

The role of theory-constitutive metaphor in nursing science

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Abstract

The current view of theoretical statements in science is that they should be literal and precise; ambiguous and metaphorical statements are useful only as pre-theoretical, exegetical, and heuristic devices and as pedagogical tools. In this paper we argue that this view is mistaken. Literal, precise statements apply to those experiential phenomena which can be defined either conventionally by criterial attribution or by internal atomic constitution. Experiential phenomena which are defined relationally and/or functionally, like nursing, in virtue of their nature, require metaphorical description and explanation. In such cases, metaphor is theory-constitutive. Using insights from the philosophies of language and mind, and examples from nursing practice, education, and our own empirical research, we explore the nature of metaphor and its role in theory constitution. We argue that the apparent resistance of certain experiential phenomena to literal description and explanation is not necessarily indicative of pre-theoretic linguistic imprecision. We suggest, rather, that such resistance provides useful insights into the nature of such experiential phenomena. We also suggest that the aim of scientific theory should be methodological or epistemological precision and not merely linguistic precision.

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Introduction

The following two quotations epitomize extant, orthodox views with respect to the nature of scientific and metaphorical statements:

A central presupposition of our culture is that description and explanation of physical reality is a respectable and worthwhile enterprise – an enterprise we call ‘science’. Science is supposed to be characterized by precision and absence of ambiguity, and the language of science is assumed to be correspondingly precise and unambiguous – in short, literal. (Ortony, 1993, p. 1)

And,

Metaphors are an essential part of scientific creativity because they provide a means for seeking literal descriptions of the world about us. These literal descriptions are scientific theories. (Miller, 2000, p. 219)

Given that all linguistic symbols, excepting those such as sentential/logical connectives (e.g. and, because, not, however, if-then, etc) refer to, pick out, or point to entities in the world and their relationships, the putative precision of scientific language reflected in these quotations implies a corresponding theory of reference. In addition, and because theories are literal statements, on these construals metaphor in research is useful only in the pre-theoretical stages of emergent disciplines. In the more established scientific disciplines metaphor is seen as useful in terms only of: (1) exegesis, e.g. white cells are soldiers in the war against cancer (Bonner & Greenwood, 2005); (2) as an heuristic device to facilitate new discoveries, e.g. styles of thinking are conceptual spaces that can be mapped, explored, and transformed (Boden, 1994); and (3) as a pedagogical tool to breathe life into ‘dry’ subjects (Cook & Gordon, 2004).

In our view, these construals are mistaken for they fail to recognize the crucial role metaphor plays in theory construction in established disciplines. We believe, following Boyd (1993), that as well as being useful to assist in explanation (exegesis), exploration (heuristics), and education (pedagogy), metaphor can be theory-constitutive. In disciplines like nursing, moreover, they very often are. In addition, and given that metaphors can be theory-constitutive, they enable epistemic access to various realities, i.e. they enable us to acquire knowledge of the nature of the world and what is in it.

In this paper, we argue both these points using insights from the philosophies of science and of lan-

guage and examples from practice, education, and our own empirical research experiences. We also demonstrate why defining nursing has been so problematic. We contextualize these discussions, however, by beginning with some very basic preliminaries regarding human language, in general, and metaphor in particular. We also discuss the constitution of linguistic meaning and its acquisition.

Language: some rock-bottom basics

Human language evolved, as did non-human calls, grunts, and gestures to enable communication between conspecifics (members of the same species group). As the size and foraging range of human social groups increased, full human language evolved from protolinguistic precursors (Wray, 2000, 2002) initially to track present and past social activities and predict future ones. Full human language enabled early humans to keep track of who is (was, will) be doing what to whom, where, how, for what reason and with what results (Dunbar, 2003). Subsequently, it was exploited to allow the verbal transmission of object/event description and complete causal mythologies about the world. Even more recently, beginning some 4000 years ago in Greece, language has also enabled the sharing of incomplete ideas and causal theories leading to their refinement, elaboration, and revision, i.e. knowledge construction (Johnson, 2003). Both these functions of language are required to enable human beings to survive and flourish in increasingly complex physical and social environments.

Language, rather obviously, is an arbitrary system of symbols, either vocal or written, invented by human beings who agree their meanings by convention (Lewis, 1969). It allows people to speak of entities which may or may not be present by referring to them. The function of language is to enable the picking out or pointing to of entities in the world and their relationships. For instance, we can speak of Mary in her absence because we share, by convention, knowledge of what ‘Mary’ picks out or refers to. Precisely the same is true of scientific terms; shared linguistic symbols, e.g. *electrons*, permit the sharing of ideas by the relevant scientific community. Sharing, refining, elaborating, and revising ideas

regarding *electrons* provide increasingly more accurate and adequate epistemic access to *electrons* in the world.

It is important to note that linguistic symbols include both literal and metaphorical terms; they both point to entities in the world and their relationships. Both literal and metaphorical terms assist human beings to make sense of and manage their worlds. What precisely metaphor is will be defined and discussed later in the paper; at this point and briefly, a metaphor will compare objects, entities, and events to another, in order to suggest a resemblance without requiring the elaboration of an analogy.

