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# Metaphor *and* Science

By Alexander Haitos  
and Deborah A.Z. Strehle

Detail of “Mind’s a Flutter” by Samantha Rivera

In the past thirty years, philosophers of science, philosophers of language, and cognitive scientists have emphasized the importance of understanding metaphor, although they rarely agree on the role it plays in thought. One dominant theory of metaphor treats metaphor as abbreviated simile. However, this theory does not acknowledge the embodied nature of metaphor, nor does it acknowledge that a metaphor has individual and influential meanings beyond the literal meanings of its constituents. In this essay, we explore this critique and discuss its relevance for understanding new concept formation.

The use of elaborate analogy, thought-experiment, and other metaphor-like tools in philosophy of mind is intriguing. In the past thirty years, philosophers of science, philosophers of language, and cognitive scientists have emphasized the importance of understanding metaphor, although they rarely agree on the role it plays in thought. In our research we found multiple theories of metaphor formation and meaning modification. This essay is an exploration of the status of metaphors, particularly in science: what they are, how they work, what they tell us about science. In the following sections, we will concentrate on providing a general explanation of metaphors by drawing on Lakoff and Johnson’s model. Then we will confront the problems with the “metaphor as abbreviated simile” theory and conclude that the most informative theory of metaphor will acknowledge that metaphors are capable of modifying meaning.

Regardless of position, there are a few features of metaphor that theorists agree on. First, metaphors play a deviant role in language: “In the utterance of a fresh metaphor the speaker explicitly violates the conven-

tional expectations of the community.”<sup>1</sup> The words or phrases used in a metaphor are employed outside of their literal use. Secondly, metaphors are about “applying information and understandings from one domain of experience, which we call the *source domain*, to enhance understanding of another domain called the *target domain*, that is typically more abstract.”<sup>2</sup> Whether or not meaning is transferred across domains is a point of contention in theories of metaphor. In the following sections, we will argue that a shift in meaning is a more plausible theory, given the apparent role of metaphor in science.

Metaphors are used widely in science to facilitate both communication and conceptual understanding amongst scientists and to the non-scientific public. From ancient models of the atom, to the concept of protein folding and global warming, scientists rely on complex metaphors to further their research and understanding.<sup>3</sup> Metaphors are not used merely for convenience, but out of necessity. It is important to acknowledge the significant role of metaphor in scientific thought because of the impact it has on thought in general. There are cases in which scientists can only express new concepts, even to themselves, by way of metaphor. For example,

when William Harvey proposed a solution to the mystery of how such a high volume of blood was pumped by the heart, he compared (what we now know as) the circulatory system to a circle.<sup>4</sup> That is, the metaphor of blood circulation as a circle helped clarify and modify important concepts in physiology, and directly contributed to the process of developing a coherent explanatory concept (the term “circulatory system” is now ubiquitous).

This shows that the meanings of metaphors are understood apart from the literal meanings of any of the words in them. The circulatory system is not literally a circle and a system; the metaphor conveys more than this. The metaphor is useful precisely because it does not simply refer to the exact meaning of the literal words. Instead, by highlighting possible relevant aspects of the source domain, it introduces a new way of understanding the target domain, which otherwise would have remained obscure. This is directly contrary to the positivist idea that “all scientific descriptions are purely literal” and concurs with the idea of a general degradation of the distinction between literal and metaphorical meaning.<sup>5</sup> As shown in the example, by altering existing concepts and adding depth of meaning to new concepts, metaphors can

(and do) help the conceptual problem-solving process of scientists. Scientists use metaphors to *interpret* data and new phenomena. “In themselves the data tell us nothing; only through the agency of models and theories can we convert raw observational data into something that makes sense.”<sup>6</sup> In order to interpret new information, we draw on “deeply ingrained bodily and social experiences that already form the framework for dealing with life on a day-to-day basis.”<sup>7</sup> In the above example, William Harvey drew on his knowledge of circles and systems and applied them to the body.

These bodily and social experiences are formed early in life from sensorimotor interactions with the world (things we experience through our bodies) and subjective experiences and judgments (emotions and beliefs). The associations we form between these types of experiences form what are known as “primary metaphors.”<sup>8</sup> An example of a primary metaphor is “Affection is Warmth.” This arises from the conflation of the sensorimotor experience of warmth, and a subjective judgment of affection. An infant conflates

formation about the more complex metaphor. We can use this complex metaphor as a model for understanding elements of relationships: How fast are the travelers going? Where are they going? Where are they stopping along the way? What else do they have planned? There are numerous ways complex metaphors inform our understanding of the world.

