then shock them all with bolts of lightning and stand back. Voilà. Organic compounds. How to bake a planet."

Cull's joyful comments—"Voilà. Organic compounds. How to bake a planet"—introduce the most well-known of the intergenerational experiences described in these essays: the moment of scientific exultation, the famed "Eureka" moment of raw delight, here consistently recounted with an object as its focus. In the 1950s Donald Ingber learns to anticipate the thrill of the gestalt with his color-by-numbers pencil set when "after coloring in multiple scattered spaces, I was always elated when I penciled in that key space that caused all the other colored tiles to merge into a single coherent image." In the 1980s Jennifer Beaudin's realization that she will change but her house will stay the same compels her to map its stable contours. In doing so, she comes to another discovery, one she finds even more startling: "A wall of one room could be the wall of another. . . . Indeed, all the rooms were adjacent to each other and formed a whole. I can remember how it felt to suddenly see something new." In the early 1990s while fishing with his father, Cameron Marlow looks up at the motion of his fly line and is reminded of drawings of long, continuous, flowing lines he had made in algebra class. "I realized that the motion of my hand had a direct effect on the movement of the line, much in the same way that the input to a function produced a given output. Without any formal understanding of the physics involved, I was able to see the fly rod as representing a function for which I was the input. . . . From this point on, the fly rod was my metaphor for understanding function in mathematics."

The themes that cut across generations introduce those of the collection as a whole. Objects provide encounters with transparent systems and manipulable microworlds. They provide opportunities to develop intimacy with objects and to develop a personal thinking style. Finally, objects provide occasions for young people to make the most of the analog and the digital, the natural and the simulated. Objects are not the only path into scientific creativity, but they are one powerful path. In these pages, we see objects helping young people realize something about self and something about science, keeping in mind that to realize means to understand and to build.

I have asked my students to consider objects at a time of transition, or as my colleague Nicholas Negroponte would put it, at a time when the world was moving from atoms to bits.[13] I have traced students' object passions across the years of the digital revolution and found that in the end there has not been so much a migration to a new digital world but rather that children now grow up in many worlds. They are seduced by the control of the digital, the freedom of the virtual, but always brought back to the physical, the analog, and of course, to nature.

Transparency

Neuroscientist Susan Hockfield begins her essay on microscopes with the question, "How do you understand how something works? From as early as I can remember, I wanted to see inside things, to understand how they worked." Cognitive scientist Donald Norman echoes the sentiment when he describes taking apart a radio:

> I loved the insides of the radio. I can remember the undersides, a mesh of thick wires running this way and that, covered with dust and cobwebs, connected at junctions with nice dull solder balls, with multiple large cylinders connected to them. . . . The radio transformed my life. I finally had focus: to understand the hidden mechanisms of electronics.

Even after Norman moves from electrical engineering to psychology, he feels that he is pursuing the same goal, understanding "mysteries of hidden, invisible mechanisms, but now my focus was on the human mind rather than the electronic circuit."

A half century later, MIT student Kwatsi Alibaruho has the same exuberance for the insides of telephones. His mother provides him with "three old telephones, a small wrench, and a screwdriver. . . . I took to taking apart the telephone—something I loved!" Prior to this, Aliburaho had spent many months building toy telephones out of interlocking LEGO bricks. He feels that the LEGO telephones prepared him for getting to work on the real thing. Building begets a love of building. For this builder, what thrills most is what is most hidden. Alibaruho comes alive when the invisible is made visible. Of the telephone he says:

> Seeing all of the wires and screws inside was an incredible high. . . . I spent hours engaged with my phones. My goal was simple. I wanted to take the phone apart and then put it back together. . . . Finally, I could take a telephone completely apart and put it back together so that it actually worked. I did not know how the components worked, but I began to get a feel for how they fit together.

From LEGOs to telephones, from telephones to bicycles, Alibaruho likes to "disassemble and reassemble." For him, the fun of a new bicycle was not riding it, but taking it apart and putting it back together, over and over again. After a time, assembly and reassembly becomes its own pleasure, a kind of meditative activity. Living in the worlds of his constructions, Alibaruho works with his objects in the spirit of what French anthropologist Claude Lévi-Strauss calls *bricolage* or tinkering, the combining and recombining of materials on their way to becoming scientific thought.[14]

Norman and Alibaruho were involved with objects they held in their hands, things exemplary of what Lévi-Strauss, punning in French, called "goods" to think with, *bons à penser,* that are also "good to think with." Hockfield's narrative adds another dimension. She plays with objects of her imagination that are none the less concrete for not being in her physical grasp. Hockfield can't remember ever being without a magnifying glass to help her get inside of things: a door latch, a watch, an iron, a toaster, a fan. But she also played with the objects of her dreams. She loved elaborate miniatures, trains, and dollhouses, but didn't own the kind she dreamed about, the most complicated kind, "with electricity, running water, a heating system, plumbing, all of the mechanics. I wanted a fully functioning miniature, so that I could understand how a house works." Papert, Alibaruho, and Feynman handled mechanisms, made them transparent, and ended up working them in their minds. Hockfield shows us the power of objects imagined as transparent from the very start.

