Being Linked to the Matrix

Biology, Technology, and Writing

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Edward Hoagland writes:

> I'd lie on my back on a patch of moss watching a swaying poplar's branches interlace with another's, and the tremulous leaves vibrate, and the clouds forgather to parade zoologically overhead, and felt linked to the whole matrix, as you either do or you don't through the rest of your life. And childhood—nine or ten, I think—is when this best happens. It's when you develop a capacity for quiet, a confidence in your solitude, your rapport with a Nature both animate and not much so: what winged things possibly feel, the blessing of water, the rhythm of weather, and what might bite you and what will not. (49–50)

Perhaps it was because my father is a fisheries biologist and we spent a lot of time on lakes when I was a child that I know this feeling of being linked to the whole matrix and that it is deeply sedimented into my thinking about all aspects of life. In 1986 I published an article about the ecology of writing in which I struggled to articulate my sense that writing is social action, not simply an activity that takes place in a social context. I hoped to encourage a view of writing and writers as fully engaged in social practices: I wanted to emphasize how writers and writings shape their social environments and are shaped by them in a manner analogous to the way organisms interact with their environments. It was also around 1986 that some of the classic expositions of complex systems theory were coming out: the first English edition of Benoît Mandelbrot's *The Fractal Geometry of Nature* (1982), Ilya Prigogine and Isabelle Stengers's *Order Out of Chaos* (1984), Terry Winograd and Fernando Flores's *Understanding Computers and Cognition* (1986), and Humberto Maturana and Francisco Varela's *The Tree of Knowledge* (1987). Although I did not read these works until much later, I was

aware of chaos theory (through the popular account *Chaos: Making a New Science*, by James Gleick, published in 1987), and after the publication of my article I increasingly thought that the systems of writing are not just analogous to ecological systems but are driven by the same principles. In meetings at the Los Alamos lab, the Santa Fe Institute, MIT, and the University of Illinois, researchers in the diverse fields of economics, physics, biology, cybernetics, mathematics, and meteorology were coming to similar conclusions. The challenges of investigating chaotic phenomena blurred the boundaries between disciplines and between the realms they studied. I, too, believed that once social phenomena such as writing were viewed as complex systems, the distinction between nature and culture would come into question, just as the related dualities of mind and body, subjectivity and objectivity, had. When I read about autopoetic systems, I felt as though someone was explaining something I implicitly knew, or, as Merleau-Ponty says about reading Husserl or Heidegger, as though I was "recognizing what [I] had been waiting for" (viii). When I finally read Gregory Bateson's *Steps to an Ecology of Mind* (which I had owned, unread, almost since it was published in 1972) and Maturana and Varela's *The Tree of Knowledge*, I found my nascent vision of writing as a web clarified and expanded in Bateson's idea of mind as "immanent in the total interconnected social system and planetary ecology" (461) and in Maturana and Varela's claim that "we humans, as humans, exist in the network of structural couplings that we continually weave through the permanent linguistic trophallaxis of our behavior" (234).

The study of complexity, originating around the early twentieth century,[1] has grown exponentially in the past three decades. Proceeding under various titles—chaos, complexity, emergence, autopoesis, self-organization—this research has generated new understandings of, among other things, brains, fractals, thermodynamics, ontogeny, software, ecosystems, synchronicity, and communication and economic systems. It is also drawn on increasingly in theories of virtual humanism and network culture, as in the work of Mark Hansen, Katherine Hayles, and Mark Taylor. At the same time, cognate understandings of systems developed in the work of phenomenologists Heidegger and Merleau-Ponty, as well as in related theories of Bergson, Wittgenstein, Deleuze and Guattari, Bourdieu, Giddens, Latour, and Bakhtin, as well as Edwin Hutchins in distributed cognition and Jean Lave and Etienne Wenger in situated learning, among others.[2] My reading in all of these theories (see fig. 1.1) increasingly led me to the conclusion that writing is not a matter of autonomously intended action on the world, but more like monitoring, nudging, adapting, adjusting—in short, responding to the world.

