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CREATION AS RECONFIGURATION:

Art in the Advancement of Science

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Abstract: Creation in the arts and elsewhere involves reconfiguration of a domain and our approach to it. In creative work, we contrive new categories, drawing boundaries where they had not previously been drawn. We highlight hitherto overlooked properties and patterns. We reject standard approaches and conventional construals of the problems we confront. In so doing, I urge, we rework accepted syntactic, semantic and pragmatic constraints on the symbol systems we deploy.

Cognitive advancement is not always a matter of learning something new. We have a vast store of information at our disposal already. Often our problem is what to make of what we've got. This is true even at the level of perception. To a large extent, looking involves overlooking; listening involves discriminating between signal and noise. So a critical epistemological question is: What is worthy of notice? What should be overlooked, marginalized, or ignored? Ordinarily, answers to these questions are simply presupposed. We seldom even notice that we notice some things and overlook others. We automatically invoke routine categories to describe or represent phenomena. We adopt familiar orientations and judge by received standards. These may vary contextually, of course. What is a routine classification in the kitchen is not a routine classification in the lab. Nevertheless, in most contexts we have, as it were, cognitive default settings that we invoke unthinkingly. Sometimes this is entirely appropriate. Using the grocery-store notion of sugar is unproblematic when looking for something to sweeten one's tea. But routine application of familiar labels does not always serve our ends. Sometimes it gives rise to anomalies or allows for the formulation of legitimate questions it lacks the resources to answer. Sometimes the sentences it yields don't satisfy our cognitive needs. Sometimes practice simply palls. Even if we have no articulable basis for

dissatisfaction, the received view of things just seems stale, flat and unprofitable. Sometimes indeed, sheer curiosity induces innovation.

By calling default assumptions into question, and developing, entertaining and invoking alternatives to them, we may come better to understand a domain. Reorganizing a domain in terms of novel kinds, highlighting hitherto ignored aspects of it, developing and deploying new approaches to it, and setting ourselves new challenges with respect to it are then among the ways we advance our understanding. Thus physics restructures its domain when it rejects the classical concept of mass in favor a pair of concepts, rest mass and relativistic mass. Things that had been considered alike under the old categories are now deemed to be different. Paleontology advances when it reclassifies brontosauruses and apatosauruses as the same kind of animal. Things that had been deemed to be different come to be recognized as the same. Medicine progresses when it elevates shared characteristics of the sufferers of a disease to the status of symptoms. Aspects that had been deemed irrelevant come to be recognized as relevant. Statistics advances when it develops novel techniques. New methods enable us to glean new information out of old data. None of these cases involves the discovery of new facts. All improve the ways we think about or operate on the information at hand. Cognitive advancement often consists in reconfiguration -- in reorganizing a domain so that hitherto overlooked or underemphasized features, patterns, opportunities, and resources come to light. In what follows, I sketch several modes of reconfiguration prominent in the arts and illustrate some of the ways they advance scientific understanding by enabling us to make something new of the information at hand.

Ordinarily, cognitive advancement is construed as the growth of knowledge. It is accomplished by the acquisition of new (justified or reliably generated) true beliefs. A person becomes aware of a hitherto unknown but properly grounded

truth[1] and smoothly incorporates it into his epistemic corpus. On this picture, information comes in discrete bits, and the growth of knowledge is additive. To be sure, we learn some things this way. If I was previously ignorant of the atomic number of gold, I learn something new when I find out that it is 79. Now I know more about gold than I did yesterday. But, it should be acknowledged, I don't know much more. If we are concerned with advancing understanding rather than merely augmenting my store of factual knowledge, we should concede that the new information contributes little. Adding discrete bits of information to one's epistemic corpus does not advance understanding much. The reason is this: That the atomic number of gold is 79 is not at all surprising. No expectations are violated, for the fact fits neatly with what I already knew or reasonably believed. Nor does the information generate fruitful consequences. It does, of course, equip me to infer infinitely many more truths. But they are on the whole pretty insignificant, being logical consequences of things I already know. Moreover, the newly acquired information creates no ripples. I don't need to reassess formerly accepted conclusions, reconsider my methods, or revise my standards. Rather like a piece in a jigsaw puzzle, the new information fits neatly into a cognitive slot that was already prepared for it.