Microworlds

Alibaruho describes mechanical constructions that draw him into worlds he can create and control. As he gains fluency with his objects, they become elements for building physical systems and for building his mind. "I thought of my imagination as constructible."

The metaphor of building is central to the Swiss psychologist Jean Piaget's constructivist description of child development.[15] Its basic tenet: children build theories based on the objects they meet in the world. Seymour Papert was one of Piaget's students and saw the relationship of object to theory in more activist terms, closer to the experience Alibaruho describes. Papert moved to a constructionist position: children make their minds through actual building. In Papert's model, we can expect that if we give children new materials, they will build different things and be able to think new thoughts. Piaget's constructivism takes the object world as something of a given; constructionism puts the child on the prowl for new objects, new ideas.[16]

In Moshe Safdie's essay, we see a child looking for new materials, seeking the joy of construction. Drawing limits him. He needs to build:

> Though I could draw with considerable ease, drawings seemed inadequate to describe what I had in mind. I joined with a friend and we decided to make a model. With a model, we could create a lake formed by a dam, show the water drop into turbines below, set windmills on the ridge, irrigate the terraces downhill, and so on. In the basement of a building that had been used as an air raid shelter during the Second World War, we found an old, unused door and used it as the base for our model. We purchased many pounds of clay to form hills, a lake, and valleys. We cut up little weeds to represent trees. We used dyes to color the landscape. We tried simulations by pouring water above and seeing it trickle downwards and we began searching for a pump that might keep the system going.

Richard Feynman's radio connected him to proud parents and became an offering to a wider community. Safdie's model provided a similar opportunity for social success. In both cases, construction nurtured social identity. Designer Sarah Kuhn's models have a different emotional valence: they are her private retreat.

Kuhn takes a set of wooden blocks and builds a fortress. She analogizes her blocks to the virtuous objects created by the nineteenth-century German educator, Friedrich Froebel, the inventor of kindergarten. Froebel proposed a set of twenty objects, "Froebel's gifts," each designed to impart specific competencies.

Like the gifts, Kuhn says that her blocks are powerful teachers; her blocks-world is the perfect place to learn how to think like a designer—how things fit, how structures work. But beyond this, Kuhn's blocks-world provides a safe haven, "my private universe." After her brother is born, her parents divide up the attic and she gets her own room. It is in this room where she sets up her blocks. Her bed is at the center of her world; it is her safety raft. She extends it with adjacent blocks.

> The scope of my ambition now expands to fill the room; the bed and the floor become part of the action. My grandfather builds me a table in the form of a giraffe, and I incorporate it, too, into my constructions. Usually my bed is a raft. . . . Anything touching my bed is part of the raft, keeping me and my stuffed animals safe and dry.

Kuhn, both client and designer, uses her constructed world to address the anxieties of childhood. She assuages fear by playing with her worst ones, declaring the blue carpeting of her attic bedroom to be a hostile sea, "its unplumbed depths harboring countless marauding sharks, the bogeymen of my childhood." The family lives only a few miles from Alcatraz, the island maximum security prison, and Kuhn "shiver[s] at stories of would-be escapees who come to a bad end. As I extend my construction, I extend my world of safety."

Kuhn's narrative exemplifies the integration of thought and feeling in a learning microworld. She is learning about design and she is saving herself, all at the same time. Children bring their emotional needs to their intellectual constructions. Outside, the world is complex, parents are occupied with grown-up matters, a new sibling presents competition. In the blocks world, Kuhn is self-sufficient. Kuhn shows us how blocks can offer a "just-right" emotional fit. Her blocks-world problems are ones she can solve. The blocks-world enables her to construct just the right degree of separation from her siblings, from her parents, from too-big problems. The "just-right" fit of Kuhn's physical microworld helps us to better understand today's children and their virtual microworlds. They play video games that are "just-right" in their presentation of increasingly difficult sequences to master, sequences just as comforting as blocks challenges are to Kuhn.[17]

Alibaruho notes that he becomes lost in his design microworlds. When he immersed himself in a bicycle-making microworld, he thought about everything in terms of bicycles and "The bicycles that I worked on felt like parts of me." Kuhn, too, becomes what she builds. She is not using her blocks to build a model but a world to her scale: "Back in the playroom, I would have had to imagine myself an inch high to live in my blocks compound; in my bedroom, I can be my own size. I inhabit my construction world." The objects of her microworld have taken on a special physical intimacy.