Although few researchers have explicitly applied complexity theory to writing,[3] several groups of researchers in rhetoric, composition, and literacy studies, working from some of the related theories just mentioned, have offered understandings of writing as a dynamic and interactive system. Members of the New

Fig. 1.1 Source theories

London Group, many of whom have backgrounds in social theories of meaning and language, envision language systems as structured by the interactions of users; compositionists such as Charles Bazerman, David Russell, and Paul Prior draw on activity theory to conceive of writing as a means of making and transforming social worlds; and Victor Vitanza and his "third sophistic" followers derive a vision of writing as an embodied and open system from their readings of Nietzsche and Deleuze and Guattari. My approach to writing differs from theirs primarily in my emphasis on writing as arising from responses to others and to social and physical environments, responses that involve both body and mind and are only partly and sometimes intentional.

The New London Group and activity theorists both see writing as predominantly an intentional cognitive process. The New London Group acknowledges that "the human mind is embodied, situated, and social" (30) and that "immersion in a community of learners" is necessary for learning literate practices (31), but they argue that "conscious control and awareness of what one knows and does" and the ability to "critique what they are learning" are crucial to the activity of writing (32). Activity theory recognizes a large role for tacit consciousness in writing, but activity theorists, like the New London Group, focus on writing as a conscious cognitive process. Bazerman and Russell argue, "Things human exist in an evanescent world held up by focused consciousness and attention and activity" (1). The emphasis on consciousness in activity theory can be traced to the Marxian assertion of fundamental differences between humans and other animals. Vassily Davydov explains, "In the process of human anthropogenesis, a break occurred between organic needs and the

means of satisfying them, that is, human beings lost their instincts" (49). In place of instincts, humans use social forms of activity to satisfy their needs, and consciousness supplies the "internal images" that link need and goal: it is "people's ideal images that make it possible to foresee the product" (40). But theories and studies of cognition in animals, beginning in the early twentieth century with Uexküll and continuing to the present (see Csányi, Griffin, and Hauser), as well as contemporary studies of human cognition, have undermined any notion that humans have lost their instincts or that the link between need and goal is determined by ideal internal images.

Vitanza, in contrast, seems to envision writers as merely channeling writing. His emphasis on the fluidity—the flow—of writing turns it into an autonomous Nietzschean life force that animates human agents who are largely or entirely unconscious of its desires. Writers are not understood to be making choices, but are driven to write. Vitanza says, **"What writing . . . wants is a writer! . . . A body filled with tics that cannot but (not) write!"** (4), a statement highly reminiscent of Barthes's idea of the death of the author—"the author is never more than the instance writing" (145). Although Vitanza's understanding of writing as engaging the body is a good corrective to the idea that writing is dominantly cognitive, he seems to acknowledge no role for intentional response.

In this essay I argue that writing is an embodied interaction with other beings and our environments. As a result, writing is as much a biological as a cultural practice: the practices that are writing emerge as people respond to others and to their world; they are not the product of minds somehow separated from bodies nor of innate technical or linguistic abilities. Furthermore, I argue that writing and technology are cognate practices. Arising as an epiphenomenon of engaged action in the world, tools and words play the same role in our lives. As concrete objects that can be manipulated and can store information, tools and words extend cognitive processes beyond the individual brain. Other beings can also be recruited in the same way, as dogs extend the abilities of shepherds to control sheep and editors extend the abilities of writers to consider other perspectives. As I use the term, writing often describes both linguistic and technological practices, practices that function to elaborate cognitive ecologies such as those that make sheep herding and publishing possible. Writing in this sense is what makes us human. The extent of our abilities to elaborate cognitive ecologies may set us apart from other animals, but no nonbiological source is needed to account for our abilities, an argument buttressed by evidence that other animals share many of the same abilities. Neither language nor technology is foreign to our nature; tools and words are us, not things we create and use.

To get a sense of what writing looks like from this perspective, consider these examples. First, the use of DEVONthink by professional writer Steven Johnson. DEVONthink is sophisticated indexing software that works on an archive of

the writer's writings and notes and excerpts from the writer's reading; Johnson explains that it not only searches on specific words but also "learns associations between individual words, by tracking the frequency with which words appear near each other." He describes how in working on a book project involving the history of the London sewers, he ran a search on "sewage." Among the results, he also received references to "waste," a word that often occurs with "sewage," including a quote about how calcium waste products were repurposed into bones in the evolution of vertebrates.

