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The Access Paradox in Analogical Reasoning and Transfer: Whither Invariance?

Abstract

Despite the burgeoning research in recent years on what is called analogical reasoning and transfer, the problem of how invariant or similarity relations are fundamentally accessed is typically either unrecognized, or ignored in computational cognitive science and artificial intelligence. This problematic is not a new one, being outlined by the epistemological learning paradox found in Plato's *Meno*. In order to understand the analogical-access problematic, it is suggested that the concept of analogical reasoning needs to be reconceptualized as a subset of a higher order domain including the lexical concept *metaphor*, *isomorphic relation* in mathematics, the concept of *homology* in biology, *stimulus generalization* in psychology, *transfer of learning* in education, and *transposition* phenomena in perception, as all share the problem of how invariance relations are generated and accessed. A solution is suggested based on two specific evolutionary and neurological models, coupled with findings regarding the cognitive importance of knowledge-base. The paper constitutes a reciprocal complementarity theory to a previous paper on metaphor, suggesting the neurological origins and a reconceptualization of what are commonly called analogical and metaphorical reasoning. The paper also introduces a higher order form of analogical reasoning called analogical progression. Implications for research on analogical reasoning are discussed indicating the need for a paradigm shift in analogical reasoning research. The paper concludes with a four-stage model of analogical access.

Analogy, and its sister concept metaphor, has disenjoyed a long and controversial history. Indeed, the history and analysis of analogy and metaphor have been traced by authors in virtually every discipline: For example, in psychology Haskell (1987), Hoffman (1980), Lakoff and Johnson (1980), Leary (1990), Ortony (1979), in philosophy Dreistadt (1968), Hesse (1963), Ricoeur (1977), in anthropology Fernandez (1991), and in artificial intelligence Kling (1971), Winston (1978). When

I first began to be interested in analogy and metaphor as cognitive phenomena (Haskell, 1968a), analogy and metaphor were basically seen as literary devises to be avoided by "hard" scientists. There were a few notable exceptions in psychology (Asch, 1955, Nash, 1963,) in archaeology (Ascher, 1961) in paleontology (Gould, 1977), in biology and general systems theory (Bertalanffy,1963), in ethology (Lorenz, 1974), in physics (Oppenheimer, 1956) and in numerous other fields. Research in the humanities already had a massive literature on both analogy and metaphor (e.g., Shibles, 1971). Neither concept, however, was conceptualized as cognitive.

Despite a negative prevailing view by psychology and physical and natural sciences during the 1960's, I considered analogy and metaphorical reasoning to be different surface manifestations of a more fundamental set of cognitive processes based on similarity relations generated by a more fundamental underlying cognitive process (Haskell, 1968a)[1] Accordingly, in addition to analogy and metaphor, I also considered the concepts of *isomorphic relation* in mathematics, the concept of *homology* in biology, *stimulus generalization* in psychology, *transfer of learning* in education, *transposition* phenomena in perception, as all based on an "analogical" process, and that analogical reasoning was fundamental to all thinking and reasoning. What I was beginning to conceptualize at that time was that these concepts were based on some kind of *invariance* relations (See Figure 1) . Over the years, I have been developing a framework for understanding the subserving processes responsible for this array of surface phenomena Haskell,1968a,1978a, 1982, 1987b,1989, 1991, 2001, 2000a, 2000b, 2002a, 2002a, 2002b, 2003a, 2003b, 2004, Haskell and Badalamenti, 2003) see note 6.

The issue this paper will explore, then, involves the fundamental cognitive and neurological process(es) subserving the various surface phenomena indicated above, all of which are here exemplified by the concept of analogical reasoning. Accordingly, when referring to analogical reasoning , this paper will, in fact, be referring to an invariance function subserving the various surface manifestations noted above. More specifically, the paper will address the problem of how this invariance function is cognitively accessed.[2] Like my article on a neuro functional shift underlying the origin of lexical metaphor (Haskell, 2002 in the special volume of this journal), this paper suggests an integrative cross disciplinary approach is needed. Together these two papers constitute reciprocal complementarity theories on the neurological origins and a reconceptualization of what are commonly called analogical and metaphorical reasoning.