Object Intimacy

Stereotypes about scientific work would have scientists, engineers, and designers thinking through problems in a "planner's" style, a top-down, divide-and-conquer style in which objects are kept at a distance. Of course, some scientists do use this style, and some use it most of the time. Others describe a hybrid style that moves back and forth from top-down planning to a more fluid and experimental bricolage, or "tinkerer's" style, one that is likely to leave more space for object intimacy. Yet the planner's style became frozen in the public imagination (and to some degree, the science education community's as well) as the way one does things in science, and even more broadly, what it means to think like a scientist.

Historian Evelyn Fox Keller writes about scientists' resistance to acknowledging the intimacy of their connections to objects. She sees its roots in a male-dominated view of mastery that equates objectivity with distance from the object of study.[18] In contrast she describes the attitude of a Nobel laureate, the geneticist Barbara McClintock. For McClintock, the practice of science was a conversation with her materials. “Over and over again,” says Keller, McClintock “tells us one must have the time to look, the patience to ‘hear what the material has to say to you,’ the openness to ‘let it come to you.’ Above all, one must have a ‘feeling for the organism.’”[19]

McClintock talks about the objects of her science, neurospora chromosomes, in terms of proximity rather than distance, in terms that recall what we have heard from Kuhn describing her blocks and Alibaruho talking about his telephones. The chromosomes were so small that others had been unable to identify them. But the more McClintock worked with them, “the bigger [they] got, and when I was really working with them I wasn’t outside, I was down there. I was part of the system. I actually felt as if I were right down there and these were my friends. . . . As you look at these things, they become part of you and you forget yourself.”[20] Similarly, when Susan Hockfield describes the pleasures of the electron microscope, she uses a language that puts the emphasis on “being there.”

> The microscope itself was a large vacuum chamber, with an array of pumps to evacuate it. The electron beam was projected through the sample under study onto a screen, which had to be viewed in the dark. So the experience of using an electron microscope, in a darkened room with lots of noise from the vacuum pumps, felt very much as though you, yourself, were “in the microscope.” I would spend hours in the microscope, scanning tissue, with a wonderful feeling of being inside the specimen.

Hockfield's intimacy with the microscope, McClintock's being "among" her cells—both evoke what the psychoanalyst D. W. Winnicott called the "transitional object," those objects that the child experiences both as part of his or her body and as part of the external world.[21] As the child learns to separate self from its surroundings, the original transitional objects are abandoned; one gives up the prized blanket, the teddy bear, the bit of silk from the pillow in the nursery. What remains is a special way of experiencing objects that recalls this early experience of deep connection. Later in life, moments of creativity during which one feels at one with the universe will draw their power from the experience of the transitional object.

For Keller, any description of scientific practice in which the scientist is distanced from his or her object of study cannot stand alone. It needs to be seen in relation to other descriptions such as those provided by a McClintock or a Hockfield that are about intimacy and presence. Keller takes the exploration of this second style as part of a feminist project in science but makes it clear that there are many male scientists who work in a "close-to-the-object" style. The scientific culture, however, has made it hard for them to talk about it or, perhaps, even to recognize it for what it is. But once young male scientists are asked about their objects, they offer rich evidence of such intimacies. One of my students spoke to me about translating the tactile experience of playing with marbles to feeling the laws of "physics in his fingertips"; another tells me that as a child he was so involved with a carpenter's ruler that it became a physical template for intuitions about proportion. Even as an adult mathematician, when he divides a number by two or four, he sees the ruler collapsing in his mind. In this collection, Thomas P. Hermitt writes about diving deep within a prism for inspiration, shrinking himself, as did McClintock, to its scale in order to make his body feel at one with its structure:

> Visualizing waves of light bouncing off nuclei, slithering through electron clouds, and singing across the vacuum between the stars became an obsession. I never tire of leaving the ordinary, everyday world, shrinking myself down to the size of an electron and diving headfirst into my prism where a front row seat for the spectacle of nature awaits.

In common with these examples of what Papert would call "body syntonic" relationships with objects, Austina De Bonte finds herself thinking with her fingers when she learns to build *siaudinukai,* an old Lithuanian folk craft. *Siaudinukai* are three dimensional objects made by threading straws on string. No Froebel gift was ever more evocative than De Bonte's thread-and-straw world. As an adolescent, De Bonte goes to a Lithuanian summer camp to explore her ethnic identity. There, she uses *siaudinukai* for an allied exploration: the search for rules for a "stable" structure, one that is "rigid, reasonably strong, and structurally complete." At camp, she gives all these things a name: *solidness.*

> I discovered, mostly by example and through trial and error, that I couldn't make a solid structure that wasn't based on triangles. I also found that every link in a *siaudinukas* was vitally important—the structure was often fully collapsible and foldable right up until the very last straw was secured. Furthermore, I discovered that this was actually the mark of a good structure—if the *siaudinukas* was rigid before I was done executing my plan, then quite likely I had redundancies in my planned structure that were not only unnecessary but in some cases actually caused the structure to lose its pleasant symmetry along an axis, hang crooked, or put unwanted tension on other straws.

