Metaphors
Moving Targets in the (Social) Sciences

Ever since scholarly discourse has concerned itself with metaphors the latter have been said to toy around with correct meanings and conventionalized usages. At best, one holds that they have no relation to true knowledge at all and lets them pass because of their merely decorous role. More often, however, suspecting the worst, one is afraid of their outright deceptive effects. Thus, it comes as no surprise that metaphors have been regarded with suspicion and can be found in the midst of various dualistically structured debates: To mention but a few, they have been seen as ornamental, yet inessential; educational, yet lacking genuine insight; as economical carriers of complex meaning, yet easily misleading. Their structure, their usage, and their function have been subject to ongoing criticism. Only Max Black's seminal paper on "Metaphors" in 1962 endowed the topic with new attraction for both philosophers (of language) and linguists. Although scholars such as Richards (1936) and Burke (1941) had liberated metaphors from being a deviant unit of speech and thought three decades before, it occurred only within a decidedly antipositivist climate that one took an unbiased stance toward metaphors and investigated their semantic and pragmatic particularities. From the sixties onward scholars increasingly were of the opinion that metaphors indeed served important discursive ends: While explanations and evaluations still vary enormously, ever few scholars doubt the considerable, if not constitutive power of metaphors.

Today, the scholarly discourse scrutinizes an impressive amount of structural and functional issues (cf. the bibliographies by Noppen 1985, Noppen and Holst 1990), engaging a huge array of disciplines, instigating a bewildering amount of new questions and theories. This multidimensional discourse on metaphors does not stop short of science studies. In particular, metaphors have become interesting for studies in the area of ideological critique; see, for example, Harrington's study of holistic science in the Third Reich (Harrington 1995) or Lakoff's study of conceptual metaphors guiding political attitudes (Lakoff 1995). The guiding notion is that metaphors, being powerful conceptual tools of producing knowledge and world-views, shape (social) scientific notions as well. This is exactly why most authors are still suspicious of

metaphors: Ideological effects of metaphors and cognitive operations based on them just cannot be fully controlled. Only a few authors, however, regard metaphors as ordinary, yet unfamiliar terms or phrases to which various discourses connect, and, by using them, shape and reshape meanings of both the metaphors and themselves. Therefore, a metaphor-view on knowledge dynamics may highlight the fate of invidual terms and phrases as they meander through heteregenous discourses, producing locally specific meanings, yet at times converging on overarching issues, paradigms, or 'cultural matrices' (see Maasen / Weingart 2000). Hence, on this view, they are tools for understanding interdisplinary communication as well as communication between different parts of society, such as science, politics, media, economy. Jim Bono will emphasize their performative function: Metaphors are instruments of thought and action.

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Why Metaphor? Toward a Metaphorics of Scientific Practice

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Why metaphor? Despite vigorous attempts in recent years to recuperate metaphor as a subject of or tool for science studies, the question why one should pay serious attention to metaphor remains a live issue for many students of science as cultural and social practice. Reasons for this resistance to metaphor are undoubtedly complex and numerous. Among them, two especially stand out for us. First, metaphor as a linguistic category seems to pose problems for revisionist historians and sociologists of science. Wishing to move beyond traditional positivistic accounts of science, many Anglo-American historians and sociologists of the 1970s, 1980s, and 1990s – invoking Kuhn, Feyerabend, and Rorty – turned away from preoccupation with scientific theories as formal propositions, rejecting language-centered models of science in favor of local analyses of the production of scientific objects and knowledge. Often they rejected as well views of science as a 'mirror of nature,' of language as mere representation, and hence of words as 'mimetic' and 'corresponding' to things. Ignoring the degree to which serious attention to metaphor engages the crisis of representation and complicates such theories of correspondence, some revisionist practitioners simply brand metaphor as too tainted by the 'literary' and 'abstract' to touch what really matters about science as a social and cultural activity. In this view, metaphor is dismissed from serious deployment as an analytic tool by virtue of its presumed associations with a rejected past and outmoded methodology (for background on science studies since Kuhn, cf. Golinski 1998; Hess 1997; Nersessian 1998).

