Metaphorical Shift and the Induction of Similarities

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Correspondences

The pillars of Nature's temple are alive
and sometimes yield perplexing messages;
forests of symbols between us and the shrine
remark our passage with accustomed eyes.

Like long-held echoes, blending somewhere else
into one deep and shadowy unison
as limitless as darkness and as day,
the sounds, the scents, the colors correspond.

There are odors succulent as young flesh,
sweet as flutes, and green as any grass,
while others - rich, corrupt and masterful -

possess the power of such infinite things
as incense, amber, benjamin and musk,
to praise the senses' raptures and the mind's.

The Flowers of Evil - Charles Baudelaire. Translated by
Richard Howard in Les Fleurs du Mal, David Godine, Boston,
1982.
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ABSTRACT

This thesis presents a view of metaphor as the syntactic realization of an underlying cognitive process: analogical reasoning. The semantic changes resulting from the 'anomalous' juxtaposition of the metaphor's referents can be represented in a conceptual semantic space by rules of construal. These rules describe the semantic changes induced by a comparison component part of analogical reasoning. The meaning of metaphor is then a set of valid transferred similarities. Some similarities are pre-encoded as part of our general knowledge and are 'discovered' through the transfer process, whereas other similarities are 'created'. A taxonomy of conventional metaphorical themes is presented that supports the creativity of metaphor by the means of similarities induced by metaphorical shifts and inherited through this taxonomy.
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Chapter 1

Can We Ignore Metaphors?

Praised by some, despised by others, metaphor has received much attention in the past years. For its detractors, it is a mere ornament or an anomaly. For the increasing numbers of its appreciators, it is a very peculiar way of seeing, a peephole in the nature of things. Metaphor, more than a semantic impertinence, is the result of a specific thought process: metaphorical thought. It is the nature of this thought we need to investigate. How is it reflected on the syntactic surface of language? What is the underlying cognitive process?

To answer the first question, we will explore how a general framework and rules can be developed that account for the semantic anomaly produced by metaphor. These rules only describe the effect of the underlying cognitive process: analogical reasoning. Analogical reasoning is a powerful technique for which careful study is highly promising in the development of Artificial Intelligence. Analyzing its use in metaphors, is a means to unveil the internal mechanisms ruling a transfer of knowledge through similarities.
1.1 What is Metaphor?

Although it seems natural to define first the object of our study, no task can be harder in the case of metaphor. A precise definition is probably impossible. We will content ourselves with a very general definition given by Tourangeau:

Metaphors involve two systems, often drawn from different domains of experience. Despite their fundamental incompatibility, the two systems can stay married because the one serves as a model for the other. [Tourangeau 82 p18]

By its generality, this definition does not apply only to the realm of language. Metaphorical thought exists also in music (e.g. nonimitative music), in painting (e.g. impressionism) and in all creative arts, since they implicate creativity, insight and interpretation and since their principal goal is to convey feelings and meanings that are beyond their constituents\(^1\) (musical note, patch of color). In this study, we will limit ourself to metaphors in language, excluding also literary discourse. This is not as restrictive as it seems! Metaphors occur in The Wall Street Journal, and in regular texts, there are about five metaphors per 1000 words, and while speaking we utter four metaphors every minute [Hall 84 p4].

This definition of metaphor would be incomplete if we did not mention the ‘mysterious’ power of metaphor. The mystery of metaphor, besides the aesthetic pleasure it can create, is its intangible ability to express the inexpressible. Metaphor has in itself something else, undefinable and yet

\(^1\)Eighteenth century philosophers carefully studied how literature, painting and music are parallel and how metaphors in the three cases link a signifier to a signified; see Dubois, Jean-Baptiste Reflexions critiques sur la poesie et sur la peinture. 6ème ed. Paris 1755.
vivid. It gives a new insight, a different way of seeing things, of structuring concepts. When ‘x is y’, x is no longer x, but is seen as y, through a stereoscopic view: x is structured, filtered by y. In such a way we can say that x acquires a new meaning. If the metaphor becomes widely accepted in a language, this feeling of novelty will fade out, and a new meaning will be entered in the dictionary (e.g. ‘cold’ used to qualify unemotive persons).

Asserting an emerging metaphorical meaning goes beyond the simple definition of metaphor. It implies a dichotomy between a ‘metaphorical’ and a ‘literal’ meaning, and furthermore suggests that there must be a systematic relation between both in order to convey the intended meaning. Because of the ‘fundamental incompatibility’ of the two referents, the literal meaning is generally viewed as ‘anomalous’. This enables one to ‘recognize’ metaphors, an easier task than to define them.