The year she wrote her essay on straws, I watched De Bonte run a small workshop on how to build *siaudinukai.* She brought straws and thread and Lithuanian snacks. One rapt five-year-old was always pleased when she could get an early-stage structure to stand on its own; this made it easier for her to thread the straws. At the workshop, De Bonte was gentle and firm in her rebuke: "If it looks ready too soon, it's not ever going to stand on its own." The lesson needed to be repeated three times. Each time De Bonte made her point, it seemed to have a wider meaning. In the end I was moved by what seemed its most general meaning: suppleness is the precursor to what is ultimately most secure.

Personal Thinking Styles

The strategies children use to engage with objects can be categorized in two ways. A first focuses on stages of development, and a second looks to personal styles. In the first, the developmental framework, we can imagine three stages: metaphysics, mastery, and identity, each of which provides its own bridge to scientific curiosity. In the metaphysical stage, objects help children consider basic questions about aliveness, space, number, causality, and category, questions to which childhood must give a response. Children wonder at objects; objects provide early inspiration for the child scientist. Here, we think of Papert and his gears, comtemplating the basic rules of causality and sequence, and a young Britt Nesheim, exploring the mysteries of number and size with her toy mailbox.

In the mastery stage, which begins at around age eight, children use objects to prove themselves and their ability to control the world. At this stage, children's thoughts often turn to winning. By the time he is nine, maps and routing offer Steven Schwartz "a world of mastery and control." Of course, sports and social life can also provide material for developing feelings of control and mastery, but objects tend to offer experiences that produce the greatest certainty. You can lose a baseball game. But with practice, you will always be able to sort objects, plan a route, or put a disassembled telephone back together.

The seduction of what can be precisely known and controlled can be a path into science. Object mastery can also provide opportunities to make false starts without penalty, to recast “getting it wrong,” as a step on the path to “getting it right.” During the mastery phase, this object optimism, explicitly called “debugging” when students talk about programming, is part of the positive experience of other objects as well.

Finally, with adolescence, children’s concerns turn to identity, and objects help them become who they are.[22] Chuck Esserman writes that when he was developing his identity as a techie, he thought of himself as his bike. Rosalind Picard wants to be the kind of girl who has a yellow nonregulation notebook and who experiments with lasers and exotic chemistry.

Metaphysics, mastery, and identity are developmental stages, but no handle cranks, no gear turns to graduate a child from one stage to the next. No stage is ever fully completed; we continue to work on all of these issues throughout life. And we do so with our objects in mind. This is so much the case that metaphysics, mastery, and identity are as much styles of engagement with objects as they are stages of development. We saw how in Kuhn’s and Alibaruho’s early engagements with objects, they were most concerned with control; later, identity—seeing themselves as builders and designers—takes center stage.

This same mix of mastery and identity, stage and style, operated for De Bonte. The *siaudinukai* show her what she can do but also who she is—not only as a Lithuanian but as a thinker. Working with *siaudinukai* concretized her personal thinking style.

De Bonte's style is to play with her materials until she gets things right. She is a classic bricoleur. She tries one thing, steps back, and tries another. As she puts it:

> Sometimes I would just start stringing some straws together, looking for ideas; once something took shape, it was easy to find ways to extend or elaborate on it. . . . Often I wouldn't be able to tell for sure whether a complicated structure would be solid until putting in the very last piece.

Those who predesign their straw structures do not do better work than she. They simply have a different style.[23] From a pedagogical point of view, looking closely at objects leads us to greater respect for the many ways of thinking like a scientist, engineer, and designer. In this collection, this range of styles is dramatized by narratives such as that of De Bonte and, as a group, by the range of responses to LEGOs, named by many of my students as a crucial object on their path to science.

Some children use LEGOs to create highly realistic structures. For others, only fantasy buildings hold any interest. Some maximize their LEGO resources by constructing hollow buildings to conserve bricks. Others challenge themselves to use all their bricks in one structure, no matter how baroque the result. Some follow a plan of detailed instructions; others throw instructions away. Some keep their constructions as trophies; others destroy what they have done as soon as it is completed. Some build designs they can live in; others build for fantasy characters. For one child, the most exciting thing about LEGOs is the LEGO "bump"—its unity suggests the idea of an indivisible particle; for another, building with the bricks is less exciting than classifying them. He expresses his creativity when he contemplates the range of algorithms possible to sort the colors, shapes, and types of LEGO bricks. Children's experiences with LEGOs dramatize that the choice of an object does not determine its creative impact. These children, young scientists all, make objects their own in their own way.

For Alan Liu, who builds structures for richly imagined LEGO people, "Most satisfying to me was that each member of the space colony had a personal identity. I had men and women who had marriages and children." In Liu's medieval LEGO world, the king "was a fool . . . the queen disliked her silly husband so much that she spent more time with the prince." Liu makes his LEGO buildings actors in his characters' dramatic lives. When the foolish king battles the astute leader of the space colony, the king always loses because he does not have the wits to work around a design flaw that Liu has built into the monarch's LEGO equipment. But while "the king never worked around his weakness[,] the spacemen always exploited it." When Liu is about nine, his relationship to LEGOs changes. Instead of building for his characters, Liu begins to build for himself. He takes apart everything he has built and starts from scratch: "I don't know if I was playing any more. It felt like serious designing."