> That might seem like an errant result, but it sent me off on a long and fruitful tangent into the way complex systems—whether cities or bodies—find productive uses for the waste they create. It's still early, but I may well get an entire chapter out of that little spark of an idea.
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> Now, strictly speaking, who is responsible for that initial idea? Was it me or the software? It sounds like a facetious question, but I mean it seriously. Obviously the computer wasn't conscious of the idea taking shape, and I supplied the conceptual glue that linked the London sewers to cell metabolism. But I'm not at all confident I would have made the initial connection without the help of the software. The idea was a true collaboration, two very different kinds of intelligence playing off each other, one carbon-based, the other silicon.

Here is a second example. A group of students in a writing class make a documentary video reporting their research on the Paulding light, a well-known mystery in the Upper Peninsula of Michigan. Their research involves a trip to the site, where, using their cell phones and a GPS unit, they establish that the light comes from headlights on a highway in the distance, and they use a video camera to record their observations and commentary. Although their teacher might be tempted to exclaim at their cleverness in using all that technology, for them the cell phones, GPS unit, and video camera simply come to hand as part of the already-established consensual domain of these extensively mediated and technologized students, students for whom nearly continual communication with others, never being lost, and being immersed in images of their own and others' making has been a way of life. Through their actions, extended in their prosthetic technologies, they create the world as knowable, a world in which there are no obstacles to ascertaining precise positions and exchanging words and images and in which, as a consequence, there are no mysteries.

These examples illustrate three points I want to make about writing considered as a biological/cultural, linguistic/technological practice. First, notice that in the process of writing, words and tools do not normally arise as separate objects to be used but are experienced as part of our bodies and brains; they are, as Heidegger says, ready-to-hand, not present-at-hand. Steven Johnson experiences the

genesis of the idea of how complex systems repurpose wastes as a collaboration between him and the indexing system, a productive interaction between carbon- and silicon-based intelligences; and in both examples, the technologies of DEVONthink, GPS unit, cell phones, and video camera are as much a part of the writers as their hands and eyes. Second, writing is not just autonomous social action but always an interaction with other beings and objects in our surroundings, an ongoing process of stimulus and response that we habitually misconceive as autonomous planned action. The "errant result" returned by DEVONthink stimulated Johnson to think in different ways about waste, and the teacher in the second example credits the students with bright ideas about using technology to achieve their goals that probably never entered their conscious minds. Third, writing is a complex system organized by dense interactions of writers and their worlds. DEVONthink, like all of the technologies of propagating and indexing writing, amplifies and makes visible these dense interactions out of which invention arises. And the students "use" "communication" technologies to investigate the Paulding light because through interactions with one another and their worlds they have become habituated to how these technologies abolish distance, and they thus experience (and expect) all people and places to be always accessible.

Words and Tools Arise from Interaction

Neither words nor tools exist prior to or separately from human action. They arise as an epiphenomenon of that action and are continually reconfigured or reinterpreted as they arise again in different situations. Perhaps the best-known enunciation of this understanding of language is Wittgenstein's in *Philosophical Investigations.* Disputing Augustine's contention that the meaning of a word is what it stands for, Wittgenstein argues that the meanings of words arise from their use in social interaction. He imagines a simple protolanguage used by a builder and his assistant: "A is building with building-stones: there are blocks, pillars, slabs, and beams. B has to pass the stones, and that in the order in which A needs them. For this purpose they use a language consisting of the words 'block,' 'pillar,' 'slab,' 'beam.' A calls them out;—B brings the stone which he has learnt to bring at such-and-such a call" (sec. 2).

Wittgenstein argues that this language is learned by training B to respond to the words in particular ways. He asks, "Don't you understand the call 'Slab!' if you act upon it in such-and-such a way?" (sec. 6). B has learned the use of the words and that is all he needs to know to understand and play this language game. Wittgenstein asks, "Now what do the words of this language *signify?*" and answers with another question, "What is supposed to shew what they signify, if not the kind of use they have?" (sec. 10). He concludes that "the *speaking* of language is part of an activity, or of a form of life" (sec. 23).