Second, the turn toward 'practice' in science studies has often meant the exclusion of the metaphoric and most linguistic dimensions of science from serious consideration as part of the dynamics of knowledge production and change in science (on the turn toward 'practice,' cf. Golinski 1990, 1998; Lenoir 1988; Pickering 1992; Rouse 1996). Despite Foucault's insistence on language and discourse as practices, and on the materiality of such practices[1], much of Anglo-American science studies resists any significant role for the metaphorical in science. Rather, metaphor may, at most, find a role as part of

strategically motivated 'literary technologies' aimed at the dissemination of socially produced scientific knowledge and recruitment of networks of loyal disciples.[2]

What follows is an attempt to outline an emerging metaphorics of science, one that, I would suggest, confronts the sources of resistance to metaphor noted above and finds them wanting. Contributing to this new insistence on the value of metaphor to the social and cultural analysis of science, is the work of Peter Weingart and Sabine Maasen. Together, they have much to teach their Anglo-American counterparts about overcoming 'fear' of metaphor (cf. Maasen 1995). One response to the resistance to metaphor is disarmingly simple: metaphor is everywhere, and cannot be dissociated from the activities constituting science. As Weingart puts it:

> Debates over the permissability of the use of metaphors in science are futile, since the flow of concepts from everyday language to scientific language, or generally between different contexts is inevitable. The problem is primarily which functions and dysfunctions certain metaphors have in a concrete case (Weingart 1995: 128).

Much as postpositivist history and sociology of science would want to draw attention away from science as a linguistic activity, Weingart's perspective suggests an abundance of empirical example for other, routine, and indeed 'everyday' uses of language in science that do not threaten to resurrect the positivist ghost of the disembodied scientist and a purely abstract, intellectual science. Quite to the contrary, Weingart and Maasen find in metaphors an analytical tool for a robust sociological account of science as a situated social activity. Central to their analysis is the function of metaphors as "messengers of meaning" (Maasen/Weingart 1995), which they have amply and effectively shown to account for the dissemination of key concepts, and the reorientation of research programs, across disciplinary and discursive boundaries (Weingart/Maasen 1997).

In certain respects, Weingart and Maasen's insistence on metaphor as an essential part of science studies' analytic toolkit complements other recent academic developments. Nowhere has the sea-change affecting metaphor been more dramatic than in the field of cognitive science, especially cognitive linguistics. Moving beyond philosophically freighted, abstract accounts of knowledge and knowing, cognitive

studies have unearthed a rich and homely lode of empirical examples drawn from everyday life suggesting the ubiquity of analogy, schemas, models, and, most centrally, metaphors to basic cognitive processes such as categorization, pattern recognition, invention, 'mental leaps,' and various aspects of reasoning. For cognitive sciences, metaphor and language are not abstract symbolic systems laid over experientially derived knowledge like a thin decorative veneer. Quite to the contrary, language – and especially metaphor – are themselves rooted in experience and in turn provide fundamental schemas – basic metaphorical structures – for organizing, comprehending, and navigating our experience and then translating it into the cognitive rudiments of knowledge and action.

Most visible, in this regard, is the work of George Lakoff and Mark Johnson. Indeed, the very first paragraph of their first book, *Metaphors We Live By*, suggests the changes that have swept over cognitive approaches to metaphor in the last twenty years:

> Metaphor is for most people a device of the poetic imagination and the rhetorical flourish – a matter of extraordinary rather than ordinary language. Moreover, metaphor is typically viewed as characteristic of language alone, a matter of words rather than thought or action. For this reason, most people think they can get along perfectly well without metaphor. We have found, on the contrary, that metaphor is pervasive in everyday life, not just in language but in thought and action. Our ordinary conceptual system, in terms of which we both think and act, is fundamentally metaphorical in nature (Lakoff / Johnson 1980: 3).

More than a linguistic trope, metaphor turns out to be a fundamental cognitive operation and, as such, central to thinking and to acting in the world. Indeed, we make contact with our world, we engage – and hence 'experience' – it through the very metaphoric operations that inform our 'conceptual system.' This movement away from a view of metaphor as 'literary' and as sharply distinguished from, while subordinate to, the 'literal' has opened up vast domains of both ordinary and specialized practices to careful scrutiny as cognitive systems through examination of their metaphoric structures and operations.[3]

Citing a wealth of empirical detail, Lakoff and Johnson and other advocates of a cognitive approach to metaphor – for example, Mark Turner and Gilles Fauconnier (cf. Turner 1987, 1991; Lakoff / Turner