[1] Though this article (Haskell, 1968), written as an undergraduate, was an awkward and groping first attempt to outline what I saw at that time was the cognitive significance and scope of application of analogical reasoning. I later developed this view into a masters thesis (Haskell, 1968), and still later into an applied aspect of analogical reasoning (Haskell, 1978b). These early works have been a blueprint that have set my agenda ever since (seen endnote 6).

[2] For purposes of this paper, I will not distinguish between "access" and "retrieval" processes as is often done in the literature.

Invariance-Relations Origins and Domain Scheme

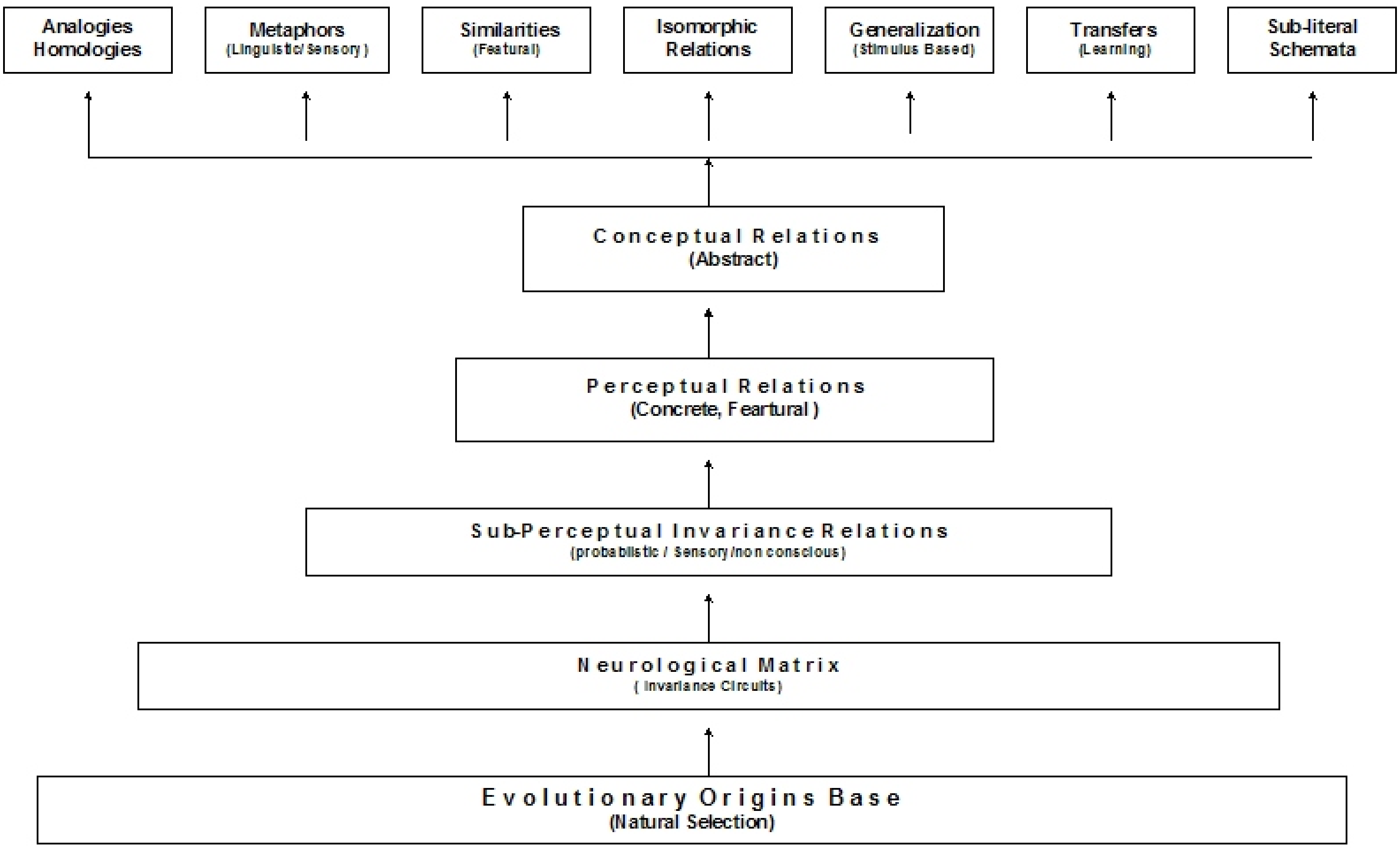

Figure 1

Overview

In the past twenty years, the concepts of analogy and metaphor have come to be accepted as reflecting not just logical and linguistic properties but deeper cognitive processes (e.g., MacCormac, 1985, Tourangeau, 1982,) that somehow involve similarity relations (see, Rips, 1989, Vosniadou and Ortony, 1989). In addition, analogy, *et al*, are also increasingly seen as fundamental to thinking and reasoning (e.g., Holyoak and Thagard, 1995; Hummel and Holyoak, 1997). During this time, a voluminous literature in psychology and cognitive science, including artificial intelligence and other fields has accumulated with most of the cognitive research and theory being domain-centered (i.e., either on analogy, or metaphor, or similarity, etc.). In addition, historically—and even now—research in each domain area has remained relatively isolated from the others. Thus, research on analogical reasoning has seldom been cited by metaphor researchers, and vise versa. Because each concept has been defined by its surface structure, it has been seen as "different" from the others (the research on similarity being somewhat an exception).

Moreover, the cognitive research on analogical reasoning has been largely conducted with a computational framework. The most well-known perhaps being the work of Gentner (1983) on analogical reasoning and Sternberg's work in analogical reasoning (1979a) and metaphor (1979b). The research of both Gentner and Sternberg concerned with the analysis of *retrieving*, *accessing*, *mapping* and *matching*, and more recently *alignment* processes involved in their work can be seen as paradigmatic of the computational approach to understanding analogical reasoning.

