

DRAWING AS A WAY OF KNOWING IN ART AND SCIENCE, GEMMA ANDERSON (2017)

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Gemma Anderson's *Drawing as a Way of Knowing in Art and Science* takes us on a guided tour of her collaborations with scientists and mathematicians. On the way, we see stunning and illuminating illustrations, we meet a panoply of artists, mathematicians, scientists, philosophers, art historians and more, and we witness the processes of discovery and insight that happens through drawing.

The first thing to notice is Gemma Anderson's drawings are exquisite. The second, her reflections and those of others she brings into the discussion are a cascade of insights. I have to resist quoting both. Drawing is a way of knowing – for whom, I asked, impertinently (but silently), the drawer or the viewer? As I read I realized the question was not just impertinent but off-key; it's for both, a way of expressing tacit knowledge so hers or theirs become yours. Drawing and looking and thinking, again and again for the drawer, and looking and thinking, looking and thinking for the viewer. Drawing is like walking, each makes lines, on the page or in the world. The lines are not necessarily straight; they can wander, they can go this way and that, configuring and reconfiguring. Lines are pathways, not just for the feet or the hand or the eye, but for the mind, pathways from one idea to another.

Anderson takes us on one of the winding paths, an annotated tour stopping at each of her recent projects. Like an unfinished drawing, the path is sometimes rocky, sometime well-paved, the scenes we view vary, some refined, some rough. On the way, we meet scientists and mathematicians, we listen to her and to her collaborators. We also hear voices from the past, philosophers and artists and poets and art historians, brought in where they have, unwittingly, something to say on the current matter. We watch collaborations and workshops as they unfold, we see what they create and we reflect on their insights. And on Anderson's, elucidated and framed by her voracious reading. The journey is choppy, a smorgasbord, not a carefully orchestrated six-course meal; it's personal and particular and idiosyncratic, yet somehow universal.

Anderson's practice is an art in itself, in part guided by wisdom from experience, in part improvisation, and altogether, a work in progress. She is fascinated by the ways science and math are depicted, following a long line of luminaries and legends like Da Vinci, Ramon y Cajal, Hardy, Audubon, Netter, and Feynman. Like them, she firmly believes that the drawings go far beyond illumination; they are thinking tools, critical to discovery and understanding. She fosters collaborations

with scientists and mathematicians that create both new science and new art. She shows you the intertwined processes, the thinking with the drawing. She expands the discussion with the insights of others, brought in at just the right time. Chapter Two, 'On drawing practice in science', recounts two such collaborations. The first is with biologists who draw to show what is visible, what they see and, crucially, what is important to see. The second is with topologists and a biologist, who draw to show what is invisible, what they think and what they want to say. The biologists drew the rhythmic hierarchical structure of the shells of new species of tiny crustaceans. They drew to understand the structure and to show it to each other and to us. Each drew it differently (hmmm, why?), raising comparisons and new thoughts. Photos cannot do the job. In photos, it is impossible to show the stunning patterns of layers inside layers that drawings can reveal. There is too much else in the photo to see that. What's more, you do not really see what you are looking at until you draw it. Then the startling scientific conclusion: a species cannot be defined solely by its DNA; you have to know what it looks like.

The next project, on showing the unseeable, began with a pair of topologists desiring to classify atomic but complex, downright weird, geometric forms. Pushed aside for later in the book are Anderson's visual notes on the development of the collaboration, delightful diagrams unfortunately too small to work through. The classification system of the geometric objects is abstruse and technical and thus not elucidated, but the drawings, the visualization, of it are beautifully suggestive. The drawings raise issues at the heart of enterprise: what similarities of form does the eye perceive? Do these superficial similarities signify deeper meanings? Indeed, the meaningless topological forms gain meaning when applied to forms of DNA by the biologist.

Many have observed that drawers have conversations with their sketches, conversations between the eye and the hand and the mind, conversations that are wordless. Words positively get in the way of that kind of thinking. Anderson extends that analysis. She splits the mind from the hand and the eye, personifying the conversation as between a thinker and a drawer, jointly, iteratively forming an idea. The topologists carry the conversation with drawings a crucial step further, as a way of conversing with a biologist working with similar forms. The drawings are crucial because the scientists share no other common language other than the forms they are creating on the page. The perspectives and the terminology of topology and biology are too different to bridge; the drawing is the bridge (here I resist a pun).