More significant advances in understanding are apt to involve reassessment. They may be prompted by new information that does not nestle neatly into its preassigned niche. Perhaps it is contrary to our expectations. Perhaps its conjunction or juxtaposition with other things we accept has surprising or counterintuitive implications. For example, we discover that plasmas behave differently from ordinary gases. That ionization could have such effects is

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1Reliabilists and internalists disagree about what the basis should be, but the structure of their positions is otherwise the same. See my 'The Epistemic Efficacy of Stupidity' in Nelson Goodman and Catherine Z. Elgin, *Reconceptions* (Indianapolis: Hackett, 1988) pp. 135-152.

unanticipated, and perhaps in tension with what we had believed about matter. So the question arises, how are we to assimilate the new information? We might develop a more complex conception of a gas which accommodates the unanticipated effects. Or we might conclude that plasmas are not really gases, but a fourth state of matter with properties of its own. There are a variety of ways we could revise our views to incorporate a surprising finding. What we can't do, if we want to understand the phenomenon, is simply add the new information to the beliefs we already have. Given our antecedent beliefs, the findings force the question: How could that be? Understanding comes not through passively absorbing new information, but through incorporating it into a system of thought that is not, as it stands, quite ready to receive it.

Realignment

Every object belongs to myriad divergent classes and is like the other members of each class it belongs to. Most such likenesses are of no interest whatsoever. Even though the members of the class consisting of a chimpanzee, the planet Neptune, and the Manhattan telephone directory are alike by virtue of their membership in that class, their similarity is surely a matter of indifference. The likenesses that matter are apt to become codified in our schemes of classification -- the families of alternatives we use to sort the objects in a realm. The availability of a scheme with the category *fastener*, for example, enables us to recognize the similarity between a button and a zipper. The availability of a scheme with the category *fast* enables us to recognize the similarity between a racehorse and a jet.

In drawing new lines, we mark out distinctions that were previously unmarked and, as a result, were often unnoticed in our encounters with their objects. When, for example, we distinguish between tedium and monotony, we discover that even boredom admits of nuances. When we differentiate between fashion and style, we

recognize that in matters of dress, trendiness and elegance often diverge. When we distinguish between viral meningitis and bacterial meningitis we discover significant differences in what had previously seemed a continuous spectrum of symptoms.

Reconfiguration also occurs when we erase or relocate previously accepted boundaries. Lepidopterists advance their science considerably when they ignore obvious differences and introduce a classification that counts caterpillars and butterflies as the same sort of thing and butterflies and moths as different sorts of things. And by denying that *bitter* and *sweet* are mutually exclusive, we gain resources for describing, hence perhaps for recognizing, savory and emotional complexities. The question is, where to draw the lines.

Picasso drew them literally. When critics charged that his portrait of Gertrude Stein didn't look like her, he purportedly replied, 'No matter, it will.' Whether or not the story is apocryphal, the point is valid. A picture that originally did not look like Gertrude Stein managed, without any repainting, to come to look like her In 'The Power of Pictures', Robert Schwartz explains how this feat was accomplished. Perception is selective. We cannot register everything that meets the eye. A vast number of potentially visible features must be overlooked if we are to discern anything. We can't see the trees for the forest or the forest for the trees, or either if we focus on the cell pattern in a single leaf. Moreover, perception is malleable. What we perceive, indeed, even what we can perceive, is influenced by a variety of factors including experience, context, interests and background assumptions. That being so, it is possible to modify what we see, even when we are looking at a familiar object. By painting a picture of Stein that highlights certain hitherto unnoticed or unemphasized features, Picasso enabled us to see her differently. People who knew her came, as a result of looking at the portrait, to realize that she actually had the features Picasso portrayed, to see her as having them, even to recognize that they are characteristic of her. The woman's appearance is thus

reconfigured as a result of Picasso's work. But that is not all. The reconfiguration Picasso effected is not just a reconfiguration of Stein. For by giving Stein a new look, Picasso set a new standard for what it takes to look like Stein. People who previously would not have qualified as looking like Stein now do, for they share the features that Picasso has convinced us are distinctive of Stein's looks. We don't just see Stein differently as result of the portrait then, we see other people differently as well.[2] Nor, one might urge, does the portrait just prompt us to reconsider what people look like. Picasso portrays Stein as a magisterial figure. The portrait thus conveys her character, not just her looks. The picture makes it clear that its subject is someone to be reckoned with. Arguably, this is the first portrait in history to portray a woman as magisterial. So it raises questions: Who else is worthy to be so portrayed? Why aren't there more such portraits? What took so long? Picasso was hardly a feminist. But his portrait of Stein provokes exactly the questions that feminists have been urging us to ask.