1.2 Criteria for Recognizing Metaphors

We can certainly ‘recognize’ metaphors in a text, whatever the importance of this recognition in the overall process of metaphor understanding. Three criteria can be distinguished: syntactic cues, semantic anomaly and pragmatic anomaly. However, the ability to ‘recognize’ a metaphor does not entail that this ‘recognition’ is a necessary preliminary step of the understanding process.

A first obvious criteria is merely to announce a metaphor by expressions such as ‘speaking metaphorically’, ‘practically’, ‘actually’, ‘virtually’. Such criteria apply only to few cases; however, a close study of style and grammar, still to be done, should provide valuable information about the syntax of metaphor. Most authors over-emphasize the importance
of the form ‘$x$ is $y$’, although such occurrences are not predominant. Adjective-noun metaphors (e.g. ‘colored quark’) and verb-noun metaphors (e.g. ‘root out your faults’) must not be neglected.

1.2.1 Semantic Anomaly

A second way of recognizing a metaphor is semantic anomaly, certainly the most discussed way. The distinction between a literal meaning and a metaphorical meaning is stressed by the ‘anomaly’ of the literal meaning. This ‘anomaly’ can be described as ‘falsity’, ‘logical contradiction’, ‘contradiction’, ‘banality’, ‘pointlessness’, ‘meaninglessness’, ‘absurdity’... All of these qualifiers are not equivalent, and counter-examples can be found for each of them.

The ‘anomaly’ or ‘tension’ classically arises from the semantic incompatibility of the two referents, i.e. the tenor and the vehicle. The tenor\textsuperscript{2} designates the new unfamiliar concept. The vehicle\textsuperscript{3} is then the familiar concept to be interpreted metaphorically. In ‘man is a wolf’, ‘man’ is the tenor and ‘wolf’ is the vehicle. Certain complex metaphors may involve more than two referents, but can be recomposed as pairs of referents. ‘Stars are pimples of consciousness’ (Tom Robbins) can be recomposed as the mixing of two metaphors ‘consciousness is skin’ and ‘stars are pimples (on that skin)’.

Counter-examples of ‘semantically normal’ metaphors can easily be found. ‘Man is not a wolf’ is metaphorical, as will also be all negations of metaphorical statements. On the other hand, there are false literal sentences

\textsuperscript{2}Also named ‘focus’ or ‘topic’.

\textsuperscript{3}Also named ‘frame’.
that do not have metaphorical meaning: ‘a whale is a fish’. Not only should true/false values not be applied to ‘literal’ meanings, but they should not be applied either to ‘metaphorical’ statements, where truth or falsity are irrelevant. If you are asked ‘are encyclopedias gold mines?’, you would answer ‘not literally’, but concerning the metaphorical statement, the answer cannot be Yes or No, but ‘yes, in a certain way, or to a certain extent’. Metaphors are not true or false, but good or bad. It is a matter of degree, of matching, and of correlation. Counter-examples do not necessarily involve negations: ‘My love is a tree’, ‘Trees are plants’ are semantically normal, i.e. they have both a literal and a metaphorical meaning. In such a case, the metaphorical meaning can be recognized only as a ‘pragmatic anomaly’.

1.2.2 Pragmatic Anomaly

Pragmatic anomaly corresponds to a literal meaning seen as ‘meaningless’ or ‘pointless’, e.g. ‘Life is not a bowl of cherries’. The intended meaning is different from the literal meaning, which represents a state of affairs, not literally false, but at least irrelevant or meaningless in the situation or context in which it has been uttered. This criterion may simply be an after-effect and may by no means precede the processing of the metaphor. It has the merit of pointing out that the sentence must be linked to a context, for such things as ‘meaningless’ can only be decided in context.

Moreover, evoking pragmatics is stressing that the metaphorical meaning of a word is only one of the ambiguous meanings of this word: ‘Trees are plants’ is obviously an ambiguous statement. In the case of dead metaphors, the ‘used to be metaphorical’ sense is not distinct from the other

---

4. ‘Trees are vegetables’ or ‘trees are factories’. 
literal meanings of the word. There is no more reason to go from a literal meaning to a metaphorical one than to go from literal meaning #1 to literal meaning #2 in the case of ambiguous words. Considering the three following sentences 'can you reach the salt?', 'can you open the window?', 'can you lift that refrigerator?', it seems objectionable that there is always a literal meaning to be processed before an intended meaning. Rather there are two meanings to be disambiguated from context, e.g. the verb 'can' in the example above.