Metaphors and literal concepts are used to group together or categorize objects, entities, and events into manageable chunks of information which are stored hierarchically in memory. Conceptual storage is considered to be at three levels (Roth & Frisby, 1986), namely, superordinate (the level of most generality), basic (intermediate level), and subordinate (the level of most specificity). The superordinate category 'bird', for instance, subsumes 'wings' (basic) and 'feather' (subordinate). Repeated activation of these categories strengthens the connections between them until, eventually, their deployment is triggered quite automatically in situations where they are relevant, i.e. when birds, wing, or feathers are present, or spoken of, or depicted.

Experiential objects, entities, and events are individually different, but they are treated in thought and language as members of the same conceptual category (Roth & Frisby, 1986; Smyth, 1987). Without this ability to categorize entities in their worlds, human beings would be constantly bombarded with new and meaningless information. They would be unable to recognize and make sense of objects, entities and events, because they would not possess a category to which to attach them (Roth & Frisby, 1986). This in no way implies, however, that in the absence of the appropriate conceptual schemas, objects and events in the world would be invisible. They would merely be, in an important sense, meaningless. A range of types of entities and substances (Aristotle, 1952; Millikan, 2005) exist quite independently of the perceptions of human cognizers. Individuals (e.g. you, me) exist; eternal substances (e.g.

gold, silver) exist; historical substances (e.g. traditions, biological species, words, meanings, and syntactic forms) exist. (Of course, by their very nature, historical substances did not always exist.) These differing substances are real and they endure. Eternal substances endure the longest (eternally!) in virtue of their chemical/atomic composition; historical substances (e.g. meanings) endure in virtue of being copied generationally either genetically or memetically (culturally), merely because they are adaptively efficacious in certain physical and social environments; and, individuals endure in virtue of the law of conservation (the blue eyes I have today I will also have tomorrow). Repeated exposure, either to actual tokens of such substances or to their linguistic descriptions, enables human beings to construct and subsequently employ conceptual structures related to them and their types. The construction of concepts or conceptual categories is the means whereby human beings impose order on the world; they are mental representations (symbols) of objects, entities, and events which enable the understanding, remembering, and communication of such objects, entities, and events. What we perceive, how we act, and how we relate to objects, entities, and events are frequently represented metaphorically (Wurzbach, 1999). On the commonsense assumptions we challenge, however, such metaphorical representations are only pre-theoretical, heuristic, exegetical, or pedagogical.

A word of caution is appropriate at this juncture. The above account emphasizes the utility of concepts in the epistemic projects of explanation and induction. However, concepts can and frequently are used for social and political ends. They can and frequently are used to distort, to condemn, to deceive and to induce behavioural conformity (Hacking, 1991a, 1991b, 1995). Metaphors (metaphorical concepts) are powerfully persuasive linguistic devices because they are vivid and figurative; they can be used, therefore, with great effect in political and social projects. This paper focuses on their utility in nursing science, i.e. in epistemic projects. We are concerned, however, that their potential for application, both for good or ill, in non-epistemic projects should also be acknowledged.

Meaning and its acquisition

Meaning is generally construed to be ‘the conventional, common or standard sense of an expression, construction or sentence in a given language, or of a non-linguistic sign or symbol’ (Loar, 1995, p. 471). Linguistic meaning is a function of linguistic convention and conception at three different levels which dictate how sentences and utterances are standardly constructed and interpreted.

As we have already indicated above, the overall purpose of natural, public language is to enable communication between persons in the same speech community (although this claim is not uncontroversial, see, e.g. Chomsky, 1980, 1992). For communication to be possible, however, (1) the interactions of interlocutors must be coordinated; (2) the contents of their utterances must map words relatively faithfully to objects and events in the world, and otherwise comply with ‘satisfaction conditions’ (see below); and (3) as we have just discussed, interlocutors must possess the appropriate conceptual structures to enable the referential grasp of objects and events in the world.

1 Each natural language is characterized by a public pool of conventional linguistic forms, each with its own conventional function, i.e. words, syntactic forms, tonal inflections, idioms, etc that are real (although what they refer to may not be, e.g. the tooth fairy). They exist in the coordinated utterances of speakers and hearers (and their ‘private’ utterances and thoughts). Words, meanings, etc are produced by precedent and they coordinate the interactions of interlocutors. The conventional function of such linguistic forms will survive for only as long as they serve the interests of both speakers and hearers often enough to avoid extinction. For instance, ‘indicative’ syntactic forms in various languages perform a variety of functions (e.g. impart beliefs, give orders, even deceive), but no form will be labelled ‘indicative’ unless one of its functions is to produce true beliefs (Millikan, 2005) having propositional contents carried by other components of the sentence. Indicative syntactic forms continue only because it is in the interests of speakers and hearers that they should. Speakers usually have

good reason to share information, e.g. to elicit assistance in some task and hearers require true information to interpret stimuli and act in the world. The repeated use of false or uninterpretable information by appreciable numbers of people in a speech community would inevitably lead to the extinction of the indicative form.

2 Meaning also involves a semantic-mapping function (Millikan, 2005), i.e. the mapping (or matching) according to convention of words to states of affairs in the world. Directive syntactic forms, e.g. ‘sit down, Paul!’ generally aim to produce states of affairs (completed actions) that vary systematically with variations in the sentences exhibiting these forms. The state of affairs which results (Paul sits) is the ‘satisfaction condition’ of a directive sentence (Millikan, 2005). Of course, directives can be used for other purposes, too, e.g. to annoy or distract. Again, however, the directive form will only survive if a sufficient number of people in a speech community use it sufficiently often in its conventional sense. Fact-stating sentences are designed to produce true beliefs in hearers, but a true belief will be produced by normal mechanisms only if the sentence corresponds to a state of affairs in accordance with its semantic-mapping function.