Primary metaphors make up a large degree of our language; they are difficult to separate from speech because they are integrated into the structure of everyday experience. From infancy we create associations grounded in physical and subjective experience that frame our experience in the world. We anchor our understanding in the metaphors we create. Without them, it is difficult to function at a high level of reasoning; our understanding of the world is handicapped. Metaphor is a fundamental component of thought. Although Lakoff and Johnson acknowledge that thought can take place without metaphorical concepts, “such reasoning would never capture the full inferential capacity of complex metaphorical thought.”<sup>11</sup> Thus in order to reason abstractly, metaphor is needed. The

## We anchor our understanding in the metaphors we create. Without them, it is difficult to function at a high level of reasoning; our understanding of the world is handicapped.

the warmth of being held and the affection of a parent. Later, we differentiate the two aspects but are able to reapply them metaphorically, such as in the case of the phrase “warm smile.”<sup>9</sup> By combining primary metaphors, we create complex metaphors, which we then use to reason about the world. For example, take the complex metaphor “A Purposeful Life is a Journey”: when we break it down into its primary metaphors we get “Purposes are Destinations” and “Actions are Motions.”<sup>10</sup> Each of these primary metaphors gives us in-

complexities of thought, including scientific thought, could not be reached without the use of metaphor.

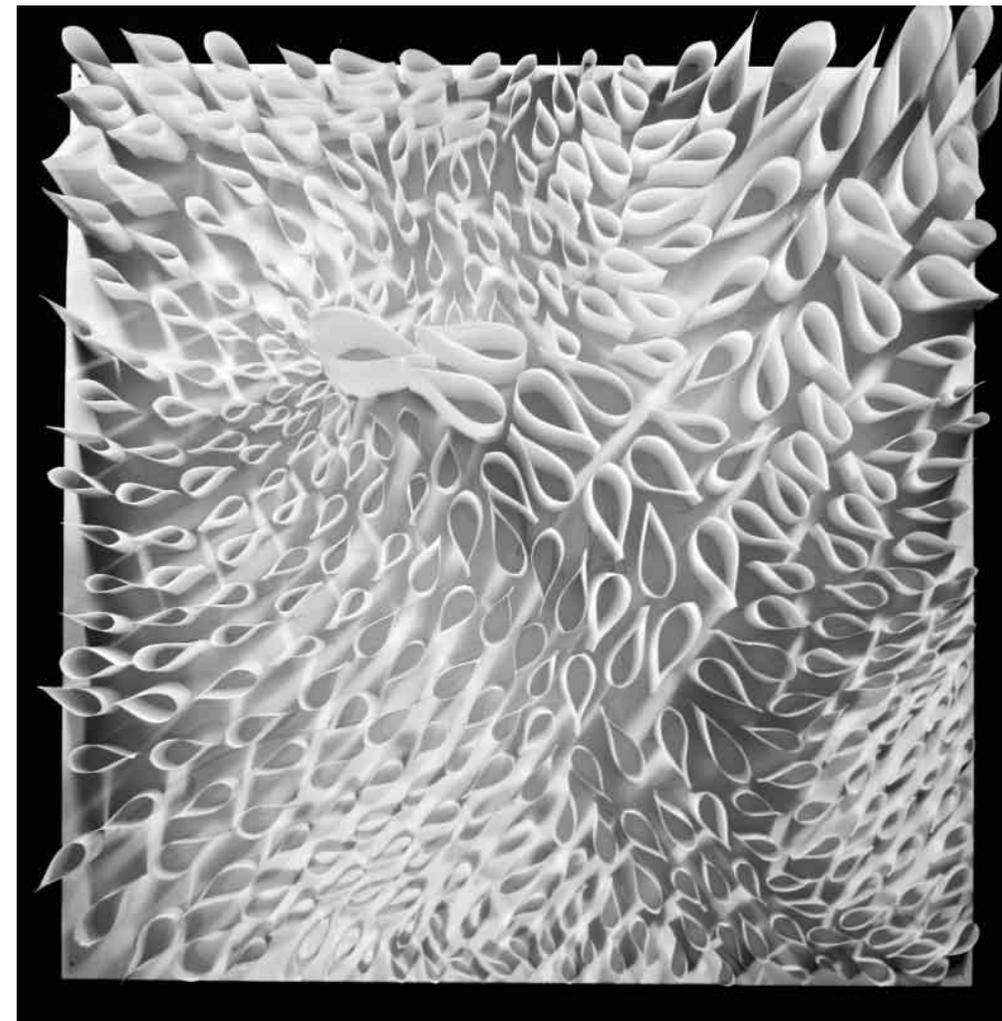
One common and dominant view of metaphor is metaphor as abbreviated simile. Under this view, “The result of a metaphoric interpretation will be the similarities that are both important and noticeable between distinct objects.”<sup>12</sup> The task of a simile is to bring out particular commonalities between two domains or objects, not to instigate a shift or change in meaning in any terms.