The same thing happens in science. A model that highlights hitherto overlooked or underemphasized features of a phenomenon not only reveals new aspects of that phenomenon, but also makes new likeness salient. A model that portrays the immune system as a defender against outside invaders accommodates its response to pathogens, but ignores its role in protecting the organism against internally generated threats.[3] A more complex model accommodates internal and external threats. It thus accounts for the immunological response to mutant cells, dying cells, and damaged cells by construing them as subversive agents. It also reveals immunologically significant similarities between internal and external hazards. Moreover, just as Picasso's portrait raises new questions, so does the more

2Robert Schwartz, 'The Power of Pictures', *The Journal of Philosophy,* (1985), pp. 189-198.

3See Alfred I Tauber, *The Immune Self*, Cambridge University Press, 1997. All of my examples about immunology hark back to this book.

complicated immunological model. Once we realize that an immunological response is not just a simple biochemical reaction to an alien organism, the question arises: How does the immune system know what to react to? How does it tell whether something, whether native or alien, poses a threat? Questions that could neither be framed nor motivated under the old categorization become pressing when new lines are drawn.

Metaphor

Metaphor is a device for drawing new lines. It reorganizes the items in a realm, grouping together things more familiar categories keep apart, distinguishing among things familiar categories group together. But it does not do so arbitrarily. Rather, in metaphor, we import a scheme that has proven effective elsewhere and apply it to reorder a new domain. Metaphor then is a device for recognizing membership in normally neglected classes.[4]

'Plasticity' is a term that applies literally to materials that can permanently change their shapes in response to stress. Cognitive scientists use the term metaphorically to characterize a range of seemingly irreversible developments that the mind undergoes in response to external stimuli. Plasticity is said to figure in some but not all learning, in some but not all character development, in some but not all habituation, in the adoption of some but not all attitudes and orientations. The metaphor effectively divides the psychological realm in three. Some things are rigid. They are 'hardwired', hence not alterable by training or experience. Some are plastic. They can be molded by experience to take new enduring or even permanent shapes. Some are elastic. They too can be shaped by experience, but the changes experience effects are readily reversed. If Chomsky is right, syntax is

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4Sometimes it supplies new labels for previously recognized classes. I neglect this function in the interests of space.

hardwired. Experience has no effect on deep syntactic structure. Plasticity enters into the explanation of what happens psychologically and neurologically when we learn our first language. The changes we undergo are profound and enduring. Some neural pathways are strengthened; others are permanently extinguished. Elasticity might account for the sort of psychological changes we undergo when, for example, we memorize irregular verbs for an upcoming exam. A change of mind is effected by such learning, but it is not particularly deep or lasting. Even though we call both the acquisition of a first language and an American student's rote memorization of the French verb 'aller' instances of language learning, they seem quite different. The metaphor enables us to express the difference. Literal, entrenched taxonomies tend to rigidify thought, guiding it along well worn channels toward clearly demarcated goals. Metaphor reconfigures the domain, drawing boundaries that cut across familiar distinctions, disclosing features of the terrain that hitherto had eluded our gaze. Learning a first language and developing a pessimistic stance as a result of early childhood deprivation may be more like each other than either is like memorizing an irregular verb or learning the name of a state capital. The 'plasticity' metaphor thus equips cognitive scientists to classify together developments that their literal categories count as different. It thus enables them to investigate similarities and differences that the standard, literal taxonomy obscures.

The metaphor highlights affinities within and across domains. It likens its referent both to other members of the metaphorical extension and to their literal counterparts. It coalesces features into patterns, affording epistemic access to characteristics and regularities we might otherwise overlook. The plasticity metaphor effects a realignment that enables us to differentiate among acquired characteristics. It cuts across the cognitive/affective divide and shows how enduring knowledge, lasting values, temperament and character are like one

another and how they differ from ephemeral knowledge, passing fancies, moods and inclinations. Such realignment provides resources for raising new questions. Once we recognize the constellation of factors a metaphor exemplifies, we can investigate whether the conception that underlies them is sound. Is there a sharp divide between hardwired, plastic, and elastic traits? Or can some things be, e.g., either plastic or elastic? How resistant to reversal does a trait have to be to be considered plastic? Does the mind's plasticity diminish with age? And so forth. The metaphors reveal new avenues of inquiry worthy of exploration.