Despite this, a computational approach to research on analogical reasoning, has led to a virtual paradigm shift in the way thought is thought about, indeed, to a new Weltanschauung: Thinking and reasoning are now nearly equated with analogical processes. Perhaps, the most important aspect of the voluminous research on analogical and metaphorical reasoning has been the wide-spread recognition and analysis of its pervasive applications, e.g.,everyday reasoning (Holyoak and Thagard, 1995, Read, 1983), in law (Levi, 1949, Marchant, Robinson, Anderson, and Schadewald,1991, Sunstein, 1993),organizational research (Tsoukas, (1993) and in governmental policy making (Spellman and Holyoak,1992). In their work on analogical reasoning, Hummel and Holyoak (1997) have noted "our aim is to lay the groundwork for a more general theory of human thinking" (p. 427). Thus the field has progressed from seeing analogy, metaphor, and similarity relations as literary devises to being fundamental to human thinking and reasoning. In this respect, cognitive science seems to be finally catching up to Plato and Aristotle:

Plato (1956), following his mentor, Socrates, says about reasoning with similarity, "I am myself a great lover of these processes of division and generalization; they help me to speak and to think. And if I find any man who is able to see 'a One and Many' in nature, him I follow, and «walk in his footsteps as if he were a god" (p. 55) Indeed, Plato was so enamored with the idea of reasoning being similarity-based he is said to have written a manuscript (now apparently lost to history) called *The Simulacrum*. Later we find Aristotle (Cooper, 1960), similarly suggesting: "The greatest thing by far is to be a master of metaphor. It is the one thing that cannot be learned from others. It is the mark of genius" (p. 101). Indeed, in one form or another, the ability at analogical reasoning, cum ability at transfer of learning, has historically been linked to intelligence. For example, Holyoak, Junn and Billman (1984) note that "Analogical thinking is widely, albeit arguably, recognized as a hallmark of human intelligence, and as such the course of its development is a topic of clear importance" (p. 2042) McKeachie (1987) in commenting on paper about transfer research says, "As I read these papers, I could not help thinking of discussions of the 'g' factor in intelligence which is characterized by flexibility. Very likely the skills described by 'g' include those we have discussed here under the rubric 'transfer' " (p. 711). Shades of Plato and Aristotle.