While Liu is happy playing with LEGOs that come in space and medieval kits, Sandie Eltringham doesn't like kits at all. She is interested in LEGO as a protean resource. Eltringham focuses on the sample pictures on the LEGO box lids because they come *without* instructions. She looks for building clues by analyzing the shadows that the suggested structures cast on the walls in their photographs. Eltringham takes LEGO people out of her play. Her only use for them is as gauges to help her build furniture and cars to scale. For Eltringham, nothing can compete with hearing "the loud snap of two pieces correctly put together" as she creates a perfect miniature. As much as putting things together, Eltringham enjoys taking things apart, sorting each piece by color, shape, and type. In the end, her passion is the pleasure of classification.

The Analog and the Digital, the Natural and the Simulated

Electrical engineering student Mara E. Vatz begins her narrative about vacuum tubes with a declaration of love for a fifty-year-old Magnavox record player being tossed out on the street. She feels compelled to rescue it: "The Magnavox took hold of me." By the time of her schooling, electrical equipment did not reveal its circuitry to the naked eye and hand. Circuits were stamped on chips, no longer traceable through their wiring. Frustrated by the opacity of contemporary electronics, Vatz finds what she is looking for when she meets the transparent Magnavox. She says, "I turned the whole thing upside down to get a peek at the circuitry inside."

Once "inside" the Magnavox, Vatz discovers its treasure. It is built with analog devices: "[M]y Magnavox had . . . vacuum tubes instead of transistor amplifiers." Vatz is not so much thrilled by what the vacuum tubes can *do* (carry sound with less potential noise) as by what they *are*. In an opaque, digital world, they embody transparent, analog knowledge. Vatz is resigned to the fact that the fragility, size, and expense of vacuum tubes dictate their disappearance from modern electronic equipment but is upset that the ideas they carry are being lost as well. She finds it nearly impossible to get information about the vacuum tubes. Vatz is majoring in electrical engineering, but her professors talk about vacuum tubes "only when [they] reminisced about them, the way they might about old friends—brilliant and wonderful friends—that we, students born too late, would never have the chance to meet." Current books don't mention them at all. Vatz begins to seek out old books, very old books, and finally finds one of her grandfather's engineering books where vacuum tubes are discussed and illustrated. Vatz is fascinated to find that in the old textbook, the vacuum tubes are put in the context of the history of the science from which they arose. For Vatz, meeting vacuum tubes leads to an interest in the ideas they carry and to the notion that if objects are lost, ideas can be lost as well. Reclaiming an object means reclaiming a set of ideas.

The generations of students who have grown up in the post-analog world can understand Vatz's concerns. They experience the trade-off between the kind of transparent understanding offered by the world of mechanism and the heightened sense of control offered by the increasingly complex and opaque digital realm. In digital culture, you may not have a traditional understanding of how things work, but you have enormous power to make things happen, to invent new possibilities, to find new creative outlets. Control and understanding begin as competing parameters, but at a certain point, control begins to feel like a kind of understanding. It is the way of understanding in digital culture. With digital objects, with programming, one is free to build "straight from the mind."

"Building straight from the mind" are the words of an MIT student I call Anthony, a self-identified computer hacker of the 1980s, who had grown up in the analog world.[24] As a young boy, Anthony took clocks apart and "tried to put them together in new ways—to make new kinds of clocks."[25] But there were limits to how much Anthony could make clocks into something new. When he met computers and programming, he sensed that he was in a world with no such limits. In a programmed microworld, the laws of gravity need not apply. "When you are programming," says Anthony, "you just build straight from your mind."

> Why do you think people call their ideas brainchildren? They are something you create that is entirely your own. I definitely feel parental toward the programs I write. I defend them and want them to do good for the rest of the world. They are like little pieces of my mind. A chip off the old block.[26]

Anthony's pride in his brainchildren is expressed in the object aesthetic of digital culture.[27] It is an aesthetic that parries constraint and claims to be a universal language while enabling individual expression.[28]

Here I have used the word *microworld* as a term of art. In the 1960s Seymour Papert used it to describe software that was designed to bring ideas from computation into the thinking vocabularies of children. Papert, influenced by Piaget's ideas about the child as scientist, wanted to broaden the scope of what children could be scientific about. Piaget had argued that children use the objects of everyday life to develop theories about such things as space, time, number, and causality, as well as what it means to be alive and conscious.[29] Papert underscored that children develop intellectual fluency about such questions because the world provides concrete materials with which they can think them through. Papert reasoned that if thinking about aliveness could be developed in a world of living and not-living things (call it Lifeland) and fluency in French could be developed in Frenchland (say, for example, in France), then thinking about mathematics might flourish in Mathland. He believed that this was best thought of as a world that could be built within the computer, a mathematically based machine in which programming languages would construct worlds that operated by mathematical rules.