Paleoanthropologist Alison Wray advances a similar theory of the origin of language in what she calls a protolanguage that consisted of holistic utterances that later developed into referential symbols. More along the lines of Wittgenstein, another anthropologist, Tim Ingold, argues that in use, language never "advances" to the level of the referential. Drawing on Merleau-Ponty's idea that "there are no conventional signs, . . . there are only words into which the history of a whole language has been compressed" (qtd. in Ingold, "Tool-Use" 435), Ingold points out that writers are always immersed in a meaningful relational world and that far from being founded in convention, "*words gather their meanings from the relational properties of the world itself*" (Ingold, *Perception* 409).

Animal behaviorists observe that animal communication also seems to emerge from interactions with others and with their surroundings rather than from acts of referring. A much-examined example is the alarm calls of the vervet monkeys in Africa. Vervet monkeys give one of three types of calls when they see one of their three main predators—leopards, eagles, and snakes—and, like Wittgenstein's builder's assistant, the monkeys respond to these calls with different kinds of behavior. In response to the leopard call, they climb into trees; in response to the eagle call, they dive into bushes; and in response to the snake call, they stand up and look around (Griffin 158). Thus animal behaviorists conclude that the calls might better be translated in behavioral rather than referential terms: for example, "behave in a way to escape a leopard," rather than "there's a leopard."

Chilean biologist Humberto Maturana elaborates these ideas in his argument that language is not a symbolic system or an instrument of communication but a result of the coordination of behavior. Conceiving of language as an instrument of communication is misleading in that it mistakes the result for the cause, as he explains: "Human beings can talk about things because they generate the things they talk about by talking about them. That is, human beings can talk about things because they generate them by making distinctions that specify them in a consensual domain" ("Biology" 56). What Wittgenstein calls language games Maturana calls "the flow of coordination of behaviors" ("Nature" 462) that results in the establishment of a consensual domain, a taken-for-granted world that arises in the interaction. He offers an example of a woman hailing a taxi by meeting the gaze of a taxi driver and making a circular hand gesture, a learned coordination of the behaviors of getting attention and committing to hiring. In this coordination of behaviors, the taxi arises as a means of transportation. In other domains the taxi may arise as something else—an art object, say—or may not be individually distinguished—if it arises as part of a traffic jam, for instance. Such domains of interobjectivity are consensual not in the sense of being agreed upon, but in the sense of a "coherent transformation of behavior of two or more organisms as they live together, [which] occurs as an unintended

result of that living together" ("Nature" 463). In sum, Maturana says, "We literally create the world in which we live by living it" ("Biology" 61).

Ingold extends this argument to tools. He contends that "tools—like words—are used to mediate an active engagement with the environment rather than to assert control over it. Meaning, thus, is not imposed on the world but arises out of that engagement" ("Tool-Use" 433). Just as Wittgenstein and Maturana see the meaning of words as arising in their use, Ingold sees the purpose of tools as arising in their use. He says, "An object—it could be a stone or a piece of wood—*becomes* a tool through becoming conjoined to a technique. . . . Thus the tool is not a mere mechanical adjunct to the body, serving to deliver a set of commands issued to it by the mind; rather it extends the whole person" ("Tool-Use" 440). Consider again in this context how indexing tools like DEVONthink enable a writer's invention and how the notion of an index itself arose out of the practice of collating instances of sign use.

Thirty years earlier, in 1964, French paleoanthropologist André Leroi-Gourhan made much the same observation about tool use by early human ancestors: "We perceive our intelligence as being a single entity and our tools as the noble fruit of our thought, whereas the Australanthropians, by contrast, seem to have possessed their tools in much the same way as an animal has claws. They appear to have acquired them, not through some flash of genius which, one fine day, led them to pick up a sharp-edged pebble and use it as an extension of their fist (an infantile hypothesis well-beloved of many works of popularization), but as if their brains and their bodies had gradually exuded them" (106). The discovery of tool manufacture and use in human ancestors who had yet to acquire the proportionally giant brains of *Homo sapiens* argues against the development of technology as a conscious mental achievement, a matter of inventing a tool for a particular use. Instead, tools seem to have arisen out of physical and kinetic coordinations between agents and their environment—they result from actions of shaping rather than being instruments designed for shaping.