The function of fact-stating sentences, however, is not restricted to the induction of true beliefs about objects and events ‘out there’ in the world. It also includes the induction of true beliefs about words. For instance, the statement ‘Cicero is Tully’ indicates that Cicero has the same referent as Tully. The conventional function of such identity statements (and, therefore, their satisfaction condition) is to induce the hearer to amalgamate all the information she has accumulated under one concept, ‘Cicero’, with the information she has accumulated under another concept, ‘Tully’ (Strawson, 1974). The hearer then possesses one clear, unambiguous concept ‘Cicero/Tully’ rather than two, separate and equivocal concepts. By the same token, sentences such as ‘Santa Claus does not exist’ are to induce hearers to disengage their concepts of Santa Claus from normal referential usage, relegating its use to pretend uses or eliminating it altogether from their conceptual repertoires (Millikan, 1984).

3 Finally, meaning is a function of the psychological mechanisms involved in the implementation of various linguistic forms, i.e. the deployment of conceptions that govern individual speakers' and hearers' grasp of conventional referents and sentential satisfaction conditions.

For language to be satisfactorily coordinated, interlocutors must share a knowledge (but not necessarily explicitly) of both the conventional linguistic functions and semantic-mapping functions of their language (otherwise, they would become extinct). In contrast, there is no requirement for interlocutors to share knowledge of the concepts they deploy to refer to entities in the world, although it is frequently the case that they do. There is, generally speaking, no one way for an object or event to manifest.

For instance, we typically perceive sounds, especially speech sounds, as the same sound at origin irrespective whether we are near the sound origin or far, whether the sound is muffled or clear, whether heard through air or water, etc. In addition, different clues are utilized by the perceptual systems in different situations, separately or together. The perception of distance, for example, is a function of at least ocular disparity, tension in focusing muscles, object occlusion by another, knowledge of size of objects viewed and atmospheric haze (Millikan, 2005). We also recognize distances by touch and stretch using many different parts of the body, and by sound. Importantly, too, we also recognize distances by using ruler and tape measure. None of these methods of distance perception is infallible, but each adds to our concepts of distance. Our sensory-perceptual organs thus enable the construction of concepts of entities we directly encounter 'in the flesh' (Millikan, 2005, p. 115). It is the case, however, that we also construct concepts of entities that we do not encounter 'in the flesh', e.g. the tooth fairy, Socrates.

Concepts of entities not encountered directly 'in the flesh' are constructed from encounters with language. Language is a standard medium for the transmission of information and learning to recognize, i.e. perceive objects and their properties through language, is as natural to intact, adult human beings as

through other perceptual channels, e.g. sight, sound, smell, touch, and taste.

Recognising a linguistic reference to a substance is as much a way of recognising that substance 'in the flesh' as any other way of recognising it. It is identifying it and recognising natural information concerning it through one more medium of manifestation. Think of this medium, the speech of another person, as like an instrument that aids perception. If one wears corrective lenses, these are another such instrument. The speech of another person is analogous to somewhat more complicated instruments of this kind. Like a camera, a radio, a CT scan or a microscope, another person who talks to you picks up information – bearing patterns from his environment, focuses them, translates them into a new medium, and beams them at you. Think of living in a language community as like being inundated in one more sea of ambient energy (Millikan, 2005, p. 117). (For detailed analyses of perception through language, see Millikan, 2000 [Chapter 6] and Millikan, 2004 [Chapter 9].)

Linguistic conventional forms are acquired in various ways including: through imitation (if something works, it is likely to get copied); through repeated exposure to conversation, i.e. simply listening and watching others as they speak; and, interactively, by taking turns in a conversation. Linguistic conventions are learned both implicitly, incidentally through participation in a speech community and, especially during formal education, effortfully and deliberately.

What is metaphor?

The New Shorter Oxford Dictionary defines metaphor as 'a figure of speech in which a name or descriptive word or phrase is transferred to an object or an action different from, but analogous to, that to which it is literally applicable' (Brown, 1993, p. 1756). Metaphors figuratively and assertively compare objects, entities, and events to another in order to suggest a resemblance and, as such, differ from analogies. Analogies merely infer that two or more things have similar qualities.

A figure of speech, e.g. 'Juliet is the sun' transfers a name *sun* (which is termed the source or secondary subject in a metaphorical statement) to an object which is different from, but analogous to that to which

it literally refers, i.e. *Juliet* (which is the target or primary subject in a metaphorical statement). The metaphor assists people to understand one phenomenon *Juliet* in terms of its resemblances to another, *sun*. Such resemblances may or may not be readily apparent (Black, 1955, 1993; Davidson, 1980; Johnson, 1981; Searle, 1993). Metaphors, therefore, point to or refer to putative resemblances between objects, entities and events in the world and their relationships.

There are multiple construals concerning how metaphors work and their cognitive status (see Johnson, 1981, Introduction). At the simplest, Aristotle (1952) construes metaphor to operate at the level of single words (*Juliet, sun*), as a deviance from literal usage (giving one phenomenon a name that belongs to something else) and as quite distinct from literal language.