The Access Problem

Given the pervasiveness of so-called analogical, metaphorical, similarity relations, generalization, transfer, and other related processes, along with their role in thinking, reasoning, and intelligence, it becomes important to understand how these processes are recognized and accessed. Despite the voluminous research we still do not know how we know that something is the *same as* something else. Intuitively, it seems simple: we perceive "similarities" between two or more ideas, events, objects. But, counterintuitively, research suggests that featural "similarity" is not the fundamental explanation (e.g, Rips, 1989).

Recognition of the Access Problem

From the vast literatures, a few researchers have recognized this fundamental problem of access or how the recognition of "sameness" is apprehended. Mostly the problem is either not recognized or is simply ignored. The problem is this: even given that similarity, relations—however defined—subserve the array of seemingly different phenomena like analogy and metaphor, how is the similarity relation identified? Some quotes by those who recognize this problem is testimonial to the importance of this problem. Eskridge (1994) recognizes that, “Retrieval of a source is arguably the most complicated issue currently facing researchers in analogical reasoning” (p. 210). And Keane (1987) notes that “one of the most important and least understood questions in analogical problem solving research is ‘where do analogies come from ?’ or, more technically, ‘how are base analogues retrieved?’... explanations of the source of such analogues have been found wanting and in the absence of a better explanation seem largely serendipitous”(p. 53). This is no small matter in understandin analogical access.

Two other well-known researchers, Holyoak and Koh (1987), also recognize that “If two situations drawn from disparate domains have never previously been associated, there can be no direct retrieval pathway linking the two. How, then, might the target activate the source?” (p. 333). Similarly, Spencer and Weisberg (1986) note that, “creative discovery is often promoted by noticing an analogy in a remote domain. However, even if one assumes that this view is correct, the question of how these creative discoverers initially noticed their analogies remains open” (p. 448). In reviewing the research on stimulus equivalence, Clayton and Hayes (1999) lament, “We are told that stimulus functions of B are transformed consistent with its mutual relation to A, but we are no closer to an understanding of transformation itself....a satisfactory description of the process of transfer or transformation is absent” (p. 152). Continuing, they conclude that “If indeed equivalence gives rise to rules, then for a rule to specify a contingency may simply mean that the rule and the contingency are members of the same equivalence class.” (p. 149). So this does not solve the problem of access either. Others deal with the problem by considering *stimulus equivalence* to be an unanalyzable primitive (Sidman, 1990).

As Johnson-Laird (1989) observes, “The processes underlying the discovery of profound analogies are much harder to elucidate than is generally realized” (p. 313), and concludes that analogies “cannot be guaranteed by any computationally tractable algorithm” (p. 313). Again, Holyoak and Koh (1987) recognize that “Particularly in the case of analogies between problems drawn from disparate domains, it is unclear how a problem solver can retrieve a potentially useful source analogue from a large knowledge base. *Computational models* of analogy have typically evaded this issue, either by explicitly directing the program to compare particular situations ... or by implementing a psychologically implausible exhaustive search mechanism” (p. 332, italics added). deJong (1989), too, asks, “How can a system retrieve a relevant source if it does not already know the ‘correct’ analogy mapping”? (p. 351). Finally, in asking how someone recognizes a similarity, Green (1979), too, laments that in recognizing metaphorical relations, “I still do not know how they get it... how anyone gets the metaphor.” But neither can I explain how anyone “gets the joke,” or “gets the parable,” or “gets the premise” needed to escape the clutches of paradox" (p. 473). The solution to the access problem is neither simple, nor obvious. It is, however, an old and venerable one preceding cognitive science. The access problem has been grappled with for over two thousand years in Western philosophy. More specifically in Plato's paradox in the *Meno*.