Like other symbols, metaphors often bear interpretations their authors fail to appreciate, and fail to sustain interpretations their authors ascribe to them. In calling the mind plastic, for example, a speaker might intend only to underscore its capacity for being molded, being oblivious or indifferent to the myriad other characteristics that the metaphor brings to light. She might even invoke the metaphor to point up affinities that do not in fact obtain, perhaps believing that all aspects of mind are alterable through training and experience. Still, despite the superficiality or wrong-headedness of her interpretation, her description is apt. The inadequacy of its author's interpretation then does not automatically impoverish a metaphor, for there can be more to a symbol than meets its author's eye. This is particularly evident in science. Metaphors like 'The mind is plastic' and 'Antibodies are the first line of defense' often function as working hypotheses. They are ventured tentatively by investigators who are, at the outset, unsure exactly what their truth would commit us to. If they look sufficiently promising, they are elaborated and tested by members of the relevant scientific community. Figuring out what a scientific metaphor means, whether it is true, and whether it is fruitful is then a community effort.

A category scheme is just a system of labels that organizes the objects in a domain. A metaphorical scheme effects a reorganization. Items that are literally

the same sort of thing -- both being, say, mental -- are metaphorically different sorts of things -- one being plastic, another elastic. And the differences the metaphor highlights are as real as the similarities the literal label locates. The extension a metaphor marks out is real, even if it lacks a literal label. And its membership is determinate.[5] The metaphor supplies a symbol that enables us to designate membership in a hitherto unmarked class. Metaphorical predication then is genuine predication and metaphorical truth is genuine truth. For the objects the metaphor picks out genuinely belong to the class the metaphor assigns them to. Some features of the mind are genuinely, although not literally, plastic; the immune system is genuinely, although not literally, a defender.

Metaphor's contributions to cognition should by now be obvious. It is a device for identifying previously unnoticed classes, and stating previously inarticulable truths. It equips us to see new likenesses and differences, patterns and discrepancies both within and across domains. It enables us to draw on cognitive resources we've developed elsewhere to advance our understanding of a given realm. It equips us to ask questions and to explore hypotheses that could neither have been framed nor motivated without the partition of the domain that the metaphor supplies.

Exemplification

Any object instantiates, and is known to instantiate a host of familiar predicates. We do not, and ought not give them all equal weight. Some stand out, others serve as a backdrop. Still others are so deeply overshadowed that we're apt to overlook them entirely. Exemplification, Nelson Goodman and I have urged, is the mode of reference by which an exemplar points up, highlights, displays or

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5Or at least as determinate as the literal extension of the term. Metaphorical terms, like literal terms, can be vague or ambiguous.

conveys some of its features.[6] An object then functions as an exemplar by referring to features that it instantiates. But an exemplar does not refer to all its features, for exemplification is selective. A commercial paint sample refers to and is an instance of its color and sheen. It does not typically refer to the age of its manufacturer, its distance from the Eiffel Tower, or its chemical composition. An exemplar, in highlighting some of its features, overshadows, marginalizes, or downplays others.

By making features salient, exemplification affords epistemic access to them. The features in question need not be particularly conspicuous, and a good deal of effort may be necessary to bring them to light. A complicated experiment may be mounted to exemplify subtle differences between closely related proteins, and an intricate plot contrived to exemplify extraordinarily complex patterns of loyalty and betrayal. But once we have access to these features, we may be able to recognize them and appreciate their significance when we encounter them in other contexts.

Every application of paint to canvas, no matter how carefully thought out, is a unique event whose effect can never be exactly reproduced. Works like *The Birth of Venus* or *Le D,juner sur l'Herbe* instantiate this truth but make nothing of it. Abstract expressionist works, consisting of paint spontaneously flung onto canvas, exemplify it. They call attention to, and make us mindful of the impossibility of reproducing a precise configuration of paints. The impossibility in question is not restricted to abstract expressionist works. We could no more exactly reproduce the configuration of paints that constitute *The Birth of Venus* than we could exactly reproduce the configuration that constitutes Jackson Pollock's *Number One*. Once the Pollock makes us mindful of this irreproducibility, we may go back and look at *The Birth of Venus* with a new eye, and appreciate its role in that work as well. Similarly, a scientific experiment may exemplify a feature that is discernible, but not

6Nelson Goodman, *Languages of Art*, Indianapolis: Hackett, 1968, pp. 52-68; Catherine Z. Elgin, *Considered Judgment*, Princeton: Princeton University Press, 1977, pp. 170-183.

standardly noticed in nature. Once we've seen it in the lab, we know what to look for, and how to recognize it in the natural environment.