At the most complex, in contrast, Lakoff (1993), Johnson (1981), and Lakoff & Johnson (1980) construe metaphor as pervading our thought, language, and action to the extent that the distinction between the literal and the figurative is unclear. Consistent with this, the locus of metaphor is not seen as being in language (let alone, *pace* Aristotle, at the level of single words); rather, it is seen to be in the way we conceptualize one representational system or gestalt in terms of another, i.e. in thought. Metaphor, on this account, is a general mapping across conceptual domains, and it pervades not just poetic and literary expression but also everyday language. Language is secondary. 'The mapping is primary because it sanctions the use of language and inference patterns in one conceptual domain, the source domain, to understand those of another, the target domain' (Lakoff, 1993, p. 208).

An example: in the *love is a journey* metaphor, one domain of experience *love* is understood in terms of another, i.e. *journey*. 'The mapping is tightly structured. There are ontological correspondences, according to which entities in the domain of love (e.g. lovers, their common goals, their difficulties, the love relationship) correspond systematically to entities in the domain of journey (the travelers, the vehicle, their destination, etc)' (Lakoff & Johnson, 1980, p. 313).

In terms of our earlier comment on linguistic meaning constitution above, the general mapping

across conceptual domains consists in semantic mapping between source and target. In addition, the satisfaction condition of such mapping appears, intuitively, to be somewhat akin to that of identity statements, i.e. to induce the hearer to amalgamate at least some of the information she possesses under one concept (*love*) with some of the information she possesses under another (*journey*).

Everyday language resonates with metaphor, both novel and conventional and, possibly surprisingly, the latter is the more common. Conventional metaphors are pervasive in thought and language and relate to a range of phenomena including language itself, and it is the norm in emotional expression. In terms of language, our thought and language is structured by the conduit metaphor. The conduit metaphor (Reddy, 1993) structures our thought and language about language. The conduit metaphor represents ideas or meanings as objects, linguistic expressions as containers and communication as sending. A speaker puts ideas into words (containers), sends them (along a conduit) to a hearer who extracts the idea objects from the word containers. In addition, thermal and orientational metaphors pervade emotional discourse (Lakoff & Johnson, 1980). For example, affection is warmth, passion is hot-blooded, and unemotional is cold. In terms of orientational metaphors, *happy is up* (I'm feeling up today) and *unhappy is down* (I'm feeling down today). These metaphors are not arbitrary; they are grounded in our physical and cultural experience. We are likely to have been physically close to and embraced by affectionate or passionate people and, in consequence, have felt the physical warmth of their bodies. In addition, 'My spirits *rose*', 'You're in *high* spirits', 'My spirits *sank*' are metaphors grounded in the physical postures typically adopted by persons when happy or sad. Drooping posture signals depression, sadness, whereas straight, erect posture signals well-being. [See Lakoff & Johnson (1980) for a whole range of such experientially grounded conventional metaphors.]

There are six points to note with respect to the above:

1 When metaphors are construed as conceptual gestalts, metaphorical expressions, e.g. *love is a*

journey, are construed merely as surface realizations of such conceptual gestalts. What this implies is that *love is a journey* is the superordinate concept under which a range of basic (e.g. we're going nowhere) and subordinate concepts (e.g. I'm the driver in this relationship) are subsumed.

2 Mapping is systematic because, as point (1) above demonstrates, the superordinate conceptual category *love is a journey* entails a range of appropriate subordinate (including basic) conceptual categories.

3 Novel extensions of such metaphors can be generated and immediately understood. The song lyric 'we are driving in the fast lane on the freeway of love' reflects correspondences between fast lane (exciting, dangerous) and sexual pleasure, and the danger can be related to either the vehicle (relationship) or the passengers (lovers) or both. The song lyric can be understood immediately (i.e. its meaning is perceived directly through language; see above) because the *love is a journey* metaphorical correspondences are already part of our conceptual systems.

4 Metaphorical meaning depends on fixed correspondences that are activated/triggered just like literal concepts in the appropriate situations to render them meaningful and manageable. Thus, grasping the meaning of the metaphorical expression, *we're at a dead end*, hinges on a grasp of the fixed correspondence of impasse in a journey to impasse in a relationship.

5 Novel metaphors become conventionalized when the appropriate linguistic community collectively recognizes their aptness to refer to and understand putatively similar phenomena in the world. Repeated use (copying; see above) renders them conventional and mundane until they seem more literal than metaphorical. For protracted periods, those who use novel metaphors may continue to read them as originally derived from their original source. Acquaintance with both sources and targets may ease comprehension. In time, however, the new use becomes as familiar as the old and may start to proliferate independently. We term such conventional metaphors *dead metaphors* (Moran, 1989) because they become the way people typically speak of their referents, e.g. mouth of river, neck of bottle. Metaphors, therefore, can become clichés (hackneyed phrases) in just the same way as literal phrases.

6 Metaphors, i.e. metaphorical concepts either individually or in conceptual gestalts, both novel and conventional are part of our common sense or lay 'theories' of the world, i.e. they are useful in assisting us to make sense of the world. *Bottleneck*, for instance, allows us to understand a build-up of volume in almost anything that moves, e.g. motor vehicles, fluids, and people, owing to some restriction in its normal functional area.

Everyday language is replete with conventional and novel metaphors because they are part of our lay theories of the world. Importantly, however, metaphors can be part of our scientific theories, too, and, when they are, they are theory-constitutive.