These are more than tasty appetizers. Next is the project dearest to Anderson, isomorphology, finding common forms across animal, vegetable, and mineral. This is a well-trodden path: all science begins with observation, then abstraction and classification, grouping like things and separating them from unlike things, where the initial likenesses are on the surface, visible and so often forms. The eye quickly finds those likenesses and the eye quickly finds forms, wholes that signify integrity. The likenesses and forms are abstractions, good Gestalts: shapes, simple geometric patterns,

symmetries, spirals, branchings, repetitions. Art captures them, analogies and metaphors are based in them, religion mystifies them and mysticism exalts them. Anderson's airy delicate etchings of creatures and plants that share forms are a celebration of those similarities suggestive of commonalities, and a meditation for us.

Next, she veers from the present, turning to Goethe. Goethe deeply believed that the natural world had essences, that those essences were expressed in form, and that observation and art, in particular, drawing, could reveal them. Goethe spent years observing nature and studying art. He drew almost compulsively, believing his thoughts were captured in his drawings. Goethe's ideas inspired a series of successful drawing workshops Anderson conducted for scientists and artists as well as the general public, in museums in the United Kingdom and Germany. Anderson turned her reflections on Goethe's into a method for drawing: first, close observation, then close description in words to focus the observation, and finally, drawing.

But these delightful and suggestive superficial similarities of form can simply be coincidences, and misleading ones at that. Something basic is missing: the processes that form the forms. Can the similar external forms suggest similar underlying processes? Do the circles of the sun and the moon and the trunk of a tree and the pupil of the eye signify the same generating process? What are the processes that form the forms? From Goethe, Anderson turned to Klee, who was obsessed with the dynamic transformations that create the static forms. Like Goethe, Klee pursued the prototypic and primordial. Like Goethe, Klee was convinced that drawing is key, the empirical method to reveal the transformations that create the primitive and universal forms. A Klee exhibit at the Tate Modern led to a meeting with the curator and a deeper analysis of Klee. Klee, like Goethe, was a close observer of nature, and fascinated by the genesis of plants and animals. Like Goethe, he believed that change was the constant state of nature. Like Goethe, he believed that drawing was the method for seeing and understanding constant metamorphosis. Significantly, Klee was a walker as well as a drawer. Both took him frequently to Goethe's garden and house in Weimar, where many of Goethe's drawings were on display. The chapter is amply illustrated with Klee's stunning pictures. Anderson guides us through them, showing that they are serious investigations of regularities of morphogenesis as well as joyous art.

An idea is a rough essence, a raw hunk of marble waiting to be carved. The sculptor begins chipping, driven by that idea, as yet only vaguely formed. The sculptor chips and inspects and ponders, then chips and inspects and ponders again; the idea and its form emerge in harmonious unison. Nature, each kind and variety, driven by its essence, forms and transforms as it emerges and changes in the world.

There is much more, but I hope that this spare buffet from her smorgasbord will whet your appetite for the more. It is a delightful feast and a journey of delights. At the end, you will wish you had more walls, to hang her drawings, and more shelves to hold her sculptures. And you will reach for a

pencil and paper, with gusto. Unlike a feast, from which you gladly leave the food, the smorgasbord of drawings leaves you hungry to do and to look.

Contributor details

Barbara Tversky is a cognitive psychologist who has done research in memory, categorization, spatial thinking and language, event perception and cognition, visual–spatial communication, gesture, creativity, art, and design. She has enjoyed collaborations with linguists, neuroscientists, philosophers, computer scientists, domain scientists, artists, musicians and designers. Currently, she is professor of psychology at Columbia Teachers College and professor of psychology emerita at Stanford University. She was educated at the University of Michigan and previously taught at the Hebrew University in Jerusalem. She has served on numerous editorial boards, governing boards and programme committees, won awards for teaching and software, and is a fellow of the Cognitive Science Society, the Association for Psychological Science, the Society for Experimental Psychology, and the American Association of Arts and Sciences. She is President-Elect of the Association for Psychological Science.