The Access Problem and Plato's Paradox of the Meno

In a critique of behaviorist learning theories, Weimer (1973) framed the problem of recognizing stimulus similarity most succinctly: "How can an organism recognize all the potential instances, on the basis of no prior exposure to them, as instances of the *same* concept?" (p. 470, italics added). In what should be considered a classic article in cognitive science, Weimer recognized this problem as one of Plato's famous paradoxes.[3]

In his *Meno*, Plato has Socrates argue "*That man cannot inquire either about that which he knows, or about that which he does not know; for if he knows, he has no need to inquire; and if not, he cannot; for he does not know the very subject about which he is to inquire*." This is the paradox and problem of accessing an analogy or similarity relation in Platonic terms. In other words, how is it possible that X is recognized as *like* Y, or X *like* X` The Socratic "solution" to this paradox is that all so-called new learning is actually *remembering something that we already know*. This is known as the doctrine of *Anamnesis* or *recollection*. While at first glance this apparent paradox may, at best, sound like something from a freshman course in philosophy or a moot academic exercise, in fact, it is one of the central problems of philosophy, education, and indeed, cognitive science.

Since Plato, philosophers, theologians, psychologists, physical scientists, and poets at one time or another, or in one form or another, have grappled with this problem and paradox. Indeed as Pylyshyn (1979) noted some time ago, "Almost every major cognitive theoretician...has had a crack at it." (p. 421). No solution, however, has been generally accepted for Plato's "access" Paradox. It is, therefore, crucial to understand this paradox in relation to analogical reasoning.

Although Weimer, like some others, (Balaban, 1994; Shanon, 1984), question whether the paradox of the *Meno*, as worded, is a true logical paradox, he recognized that the problem it poses is, nevertheless, a real problem for both philosophy and psychology that must be dealt with if progress is to be made in

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[3] Being in a largely behaviorist psychology department at the Pennsylvania State University at a time when behaviorist approaches were inordinately influential, despite his penetrating publications, Weimer did not receive tenure. He dropped out of academia, to run a family business. Apparently disillusioned, he would not respond to academic inquies.

understanding analogical reasoning.[4] In short, whither invariance? For a more extended treatment of Plato's paradox in relation to this issue, see Haskell, R. E .(2000b). While this paper will not presume to have logically solved the paradox, it will have a crack at a resolution, suggesting (1) a possible evolutionary basis, (2) a neurological substrate and (3) how, on these biological bases, access can be better understood and therefore initiated.

Transfer of Learning and the Access Problem

Like analogical reasoning, the instructional concept of transfer of learning is emblematic of the problem of access. Transfer of learning is the use of past learning in learning something *new* and the application of that learning to both *similar* and *new* situations (See, Haskell, 2000a). As indicated above, for purposes of this paper analogical transfer and transfer of learning are considered interchangeable, with the latter being a more general and often more implicit process of perceiving a similarity of some kind. Like analogical reasoning and its other equivalent terms, transfer of learning, too, has had a long history regarding the access problem.

From the very beginning of research on transfer in experimental psychology, Thorndike (1901) explained transfer of learning on the basis of *identical elements* theory. This theory maintains that transfer of learning only occurs when two situations have identical elements (read, highly similar) in common. If identical elements are not present, then, no transfer of learning will take place (except by sheer contiguity). Thorndike's view of transfer has held sway in educational theory ever since. Modern cognitive research on analogical reasoning and artificial intelligence is also based on Thorndike's 1901 identical elements view. Singley and Anderson, two well-known cognitive scientists (1989) in their seminal computational theory of how we acquire skills make clear:

"The essence of this book is that Thorndike's identical elements theory is alive and well in a new body. We have resurrected Thorndike's theory by redefining his identical elements as the units of declarative and procedural

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[4] Although Weimer, like others (Boom, 1991; Calvert, 1974; Moline, 1969; Rohatyn, 1974; Simon, 1976) have questioned whether the paradoxes of the Meno, as worded, are technically logical paradoxes, he argues that the learning paradox is a serious conceptual problem for both philosophy and psychology and that its resolution must be dealt with by both disciplines. Shanon (1984) addressed the Meno from a cognitive psychology perspective, but he did not address the resolution of the paradox. Using cognitive psychology findings, his approach was to address the issue of whether the paradox as stated by Plato was in fact a paradox. His conclusion was that it was not.

knowledge in the ACT* theory... The key difference between his proposal and ours is that, whereas Thorndike's elements referred only to external behaviors, ours include purely cognitive operations that reference abstract mental objects" (p. 248).