Theory-constitutive metaphor

Theory-constitutive metaphors are introduced into scientific theorizing when there seems good reason to believe that there are theoretically important points of similarity between primary and secondary subjects. Metaphorical expressions constitute at least temporarily an irreplaceable element of the linguistic machinery of a scientific theory. These are metaphors which researchers employ to express theoretical claims for which no adequate literal paraphrase is known. In cognitive science, for instance, there are no literal paraphrases of the metaphorical expressions related to computers (*the brain/mind is a computer* is the dominant metaphor in philosophy of mind and cognitive science) which express the same theoretical claims (Boyd, 1993; Wilson, 2004; Wheeler, 2005). **When there is no adequate literal expression with which to express the same theoretical claims, metaphorical expressions and statements are theory-constitutive.** They are not merely exegetical or heuristic, even in the most established of sciences. In addition, theoretically constitutive metaphorical expressions allow the introduction, at a relatively early stage of theory construction, of theoretical terms which refer to various plausibly postulated similarities and dissimilarities between target and source. These then serve to initiate investigation of such plausible possible resemblances (Boyd, 1993).

There are further important points to note with respect to theory-constitutive metaphors. To begin

with, they may refer to as yet only partially understood phenomena. Users typically are unable to specify precisely the relevant points of resemblance, and their success depends crucially on this sort of open-endedness. They are, as Boyd (1993) puts it, inductively open-ended. Their function is to put researchers on the track of similarities, many of which will be incompletely understood. In addition, they are capable of further refinement and disambiguation through further research into possible similarities. They may or may not be fully explicated through research and, where full explication is impossible, this could be indicative of an accurate fit of scientific language to the complex messiness of the world. Their repeated articulation and employment leads to an increase in cognitive utility because undiscovered features of primary and secondary subjects can be discovered and articulated.

These points refer not merely to tangential or marginal theoretical concepts; they can refer to fundamental concepts in established scientific disciplines. For example, representation and computation are absolutely fundamental to contemporary construals of mind/brain as computer, yet they remain only partially understood concepts and radically different views of their nature (and location!) obtain (Wilson, 2004; Wheeler, 2005). Some theorists view the location of representational and computational resources as being bound by the skull and skin of individuals (e.g. Adams & Aizawa, 2001; Rupert, 2004) and others view it as extending beyond individuals out into their environments (e.g. Clark & Chalmers, 1998; Hurley, 1998).

What the above implies is that theory-constitutive metaphors provide the linguistic machinery to describe, explain, and predict ill-understood or undiscovered causal features of the world and this points to both an important caution and an important question. The important caution is this: just as literal concepts and conceptual frameworks can be found wanting in terms of adequacy and accuracy through further research so, too, can metaphorical concepts. We have already noted, above, however, in an earlier caution that metaphors are powerfully persuasive because they are vivid and figurative. This implies that they could be rather more resistant to refinement or aban-

donment in light of the appropriate evidence than literal concepts. The important question is this: if metaphors and metaphorical terms are to be understood as referring or pointing to entities in the world, why is it that their lack of referential precision does not render them unsuitable for scientific theoretical construction? The answer is this: there are entities in the world the essential nature of which renders them referentially imprecise. These are what Boyd (1993) terms homeostatic property cluster phenomena.

Homeostatic property cluster phenomena are characterized by a range of properties that 'cluster' or co-occur in a significant number of cases. Their co-occurrence is typically the result of what may be described either literally or metaphorically as a form of homeostasis. The term homeostasis is appropriate because either (1) the presence of some properties favours the presence of others (under the appropriate conditions) or (2) there are underlying mechanisms or processes which tend to maintain the presence of both (sets of) properties. In terms of biological kinds, the underlying homeostatic mechanism is descent from a common ancestor. (We illustrate these points, below, in our discussion of infant primate development.)

Reference and literal interpretation

It was John Locke's (1690/1959) insight that 'real essences', i.e. the atomic construction of entities/matter like the corpuscles in Boyle's corpuscular theory of matter are not perceptible by the senses; they need to be defined by conventional definition or criteria of membership. He termed these 'nominal essences'. Thus, nominal essences are defined conventionally, typically by their macrosensible criterial attributes, e.g. yellow, malleable metal = gold. Since Locke's time, however, science has identified the atomic construction, i.e. real essence of a great deal of matter (i.e. of eternal substances) in the world. Many real essences can now be defined by their internal constitution; water, for example, is defined as H₂O. Reference can be fixed, therefore, by the conventional identification of criterial attributes for category membership or atomic constitution of substances. It is crucially important to note, however, that people must