Such a position denies essentially that we go from literal to metaphorical, although it accepts that a sentence may have several meanings including a 'metaphorical' and a 'literal' one at the same time. It simply reduces metaphorical meaning to the same level as any other meaning, and the comprehension task is then to 'disambiguate' meanings. 'Time flies like an arrow', 'My love is a tree' and 'John is a pig' must all be accounted for by the same disambiguation theory.

In conclusion, metaphor is indeed recognizable, since it always falls under one of the three criteria above. However, that we recognize a metaphor as such does not imply we need to do so to process it. In other words, the classical three-step schema (metaphorical process triggered when literal interpretation fails) can be challenged.
1.3 Must We Recognize Metaphors to Understand Them?

1.3.1 The Three-Step Schema

Semantic anomaly and pragmatic anomaly criteria can be summarized as: the literal meaning failed, therefore the meaning is metaphorical. This assumption of a recognition step anterior to the metaphorical process is the basis of the three-step schema [Miller 79].

According to this intuitive schema, there is a metaphorical process distinct from a literal process. While reading/hearing a text, we try to make sense of it at a literal level (step 1), if the literal meaning fails to make sense when tested against the context (step 2, i.e. recognition), the metaphorical process is triggered (step 3) and the sentence is hopefully understood. Thus, in this schema, a metaphorical process cannot be triggered directly without a prior recognition step.

Because the above criteria are defeasible and may be only after-effects of the metaphoric process, this schema can be challenged in favor of a common process for literal and metaphorical meaning that would include a disambiguation through general discourse-processing strategies [Ortony 78].

1.3.2 A Common Process for Both Literal and Metaphorical Meaning

According to the three-step schema, metaphors should take longer to be processed than literals. Psychological experiments were conducted which measured reaction times to understand metaphor, and strongly challenged this view [Ortony 78], [Gildea 83] and [Glucksberg 82]. Experiments showed
that nonliteral meaning or intended meaning can precede literal meaning in the case of idioms such as 'kick the bucket' or indirect speech acts such as 'Do you have the time?', and that they are processed as quickly as single lexical items.

Glucksberg's experiments [Glucksberg 82] tested the ability to ignore the metaphorical meaning when the literal meaning is not anomalous. Subjects were presented with metaphors (e.g. 'Some jobs are jails', 'Some flutes are birds') and 'scrambled metaphors' (e.g. 'Some jobs are birds', 'Some flutes are jails'). They were asked to judge these sentences as true or false and reaction times to do so were recorded. The hypothesis to be tested is the following: If subjects ignore the nonliteral meanings of the metaphors, then the metaphorical sentences should take no longer to reject than the scrambled metaphors. This is because in neither case would a 'true' nonliteral meaning conflict with the 'false' literal meaning. On the other hand, if subjects automatically register any nonliteral meanings that are available, then the metaphor sentences should take longer to judge as false than their scrambled counterparts. This is because there would now be a conflict between the 'true' nonliteral meanings and the 'false' literal ones. The reaction times showed that:

The Metaphor sentences took significantly longer to judge as false than their scrambled counterparts. This suggests that our subjects were, at some level, apprehending the nonliteral meanings of the metaphor sentences. When these nonliteral meanings were apprehended, they produced a conflict in truth value: the literal meanings were false, the nonliteral true. This conflict, in turn, delayed or slowed down the final response. [Glucksberg 82 p90]

If, as stated in the three-step paradigm, the metaphorical process
were optional, all literally false statements should have been treated the same way, even when metaphorical interpretation was possible.

It has also been shown that metaphorical meaning and literal meaning are processed as quickly if preceded by a long context [Ortony 78]. Furthermore, even idioms and frozen metaphors were processed as quickly when two different contexts induced for the same idiom a literal or a metaphorical meaning.