Writing Is Interaction

Writing is always an interaction with other beings and objects in our surroundings, an interaction that we habitually misconceive as autonomous action that begins in our minds. The idea that words and tools are "the noble fruit of our thought," invented to serve a specific purpose, is a correlate to our tendency to interpret our ideas for book chapters or production of a video research report as the result of intentions and plans arising autonomously in our minds rather than as arising from interactions with our surroundings. According to this view, all we need to create texts is linguistic, rhetorical, and technological cognitive abilities. Tim Ingold targets this idea, "the assumption that for people to speak they must first 'have' language, or for people to use

tools they must first 'have' technology—or indeed for people to engage in intelligent activities of any kind they must first 'have' intelligence" *(Perception* 407), as preventing us from understanding that "skill . . . is a property not of the individual human body as a biophysical entity, a thing-in-itself, but of the total field of relations constituted by the presence of the organism-person, indissolubly body and mind, in a richly structured environment" (353).

That skill is based in intelligence is such a common assumption that the headline on a report of tool use among New Caledonian crows in *USA Today* (Friend) reads: "Crows exceed expected intelligence levels," a conclusion not really borne out in the story. In experiments conducted at Oxford University, Betty, a female crow, and Abel, a bigger, dominant male, were faced with a piece of meat in a tube and given a hook and a straight piece of wire; both crows quickly chose the hook and used it to get the meat. More interesting, when Abel stole Betty's hook, she made a hook out of a straight wire and continued to get food. When retested with just straight wires, she made a hook nine out of ten times. Experimenters did not test Abel for this ability, because "dominant males employ more efficient, though perhaps less clever strategies: They wait until the work is done and steal the food from subordinates." Betty and Abel achieve these feats not because they have technological or social intelligence but by interacting with their surroundings in ways that benefit them. Consider again, in this connection, how the students created the documentary video about the Paulding light by interacting with one another in their extensively mediated and technologized environment.

As examples of skill as a matter of organisms interacting with their surroundings, Ingold uses the weaving practiced by Telefol women in central New Guinea and by male weaverbirds. He emphasizes not only how weaving engages bodily movement and perception with properties of materials and characteristics of the surroundings in an interactive system but also how important practice in these interactions is in developing the skill. The weaving of string bags by the women and of nests by the birds both involve collection and preparation of appropriate materials and complicated knot making, none of which can be achieved without active engagement with the materials over time. Just as children and young birds babble sounds as a prelude to speaking and singing, Telefol girls and young male weaverbirds play with fibers to develop their facility with them. Weaverbird nests are attached to branches by "a variety of stitches and fastenings" that involve a tricky operation of "threading the strip [the bird] is holding under another, transverse one so that it then be passed over the next" (*Perception* 358–59). Ingold comments: "Mastering this operation calls for a good deal of practice. From an early age, weaverbirds spend much of their time manipulating all kinds of objects with their beaks, and seem to have a particular interest in poking and pulling pieces of grass leaves and similar materials

through holes. . . . Experiments showed that birds deprived of opportunities to practise and denied access to suitable materials are subsequently unable to build adequate nests, or even to build at all" (359).

Similarly, when a Telefol girl made a hopeless mess in trying to complete a string bag her mother had started, her mother told her, "You must practice to get the proper feel of looping" (356). Ingold, commenting too on attempts he and his colleagues made to learn complicated knots by following written instructions and diagrams, concludes: "It seems, then, that progress from clumsiness to dexterity in the craft of [weaving] is brought about not by way of an internalization of rules and representations, but through the gradual attunement of movement and perception" (357). Understanding skill as an interactive achievement of organisms and their environments rather than as a flash of genius—as Gregory Bateson so famously argued—emphasizes the importance of playing around with stuff (pieces of wire or grass, string, words, cell phones, computer programs) in any kind of production or invention.[4]

Writing Is Response

Writing engages writers in a complex system that is structured by their responses to one another and to the environments created by those responses. Stephen Jay Gould called this process cultural evolution, remarking on how it proceeds so much more quickly than biological evolution, but I am arguing that both cultural and biological evolution are kinds of co-evolution, or what Maturana and Varela call structural coupling, a process through which beings whose interactions are recurrent and stable undergo "mutual congruent structural changes" (75). The examples of simple tools and languages already demonstrate how animals, including humans, change themselves and their environments through coordinated action. But with humans both the interactions and the changes are more extended and elaborate.