1989; Fauconnier 1997; Turner/Fauconnier 1999) – have sought no less than a systematic reformulation of our understanding of cognition itself. For Lakoff and Johnson, this has meant pushing a very specific argument about the sources of metaphor and of metaphorically based cognitive processes. While using as evidence the empirical data of linguistics and analysis of metaphorical expressions, Lakoff and Johnson argue that the latter are but linguistic instances of larger, overarching conceptual structures that they call 'conceptual metaphors.' The conceptual metaphor, 'Argument is War,' for example, structures the way in which we think about a whole range of experience. It defines, in other words, a fundamental conceptual structure that gives rise to particular linguistic forms within everyday speech as captured in actual metaphoric expressions such as claims about 'winning an argument' or 'successfully defending one's position.' Metaphors, in this view, are common everyday expressions that depend upon, and reveal, the existence of 'deeper' conceptual structures that are part of our basic cognitive apparatus, and which are themselves metaphorical in nature. Similarly, Lakoff and Johnson frequently point to the conceptual metaphor, 'Love is a Journey,' as structuring a whole range of experiences and discourse concerning human relationships: "I don't think this relationship is *going anywhere*"; "This relationship is a *dead-end street*" (Lakoff/Johnson 1980: 44–45). Conceptual metaphors, then, are fundamental constituents of our underlying 'conceptual system' providing us with categories and schemas to organize our world.[4] Conceptual metaphors are meaning-generating products of our cognitive apparatus that, in turn, produce and authorize a vast array of detailed metaphorical expressions that link together the tissue of our experience.

Where do such conceptual metaphors come from? According to Lakoff and Johnson, the more fundamental and basic of our conceptual metaphors have their roots in our experience of the physical world. This is especially clear in the case of what they term 'orientational' and 'ontological' metaphors, which, they argue, provide us with powerful conceptual tools for organizing "a whole system of concepts" (Lakoff/Johnson 1980: 14) and for distinguishing the relationships (such as spatial boundaries, or actions/agencies) that define and distinguish one thing from another with which it nonetheless stands in some relation. Like orientational metaphors ("Happy is up; sad is down," Lakoff/Johnson 1980: 15), ontological metaphors depend

upon the primacy of bodily experience of the physical world. Three of the most powerful such metaphors, for Lakoff and Johnson, are to be found in the schemas of 'containment,' 'force,' and 'balance.' Each of these metaphors represent fundamental conceptual structures that pervade virtually the entirety of our experience, structure our rational, or logical, thinking about the world, and ultimately derive from our *embodied* experience of the world. Even though Lakoff and Johnson open the door to the role of cultural experience in shaping our metaphorical conceptual system, the clear priority placed on the body, and embodiment, as source of basic cognitive operations, especially metaphoric processes, is indisputable in their work. Theirs is a *Philosophy in the Flesh* (Lakoff / Johnson 1999)!

Redefining metaphor as an important, if not fundamental, cognitive process, rather than simply as a rhetorical category and linguistic phenomenon, and insisting upon an embodied dimension to metaphor, are two crucial moves that I wish to affirm as genuine contributions to the kinds of account of metaphor that are needed, I believe, in science studies. Moreover, both these dimensions of the new cognitive model of metaphor can be adapted to complement and support a performative model of scientific metaphors that insists that the metaphorics of science operates on the level of both scientific discourse *and* practice. Valuable as cognitive linguistics has proven, certain missteps and suspect assumptions – at least, in Lakoff and Johnson's views – must not go unremarked. Two difficulties are especially worth noting: the universalizing tendencies of Lakoff and Johnson's account of metaphor; and the peculiarly abstract, foundationalist, and unsituated view of embodiment they embrace.

Universalizing tendencies may be the shibboleth of much theorizing in the humanities, and rightly suspect in analyses of social and historical phenomena, but nonetheless retain a certain legitimacy in the scientific study of natural phenomena. Few would deny the power and utility of well-supported scientific explanations that, in fact, do extend their reach to all phenomena of a given kind. Hence, in questioning the universalizing tendencies of Lakoff and Johnson's account of metaphor, it is not my purpose simply to give voice to a fashionable mantra. Seen as a contribution to cognitive *sciences*, Lakoff and Johnson inevitably seek those aspects of language and cognitive processes that indeed are as close to being 'universal' phenomena in human cognition and communication as possible. My criticism of

their work should not be construed as a rejection of this aspiration. On the contrary, the question of what linguistic and cognitive processes and phenomena may rightly be considered 'universal' is well worth asking, and the answers inherently significant.