This strongly suggests that the two processes involved are at least similar, if not the same. They both share important disambiguation features and include general discourse-processing strategies. People do not ignore metaphors, that is, they cannot ignore non-literal meanings and process both literal and non-literal in the same way (and maybe at the same time). This does not exclude the fact that each process may be based on a try/fail paradigm to discriminate among meanings (including metaphorical ones). Excluding the three-step schema does not imply that all metaphors are to be understood directly (literary metaphors are certainly not) and that there is no specific underlying process. As we will see, all statements 'x is [like] y' such as 'Tomatoes are vegetables', 'Raspberries are like blackberries' and 'John is a giraffe' can be understood by the same process: analogical reasoning. Also, the denial of a preliminary recognition step does not entail refusal of the existence of both literal and metaphorical meanings.
1.4 Conclusions

In conclusion, recognition appears to be a critical component only if staying at the semantic level of the metaphor. Then, the semantic anomaly, recognized by the criteria described, must be suppressed by rules allowing semantic changes, i.e. metaphorical 'anomalous' meanings. In the next chapter, we will see how a semantic framework can be developed to account for these semantic changes induced by metaphorical meanings. These rules are only describing the effects of an underlying cognitive process, i.e. analogical reasoning for which recognition is only the side effect of searching for certain kinds of similarity. Chapter 3 will justify the use of analogical reasoning as underlying the process of understanding comparison statements. Metaphorical meaning will be shown to result from the transfer of valid similarities between the two referents. Chapter 4 will focus on principles to select the valid existing similarities, and Chapter 5 will argue the possibility of creating similarities. This will result in giving a structure to the set of metaphors and a promising taxonomy that, by allowing inheritance of similarities, will account for the creativity of metaphors.
Chapter 2

Metaphor and Semantic Anomaly

Several theoretical approaches view metaphor as a semantic anomaly they can recognize but not account for. The semantic anomaly of metaphor must be accounted for by rules of semantic shifts. Such rules can be developed only in a framework flexible enough to allow semantic changes, such as the conceptual semantic space described.

2.1 Three Basic Approaches Seeing Metaphor as a Semantic Anomaly

2.1.1 Tension Theory and Emotive meaning

Tension theory, also called emotive emphasizes the emotive and affective impact of metaphors: metaphor gives rise to feelings [Adank 39]. This affective impact springs directly from the emotional tension due to the 'anomalous' juxtaposition of the metaphor's referents. 'Anomalous' is taken here in a very broad sense: 'false', 'contradictory', 'ungrammatical', 'meaningless' and so on.

Emotivism distinguishes literal from metaphorical through emotive meaning. While metaphor has both an emotive and a cognitive meaning, only the latter can be replaced by a literal paraphrase. Furthermore, conveying
this cognitive meaning is not the primary function of metaphor. The accent is on the emotive content and a word can even lose its initial cognitive content. The following example illustrates this distinction between emotive and cognitive meaning:

For example, the sharpness of a knife can be tested by various means, so that the phrase 'sharp knife' is meaningful. We may also suppose that 'sharp' has some negative emotive import, deriving from our experience with sharp things. Now, when we speak of a 'sharp razor' or a 'sharp drill', the emotive import is not active, because these phrases are meaningful. But when we speak of a 'sharp wind', a 'sharp dealer', or a 'sharp tongue', the tests for sharpness cannot be applied, and therefore, though the individual words are meaningful, the combinations of them are not. In this way the emotive import of the adjective is released and intensified. [Beardsley 58 p135]

In such a view, we see each concept as a double entity: a logical or *denotative* concept and a psychological or *connotative* concept. The psychological concept contains the emotive charge. It is doubtful that all words have such an emotive impact. However, Adank claims that even such a simple word like 'French' can lose its cognitive content in 'a very French clarity' to mean an 'extraordinary' clarity [Adank 39]. But certainly not all metaphors retain their emotional impact. The tension due to falsehood can fade out with familiarity and such frozen metaphors, as in 'sharp cheese' are no longer accounted for in the theory. Furthermore, the distinction between literal and metaphorical on the basis of emotivity does not hold: literal meanings can also be highly emotive without metaphorical meaning ('hydrogen bomb', 'death').
2.1.2 Controversion Theory and Truth Values

Controversion theory recognizes metaphorical meaning as such when 'taken literally, the sentence is false'. Not only the literal meaning is attributed a true/false value, but so is the metaphorical. 'Metaphor must be read speculatively as if it were true or false' [MacCormac 85 p28]. The metaphorical meaning gets its true/false value by being reduced to a simile: a true metaphor only asserts true similarities. But reducing metaphors to a set of strictly true propositions sacrifices the suggestivity and creativity of metaphor. False metaphors are merely rejected. As we already stated, metaphors cannot be subject to true/false judgements; if there is any truth in metaphors it can only be a matter of degree. Such an approach also fails to discriminate successfully between literal and metaphorical, since there are true sentences that are metaphors: 'My love is a tree'.