But Mathland needed a way to connect to people. For Papert, that was the turtle, a robotic creature connected to the computer that took its marching orders from the Logo programming language. In that language, an original robotic "floor turtle" evolved into a "screen turtle," a triangular cursor on a computer screen. Both floor and screen turtle could be told where and how to move and whether or not to leave a "trace" by lowering a pen, physical or virtual. So a turtle could be made to trace a square by giving it the following sequence of Logo commands:

```
PEN DOWN
FORWARD 10
RT 90
FORWARD 10
RT 90
FORWARD 10
RT 90
FORWARD 10
RT 90
PEN UP
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The turtle had many virtues as a way to convey ideas, foremost the fact that it connected with both mind and body. Children wrote the programs that controlled the turtle—that was the mind connection—and children could "play turtle," directly identifying their body with that of the turtle as a way to learn programming. In a classic assignment, Papert would ask a child to program the computer to make a circle. The most direct way to solve this problem is to "play turtle" and act out the drawing of a circle. Using the "body-as-turtle" method, children could come up with the Logo program "To Circle." This program instructs the turtle to go forward one unit, turn by one unit, and then repeat this again and again. By trial and error, children learn that 360 repetitions is the right number to get you to a full circle. Whether the turtle was a floor robot or a point on a computer screen, the body-to-body path to mathematical insight remained intact.

This kind of thinking—ask digital objects to relate to body and mind, ask digital objects to carry ideas—continues to inspire research on educational computing in the tradition of Papert's Logo work. At MIT, Mitchel

Resnick, once one of Papert's students, leads a research group on science education under the rubric of "Lifelong Kindergarten." In a personal introduction to his work, Resnick explains his fondness for the kindergarten metaphor as follows:

> Kindergarten is one of the few parts of our educational system that really works well. In kindergarten, kids spend most of their time creating things they care about: building towers out of wooden blocks, making pictures with finger paint, creating castles in the sandbox. As they playfully create and experiment, kids begin to develop new understandings: What makes structures fall down? How do colors mix together?[30]

After kindergarten, says Resnick, education too often shifts to "broadcast mode," with schools trying to deliver information, rather than allowing students to learn through building and experimenting.

Resnick's research group has made "programmable bricks" for LEGO construction kits that enable children to program LEGO objects much as one could program Papert's floor turtle. Only now, the objects are not only able to move, they are able to sense their environment and communicate with other objects in their world. In this way, LEGO constructions evolve into LEGO creatures. Papert's Logo world enabled children to explore mathematics and physics. Resnick's designs enable children to explore biology and psychology. They can investigate notions such as feedback and emergence (how complex behaviors can emerge from simple rules) that were previously viewed as too hard for children to think about.

Indeed, one of Resnick's central ambitions has been to bring ideas about the importance of decentralized control into the thinking vocabulary of children.[31] In arguing for its importance and in pointing out the resistance to it, Resnick cites the work of Evelyn Fox Keller.[32] When Keller's research led her to propose a decentralized model of cellular communication, she found the community of professional biologists arrayed against her in almost-universal protest. They preferred thinking of communication within cells as a centralized, top-down, command-and-control structure.[33] Resnick creates programming environments that dramatize the power of decentralized phenomena. In one of these, the programming language StarLogo, objects can be made to respond to changes in their local environment. Over time, if each object follows simple local rules, global patterns emerge that appear to have been designed from "above." The effects are stunning, memorable demonstrations of what can be achieved by decentralized processes. They help to fight our prejudice that all structure is planned. Structure can also be emergent. The demonstration is timely since it is at the heart of embattled evolutionary theory.

Most recently, the Lifelong Kindergarten group has focused on integrating computation into children's everyday experience. It has developed a new language, Scratch, in which one is able to use popular culture—music, art, storytelling, and video—as elements in a program. Resnick's work illustrates the best in digital media for education. It takes the Froebel gifts as its touchstone and uses them as inspiration to enhance each child's creativity. Unfortunately, many digital worlds make everything possible but constrain experience, a trade-off apparent in most science classes where virtual science laboratories are in use.

Experiments in simulated laboratories are usually made to work out. The experiments become a performance; students are elements in that performance, but the main actor is the program. One can program random failures into the simulation (spilled coffee, broken equipment, an overheated atmosphere, the delivery of defective mice), that is, the kinds of things that make laboratory science go awry. But these slips will not *happen,* they will be *found.* They are there from the start, placed in advance by a programmer in charge of the virtual world.[34]

The young scientists in this collection show a certain craving for the contingent, for that which cannot be anticipated. Today's complex computer games go to considerable lengths to "program in" surprise (the famous "Easter eggs" within computer games that offer special tips and bonuses), but even the determined children who find them are not making the kind of discoveries that give an experience of full ownership. Someone has been there before: the programmer.