The ubiquity of metaphor and its central role in higher order cognitive processes may well constitute such empirically grounded universal phenomena. Beyond such very general conclusions, Lakoff and Johnson's tendency to impute universalistic status to specific metaphorically configured cognitive schemas, and then to regard such schemas as the basis for producing their cognitive-linguistic maps of all kinds of social and cultural interactions and artifacts, is suspect. Indeed, Nickles suggests that "schemas" do their work "in a local, instance-by-instance manner – something closer to a Baconian, pragmatic-experimental demonstration than to projection in the form of a universally valid law or rule" (Nickles 1998: 80). Take the metaphorical schemas of containment, force, and balance that are so fundamental to their argument and putatively universal. There is no question that these schemas are widespread and the basis for further metaphoric extensions. But are they universal in any meaningful sense? For Lakoff and Johnson the implications seems to be that they are. Containment, force, and balance are "image schemas" and, as such, "are relatively simple structures that constantly recur in our everyday bodily experience" (Lakoff 1987: 267). Further, "these structures are directly meaningful, first, because they are directly and repeatedly experienced because of the nature of the body and its mode of functioning in our environment" (Lakoff 1987: 268). As if this were not enough to make the point, Lakoff goes on to suggest that "since image schemas are common to all human beings, as are the principles that determine basic-level concepts, total relativism is ruled out, though limited relativism is permitted" (Lakoff 1987: 268).

Lakoff's 'limited relativism' undoubtedly opens the door wide enough to permit a role for 'cultural influences and differences.' If so, it nonetheless leaves intact the universalism and foundational nature of schemas like containment, force, and balance as such. The persistent claim is that such schemas are shared by all human beings and subject only to minor subsequent variations or, put differently, different subsequent metaphorical extensions. Sufficient evidence exists, I would claim, to suggest that what is 'universal' about such schemas is of such a general nature as to be devoid of any meaningful content. Is

there, for instance, anything in common between, let us say, Western and ancient Chinese 'containment' schemas other than the *unspecified* duality, 'in-out'? Once we examine in any detail the specificity of this in-out duality, we find precious little in common, precisely because 'containment' as a schema implies different sets of relationships in the conceptual and experiential worlds of the two cultures. This is not to say that there are not 'insides' and 'outsides' in both cultures, nor that they are not both linguistically marked as such; it is to claim, however, that the boundaries between what is inside and what is outside are differently drawn and, at its most extreme, that the very notion of a 'boundary' itself is differently constituted in the two cultures. These differences are fundamental, for example, to acupuncture, to the very idea of 'organs' and their anatomical and physiological relationships to one another, and to the understanding of the body in relation to its 'external' environment in classical Chinese as opposed to both ancient and modern Western medicine. In all of these instances, attempts to understand Chinese medical schemas in terms of Western containment schemas in which there is an expectation of sharp boundaries between 'things' and in which agency is solely granted to such sharply distinguished entities leads to misunderstanding and outright confusion. Such energetic principles as *ch'i* and *yin* and *yang* operate exclusively in a world in which cosmos and body, concrete organs and their 'surrounding' environments, do not stand in any simple sense in relations of exclusive interiority versus exteriority to one another. Similar arguments and distinctions can easily be made regarding the schemas of 'force' and 'balance,' again using classical Chinese culture, and such examples as medicine, Buddhism, and definitions of 'personhood' as a foil for Western schemas of force and balance.[5]

As the above discussion suggests, Lakoff and Johnson's questionable assertions of universalistic claims for their metaphoric schemas direct attention to their assertions about embodiment and the bodily basis of metaphors and schemas. For these authors, cognition is a relentlessly 'bottom-up' process, with the fundamental schemas, metaphors, and categories driving cognition arising from our condition as embodied creatures. Again, let me be clear in stating that my objection is not to the notion of cognition as an embodied process, nor to attempts to understand 'mind' as necessarily embodied. On the contrary, I would insist that any account of the embodied nature of cognition must pay exquisite attention to the variegated ways in

which embodiment is produced, achieved, and experienced. This, it seems to me, is precisely the step that Lakoff and Johnson elide. Instead of attending to concrete, situated, forms of embodiment and embodied cognition, they offer us a generalized, abstract, homogeneous body: one that gives rise to 'image schemas' and foundational metaphors that are universal. One might go so far as to say that, in avoiding the Cartesian conundrum of mind-body dualism, Lakoff and Johnson reenact an intransigent nature-culture dichotomy. They do this, it seems to me, by insisting on the origins of schemas and metaphors in the body's *physical* experience of itself and its environment.