Bruno Latour, who argues memorably in his book *We Have Never Been Modern* that we have never escaped nature but have continually recruited it into hybrids, complicated nets of meaning and action, defines human co-evolution as a process of delegation, a "transcendence that lacks a contrary" because nothing is left behind: "The utterance, or the delegation, or the sending of a message or a messenger, makes it possible to remain in presence—that is, to exist. When we abandon the [assumptions of modernity], we do not fall upon someone or something, we do not land on an essence, but on a process, on a movement, a passage—literally a pass, in the sense of this term as used in ball games. . . . The world of meaning and the world of being are one and the same world, that of translation, substitution, delegation, passing" (129). Much as members of the New London Group see the Designer as one who refashions Available Designs into the Redesigned, Latour sees the human as "a weaver of morphisms," the

mediator between subject and object, continually rearticulating those extended nets of meaning and action (137).

In concurrence with Latour, Andy Clark sees being human as a process of transformation, and especially self-transformation that is enabled by humans' "natural proclivity" for elaborating cognitive ecologies: "It is our natural proclivity for tool-based extension, and profound and repeated self-transformation, that explains how we humans can be *so very special* while at the same time being not so very different, biologically speaking, from the other animals with whom we share both the planet and most of our genes. What makes us distinctively human is our capacity to continually restructure and rebuild our own mental circuitry, courtesy of an empowering web of culture, education, technology, and artifacts" (10). Leroi-Gourhan also identified a natural proclivity for tool-based extension with what makes humans special, observing that human tools include symbols: "Humans, though they started out with the same formula as primates, can make tools as well as symbols, both of which derive from the same process or, rather, draw upon the same basic equipment in the brain. This leads us to conclude, not only that language is as characteristic of humans as are tools, but also that both are the expression of the same intrinsically human property" (113).

Jacques Derrida applauds Leroi-Gourhan for refusing to trace the origin of the human only to symbolic language, but, along with Latour and Clark, Derrida sees this "intrinsically human property" more as a process, describing it as "a stage or articulation in the history of life" (84), what he calls "différance." Derrida explains, "Instead of having recourse to the concepts that habitually serve to distinguish man from other living beings (instinct and intelligence, absence or presence of speech, of society, of economy, etc. etc.), the notion of *program* is invoked" (84), a notion that links the biological (genetic programs) with the technological (electronic programs). The emergence of the written sign, like the emergence of the tool, marks the emergence of "a 'liberation of memory,' . . . an exteriorization always already begun but always larger than the trace which, beginning from the elementary programs of so-called 'instinctive' behavior up to the constitution of electronic card-indexes and reading machines, enlarges différance and the possibility of putting in reserve" (84). Writing creates distinctions through a process of exteriorization and reification, liberating memory by turning ideas and actions into objects that can be passed to others, as Latour says, to be reinterpreted and rearticulated into new practices.

But, again, we do not simply use writing as a system extrinsic to our being to pass on our ideas and cultural practices. It is a system we are involved in, that we create in our living and that re-creates us in an ongoing way. Words and tools liberate memory not through being a record of past thoughts but by providing what Clark calls problem-solving artifacts or cognitive shortcuts that "effectively

transform complex problems into ones that the biological brain is better equipped to solve" (77).[5] By now, it should not be surprising to realize that animals other than humans have these shortcuts and can be taught some of our shortcuts too. Clark describes a study that illustrates how abstract thinking is enabled by manipulating symbols. Chimpanzees were taught to associate a particular shape (a circle, for instance) with any pair of identical objects (two roosters) and a different shape (a triangle, for instance) with any pair of different objects (a rooster and pencils). They could then solve the more abstract problem of telling whether two pairs of paired objects were the same or different (see fig. 1.2): two pairs in which one pair contains identical objects and the other pair contains different objects are represented by different shapes (a circle and a triangle, respectively), and thus the pairs can be seen to be different, whereas two pairs in which each object in the pair is different from the other are each represented by the same shape (two triangles), and thus they can be seen to be the same. Just as the shapes make a concept (sameness, difference) into an object that can be manipulated and reinterpreted, words and tools enable us to play around with "stuff" and create new patterns, and then to use those new patterns to create others in levels of increasing complexity.