2.1.3 Deviance Theory and Ungrammaticality

Deviance theory recognizes metaphor as 'ungrammatical' when read literally, i.e. there is a semantic violation. For example, in 'his heart is a stone', we try to combine 'stone' and 'heart' that have opposite semantic markers (inanimate vs animate). For deviance theory, metaphors are deviant; the dichotomy between literal and metaphorical is realized as a difference between grammatical and ungrammatical. Such an approach ignores any cognitive meaning of metaphor and does not account for semantic changes: after the first airplane, the entry for 'to fly' had to be modified to accept 'inanimate' objects, or in the case of dead metaphors, 'time flies' requires a new entry for 'to fly'. Accounting for metaphor as a deviance is also failing to account for so much of the language that such a grammar would be inadequate.
From these three crude approaches, three points need to be stressed. First, metaphors can be affective. Second, if truth values are to be applied to metaphor, these values should be able to represent different degrees of truth. Third, although metaphors produce semantic deviance, they should not be considered as deviant. Therefore, rules to account for semantic deviance can be defined within a framework whose structure allows semantic changes.

2.2 Rules for Semantic Changes

Levin’s approach is an attempt to build rules to describe semantic changes [Levin 77]. By the means of these rules, named construal rules, semantic markers will be added or deleted in the list of semantic markers associated with a word. This approach is purely descriptive, as it hardly explains which features to add or delete, and does not define any meaning of the metaphor. However, this descriptive approach is already an attempt to capture the ambiguity between metaphorical and literal. Such rules try to include metaphorical meaning so that it is no longer a deviance, but at the same time it is not assimilated as literal. Different construal rules may apply, resulting in different meanings.

In the following, we will consider the example from Levin: ‘the stone died’. The representations used are [Levin 77 p34]:

\[
\text{stone;}(((\text{Object})(\text{Physical}))(\text{Natural})(\text{Nonliving})(\text{Mineral}) (\text{Concreted}))
\]

\[
\text{die;}(((\text{Process})(\text{Result})(\text{Cease to be})(\text{Living}))X)
\]

[NP,S]

\[
X
\]

\[
<(\text{Human}) \lor (\text{Animal}) \lor (\text{Plant})>\)
'Process) ... (Living)' are the semantic markers of the verb. 'X' is a variable associated with it. [NP,S] specifies the syntactic environment in which the value of 'X', i.e. 'stone' must appear relative to 'die'. <(Human) v ... v (Plant)> are the semantic markers that must be compatible with those of the value of 'X'.

As none of 'Human', 'Animal', 'Plant' appears in the list of the semantic markers of 'stone', we are confronted by a semantic anomaly\(^1\). The construal rules developed will account for this clash of semantic markers by transferring semantic markers.

2.2.1 The Positioning of Transfer Markers

All semantic markers are nodes of a hierarchical tree (see figure 2-1, from [Levin 77 p40]). The positioning of the transferred feature in the list it is transferred to is done according to the position of this feature in the hierarchical tree. Since a node excludes all other nodes at the same level, the transferred feature will be inserted in the list where its collateral feature is situated, i.e. at that part where the anomaly is detected.

In our example, any of the three markers, 'human', 'animal', 'plant' can be shifted. At the same hierarchical level are the markers 'mineral', 'liquid'. Consequently, if we decide to shift 'human', this marker must be inserted at the 'mineral' level. Thus, the new reading for 'stone' is now:

\[
\text{stone}(\{(\text{Object})(\text{Physical})\}(\text{Natural})(\text{Nonliving}) \\
(\text{Human}) \ldots (\text{Mineral}) (\text{Concreted}))
\]

\(^1\)Levin draws here a distinction between anomaly and contradiction: we would have a contradiction if one of the antonyms of the markers were present in the list.
Figure 2-1: A Hierarchy of Semantic Markers

By comparing the position of 'Human' and 'Mineral' in the hierarchical tree, we see that there seems to be an additional incompatibility 'Nonliving'/‘Living’ that we did not account for. Actually, the feature 'Nonliving' is made redundant by the presence of 'Mineral'. Hence, the incompatibility 'Human'/‘Nonliving’ is reflective of the incompatibility 'Human'/‘Mineral’. This last pair is enough to fully represent the incompatibility. Given this rule to shift semantic markers, we can now analyze the different rules of construal, each one giving a different ‘interpretation’ of the metaphor.
2.2.2 Six Rules of Construal

Levin distinguishes six modes of construal. A semantic feature can replace another (displacement) or be added to another (adjunction), which gives two classes of rules. Then, in the case of adjunction, the production set, i.e. the pair [marker, added-marker] can be read as a conjunction or a disjunction, which gives two sub-classes of adjunction. Then, in each case, the semantic shift can go from the noun to the verb (N ----> V), or from verb to noun (N <---- V), which doubles the number of rules. The six resulting rules are summarized as follow, where \( \alpha \) represents the transferred marker, \( \beta \) the marker to which \( \alpha \) is added, and the lower-case letters other semantic markers [Levin 77 p48].