Instead of giving priority to some pristine physical experience and consequently drawing the lines of 'influence' or 'causality' from the body / physical *to* the metaphoric / cultural, we should look instead to the body and embodiment as itself a hybrid, mixed 'thing,' as a site where the natural and the cultural are produced, or, better yet, as the place where the 'physical' and the 'discursive' become inseparably entwined in complex feedback loops. Put more concretely, how we come as bodies to experience the physical constraints of our world has much to do with how we, as embodied cognitive subjects, are situated in our world. Rather than a single, universal form of embodiment in the world attributable to a single, universal physical body that, for all practical purposes, does not vary from individual to individual, or from culture to culture, gender to gender (and so forth), embodiment takes multiple forms. While all bodies share certain physical characteristics, embodiment – and embodied experience of self and the world – varies in all kinds of ways. Some differences in embodied experience arise from patent differences among physical bodies themselves; bodies, for example, that have been marked as 'abnormal' by the standards of a medicalized bureaucracy. Others, while marked as 'normal,' nonetheless experience embodiment in multiple and varying ways due to subtle physical variations attributable to a range of factors from anatomical and developmental variations, to hormonal and biochemical variation, to variations produced by disease and immunological factors, to – in the world of postmodern medicine – the emergence of prosthetically transformed bodies. Such differences, and their relations to lived, embodied experience of self and the world, have only begun to be articulated in the burgeoning literatures of patient autobiographies, 'pathographies,' medical humanities, disability studies (including literature and disability studies), intersex and

transsexual studies, and a range of related literatures and scholarly studies (Davis 1997; Dreger 1998; Hawkins 1993; Hunter 1991; Lykke/Braidotti 1996; Mitchell/Snyder 1997; Price/Shildrick 1999; Price 1995; Thompson 1996; among his many patients and cases cf. that of Virgil in Sacks 1995: 108–152).

Moreover, such variations in physical bodies are enormously difficult to separate from other factors – whether we label them 'cultural,' 'discursive,' or otherwise – that contribute to the way in which individuals regard their physical bodies and hence experience themselves as embodied. Indeed, it is precisely because of this difficulty that it makes little sense to speak of a dichotomy between nature and culture or the physical and the discursive/metaphorical. We experience our bodies – we experience ourselves *as* embodied – as simultaneously physical and redolent with meaning. This is why changes in our physical bodies have such unpredictable consequences: whether the changes are major or minor, abrupt or gradual, traumatic or 'natural,' the effects of such changes vary tremendously from person to person, and, among other factors, may be affected by cultural and gender differences. What seems to matter is the meaning such changes come to have for individuals and for the groups to which they belong: how physical changes come to 'fit' into the stories we inherit and subsequent (re-)tell of ourselves. While embodiment depends upon the existence of a living, physical body, embodiment itself is the product of the particularities and specificities of inhabiting a body in a certain way. Put differently, embodiment is neither 'physical' nor 'discursive,' neither 'natural' nor 'cultural,' but rather the primary (if learned) and concrete way in which we *relate*. Indeed, we are, in a sense, *not* embodied *until* we relate – to others and, through the 'other,' to self and the world. Embodiment attaches us to our world, to our 'self, ' and to 'others.' How we inhabit our bodies – whether 'able' or 'disabled', however 'enhanced,' 'altered,' 'prostheticized,' 'gendered,' or otherwise marked – produces an embodied, cognitive self that orients itself within, relates to, and operates in the world in specific ways. Just as such an embodied, cognitive self shares a physical world with others, it also shares a cultural and discursive world. Yet, precisely because of the particularities and specificities of its embodied relationship to self and world, its experience of the physical world is both shared and multiple and heterogeneous with respect to others.[6] Similarly, it both shares schemas and metaphoric

structures with others, and also inhabits the world differently, investing its schemas and metaphors with particular variations of meaning, leading to subtle variations in relating to self, other, and the world.