The authors have not in fact resurrected Thorndike's theory—since it never died—but have recast it in modern computational language.

In much of computational cognitive science, the view of how general concepts are constructed has not changed from the time of Aristotle. Following Aristotle, Singley and Anderson, in explaining how generalization works in their computational system say it, "is done by *abstracting common features* of the source and target of the analogy" (p. 31 Italics added). Aristotle's attempt to solve Plato's notion of universal concepts by positing abstract categories based on "*common*" features merely eliminates the problem of access by defining it away since claiming "common" features already assumes similarity relations. Further, Singley and Anderson (1989) clearly state, "Conspicuous by its absence in this discussion is any mention of the...mechanisms of *generalization* and discrimination *which create new productions by inductive*, syntactic transformations....processes of generalization and discrimination do not figure in our analysis of skill acquisition....*we have nothing new to say about this type of transfer* in this book" (p. 50, italics added). These two major figures reflect the more general state of affairs in cognitive science regarding this fundamental problem of access.

With some exceptions, then, nearly the entire history of research on metaphorical and analogical reasoning in the humanities, philosophy and in psychology has been dominated by the idea that analogies and metaphors are accessed by similarity relations of some kind (concrete, abstract, sensory, etc) despite the concept of similarity itself being known to be problematic for some time both logically (See Goodman, 1952; Quine, 1953) and cognitively (Rips, 1989, Shanon. 1988). And Medin and Ortony (1989), "agree with Rips that, unless one can specify how similarity is determined, the resemblance approach to similarity is vacuous" (p. 188). I will address Plato's paradox in more detail below. At this point it is necessary to look in somewhat more detail at the current state of cognitive science with respect to the problem of analogical access.

To reiterate: While the look of similarity has changed from referring to the concrete features of things to abstract conceptual relations and to procedural or computational production sequences, similarity—in one form or another—remains the primary explanation. From Edward Thorndike's influential identical elements theory of transfer, up through the contemporary computational cognitive science and information processing literatures on analogical transfer, then, similarity remains the default position for explaining analogical transfer and, by implication, Plato's paradox.

The question now is: how are identical elements and similarity recognized? Briefly, the classic answer has been Aristotle's: by *abstracting* out the *common features* from an array of stimuli, despite long standing research to the contrary on categorization processes (e.g., Rosch and Mervis, 1975). According to this *abstraction* view, categories are constructed by the increasing predominance of the similarities among stimuli over their differences. The process of abstraction subtracts from an array of the relevant attributes, which are defined in terms of similarity. Thus the theory presupposes in its explanation what it proposes to explain. Shades of Plato paradox, once more. As I have briefly noted (Haskell, 1997) elsewhere, "Though there is a great deal of research on cues, systematicity, and other apparent routes into "recognizing" similarity, what computational models, in fact, actually do is to tell us how we process a similarity relation after we have already recognized or accessed it" (p. 92).

Computational Approach to Analogical Reasoning

Such computational research on analogical reasoning and transfer holds that accessing an analogy is largely based on searching and finding a similarity and then mapping and matching, and more recently *aligning* the similarity between the two parts of the analogy. Thus, the obvious and conventional approach to how an analogy is initially recognized is that the brain rummages around its memory stores in search of a similarity and finds a "match."