Consider a computer project that uses computational straw to design and build virtual *siaudinukai.* There, the lesson of "seeming solidness" might emerge from thousands of iterations of a building program that models virtual straw. A user manipulates plastic dowels that are represented in the computer. When a builder makes a simple structure, the computer transforms it into thousands of alternate configurations. Thus programmed, building *siaudinukai* could take place on a vastly wider scale. Robust structures would pop up from the many virtual configurations developed in collaboration with the computer. For some students, such multiple iterations of geometrical possibilities would facilitate learning.

Contrast this power with how De Bonte learned the lessons of the *siaudinukai*—through her fingers and in community with her peers, learning as part of her contact with Lithuanian culture. For some people, what might have been magical about the straw shapes will be lost in their digital variant. Otherwise put, in a digital world, children may get the point, but that may be all that they get.

Or contrast the exploration of the principles of heat and energy in a computer world with the adventure recounted in Daniel Kornhauser's essay on discovering a heat source within his shirts. The seven-year-old Kornhauser begins with a real problem that involves his comfort, his family, and economic realities: after a move from Mexico to France, Kornhauser is freezing cold at night, but it is beyond his parents' means to purchase twenty-four hour heat for the new family apartment. Kornhauser becomes fascinated by the sparks emitted by his thermal underwear. He decides he has "tapped into an undiscovered source of energy." It is his discovery, his "secret idea": "I shared most of my ideas with my father, but this one I kept to myself. . . . I was sure that I had developed a way to generate electricity that would enable us to keep the heat on all night long."

Ultimately, Kornhauser's father talks to his son about the scientific principles that deflate his first fantasies. But in the process of making his discovery, Kornhauser has become committed to science. That commitment is not tied to things going right. Indeed, Kornhauser says that although things went wrong, what matters is that he owned his failures. Kornhauser says that he uses his failed projects to think about entropy and the conservation of energy. As his mastery over large scientific principles grows, the world becomes reanimated, luminous. He learns that science leaves room for "invisible things," that "magic was not only to be found in fantastic tales; you could find it everywhere, invisibly surrounding you."

For the three-year-old Matthew Grenby, a bottle of soap bubbles also contains such magic. The soap bottle is a "made" thing, but Grenby experiences it as part of nature:

> I would shake the bottle and thousands of small bubbles would fill the small airspace in the container. Once agitated, any amount of continued shaking would have no effect, except to reshuffle the existing bubbles. And then, somehow, impossibly, the bottle would lighten. The fluid would

> disappear among the bubbles. If I wanted to play again, I had to wait until the bubbles turned back into fluid. I have no recollection of ever attempting to unscrew the bottle's cap. In spite of my frustration, I was content with the integrity of this little world. The bubbles offered no explicit insight into the ways of their world; rather they left an almost imperceptible impression.

The soap bubbles are only one natural object that draws Grenby to science. There is also an avalanche and a creek, sometimes dammed up with mud and twigs. All of these inspire him to feel awe for the mystery of science and at one with all that is beyond him. He calls it "a humility born of the violence of the mountain."

Nature encourages us to be messy because it is. The geologist Selby Cull thinks of it as the "challenging, beautiful, and delightfully tasty." When we deal with nature, we need to become comfortable with the idea that things may go unresolved for a while, that we may break things that are not easily replaceable, and that actually, things may not work out. In simulated science, there doesn't have to be any waiting. Time can be sped up. And when something breaks, the simulation can be run again and whatever was broken can be magically restored. Simulations encourage the idea that one can push forward to resolution—of the game, the quest, the experiment. One can push forward because possible resolutions are already there, in the program.

While the digital is explicit, the physical can exhibit a certain reticence. In this collection, among the most dramatic stories of learning is one that has as its central actor a piece of furniture whose presence is never quite acknowledged. This is a table in Alan Kay's fourth-grade classroom, an old dining table belonging to his teacher, Miss Quirk. It is completely covered, as Kay puts it, "with various kinds of junk: not only books, but tools, wires, gears, and batteries." Miss Quirk never mentions the table. But students are drawn to it. On it, Kay finds a book about electricity and the materials he needs to follow through on one of the projects in the book:

> One afternoon during an English class I set up my English book with the smaller electricity book behind it, and the large dry cell battery, nail, wire, and paper clips behind that. I wound the bell wire around the nail as it showed in the book, connected the ends of the wire to the battery, and found that the nail would now attract and hold the paper clips!
>
> I let out a shriek: "It works!"

Much more is working in this story than Kay's new electric magnet.

The objects on Miss Quirk's table are presented as bits and pieces of things. Students are given space and time to discover which objects should belong to them. Students can take things off the table without knowing why they are doing so. Kay gets a result, but he didn't go to the table with the aim of achieving one. The objects on Miss Quirk's table don't have predetermined uses. A beaker can be used to pour chemicals, water plants, hold flowers, or make a vacuum. The table presents familiar objects to get you to unfamiliar places. Kay is first drawn to a book because he thinks of himself as a reader, but he ends up making a circuit.