Recognizing the complexities and rich variations of embodiment leads us away from an account of metaphor that stresses its universal features and foundations. Instead, it leads us to acknowledge that schemas, metaphors, and metaphoric systems of meaning are themselves subject to and situated in the particularities and specificities of history, culture, discourse, and all sorts of webs of relations. Returning to Lakoff and Johnson's schemas of containment, force, and balance and their cognitive analysis of metaphor, one is struck by their desire to find a single Archimedean point in a unmarked and abstract physical body as not so much empirical as, following Richard Coyne, metaphysical (Coyne 1995: 249–301; for discussion of Lakoff and Johnson 1987: 264–276). In particular Coyne invokes a Heideggerean perspective to critique Lakoff and Johnson:

> For Heidegger, the spatial 'in' of containment is subservient to a primordial notion of 'in' as involvement. There is the nonspatial 'in' of being-*in*-the-world, being *in* a good mood, being *in* love. Seen in this light, Lakoff and Johnson's notion of containment is subservient to the more primordial notion of involvement. Prior to our bodily experience of containment is our being-in-the-world, an altogether more primary and important concept. Similarly, Heidegger offers a revision of notions of causality, which for Lakoff and Johnson is related to the bodily experience of force. For Heidegger, causality is subservient to care. From our being-in-the-world, we direct our attention within a region of concern. Notions that we may cause something to happen and that we may exercise control over a situation are derivative of this more-basic understanding of our place as exhibiting care … These arguments are obviously counter to those proffered by Lakoff and Johnson. Heidegger argues that there is a more basic experience than embodiment … Whereas Heidegger's identification of preembodied experience could be construed as yet another instance of discovering a foundation (not in the body, as for Lakoff and Johnson, but experience *prior* to the body), the preembodied has the appearance at every turn of being undecided. It is a fluxional involvement that defies pinning down. Heidegger's primordial concepts are not foundations but excursions into Pre-Socratic concepts of contradiction, flux, and play. How else could we characterize being-in-the-world? (Coyne 1995: 274–275).

Rather than grounding metaphoricity in such a metaphysical conception of a singular and stable form of physical embodiment, the position I have suggested is precisely to regard metaphor as a contingent, historical 'tool' which we use (and which 'uses' us) to approach, ultimately to inhabit, the unstable flux of things from which our world must emerge (Bono 1999).[7] Through metaphor we 'turn' toward the world and establish complex webs of relations with it. Take, for example, the metaphors of 'balance' and of 'warfare' that have characterized different epochs of medical thought in the West. The Hippocratic and Galenic ideals of health as a balance of humors, or active bodily fluids, authorized a particular set of relationships between individual bodies, and their external environment, and led to the cultivation of certain regimes of bodily care and control. By contrast, the 'embattled' body of modern germ theory adopts a quite different set of relations to its hostile external environment and enforces on itself – and on society more generally – a stringent medicalized, socio-political regime. Through metaphors we thus define ourselves as embodied cognitive selves in relation to what 'involves' us, or not (containment schemas), or what 'concerns' or moves us, or not (force schemas).

Schemas, metaphors, and metaphoric systems of meaning are not stable and universal, but respond to contingencies of history and environment. Whether arising from the body and embodied experience, or from other domains, metaphors do and must vary, as Sabine Maasen has insisted, "culturally, historically, situationally, individually" (Maasen 2000). Like Maasen, I reject the "analytical priority" Lakoff and Johnson give "to bodily experience" (as they define it) and insist upon the important tasks "performed" by metaphors at the discursive level (Maasen 2000: 210). At the level of discourses, metaphors serve as "messengers of meaning" as Weingart and Maasen have argued, and also as "mediums of exchange" among different disciplinary discourses, among different disciplines and cultural domains, and within different discursive ecologies (Bono 1990; Rosenberg 1999). Yet, if metaphor is to provide a significant analytical tool for the new science studies, I believe that we must also insist upon an embodied dimension to metaphor.