Exemplification is selective. But there is nothing in the nature of things that makes some features inherently more worthy of selection than others. Reconfiguration may result from re-selection -- from, that is, bringing an item to exemplify features that had previously only been instantiated. Rather than using volumes and shapes as the means for depicting scenes, Cezanne uses the depiction of scenes as a vehicle for the exemplification of volumes and shapes. By, as it were, shifting figure and ground, he makes us mindful of the composition of a painting, of the elements and combinations that make it up. Evolutionary theorists all acknowledge enormous gaps in the fossil record. By and large, transitional forms are not to be found. Gradualists, following Darwin, regard this as an unfortunate paleontological fact. Sedimentation is sporadic, so much evidence is bound to be lost. They thus smooth over the gaps, interpolating the many missing links necessary to complete the incremental evolutionary chain. Adherents of punctuated equilibrium, on the other hand, construe the gaps in the fossil record not as *a lack of evidence* of transitional forms, but as *evidence of a lack* of transitional forms. The reason there are no fossils of intermediate stages, they contend, is that there were no intermediate stages. Evolution, they believe, proceeds largely by leaps -- long periods of stasis being punctuated by short intervals of rapid speciation. Successor species then differ significantly from even their closest ancestors.[7] A shift in emphasis thus alters the intellectual landscape. Adherents of punctuated equilibrium adduce no new information. To frame their alternative, they just highlight acknowledged gaps in the fossil record and elevate them to the status of evidence. That is, they bring the fossil record to exemplify the

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7Stephen Jay Gould, 'The Episodic Nature of Evolutionary Change,' *The Panda's Thumb*, New York: Norton, 1980, 179-185.

gaps that it previously only instantiated.

In classical tonal music, even when all the notes of the chromatic scale are utilized, a particular key predominates. Melodic and harmonic relationships, consonances and dissonances are defined and discerned by reference to this key. Atonal music alters the structure of the musical field by giving equal weight to each note in the chromatic scale. Without the differential importance that tonality assigns to a particular key, the distinction between dissonance and consonance breaks down, and new musical configurations emerge. In tonal works the keynote serves as the center of musical gravity, as that by reference to which musical relationships are defined. Atonal works lack and exemplify their lack of such a center of gravity. Here reconfiguration results from reweighting.

Something similar happens in science. Information exemplifies different patterns depending on the orientation the investigator adopts. A geneticist looks for the genetic underpinnings of a disease like diabetes. A physiologist might focus on the physical events that trigger its onset. An epidemiologist attends to the distribution of the disease in different environments. All three may draw on the same data. But because they have different interests, they interpret the data differently, each taking it to exemplify features relevant to his concerns. None, of course, believes that his approach tells the whole story about the incidence of the disease. The epidemiologist readily concedes that diabetes has a genetic basis. But that is not his concern. He consigns genetic considerations to the background in order to highlight environmental factors. By shifting the center of gravity from the organism to the environment, he may be able to discern patterns in the data that would be lost in the welter of details had no choice been made, and would be obscured in interpretations of the data that focus on the organism or its DNA.

A symbol must instantiate the features it exemplifies. But its instantiation need not be literal. For, as we've seen, metaphorical instantiation is genuine

instantiation. So a literally lifeless painting can exemplify the vigor, vitality, exuberance, and optimism that it metaphorically instantiates. And a literally inert proof can metaphorically exemplify power, panache and promise. The importation of a metaphorical scheme then supplies means not only for marking out new categories, but also for making manifest the features their instances share.

Exemplification also figures in metaphorical likening. In a metaphorical usage, a term likens the objects in its metaphorical extension to those in its literal extension. It does so, I suggest, by effecting the joint exemplification of a constellation of telling features. Often the constellation in question is semantically unmarked. Then our language lacks the resources to say precisely and literally what shared features underwrite the metaphor.[8] Despite their obvious differences, armies and antibodies are alike in fending off dangers. When we label antibodies defenders, we highlight such similarities. The metaphor thus forges a chain of reference linking the literal and metaphorical referents of the term.

This might seem to undermine the common contention that metaphors elude literal paraphrase. If antibodies qualify as defenders because, like armies, they kill invaders, why isn't the phrase 'killer of invaders' the literal paraphrase of the metaphor 'defender'? In fact, of course, it is *a* paraphrase, but an inadequate one. For it is neither exact nor exhaustive. There are any number of metaphorical defenders that do not kill. Computer firewalls are metaphorical defenders that protect computers from being hacked into, simply by preventing entry. Skin plays a similar role in animals. Rust proofing paint is a metaphorical defender that protects cars against rust. Secretaries are metaphorical defenders that protect their bosses from interruptions without killing the folks who want to interrupt them. Evidently

8Sam Glucksberg & Boaz Keysar, 'Understanding Metaphorical Comparisons: Beyond Similarity,' *Psychological Review*, 97 (1990), 3-18.

defensive agents can repel, disarm, or eliminate threats. There are probably other modes of defense as well. The point is clear. Even so pedestrian a metaphor as 'defender' outruns our efforts to paraphrase it.