Adjunction

1. N <---- V Disjunctive reading
   \[ N/V ----> N(a [\beta \lor \alpha] b) \]
2. N <---- V Conjunctive reading
   \[ N/V ----> N(a [\beta \land \alpha] b) \]
3. N ----> V Disjunctive reading
   \[ N/V ----> V(((d, e)X) <[\alpha \lor \beta]> ) \]
4. N ----> V Conjunctive reading
   \[ N/V ----> V(((d, e)X) <[\alpha \land \beta]> ) \]

Displacement

5. N <---- V
   \[ N/V ----> N(a [\beta] b) \]
6. N ----> V
   \[ N/V ----> V(((c,d,e)X) <[\alpha]> ) \]

Applying the six rules to the example 'the stone died' gives the following interpretations.

Rule 1: N/V ----> N(a [\beta \lor \alpha] b). The disjunction [(Human) \lor (Mineral)] is incompatible since both nodes are at the same level in the tree, thus are disjunctively incompatible. We must then take the least general
feature they have in common, i.e. 'Natural'. This feature will neutralize both incompatibilities 'Human'/'Mineral and also 'Living'/'Nonliving'. This interpretation would not have been changed, had we shifted 'Animal' of 'Plant' instead of 'Human'. The sentence can be understood as 'The natural physical object died'.

Rule 2: N/V ----> N(a [θ ∧ α] b). The conjunction [(Human) ∧ (Mineral)] results in a personification. If we had shifted 'Animal' or 'Plant', we would have obtained an 'animalization' or a 'plantification'. The resulting reading is thus 'The stone - as if human - died'.

Rule 3: N/V ----> V(((c, d, e)X) <[α ∨ β]>). We need to construe the verb's markers so that it becomes applicable to 'Human' or 'Mineral'. To do so, the non-applicable markers are generalized: 'Cease to be' and 'living' are generalized into 'Cease to exist'. Just as for rule 1 the same meaning would have been derived if 'Animal' or 'Plant' had been chosen instead of 'Human'. The reading obtained is then 'The stone ceased to exist'.

Rule 4: N/V ----> V(((c, d, e)X) <[α ∧ β]>). The construed sense must hold for 'Animal' and 'Mineral'. We must therefore fuse the sense of 'Living' with the sense of a comparable activity holding in minerals. There is no such obvious characterization. Sentences like 'His ego died', 'The grass died', 'His hopes died' allows one to infer such meaning more easily. The 'stone died' must in this case be understood as 'The stone died (as though die were predicable of objects jointly human and mineral)'.

Rule 5: N/V ----> N(a [θ] b). The feature 'Human' displaced the feature 'Mineral' in the list '((Object)(Physical)(Natural)(Nonliving)
(Human)(Concreted)). We then must construe 'Human' with the incompatible markers to its right, i.e. 'Concreted'. This results in readings such as 'The dolt died'.

Rule 6: N/V ----> V((c,d,e)X) <[a]>). 'Mineral' displaces 'Human'. As a result 'Cease to be' and 'Living' must be construed to produce a meaning applicable to mineral: to disintegrate, or to crumble. The resulting reading is therefore: 'The stone disintegrated'.

Rules of construal capture only surface changes and account for them. Why the combination of 'Human' and 'Mineral' should result in a meaning of 'dolt' is not explained. Such an account can only result from a study of the cognitive process underlying metaphor. However, such rules are eminently useful as they recognized the 'heart' of the metaphor. From 'the stone died', they recognized an instance of a more general metaphor 'see a human as a stone'. If an efficient hierarchy of general metaphors is designed, such a recognition device can be highly determinant [Carbonell 80]. The power of construal rules relies on an adequate representation of meanings by semantic features. This general representation must be a hierarchization flexible enough to allow for semantic changes and the representation of new meanings resulting from semantic shifts. MacCormac developed such a framework based on the notion of fuzzy sets [MacCormac 85].
2.3 A Framework for Semantic Changes

MacCormac takes fundamentally the same approach as Levin [MacCormac 85]. Semantics of metaphor must account for semantic changes. Furthermore, in its representative form, this theory will represent a metaphorical statement in all its 'ambiguity', whereas for Levin, different rules had to be applied to construe different meanings. The originality of MacCormac's work is to define a four-valued logic to allow different truth values for metaphor (true, epiphoric, diaphoric, false) and to use fuzzy sets to represent meanings. From this basis, a conceptual semantic space is designed to allow metaphoric changes and represent new metaphoric meanings.