Clark argues that humans are "natural born cyborgs": "One large jump or discontinuity in human cognitive evolution seems to involve the distinctive way human brains repeatedly create and exploit various species of cognitive technology so as to expand and reshape the space of human reason. We—more than any other creature on the planet—deploy nonbiological elements (instruments, media, notation) to *complement* our basic biological modes of processing, creating extended cognitive systems whose computational and problem-solving profiles are quite different from those of the naked brain" (78). Clark's idea of extended cognitive systems is inspired by Edwin Hutchins's oft-cited study of navigation as an expert system in which "a good deal of the expertise in the system is in the artifacts (both the external implements and the internal strategies). . . . The system of person-in-interaction-with-technology exhibits expertise" (155), which, in turn, derives from Bateson's idea of "a flexible organism-in-its-environment" (451).

Teaching with Technology

There are many implications for teaching writing, and especially for teaching writing with technology, of this vision of the human as a natural-born cyborg, and if you are attuned to the possibilities, you have undoubtedly already come up with many ideas about how to apply it in your own teaching. Thus I will not venture to compile a list of strategies, but I would like to briefly suggest how understanding writing in this way might alter how we think about teaching with technology. One important difference lies in how we encourage students to approach the rhetorical situation. Writers are never separate from the rhetorical

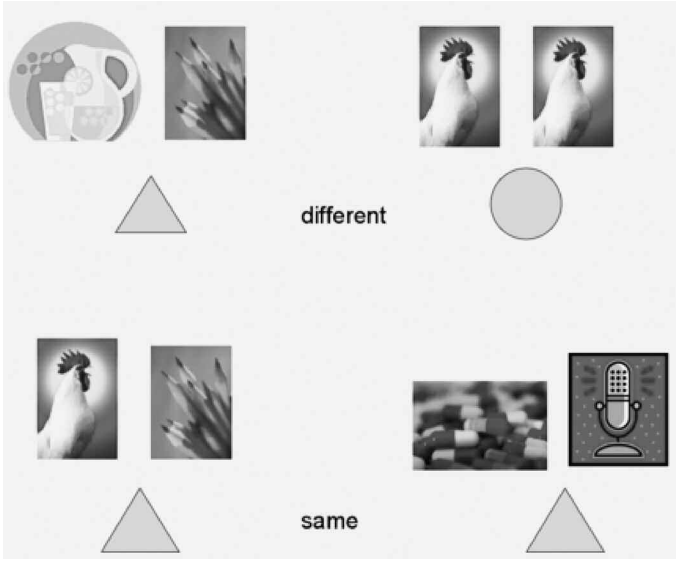

Fig. 1.2 Cognitive shortcuts

situation in which they write. They do not study the situation as something apart from them and then create in a vacuum a text that will change the situation; instead, they fully engage in the situation and respond to it. Anne Wysocki has argued that because a design approach to creating communications "has been tied to the development of useful (instead of readable) objects, it tends to foster a more concrete and bodily sense of audience, purpose, and context," and because designers tend to experiment to find what works, "by exploring and testing possibilities, they are more likely to develop what fits" (69). Understanding writing as embodied, as biological and technological as well as social and cultural, means taking a design approach to creating texts and encouraging students to do so.

Another difference is that, as Elizabeth Ellsworth and Jean Lave and Etienne Wenger have pointed out, teaching a skill is not simply a matter of detailing rules, procedures, and strategies. The direct transmission model of teaching remains influential in writing pedagogy and can lead teachers to overvalue "systematic, analytic, and conscious understanding" and undervalue practice (New London Group 35).[6] In discussing the challenges of teaching multimodal composition, Cynthia Selfe comments that in contrast to students assigned alphabetic essays who can rely on a robust understanding of written English acquired through immersion and direct instruction, students assigned audio and visual essays, "although they have been immersed in media-rich environments . . . may not have had any *direct* instruction in the genres of multimodal composing or the compositional elements that make up such genres" (17). Alhough her emphasis

here on direct instruction suggests that the resources for teachers offered in this edited collection might consist of definitions of multimodal genres and their elements, the chapters that follow instead recommend experimentation and open-ended and flexible assignments. Understanding the acquisition of writing skills as a matter of gradual attunement of movement and perception that comes dominantly through practice, a lot of playing around with stuff, helps us remember that what students lack most when faced with audio and visual essay assignments is any experience—and practice—in producing such texts.