One influential computational model of analogical reasoning is Gentner's (1982, 1983, 1988, 1989), analysis of the well-known analogy between the solar system and the atom. The research by Gentner purports to explain analogical transfer but being based on similarity relations—whether concrete or abstract—does not address the paradox. Markman and Gentner (1993), however, propose an interesting perspective on the concept of recognizing similarity. Instead of dealing with individual featural similarities, they assume similarity resides in a set of systematic alignments of all features between an analogy. Accordingly, similarity resides in an isomorphic matrix (my term, not theirs) alignment, or structure-mapping, between source and target, X and **X'**. For example, given source characteristics $X_{\mathbf{1\,4\,3\,7}}$, target characteristics must have the same alignments, $\mathbf{X'}_{\mathbf{1\,4\,3\,7\ldots}}$ They can not be $\mathbf{X'}_{\mathbf{1\,7\,4\,3.}}$ While this is a most interesting advancement, it merely adds another step in explaining of how similarity is established. It does not change the problem of access as it, again, assumes what it later purports to show—similarity; it merely switches the burden from *individual features* to *a systems alignment*. Though the concept alignment is itself important (see Haskell, 1968b) this view of similarity compounds the problem.

A variant to a strict computational approach to analogical reasoning is the work of Holyoak (1985, 1987, 1989) who emphasizes plans, goals and other cognitive constraints in accessing analogues. This view is not so much interested in the mechanisms underlying analogical reasoning as it is on the multiple constraints imposed on the reasoning process, i.e., its use. For example, problem space constraints, purpose or plans of use, etc. While quite aware of the problem, Holyoak's approach does not solve the access problem either.

In addition to the historical and voluminous research on the function of similarity relations in accessing analogical transfer, other techniques like giving hints (e.g., Gick and Holyoak, 1980), cues (Gick, 1985), and use of metacognitive strategies (Gray, 1991, Nickerson, Perkins, and Smith,1985) —while useful in other respects— do not address the fundamental problem or paradox of access. Still another approach in artificial intelligence is the use of an abstract plan and other conceptual features that are used to *index* the source of analogy. But as deJong (1989) points out "Any example of the source would be stored under these conceptual indexes"(p. 351) and therefore, again, assumes what it later purports to explain as similarity relations are built into the indexing.

Brief Critique of the Computational Approach to the Access Problem

Thus, neither strict computational approaches in cognitive science nor other artificial intelligence approaches add anything of significance to explaining analogical access. In fact, it could be said that other than as a systematic heuristic, the analysis of mapping, matching, and alignment of analogical components has yielded little of consequence that has not been known previously by philosophers, those in the humanities, and by other non computational research analyzing and applying analogical reasoning.

Computational approaches have essentially contributed only a set of abstracted algorithmic-like steps for processing analogical reasoning e.g., accessing, retrieving, mapping, matching, and alignment, by which to analyze how subjects' reason about and "retrieve" an analogy after the fact. Just as Weimer recognized that this approach does not solve Plato's learning paradox, so, too, Koestler (1967) understood that in similar learning theory explanations, there is a "ghost in the machine."

This brief critique of the computational approach to analogical reasoning and access is not meant as a broad sweeping indictment. Certainly for certain heuristic and pragmatic purposes computational listings of presumed systematic steps involved in analogical reasoning have been useful, just as a listing of the problem solving procedures in medical emergency manuals are useful. But it needs to be recognized that such computational lists are simply like a "911" operating manual for analogical reasoning. Accordingly, just as for everyday purposes the concept of similarity is often useful, so, too, are computational analyses, but as a fundamental explanation for explaining the access problem they both fail.[5]

Finally, almost by definition, most of the computational approaches to analogical reasoning—connectionist models not withstanding—are, of course, based on the assumption that the brain functions like a computer. Thus, all such artificial intelligence-like computational programs and systems for analogical reasoning operate on programs that already have built into them "recognition" algorithms for accessing the analogy or similarity relation. Perhaps what Jerry Fodor (1980a), concludes about computational and artificial intelligence approaches is appropriate here. Says Fodor, "People who do machine simulation, in particular, very often advertise themselves as working on the question of how thought (or language) is related to the world. My present point is that, whatever else they're doing, they certainly aren't doing that" (p. 65).