Thus metaphor as simile presupposes two things: first, that the two linked domains/ words, taken “literally,”<sup>13</sup> have at least one common element between them; second, that the metaphor does not alter or change the meaning of any of the words involved. The presuppositions of the simile approach do not allow for metaphor to execute its role concerning novel concept formation in science, and thus it is ruled out as an accurate characterization of metaphor, its meaning, and its function.

The reason for the first presupposition is obvious: to highlight a commonality, there must be a commonality in the first place. The second presupposition follows from the nature of “highlighting”; if you are simply highlighting a commonality between two things, you are drawing attention to it, so it will be more readily noticed. But, other than the attention being focused differently, the words still mean what they always mean. When metaphor is understood simply as simile, one must make due only with the literal meanings of words. Otherwise, the metaphor takes on new meaning beyond the literal. This is similar to another view which holds that, in a metaphor, words mean simply what they mean, and all a metaphor does is provoke some reaction in the listener.<sup>14</sup> In this view, a metaphor is a set of words that produce an unusual effect.

If one accepts the abbreviated simile view or the alternative view of metaphor mentioned above, one must then find some way of accounting for the seeming indispensability of *metaphoric meaning shifts* in scientific thought and concept formation. Metaphoric meaning shifts take place when, in the context of the metaphor, meaning moves from one domain to the other. Accounting for this shift is no easy task, especially considering the insights of cognitive science on the nature of metaphor. In addition, the abbreviated simile view of metaphor does not account for novel metaphor use.

Earlier we said the first presupposition of the abbreviated simile view of metaphor



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is some commonality between the literal meanings of the two words. It is this commonality that a metaphor is supposed to bring out. Consider the case in which two words’ literal meanings have no commonalities. For example, before blood was known to circulate around the body, the phrase “blood vessel” did not include the idea of “passage of fluid.”<sup>15</sup> But one could say (during this pre-circulatory time), “Blood vessels are irrigation canals for the body,” which is a perfectly acceptable metaphor because it introduces a new ideas that the phrase “blood vessel” could come to include. The similarity

between the two main ideas—blood vessel and irrigation canal—is at least going to include the idea of “passage of fluid.” But this similarity is not something that existed before the metaphor! The concept of “blood vessel” can undergo modification (i.e. inclusion of “passage of fluid”) *as a result of* the metaphor; there is a shift in the meaning. In the context of the metaphor, the target domain takes on some qualities of the source domain. The metaphor, target, and source domains can all shift in meaning. It is this modification that leads to the importance of metaphor for science; new concepts cannot be understood

without adequate metaphors. It is this modification that is precluded by the simile and related approaches.

Some may raise the objection that this similarity did in fact exist before the metaphor was made. Or, some may say that the person who uttered the metaphor first found the similarity, and thus uttered the metaphor as an abbreviated simile. In response to the first objection, we point out that there is a distinction between similarity in objects or referents on one hand, and the meaning of a word on the other. In response to the second, we will clarify what constitutes a word’s literal meaning. We will address both of these objections in the following paragraphs.

First, though a blood vessel and an irrigation canal may both include the “passage of fluid” in their actual, physical operation, the meaning of “blood vessel” did not include “passage of fluid” before someone connected the two. To argue otherwise implies the meaning of a word is dependent wholly on the actual object and not on the knowledge of the speaker. This would mean there are times when we speak with words full of unrealized truth, and thus do not know the meaning of what we speak. One would not know what “blood vessel” (or any word) really meant until one knew everything about it, yet this *everything* is what would be spoken at all times! This is a strange and counterintuitive view. To us, the departure this view takes from common intuition and the difficulties it creates for epistemology is enough reason to abandon it; it is much more likely that the meaning of “blood vessel” did not include “passage of fluid,” while the passage of fluid was not attributed to blood vessels.