2.3.1 Epiphors and Diaphors: Two Ranges for Metaphorical Meaning

MacCormac uses a four-valued logic to define four ranges for metaphor: true, epiphoric, diaphoric and false. The distinction between epiphors and diaphors comes from Weelwright [Weelwright 62]. This author went back to the very meaning of metaphor (μεταφορά) to define metaphor as a semantic movement (φορέω = to carry). The metaphoric process, defined as such a metaphoric move, is a combination of two acts: 'the double imaginative act of outreaching and combining'. These two acts, 'epiphor' and 'diaphor', although most of the time combined in various degrees, can be examined separately.

The one [is] standing for the outreach and extension of meaning through comparison, the other for the creation of new meaning by juxtaposition and synthesis. [Weelwright 62 p72]

Epiphor can be viewed as the conventional Aristotelian sense of
metaphor. In epiphor, the semantic movement goes from something relatively well known (the vehicle or frame) to something less known (the tenor, focus or topic). The meaning of the old (vehicle) is transferred (φορέω) onto (έπη) the new object (tenor). The basis of this one-way transfer from vehicle to tenor is a presupposed similarity between the two. This similarity does not need to be explicit, for it involves, to quote Aristotle ‘an intuitive perception of the similarity of dissimilars’. Epiphors highlight these similarities and make us aware of them, for understanding epiphors consists mainly of recognizing features of similarity as in ‘the stone died’ analyzed above.

Diaphor characterizes those metaphors whose meaning arises from a mysterious mingling of vehicle and tenor. The meaning of metaphor does not result from a shift from vehicle to tenor, but arises through (κατά) the juxtaposition and synthesis of those two referents. In a simplistic way, epiphors express, whereas diaphors suggest. Diaphors characterize best what is usually called ‘novel metaphors’. These metaphors confront referents usually unrelated, hence, they emphasize dissimilarities. Such a juxtaposition creates new meanings, new insights. Diaphors are then responsible for that mysterious component of metaphor that induces its tension, its emotion. Pure diaphors are, however, hard to find: Weelwright gives as examples non-imitative music and the most abstract painting, since only for these, have all imitative, mimetic or similarity factors been rejected. Verbal diaphors, although less pure, can be found. ‘Toasted Susie is my ice-cream’ (Gertrude Stein) and ‘The apparition of these faces in the crowd; / Petals on a wet, black bough’ (Ezra Pound’s ‘In a Station of the Metro’) are examples. Actually, since diaphors emphasize dissimilarities rather than similarities, no pure verbal diaphors can exist. One could not recognize metaphor as such if it confronts two referents without any analogy between the two.
Epiphors and diaphors must then be considered as complementary: metaphors relate on the basis of similarities (epiphoric component) two referents first perceived as unrelated (diaphoric component).

The take-it-or-leave-it attitude that is implicit in all good metaphor is in itself, so far as it goes, diaphoric; the sense of an invisible finger ambiguously pointing is epiphoric. The role of epiphor is to hint significance, the role of diaphor is to create presence. Serious metaphor demands both. [Weelwright 62 p91]

2.3.2 Four Ranges of Truth for Metaphors

The mixing of epiphoric and diaphoric component is a matter of degree. For a defined metaphor, this degree can vary, depending on the reader or hearer, or additionally depending on time. A metaphor can certainly be considered more epiphoric for the writer than for the reader. If we consider the following verse by Rimbaud:

A noir, E blanc, I rouge, U vert, O bleu: voyelles,
Je dirai quelque jour vos naissances latentes².
Black A, white E, red I, green U, blue O - vowels,
Some day I will open your silent pregnancies³.

For the reader, such verses are predominantly diaphoric, since the association of colors with vowels rejects any kind of similarity we can think of. However, for Rimbaud (and for the critics), such an association is epiphoric since it is grounded on a primer that Rimbaud had as a child where each vowel was associated with and symbolized by a color. The same metaphor can also be perceived as more or less diaphoric depending on how

²Le sonnet des voyelles by Rimbaud.