have been talking about (referring to) entities in their worlds long before they were able to define them conventionally by criterial attributes or the nature of their internal constitution. They may well have used 'dubbing' (Kripke, 1972) or 'naming' ceremonies (Putnam, 1975) where statements like 'Let's call this *water*' were associated by precedent (see above) with descriptions of its referent, e.g. drinkable, wet, and colourless. This constitutes non-definitional ostensive reference fixing because it allows us to fit language (to enable us to point to) as yet undiscovered causal structures (ostensive reference means to refer to something by pointing to an example of it, e.g. '*red* is *that* colour'). It is necessary for human beings to introduce terminology to pick out substances in the world prior to the discovery of those properties which would constitute necessary and sufficient definitional conditions (e.g. H₂O). In this type of literal ostensive reference fixing, terminology is introduced for substances in situations where they are exemplified prior to the discovery of their essential or fundamental properties. This is relatively easy for eternal substances, e.g. water, gold, the internal constitutions or properties of which are fixed. It is not easy, however, for complex causal relational/functional properties like biological, psychological, and social kinds identified above as historical substances. The properties of such kinds are never fixed; they can be gained or lost through a change in the kind's relations or in the context in which it exists/occurs. Biological kinds are essentially what they are because of the interaction of morphology, physiology, and behaviour (Boyd, 1993). Species, for instance, are necessarily indeterminate; each species is an intermediate between its parent species and its emerging (or daughter) species. The example of species is instructive; it demonstrates clearly that biological kinds are what they are in virtue of their common history, not in virtue of any intrinsic resemblance to one another (Guiselin, 1974; Hull, 1978). In addition, species typically show variation, not in some peripheral subset of their features, but in all of them. No character, however central to our stereotype of that species, to its morphology, or to its genotype, is essential for an individual organism to be a member of the species. Tigers exist without stripes, calves are born with two heads, and Down's syndrome human

beings have highly abnormal genomes. Yet, unstriped tigers are tigers, two-headed calves are calves, and sufferers of Down's syndrome are human despite an additional chromosome. Biological kinds, therefore, are homeostatic property cluster kinds. Homeostatic mechanisms bring about the co-occurrence of their properties in nature. In terms of the evolution of species, e.g. factors which enhance reproductive isolation between species are a significant factor; they alter the species-defining property cluster and homeostatic mechanisms over time. Some properties of the cluster kind must be present for the cluster kind to be that kind, but not all the cluster properties must be present all of the time for a cluster kind to be that kind (unlike H₂O = water).

In terms of psychological kinds, mental states, e.g. beliefs, are what they are only in virtue of their connections to organismic input and output. Beliefs are essentially a relation between an organism and the world. The same is equally true of social kinds like marriage.

In sum, thus far, and an example: biological kinds are historical entities; conspecifics are what they are in virtue of their pattern of common descent and, as such, they are homeostatic property cluster phenomena. They are the result of evolutionary processes the outcomes of which are influenced as much by initial and background conditions as by any underlying laws. Adaptive forces are the result of local conditions; the product of any particular set of adaptive forces, therefore, will be affected by the range of existing organisms available for them to act on, the occurrence and sequence of relevant mutations and genetic drift.

Biological kinds, on this account, are evolutionary products of 'developmental systems' (Oyama, 1985; Griffiths & Gray, 2001) which include both environmental and intrinsic, including genetic factors. Biological kinds, e.g. mammals, inherit an environment along with their genes. This environment, however, is not the same as that of their ancestors. 'Rather, their parents create very specific conditions for them and the adult is the product, not of its genes, but of the interaction of its genes with this structured developmental context' (Griffiths, 1997, p. 61). The role of the environment in the developmental system is particularly evident in the development of mental capacities,

i.e. it provides the conditions under which one set of properties favours the co-occurrence of certain others (see above).

An example: an infant primate inherits a social environment without which it will fail to develop a normal adult mind.

Even short periods of deprivation of the usual social stimuli may throw its development permanently off-course. Social deprivation in infancy of rhesus monkeys can entirely eliminate normal play and maternal care from its behavioural phenotype and create inability to successfully complete copulation. It would be absurd to deny that maternal care and copulation behaviour are the results of evolution, and yet their development requires a highly structured environment. (Griffiths, 1997, p. 61)

What the above implies is that the 'homeostasis' in homeostatic property cluster phenomena is never static or fixed. It further implies that such homeostatic mechanisms will result in an irremediable indeterminacy of reference (Boyd, 1993). This in no way reflects an imprecision in scientific terminology, however; rather, it reflects the causal structures of the world (how the world is). It is an entirely satisfactory way of fitting linguistic symbols to entities in the world to allow their appropriate epistemic access.

The same holds true of ostensive metaphorical reference fixing. 'Metaphors in science reflect epistemological (and therefore methodological) necessity for the accommodation of conceptual structures to the causal structures of the world. Scientific kinds and categories must be defined in ways which reflect a *deference to the world even at the cost of conceptual complexity* . . . the existence of kinds with the sort of definitional complexity which homeostatic property cluster kinds exhibit helps explain why theory-constitutive metaphors are so stable a feature in complex systems (indeed, such metaphors may be especially important for the investigation of homeostatic property cluster phenomena)' (Boyd, 1993, p. 485; our emphasis).

Theory-constitutive metaphors function as non-definitional reference-fixing devices in exactly the same way as 'let's call this stuff in the bucket *water*'.

Of course, it might be objected that metaphors cannot function in exactly the same way in ostensive

definition for, by definition, they are not true (if they were true, they would not be metaphors). However, 'Let's call this stuff in the bucket *water*' is a dubbing, by precedent, and agreed by convention as a means of enabling at least some epistemic access to the world. Once the colourless fluid which one drinks has been conventionally dubbed as *water*, people can speak of it, add further definitional attributes and research and refine their construals of it. 'Let's call the mind/brain *computer*' has exactly the same function (see above).

Our earlier discussion, however, points to an important distinction between *water* and *mind/brain*. We have argued that water is what it is in virtue of its atomic constitution. Water always was and always will be H₂O irrespective of where it is found and how it manifests (snow, ice, mist, water). Water as H₂O is referentially determinate, and the satisfaction conditions of the statement 'this is water' are fulfilled by its actual constitution by H, H, and O. The semantic mapping in such cases is word (*water*) and world (H, H, O), and epistemic access is primarily by the senses, or at least technologically assisted senses. It is the very nature of such substances that allows scientific research to construct literal ('true') theories to describe and explain them. Given this, it should remain the aim of scientific research to continue to do this.