The reason is not just a dearth of literal labels. Metaphor's resistance to paraphrase stems from the complexity and interdependence of its multiple referential functions. A sufficiently long-winded explication could conceivably enumerate the bases and degrees of likeness of literal and metaphorical defenders. But in likening the two referents, the metaphor does more. It exemplifies a shared constellation of interanimating features. An enumeration does not exemplify the features it lists. Nor does it coalesce them into a constellation. The enumeration does not then exhibit the ways the features on the list bear on one another or the ways their doing so connects the two classes of objects that instantiate them. A fully adequate paraphrase preserves reference. But a literal paraphrase can preserve some of a metaphor's referential functions only by ignoring or downplaying others. Inevitably, something is lost in translation.

One of the likely losses is epistemic access. Even if an immunologist could describe in precise and literal biochemical terms just how the immune system engages with pathogens, many of us would not know how to interpret the description until we were told that this is the way antibodies fight disease. The literal story would omit something important. A purely biochemical account of the relation between a tuberculin bacillus and a host organism is an accurate literal description of a chain of biochemical reactions. An evolutionary account tells a story of an organism seeking an ecological niche, a story in which the organism needs to alter the environment in order to survive, and the environment, being itself alive, resists alteration. It is then a story about competition between organisms. The account in terms of competition (itself a metaphor) adds something to the

biochemical account. Among other things, it tells us what is at stake -- viz., survival. To construe the bacillus as an invader and the host as a defender, to construe the bacillus as threatening the host (rather than vice versa, and rather than merely seeing them as competitors) is to adopt a yet a third perspective on events. Immunology, through its metaphors, supplies the perspective that enables us to see the biochemical changes in terms of their effects on the well being of the host. The biochemical and evolutionary accounts do not supply this perspective.

Evidently metaphors contribute cognitive value to the sciences they belong to. They are not mere decorations. They advance scientific understanding by providing classifications and perspectives that available literal language cannot provide.

Fiction

That there exists no ideal gas does not discredit the ideal gas law. But that there exists no phlogiston decisively discredits the laws of phlogiston theory. The difference is plain. The ideal gas law is a fiction. So its falsity does not tell against it. Since phlogistic laws purport to be factual, their falsity is their undoing.

The ideal gas law configures the domain, locating actual thermodynamic processes by reference to a fictive ideal. That ideal is selective. It specifies only thermodynamically significant features and restricts itself to thermodynamically relevant characterizations of them. It does not, for example, determine how the ideal gas is supposed to smell, even though odors of actual gases are often overpowering. The ideal is contrived to fit the demands of the discipline -- to supply the sort of understanding thermodynamics seeks within the constraints the science sets for itself.

The concept of an ideal gas involves sweeping simplifications. It construes its molecules as perfectly elastic spheres and characterizes their behavior only under

idealized conditions. The concept of an ideal gas is not, and does not purport to generate, a complete gas description.

Ignoring complexities does not, of course, eradicate them. We cannot responsibly treat argon or neon as though it were an ideal gas. Calculating thermodynamic properties of actual gases involves recognizing and accommodating divergences from the ideal. Still, the fictive ideal provides focus. Patterns and properties it exemplifies remain salient when complicating factors reenter. And the statistical stance the law adopts yields insight into non-ideal gases as well.

A driving assumption of thermodynamics is that characteristics and behaviors of actual gases can be understood as deviations from the ideal. The science's success attests to the utility of this assumption.

Intractable direct comparisons give way to streamlined indirect ones, the (fictive) ideal serving as common denominator. Irrelevancies wash out. For the law serves as a filter, disclosing regularities hidden among the myriad complexities of actual molecular interactions. By paring away inessentials, the ideal gas law presents a fiction that cleanly exemplifies thermodynamically significant features. And by characterizing actual gases as deviations from the ideal, thermodynamics brings them to exemplify the same features. Not despite, but because of its limitations, simplifications, and idealizations, the ideal gas law furthers the ends of the science.

Literary fictions function similarly. A fictive character like Don Quixote or a fictive action like tilting at windmills provides focus, enabling us to orient acts and aims by reference to it. The domain of human behavior reconfigures around the fiction of the Don. Devices for description become available; aspects of behavior and circumstance stand out. The man who devotes himself to developing a solar powered car despite years of frustration and the active discouragement of the auto industry is no longer just a crackpot, even though his prospects of success remain dim. As *Don Quixote* exemplifies, courses of action like his are at once noble,

preposterous, hopeless, and eminently worth pursuing -- they are, in a word, quixotic. Seen in the light of Cervantes' great work, what once looked like profitless, idiosyncratic endeavors take on a different, more admirable cast.