The relation between metaphor and embodiment is, I think, crucial to overcoming the resistance often expressed by proponents of science as practice to metaphor and literary dimensions of science. As I suggested at the beginning of this essay, one source of resistance to

metaphor has been the persistent tendency to oppose practice to discourse. The rejoinder, of course, is to claim, following Foucault and others, that discourses are practices and, indeed, to insist upon the materiality of discourses and practices.[8] Within science studies, the drift has been strongly toward understanding scientific practices as intimately engaged with the materialities of experimental protocols, of instruments and the machinic dimension, and of natural and scientific objects.[9] Despite this convergence of science studies, and the discursive analysis of science, upon 'practice' and materiality, a gap remains. This gap can perhaps be characterized as one forcibly separating 'textual' practices and laboratory or instrumental practices. My claim is that an understanding of metaphor as embodied and performative can help us bridge this gap, indeed, can help us reimagine the gap as a kind of optical illusion. In so doing, the textual comes to be recuperated, not as a site of mere transcription – an archive for dead knowledge and information, but as a site of action and invention.

Here I must gesture toward a much longer argument. That argument begins by tracing the shift from a synchronic analysis of practices in the science studies literature to a fertile notion of 'practice' as *temporally emergent* in the recent work of Andy Pickering (Pickering 1995). Pickering wishes to see science as concerned with encountering (and then acting with and upon) agencies in nature. "The world is filled," for Pickering, "with *agency*": it "is continually *doing things*" (Pickering 1995: 6). He goes so far as to contrast science as practice – seeking to uncover the "dance of agency" (Pickering 1995: 22) – with traditional conceptions of scientists as "disembodied intellects" (Pickering 1995: 6) seeking mirror-like representations of things. Pickering's move doesn't just reproduce the concerns with material practices, objects, and instruments found in the turn toward practice in science studies. By emphasizing the temporal emergence of agencies *and* practice through the scientist's 'accommodations' of machines, instruments, experimental protocols, and models to the resistances of material agencies, he underscores the central importance of the scientist as a situated, embodied actor and, with it, the embodied and temporally emergent nature of scientific practice and knowledge. Interestingly, though Pickering exhibits an appreciation for the role of "models" in this emergent process, he explicitly demurs from granting any role to metaphors, precisely because, in the accepted view, metaphors are simply 'textual' (Pickering 1995: 19).

But metaphor, as Lakoff and Johnson insist, is a cognitive operation. More to the point, within the new cognitive regime metaphorical processes are basic to cognition itself, and therefore to extending human thought and action to new – or, as we might recast it, emergent – terrain. The cognitive model of metaphor, despite the shortcomings noted earlier, provides valuable empirical support for a shift that I have insisted upon elsewhere: from metaphor as representational to metaphor as *performative*. The work of metaphor, I argue, is not so much to represent features of the world, as to invite us to *act upon* the world *as if* it were configured in a specific way *like* that of some already known entity or process. It is this capacity of metaphor to, for example, make us act upon Nature as if it were a Book (as in early modern natural philosophy and natural history), or to act upon biological organisms as though they were the product of complex informational codes, that makes it so central to science and scientific practice. Without the metaphoric construction of heredity – especially DNA – as an informatic code, the mobilization of molecular biology and affiliated disciplines in the late twentieth century to produce an entire array of instruments, recording devices, and protocols to 'read' the molecular alphabet in which the book of life is written could not be imagined.[10]

With this notion of metaphor in mind, we can reimagine Pickering's temporally emergent 'practice' as a process whereby the 'models' embedded in the material practices, machines, and instruments of science and projected onto the material objects and agencies in nature are themselves instantiations of metaphors. They are, in effect, metaphors put into – or translated into – material actions and things. Put differently, we can say that the materialities of scientific practice – machines, instruments, experimental designs and protocols, and objects – are discursively configured and deployed through the metaphors embedded in and operating through them. A good example of scientific instruments and protocols embedding metaphoric models is the now ubiquitous Flourescent Activated Cell Sorter (FACS), which embeds in its design the informational metaphorics of molecular biology, thus tending to favor the skill-set and interpretive modalities of the molecular over the morphological approach to immunology.[11]

In effect, what I am suggesting here is a way to think about the limits, indeed the liabilities, of the discourse vs. practice, or the text vs.