This point segues nicely into the response to the second objection about our response to a person determining the similarity before uttering the metaphor. A metaphor, like all words and phrases, is uttered and has meaning in a community of language users. The literal meaning (or dictionary definition) of a word is derived from the standard use in a community of language users. One person

can introduce deviations in meaning—and these generally at a particular time—but cannot instantly alter the literal meaning of a word for the larger community. When the phrase “blood vessels are irrigation canals for the body” is uttered to unsuspecting members of the community, the literal meaning of blood vessels still does not include the notion of “passage of fluid.” Thus the similarity is not yet embodied in (literal) meaning (as required by abbreviated simile), and yet the metaphor holds. The metaphor is still expressive of some meaning beyond the known similarities. For a perhaps clearer example:

William Harvey raised the following problem: How could the heart pump out more blood in the space of one hour than the weight of a person? Only through the metaphor of the blood’s movement in terms of a circle could Harvey explain how the blood went through the body at such a high rate. This hypothesis of continual circulation required a significant reformulation of the concept of movement of blood.<sup>16</sup>

This metaphor of “circular movement” to “movement of blood” was applicable and meaningful in a way that cannot be captured by simile, because the relevant similarities that the simile purports to expose are not known or understood. The meaning of a metaphor must be derived from somewhere else. Properties seem to be transferred, in a semantic sense, from the source domain (ex. irrigation canals) to the target domain (ex. blood vessels).

To discuss an alternate theory, as opposed to metaphor taken to be an abbreviated simile, in this theory a metaphor genuinely has meaning beyond the literal meanings of its constituents; it does more than highlight similarities within the concepts. A metaphor’s meaning is an amalgam of the two or more words or ideas present in the statement. This meaning alteration can go both ways, with both domains taking on new meaning, or it can be unidirectional, with the target domain taking on qualities of the source domain. In

both cases, the metaphor generally requires the fields of comparison to be mutually exclusive. This means relevant aspects of each domain are highlighted, while other aspects are left out.<sup>17</sup> As a result, those who use the metaphor will be influenced by it—they see through the lens of the metaphor, so to say.<sup>18</sup>

## When individuals are trying to express something new (whether it be in science or poetry), metaphor lends itself to this endeavor because it can forge links between things that did not previously exist.

The metaphor takes on a certain power to dictate conceptual understanding.

Instead of bringing out similarities in ideas, a metaphor applies aspects of the semantics of one idea (generally the source domain) to the semantics of the other idea (generally the target domain) by either addition or replacement.<sup>19</sup> Thus the target domain is now characterized by semantic elements it is usually not characterized by, and the fruitfulness of such an alteration (determined by interacting with the object [referent] of the target domain) will determine the power of the metaphor. For example, when aspects of “circular movement” were added to “movement of blood,” that alteration in “movement of blood” proved to have great fruitfulness in explanatory and problem-solving situations. And so, metaphors begin to move from their role in concept alteration to the assimilation into the grammar of a language.