I point all this out, in part, to support the fact that cognitive science research on analogical reasoning and transfer has not only remained provincially cloistered from the vast philosophical and other non computational literature, but from the long line of research on the other similarity-based concepts indicted in this papers. Quite frankly much of the research has become repetitive, uninteresting and firmly engaged in what Kuhn (1970), describing scientific revolutions, has called "normal science,"where after a paradigm shift the drudge work on details is conducted. Accordingly, the normal science approach in analogical reasoning research has been merely tweaking minor issues. The problem is that there was never a prior paradigm shift, or revolution, from what basically has been, and largely remains, a "folk" conceptualization of analogical reasoning.

I point all this out, too, in hopes of generating integrative research and theory based on a more fundamental paradigm leading to a broader spectrum of what is typically conceptualized as "analogical" processes. Just as juxtaposing two metaphors—*al la* Black's (1962) interactive view of metaphor—often leads to new insights on the target and/or source, bringing together the seemingly different concepts of analogy, metaphor, isomorphism, transfer, etc., will likely lead to

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[5] The problem with most U.S. cognitive science as it relates to analogical reasoning is not just its componential approach, but also its dedication to the use of experimental design to the exclusion of all other methods. The problem, however is not componential and experimental designs per se, but with their exclusionary nature that casts suspicion on all other methodological approaches. In any event, with the unfortunate exception of textbooks on learning and cognition, the componential approach seems to be reaching the end of its explanatory power for everyday reasoning.

new insights, hypotheses, and research. A broader and integrative approach will undoubtedly generate new hypotheses to be investigated by both experimental and non experimental methods. For example, see my concept below of *analogic progression*, a higher order continuous form of what is currently called analogical reasoning.[6]

Are Analogical Reasoning Findings Constrained By Literacy?

A final problem similar to one examined in my article (Haskell, 2002) on a neuro functional shift underlying the origin of lexical metaphor (in the special volume on metaphor of this journal) remains. That article argued that the prevailing view of lexical metaphor as a figure of speech is the consequence of an inappropriate cognitive turn that resulted in a superimposition or back scanning of a modern alphabetic/literacy-based epistemology on to a linguistic phenomenon originating in a preliterate or oral culture. In that article, I suggested that lexical metaphor was originally not a linguistic figure-of-speech derived from literal language but only later came to be so conceptualized as the consequence of a neurofunctional shift (NFS) in hemispheric laterality, a shift precipitated by the invention and adoption of the Greek vocalic alphabet.

It is generally accepted that most of the cognitive science agenda can be directly traced to Greek philosophy (Gardner, 1985). More specifically, Le Doux, (1996) notes, "Cognitive science resurrected the Greek idea of mind... as a carefully engineered machine [which]seemed more appealing than the idea of the mind as a biological organ with an evolutionary history" (p. 39). Being a modern variant on Aristotlean logic which was developed as a philosophy hundreds of years after the adoption of the Greek vocalic alphabet had become

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[6] For some years now I have been developing an applied linguistic and cognitive framework with a structural methodology for analyzing verbal narratives that are based on the "analogical invariance" relations described in this paper (Haskell, 2004, 2003a, 2003b,2002a, 2002b,1989 , 1982, 1978). For purposes here, suffice it to say that I have found in my small group dynamic laboratory where there is a one-way vison mirror, or tape recorder and (even when aware of both) discussants will select into conversation stories about the CIA or FBI, secrets, and wiretapping. These literal topics and stories I have repeatedly found to be "analogical" expressions of members affective concerns about being watched. Discussants have no conscious recognition of why these stories were selected into the conversation. Somehow non conscious affective concern schemas cue linguistic schemas that then generate literal linguistic selections that in fact are analogues of what is occurring in the group discussions. While these stories are otherwise literal, they isomorphically map onto the group situation,where stories about *X* have what I have called sub-literal meaning ***X´***. Such findings call into question the very definition of what constitutes literal v. metaphoric, analogical or figurative just as does the parable, the pun and the double entendre. Significantly, since this article was written nearlyfour years ao, Haskell and Badalementi (2003) found an algebraic structure underlying such invariant sub-literal material.

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