action, dichotomies.[12] As Elizabeth Grosz powerfully suggests, "A text is not the repository of knowledges or truths, but also passage or point of transition from one (social) stratum or space to another. A text is not the repository of knowledges or truths, the site for the storage of information (and thus in danger of imminent obsolescence from the 'revolution' in storage and retrieval that information technology has provided as its provocation to the late twentieth century) so much as a process of scattering thought, scrambling terms, concepts, and practices, forging linkages, becoming a form of action. A text is not simply a tool or instrument; this makes it too utilitarian, too amenable to intention, too much designed for a subject. Rather, it is explosive, dangerous, labile, with unpredictable consequences … Texts, like concepts, do things, make things, perform actions, create connections, bring about new alignments. They are events – situated in social, institutional, and conceptual space" (Grosz 1995: 125–126). The world as we know it and operate upon it is one in which we continually conjoin discourse and practice, text and action: where we simultaneously learn *and* act by embodying intentions and projecting our metaphorically constructed models onto matter which we shape and use to our ends as *instruments* of thought and action. The world as we know it and study it is filled with material-textual, or material-discursive, hybrids – instruments; machines; illustrations; diagrams; maps; charts; physical models; computer simulations – that are simultaneously part of the material world and *instruments* for our knowing and manipulating it.[13] They are all, in their own way, what I like to call *material metaphors*: embodied metaphors-in-action![14]

Notes

1 For example, "Discursive practices are not purely and simply ways of producing discourse. They are embodied in technical processes, in institutions, in patterns for general behavior, in forms for transmission and diffusion, and in pedagogical forms which, at once, impose and maintain them" (Foucault 1977: 200).
2 On the notion of literary technologies in science studies, cf. the seminal work by Shapin/Schaffer 1985.
3 For an indication of the expansive reach of metaphorical analysis and of metaphor theory generated by the cognitive paradigm, cf. the recent Special Issue by Fludernik/Freeman/Freeman 1999.

For an example of the application of cognitive analysis of metaphor to a specialized field, cf. van Rijn-van Tongeren 1997.

4 The notion of schemas has received much attention in psychology and cognitive sciences. More recently, it has been applied to the sciences by philosophers inspired by the cognitive revolution. Thomas Nickles, e.g., regards schemas as "cognitive mechanisms" that can help us understand how "a complex situation or set of inputs" can be structured "into an organized whole" (Nickles 1998: 78–79). For Nickles, quoting Ulric Neisser (Neisser 1976: 22), "schemata are anticipations" in which specific exemplars or frameworks are transferred or projected onto new situations, thus illustrating how "the past affects the future" (Nickles 1998: 80, quoting Neisser 1996: 22). I would suggest that the cognitive mechanism of metaphor is closely related to the generation of such schemas.

5 For a rich source of examples, and for careful analyses of contrasting Western and Chinese schemas, cf. the brilliant book by Kuriyama 1999.

6 On issues of nature vs. culture, the body, and cognition, cf. Grosz 1994; Kirby 1997; Wilson 1998.

7 I argue for this perspective as well in an unpublished paper, Bono 1997; in expanded form the latter constitutes a chapter of Bono, in progress.

8 On the relations between discourse and practice, cf. also Certeau 1984; Bono 1995.

9 For the turn to practice, cf. Lenoir 1988; Golinski 1990; Pickering 1992; Rouse 1996.

10 Cf. the essential new book by Kay 2000.

11 Thus, a very detailed example of the metaphoric configuration of the materialities of scientific practice can be read into the very careful study by Cambrosio / Keating 2000. I plan to provide such a reading in my book, *Figuring Science*.

12 For views of texts as action, cf. the fundamental work of Paul Ricœur 1991; for example, "the models *of* actions elaborated by narrative fiction are models *for* redescribing the practical field in accordance with the narrative typology resulting from the work of the productive imagination. Because it is a world, the world of the text necessarily collides with the real world in order to 'remake' it, either by confirming it or by denying it. However, even the most

ironic relation between art and reality would be incomprehensible if art did not both disturb and rearrange our relation to reality. If the world of the text were without any assignable relation to the real world, language would not be 'dangerous'" (p. 6).

13 For a stimulating discussion of diagrams and mathematics that complements this view, cf. Knoespel 2000 and Châtelet 2000.

14 Cf. my unpublished essay, Bono 2000; an expanded version will be included in my book *Figuring Science*.

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