In closing, here are a few more examples, drawn from Stuart Selber's discussion of functional computer literacy, of how encouraging students to engage with rhetorical situations and technologies leads to the emergence of capabilities that are not individual but rather the property of cognitive ecologies—organism-persons interacting in richly structured environments. As with the examples drawn from Wysocki's and Selfe's work, Selber's discussion evinces a tacit understanding of writing as an emergent, embodied response, an understanding I am simply trying to make more recognizable. Selber argues that teaching functional computer literacy involves enabling students to deal with educational goals, social conventions, specialized discourses, management activities, and technological impasses, and he describes some activities he finds most useful to "help programs and teachers develop their own" activities (475). The activities he suggests are described as explicit procedures and strategies, but they can be framed more productively to engage students in the systems of working with computers.

For example, to help students understand social conventions of computer use, he asks them to use a taxonomy of types of unacceptable behavior to analyze the conventions of a newsgroup they are interested in. He cautions, however, that the assignment can lead students to overgeneralizations about the norms for behavior in all newsgroups, norms that have actually proved to be highly localized and "still in a somewhat embryonic state" (483). If, instead of asking students to objectively analyze a system from the outside, we ask them to think about their own engagement in an interobjective system, students can understand how norms emerge from users' coordinating their behaviors to achieve benefits. Thus we might ask students what they like about a particular newsgroup they participate in and what behaviors enhance or detract from their enjoyment or benefit. Asking students about what kinds of behaviors draw complaints from other users (and, more important, why) and how these behaviors conflict with the purposes of the newsgroup focuses their attention on the purpose or value of a particular interaction in a particular context and how certain behaviors create ongoing consensual domains that offer specific benefits to users. How computer users tend to interact with computers in ways that benefit them rather than trying to learn how to use them first, like the crows Betty and Abel who get the meat not through first acquiring the technical skills needed to use hooks but through interacting in beneficial ways with their environment, is

also demonstrated by Selber's students' reluctance to use email filters to manage their coursework. As he concedes, setting up filters makes sense only in a situation where there is a reason to commit to long-term managerial structures, and in most courses lasting only ten to fifteen weeks deleting or manually sorting messages is easier (492).

Selber suggests that dealing with technological impasses is like locating the exigency in a rhetorical situation: "the key is to situate technological impasses in a broader context so that their characteristics can be organized and understood" (495–96). He offers a "relatively simple heuristic" that involves phrasing the impasse as a qualitative question, locating the question in a matrix of five categories of computer-user concerns, and matching the categories to types of assistance that will enable students to resolve their problem. Apart from not being a particularly simple task, this procedure construes the technology as a tool separate from its user, not as something that arises out of an engagement in a rhetorical situation. Students "who think that the only way to turn the grammar checker off is to stop writing 'ungrammatical' sentences" have not so much misunderstood themselves as "the causal root of technological impasses" (496) as mistaken a rhetorical problem for a technological one. Asking themselves what rhetorical exigency led to the emergence of grammar checkers (as well as whether grammar checkers usefully respond to that exigency) will lead students to a variety of ways to resolve their impatience with squiggly lines in their texts: deciding that "correct" grammar does not matter in this rhetorical situation (and therefore that turning off the grammar checker makes more sense than trying to change their texts), or asking their teacher whether and why teachers require the use of grammar checkers, for example.

This is the mistake Horkheimer and Adorno identified as the disaster of Enlightenment thinking, which they trace to the shift in classical times from seeing language and technology as living forces in the world to seeing them as instruments alien to the natural world and alienating to the human psyche. Heidegger, too, sought to liberate Western culture from technological "enframing" that converts every thing and every being into "standing reserve." Understanding writing as a complex system in which human interactions elaborate cognitive ecologies allows us to understand words and tools as Ingold suggests we should, as mediating our active engagement with our environment rather than asserting our control over it. Far from alienating us from the world and our own natures, words and tools connect us inextricably to others and to our environment and make us what we are, the animal who writes.

Notes

1. For details of the history of complexity theory, see Capra, Harrington, Hayles, Taylor, and Waldrop.

2. See also Engeström and Miettinen, who in their argument for the relevance of activity theory similarly observe connections between distributed cognition, situated