We have also argued, in contrast, that mind/brain is what it is in virtue of its history and functional relations; it is a homeostatic property cluster phenomenon. The mind/brain is never fixed in the way that water = H₂O is: at any given moment, the mind/brain is a product of interrelating historical, physical, social, and environmental influences. Homeostatic property cluster phenomena are irrevocably referentially indeterminate and that is the reason why the essential open-endedness of metaphor fits them so well. Given this, it seems that scientific research should abandon its pursuit of literal ('true') descriptions and explanations of homeostatic property cluster phenomena. Theory-constitutive metaphors are *productive*; they are massively effective in enabling epistemic access to phenomena whose very nature precludes literal ('true') description and explanation. It is epistemic access to the world that science purports to enable and it is this aim which scientists should energetically

and continually pursue. It is our view that the pursuit of literal description *per se* as a scientific aim is mistaken (see below, *Precision in Science*).

Nursing as homeostatic property cluster phenomenon

Nursing practice, just like any other practice, is a homeostatic property cluster phenomenon insofar as what nurses do is functionally and relationally defined. Nurses practice in social environments where what they do is a function of, *inter alia*, the nature of the patient's illness/wellness, the nature and extent of their expertise or skill-level and the nature and extent of their relationship to other healthcare professionals, managerial staff, standards of practice and available resources. This is why efforts to define nursing in the 1960s and 1970s proved so difficult. Nursing scholars of the time apparently construed nursing more as a pure kind like water or gold rather than as homeostatic property cluster kind.

Researching nursing practice (education, management, research) is likely, therefore, to require the employment of theory-constitutive metaphor to describe and explain it. Our own empirical research into the acquisition and exercise of nephrology nursing expertise certainly demonstrated that this is the case (Bonner, 2002). A metaphor 'Producing the Magnum Opus' was required to adequately describe and explain it.

Producing the magnum opus

Details of the research design and findings have been published fully elsewhere (Bonner & Greenwood, 2005); we include here only sufficient detail regarding the research process and the findings to make our case. The aims of the study were to discover the structure and process of expertise acquisition and its exercise by nephrology nurses, reveal the characteristics of expert nephrology nursing practice and the differences between expert practice and less expert practice.

The research utilized a grounded theory approach and, consistent with this, each data collection episode was followed by analysis. Initial line-by-line analysis

generated a multitude of codes and, gradually, as more data was collected and analysed, properties and dimensions of each category began to emerge (Strauss & Corbin, 1998). The properties of the core category (e.g. using multiple sources of knowledge, keeping a close eye on, confident practice) emerged early in the analysis, but labelling the core category proved highly problematic. We were unable to find a literal label for it that could adequately subsume the subcategories, properties, and dimensions as well as adequately explain the theoretical relationship between them. 'Leading the clinical team', 'coordinating patient care', and even 'providing holistic care' were among the core categories suggested and rejected. They simply failed to subsume the range of subcategories that had been identified in the data. In short, our suggested linguistic symbols failed to fit the realities we sought to describe and explain. In addition, we failed to generate category labels for the three-stage nature of expertise acquisition that had been identified earlier in the analysis. The literal labels we variously suggested and rejected failed to reflect the complexity of the activities engaged in by renal nurses at each stage of the acquisition process. They also failed to capture the process of movement from one stage to the next.

It took several months to generate an orchestral metaphor which adequately captured the complexities of nephrology nursing expertise acquisition and exercise. The expert nephrology nurse is composer (using multiple sources of knowledge), conductor (coordinating patient care, leading the clinical team) and expert player of a major piece of music (confident practice), the magnum opus. The core category (or source metaphor) of producing the magnum opus reduced all of the data into one overarching theory to explain the highly complex target process of expertise acquisition and expertise.

Very briefly, producing the magnum opus, the core category and highest level of nephrology nursing expertise, subsumed the two earlier stages of expertise acquisition and exercise identified early in the analysis. These were labelled as movements entitled 'learning to play in the orchestra' and 'playing better, learning to compose and conduct music'. Transition from one stage (i.e. movement) to the next was

dependent on a range of factors such as richness of knowledge and experience, intellectual ability, motivation and attitude to nephrology nursing. That is, non-expert nurses were 'learning to play in the orchestra', and the ontological correspondences onto which they were mapped in terms of nephrology nursing in the first stage included 'being told what to do', 'seeking confirmation', and 'getting the job done'; the second stage ('playing better, learning to compose and conduct music') mapped to 'repeated practice', 'beginning to take a leading role', and 'changing focus of practice'. Producing the magnum opus (i.e. expert stage) was mapped onto 'best practitioner', 'leader of nursing team', and 'designer of nursing standards of care'.

This study suggests that expert nurses are not merely directing other nurses but are also maestros of nursing practice. Expert nurses, therefore, are composers, conductors, and players of nursing activities, and the combination of these differing activities results in the production of the magnum opus (i.e. very high-quality nursing care).