Miss Quirk's table is one thing; Miss Quirk is another. Her presence means that she can see the young Alan Kay slouched down, trying to hide his electrical circuit. She intervenes to encourage him; she intervenes to build a relational bridge between an object passion and the rest of life. In this collection we meet parents, relatives, friends and teachers who bring children old telephones, maps, LEGOs, and blocks. Sometimes they work alongside children. Sometimes they appreciate what children have accomplished. Like Miss Quirk, they bring sociability and community to what begins as a private moment. It is perhaps less important to think about the dichotomy between physical and digital artifacts than to make sure that we communicate with our children about their objects—physical or virtual. Virtual objects challenge us to learn how to enter someone's digital world as easily as moving aside the book that the young Alan Kay used to hide his circuit.

Yet Kay himself sees Quirk's table as close to a programmed object. For Quirk chose her materials carefully so that the children in the class would come upon objects in the right sequence. Kay says, "Because discovery is difficult, children have to be given scaffolding for their ideas. They need close encounters with rich materials; they need a careful yet invisible sequencing of objects." For Kay, the table is an inspiration for educational programming. He aspires to build computer microworlds in which, like the worlds designed by master teachers, students are not told what to learn but are encouraged to explore in sequences that "will enable them to make the final leaps themselves."

Kay's aspirations for the computer's use in education—as a laboratory for exploration—is close to how scientists use the computer. Chemists manipulate virtual molecules; biologists fold virtual proteins; physicists explode simulated nuclear devices. The children of today, the scientists of tomorrow, need to be comfortable in virtual space. Children's passions for objects teach us that there are possibilities in the digital that should be pressed into the service of a more effective science education and there are things to learn from the physical that are worth fighting for.

The Things That Work

Science is fueled by passion, a passion that often attaches to the world of objects much as the artist attaches to his paints, the poet to his or her words. Putting children in a rich object world is essential to giving science a chance. Children will make intimate connections, connections they need to construct on their own. At a time when science education is in crisis, giving science its best chance means guiding children to objects they can love.

At present, there is some evidence that we discourage object passions. Parents and teachers are implicitly putting down both science and scientists when they use phrases such as "boys and their toys," a devaluing commonplace. It discourages both young men and women from expressing their object enthusiasms until they can shape them into polite forms.[35] One of the things that discourages adults from valuing children's object passions is fear that children will become trapped in objects, that they will come to prefer the company of objects to the company of other children. Indeed, when the world of people is too frightening, children may retreat into the safety of what can be predicted and controlled. Many of the papers in this collection recall childhoods at a moment of vulnerability when objects reassured. This clear vocation should not give objects a bad name. We should ally ourselves with what objects offer: they can make children feel safe, valuable, and part of something larger than themselves. These essays demonstrate that objects can become points of entry to larger, transformative experiences of understanding, sociality, and confidence, often at the point of being shared.

In his memoir, *Uncle Tungsten,* neurologist Oliver Sacks describes the importance of old family photographs taken in London during World War II to his developing sense of scientific identity. They provided him, at a vulnerable point in his life, with a sense of stability by giving him objects to catalogue: "They seemed to me like an extension of my own memory and identity, helped to moor me, anchor me in space and time. . . . I pored over old photos, local and historical ones as well as the old family ones, to see where I came from, to see who I was."[36]

The photographs bring more than a sense of identity and history. They are "a model, a microcosm, of science at work." Sacks explains how they provide him with a grasp of a scientific sensibility, and that of a "particularly sweet science, since it brought chemistry and optics and perception together into a single, indivisible unity."[37]

It seems wise to attend to scientists telling the story of their romance with objects. Memoir encourages us to make children comfortable with the idea that falling in love with things is part of what we expect of them. It moves us to introduce the periodic table as poetry and radios as a form of art. Writings that describe the birth of scientific identity make for a deeper appreciation of its nature. Understanding how scientists are made can help us to make more science. Scientific memoir should be part of science education. There, memoir should be written and memoir should be read.

See more of Falling for Science: Objects in Mind on Facebook. Log In. or. Create New Account. See more of Falling for Science: Objects in Mind on Facebook. Log In. Forgotten account? Introduction: falling for science. (pp. 3-38). Sherry Turkle. This is a book about science, technology, and love. An eight-year-old sits braiding the hair on the tail of her My Little Pony doll, completely absorbed in the job.Â I immediately fell in love. Within a year, I saved and borrowed enough to buy my own. In short succession, I would lose my girlfriend, spend over a hundred dollars on a monthly phone bill, have my grades drop to Cs and then have them come back to As, and grow closer to my brother without his knowing it.