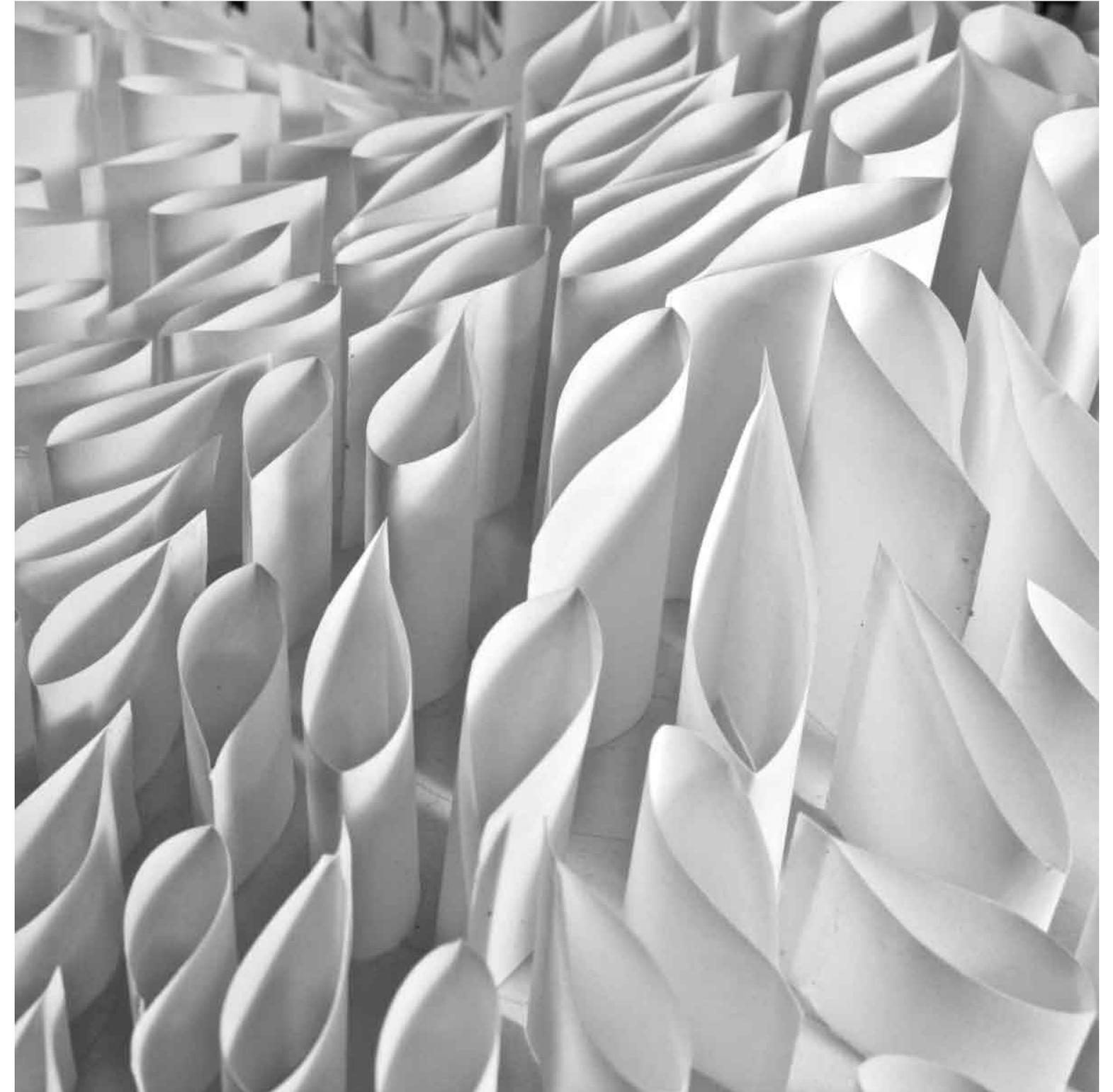
It is important to acknowledge the significant role of metaphor in scientific thought because of the impact it has on thought in general. We cannot build up to abstract thought without primary metaphors. An important implication of the primary metaphor theory is that it demonstrates metaphor is embodied in three ways. In metaphor, the “correlation arises out of our embodied functioning in the world . . . Second, the

source domain of the metaphor comes from the body’s sensorimotor system. Finally, the correlation is instantiated in the body via neural connections.”<sup>20</sup> Understanding that metaphor as essentially linked to our embodied experience opens up the potential for new classes of metaphors. As we encounter

new sensorimotor or subjective experiences or judgments, we can create new primary metaphors, which could lead to the creation of new concepts and ideas and then to new stages of a language. This cannot happen if we accept the simile theory of metaphor because it does not allow for new meaning creation through metaphor.

### Conclusion

In accepting the position of metaphors as capable of modifying meaning, we have demonstrated that metaphors are not secondary to literal meaning; they are distinct from literal meanings of words. Metaphors can act on the involved domains in order to alter and refine established concepts and potentially generate new concepts. This linking and altering of concepts, in conjunction with the theory of primary metaphors, suggests that metaphor is an early and primary component of new concept formation. When individuals are trying to express something new (whether it be in science or poetry), metaphor lends itself to this endeavor because it can forge links between things that did not previously exist. The expressive power of metaphor runs deep. It is how individuals utter what they feel yet cannot say. It is at once an expression of links beyond words and also the first step to introducing new elements into linguistic life.



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