Two points are worth emphasis at this juncture. First, when we undertook this analysis we possessed the same commonsense assumptions concerning metaphor as other researchers, i.e. that it was a useful analytic (or heuristic) device. This was in spite of our inability to generate adequate literal category labels for the phenomena we were analysing. As pointed out earlier, however, in these cases metaphors are not merely heuristic devices; they are, rather, theory-constitutive. An additional point is that when metaphor is useful as an heuristic device in analysis, it can only be a useful device if it fits, at least in important respects, the phenomena in question. (In other words, it fulfils the satisfaction condition of its semantic-mapping function.)

Theory-constitutive metaphor in nursing practice and education

As homeostatic property cluster phenomena nursing practice and education are replete with metaphor, both implicit and explicit, many of which are theory-constitutive. This is hardly surprising given that practice and education typically share the same dominant

metaphorical terms as research. One ubiquitous if often implicit metaphor which operates in nursing practice (research and education, too) is *disease is war*, especially and unremarkably, life-threatening disease, e.g. cancer (Wallis & Nerlich, 2005). Similarly, in nursing education, an ubiquitous, often implicit metaphor is that of *memory is storehouse* (Neisser, 1981, 1996; Wilson, 2004). We discuss these below. It should be noted, however, that their influence is not as positive as that of *producing the magnum opus*. As we have repeatedly cautioned, theory-constitutive metaphorical concepts, just like literal concepts, serve to structure for good or ill the practical activities of the agents who possess them.

The conceptual cross-mapping which characterizes *cancer is war* and which operates day after day in clinical units and structures both the professional therapeutics of the healthcare team and the responses of patients to them, includes the following: the enemy (war) is cancer (disease); the commander is the physician in charge; the soldiers are the patients; the allies are other healthcare professionals, including nurses and allied health professionals; the weaponry, conventional arms, biochemical and nuclear weapons, include surgery, chemotherapy, and radiotherapy; winning is surviving; winning is a result of fighting hard enough, long enough; and losing results in the commander leaving the field with the appropriate weaponry.

There are three points to note with respect to this metaphor. First, it assumes that a good death preceded by the appropriate palliation is a failure. In light of this, it might encourage the commander to remain in the field long after she/he should have withdrawn. Second, and just like a number of literal and metaphorical superordinate categories, it permits of the subsumption of a range of alternative subordinates. For instance, the patients could be seen as either passive civilians over whom the war is fought or even as the battlefield itself with nurses and physicians as soldiers.

Third, it assumes that anti-cancer weaponry either kills or impedes the division of tumour cells. It is the case, however, that the metabolic life cycles of many tumour cells remain ill-understood as, indeed, do the precise intracellular effects of many chemotherapeu-

tic agents (Reisfield & Wilson, 2004) used alone or in combination. Despite this, the metaphor clearly fulfils the satisfaction condition of its semantic-mapping function; both patients and healthcare professionals immediately understand (perceive) the meaning of 'zapping' the tumour.

In terms of the *memory is storehouse* metaphor operational in nursing education, items of information are acquired by various sensory-perceptual organs, transmitted to memory where they are stored hierarchically and subsequently retrieved when required. This metaphor persists, as our routine teaching and assessment strategies attest, despite over 30 years of relatively sterile research using it (Neisser, 1981; Wilson, 2004). Such research, underpinned as it is by an essentially passive construal of memory, has failed to produce useful insights into 'memory in the wild' (Wilson, 2004, p. 191), i.e. the memorial processes that underpin the day-to-day activities of people as they actively go about their lives. Fortunately, as an historical substance, the meaning of memory can change: indeed, this process has already begun).

Precision in science

There are two kinds of precision that can be pursued in science. The first kind is linguistic precision of the sort alluded to by Ortony and Miller, above. Linguistic precision is a function of following linguistic rules in the use of theoretical terms. The ubiquity of homeostatic property cluster phenomena and theory-constitutive metaphor indicates that this is a mistaken type of precision to pursue. The other and second type of precision to pursue in science, and the one which should be properly pursued, is methodological (or epistemological) precision (Boyd, 1993). This is a more generalized type of precision and requires precision in reasoning, proper control of variables, precision in measurement and, where appropriate, precision in linguistic expression. The fundamental rule of methodological precision can be sloganized as 'always enquire'. We should 'always enquire' in light of the best available knowledge, in what ways our current beliefs about the world might plausibly be

incomplete, false or inadequate and design research studies to remediate such defects (Boyd, 1993).

Summary

Both literal and metaphorical statements refer to and provide epistemic access to entities in the world and their relationships. Literal statements refer to kinds that can be defined conventionally by criterial attribute and by internal atomic constitution because their constituent properties are fixed and unchanging. Metaphorical statements refer to kinds that are defined functionally and/or relationally the properties of which are not fixed and unchanging. Such kinds are homeostatic property cluster kinds the properties of which, typically, resist literal expression. Homeostatic property cluster kinds, therefore, require metaphor in their description and explanation and, when they do, metaphor is theory-constitutive. Theory-constitutive metaphor in research, including nursing research, is inductively open-ended; by allowing the early introduction of terminology for ill-understood but plausibly postulated similarities they invite scientists to investigate such plausibly postulated similarities. As such, they constitute an essential element of the linguistic machinery of scientific theory. In addition, and because they are capable of further refinement and disambiguation through further research, they provide progressively more adequate and accurate epistemic access to the different ontological entities in the world. Methodological precision is the continuing aim of science; linguistic precision should not be pursued for its own sake. Linguistic precision should be pursued only when the phenomenon under investigation allows of literal description and explanation.

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