Literary fictions, I suggest, are thought experiments in art. Thought experiments are fictions in science. In neither domain do thought experiments directly disclose matters of fact. They highlight features, draw out implications and exemplify constellations of commitments. They may enable us to recognize hitherto unknown facts or to recognize the importance of known facts that had previously been considered insignificant. They may then catalyze the discovery of unsuspected truths. But they need not. A misleading model or narrative lends plausibility to a falsehood. So, of course, does a misleading truth. The capacity of data to support untenable hypotheses is a regrettable but unavoidable fact of epistemic life.

The Range of Epistemology A problem remains. Positivist philosophy of science distinguishes between the context of discovery and the context of justification. The context of discovery is the playground where the free play of ideas takes place. One might investigate the psychology, sociology or even politics of discovery. But there is no perspective from which to say, in advance, that one approach is epistemically preferable to another, for there is no logic of discovery. It is in the context of justification where epistemological issues arise. For justification is a matter of evidence, and epistemology is involved in determining what evidence, and how much evidence is required to confirm an hypothesis. But the context of justification is the realm of hard fact. Evidence is stated in literal, declarative, preferably quantitative sentences. Its weight is determined by rigorous scientific standards, which themselves are vindicated by their prospects of yielding truths. If this picture is accurate, then the aesthetic factors I have discussed seem to reside on the wrong side of the divide. They figure in the formation of hypotheses, not in

their justification.

There is something to this worry, but it is not as scathing as it seems. I am not saying that the suggestions adduced by works of art or by aesthetic devices in scientific domains should be accepted without further ado. They need to be tested in the realm of fact. That the *B-Minor Mass* or *Middlemarch* suggests something interesting and important about moral psychology may be a reason to take the hypothesis seriously. If so, it is a reason to subject that hypothesis to further investigation, but not a reason to accept it without further investigation.

It might seem that this simply concedes the point to the positivists. If epistemology is concerned exclusively with the context of justification, and the context of justification is concerned exclusively with the question whether a given hypothesis is confirmed by the evidence, then the aesthetic factors I have mentioned have no epistemological weight. But I do not think we need accept this view. The problem is a problem of plenty. There are a huge number of hypotheses that might be framed. Indeed, there are a huge number of true hypotheses that might be framed. This follows directly from the fact that every object belongs to infinitely many extensions, and is therefore like every other object. The question is, which hypotheses are worth framing and investigating. Not every truth is worth knowing; nor is every falsehood worth dismissing. Some truths are trivial. Some falsehoods are useful approximations or idealizations. If we can zero in on the truths and falsehoods that are worth taking seriously, we make cognitive progress. In that case, the determination of what makes an hypothesis worth taking seriously falls within the scope of epistemology.

I have suggested that the aesthetic devices I have been discussing equip us with resources for doing this. They provide alternatives to our standard ways of seeing, representing, and understanding phenomena by reorganizing, reweighting, and shifting the center of cognitive gravity. They invite us to consider whether the

alternatives enhance or undermine the adequacy of the beliefs we already hold, or the perspectives we ordinarily adopt. They may highlight the need for conceptual clarification. They may underscore the vulnerability of our methods. They suggest and flesh out possibilities, affording what Bernard Williams calls 'thick' descriptions or depictions of how such possibilities would look in detail. They thereby afford the resources for thought experiments, and for recognizing the possibilities should we encounter them in fact.

The devices I have been talking about thus bridge the gap between the context of discovery and the context of justification. If they afford us resources for deciding what hypotheses, stances, or modes of categorization are worth taking seriously, they provide some normative structure to the context of discovery. They indicate that discovering *p* would be fruitful, whereas discovering *q* would not. So they afford some cognitively grounded incentive for investigating *p* rather than *q*. They tell us which truths are worth having. So they enrich the context of justification as well. They not only yield the information that *p* is justified, but also that the categories in which *p* is cast, the stance from which *p* is framed, the questions to which *p* affords an answer, and the questions which the confirmation of *p* enable us to raise are epistemologically valuable.

Part of the reason is pragmatic. We may decide for good reasons that we want one sort of knowledge rather than another. That is, we want to know some things and not others. Perhaps we want the fruits of current inquiry to serve certain purposes -- purposes that they will not serve unless they are cast in particular terms, or the inquiry is done in particular ways. For example, if we want to make predictions of events in the near future, we cannot require calculations that take so long to perform that the events in question would already have taken place by the time the computations are complete. This might make it reasonable to settle for less precise calculations or a greater margin of error. If we want to use our findings

for self improvement, we need to glean information that is available and useful from a first person perspective. If we want the findings from one inquiry to interface with the findings of others, we have reason to seek commensurate vocabularies, methods, and perspectives. If we know whether *p* is confirmed by the evidence, we know whether we have reason to believe that *p* is true. But if the issue is the advancement of the understanding, we also need to know whether we have reason to care whether *p* is true.

In crediting metaphor, fiction, and exemplification with epistemic standing, I might seem unduly to extend epistemology's scope. Traditional theories of knowledge, after all, construe their range more narrowly. They limit their scope to literal, descriptively true beliefs and the perceptual inputs that give rise to them. I want to conclude then by arguing that the cognitive functions I've discussed -- orientation, focus, and categorization -- are ones epistemology cannot responsibly ignore.

Such matters do not admit of support direct by empirical evidence. So a theory that takes its task to be identifying the conditions under which evidence supports a hypothesis might try to bracket them, to construe them as lying at a distance from epistemology's proper concerns. Such a theory might, for example, determine whether available evidence warrants accepting the sentence 'All vegetables are nutritious' under some interpretation of the predicates 'vegetable' and 'nutritious'. But it will not afford the resources for evaluating the classification that interpretation reflects. This might seem unobjectionable, even reasonable. So long as we know where the lines are drawn, we know what accepting the sentence amounts to. There may be pragmatic grounds for favoring one partition of the domain over others, but the impracticality of a scheme that includes pine cones in or excludes tomatoes from the class of vegetables is hardly epistemology's concern.

The difficulty is that sometimes the grounds for rejecting a hypothesis derive

from the categories in terms of which it is framed. To see this, consider the predicate, *grue*.[9] An object is (by definition) grue, just in case it is examined before future time *t* and found to be green, or is not so examined and is blue. Since all the emeralds we've ever seen have been green, they have all been grue, *t* being in the future. Should we conclude, on the basis of induction, that all emeralds are grue? The issue is not whether the evidence at hand supports the hypothesis, but whether the hypothesis admits of evidential support. To decide that requires assessing the suitability of the category 'grue' for induction. Epistemology cannot evade the problem of induction, hence cannot ignore the challenge the grue paradox poses. To address that challenge requires recognizing that the partition of the domain that a category scheme supplies is a proper object of epistemic scrutiny.

Nor can epistemology distance itself from matters of orientation. The Copernican hypothesis was originally proposed as a factual claim. As such, it was clearly within epistemology's purview. With the repudiation of absolute space, however, its status becomes trickier. Neither the Earth nor the sun is absolutely in motion or absolutely at rest. For all motion is relative to a frame of reference. Because nature favors no one frame of reference over the others, there is no saying absolutely whether the Earth moves. Still, the denial of absolute space does not exempt the Copernican hypothesis from epistemological scrutiny. It just shifts the grounds for assessment. Even if there is no saying absolutely what is in motion and what is at rest, there is something *to be said for* taking some things to be in motion and others at rest. What is to be said for the Copernican hypothesis is that when the sun is treated as fixed and the Earth as moving, the solar system displays an order that makes sense of astronomical observations and fits planetary astronomy into a more comprehensive physical theory. The heliocentric perspective thus

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9Nelson Goodman, *Fact, Fiction, and Forecast* (Cambridge, Massachusetts: Harvard University Press, 1984), p. 74.

affords epistemic access to regularities in celestial motion that the geocentric perspective obscures. The elaboration and evaluation of such a defense is the business of epistemology. What is at issue is the acceptability not of a law or a factual claim, but of an orientation. If the defense succeeds, it demonstrates the tenability of adopting a particular frame of reference.

Even salience is subject to assessment. In arguing for punctuated equilibrium, evolutionary biologists focus on, rather than glossing over, gaps in the fossil record. Such gaps have long been recognized. The theory of punctuated equilibrium highlights them, insisting that evidence for the course of evolution consists not just in what we find but also in what we fail to find. An epistemological assessment of the controversy between gradualism and punctuated equilibrium must decide whether the lacunae deserve the status of evidence.

Orientation, categorization, and focus are then already within the scope of any epistemology that accommodates science. Rather than extending epistemology's range, I have shown that epistemology's acknowledged range comprehends functions exemplification, fiction, and metaphor perform.

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