³Translation by Paul Schmidt.
well acquainted the hearer is with it. Dead metaphors are examples of metaphors which gradually shifted from diaphoric to epiphoric through an extensive use that 'wore them out' so that the anomaly and the diaphoric disparities of the metaphor are no longer felt. This shift from diaphoric to epiphoric is by no means obligatory. Some diaphors may stay diaphors: the 'tachyon' will stay a diaphor designating a particle travelling faster than light as long as such a particle is not discovered. Some epiphors may stay epiphors: poetic epiphors will remain as such since they are used only in reading poetry, unless they fall into ordinary language like the famous 'Juliet is my sun'. Accordingly, we may question the use of four ranges of truth and not two, one for epiphor and one for diaphor? For if the combination of referents involves a pair of referents too unrelated, this combination will be rejected and will not be considered a metaphor. Similarly, if the referents are too close, we would rather speak of an analogy than of a metaphor. However, the introduction of four ranges True, Epiphoric, Diaphoric and False (T, E, D, F) allows the introduction of two ranges T and F that may be tiny and applicable to only a few instances, but two ranges that are essential to the theory. Due to these four ranges, metaphor with its epiphoric and diaphoric components is no longer an anomaly but is merged into a True/False scale of which it is a significant part. By this means, metaphors are not excluded from True or False conditions, but rather, corresponding to our intuitive feeling that 'metaphors are certainly true (false) in a certain way', are between the two. This continuous scaling from False to True going through Diaphoric and Epiphoric will then allow a metaphor to become True as it becomes an idiom or to become False if the grounds for the similarity allowing the diaphor are discovered as false (example of the 'tachyon').

Identifying these two components of metaphor, epiphor and diaphor
is crucial for a theory of metaphor: most theories tend to account only for the component they fit best. The comparison view ([Miller 79], [Ortony 79]) emphasizes the epiphoric component since it is the one that is grounded on similarity; whereas the interaction view ([Richards 36], [Black 62]) will focus on the diaphoric component, trying to account for a meaning of metaphor arising through a synthesis or interaction of the two referents' meaning. MacCormac avoids this trap. He not only recognizes the existence of the components, but also, by scaling them into degrees, his theory becomes a dynamic theory that fully represents the whole span of metaphorical degrees.

The goal of MacCormac's approach is to allow a representation of semantic meaning that erases the notion of semantic anomaly and replaces it by the creation of new meanings: by accounting for the anomaly, we will in fact render it no longer anomalous. In the remainder of the discussion, we will first explain how a word gets its meaning from its semantic markers and by the same token how metaphor is freed from semantic contradiction and anomaly. Second, we will have to organize those semantic markers into a structure flexible enough to allow semantic changes. Finally, we will explore how new semantic meanings can be generated from new associations of referents.
2.4 Semantic Markers Define Meanings

2.4.1 Semantic Markers and Fuzzy Sets

Each single word is defined by a set of semantic markers, also called attributes. For example, just as in Levin's approach, the word 'stone' will be associated with the following list of attributes '(Object, Physical, Natural, Non living, Mineral, Concreted)'. Whether such attributes should be part of a finite and predefined list of words is arguable; but MacCormac allows any word to be taken as attribute. Thus, in the semantic space described below, new links will be allowed to be created, giving new meanings. However, such a position may be dangerous and give birth to circularity, just as in any theory of meaning it is difficult to define 'meaning' without using the word 'to mean'.

Each attribute defines a set of which any word having this attribute in its list is a member. Other theories define the membership of a word to the set defined by its attribute as a 0/1, or True/False decision. MacCormac, on the contrary, defines such sets as fuzzy sets. A fuzzy set 'X' is characterized by a membership function 'f_X' that for each member 'x' of the fuzzy set 'X' associates a value in the interval [0,1] that represents the degree of membership of 'x' in 'X'. Relying on fuzzy sets may, at first glance, seem unnatural, however, most categorizations utilized by humans are based on consideration of relativity. 'Tallness' and 'age' are concepts defining sets in which membership depends heavily on relativity between the other members of the set.

The use of an interval [0,1], rather than a two valued scale True/False, is the very means by which an anomaly is no longer viewed as
anomalous in the theory. 'John is tall and is not tall' will, in a two valued logic be considered as a contradiction. If one agrees not to assign the value of only true or only false to the statement 'John is tall', but uses degrees of tallness instead to mark the degree of membership of John in the set of 'tall people', the initial statement 'John is tall and is not tall' is no longer a contradiction. In the same way, the anomaly resulting from the clash of apparently contradictory semantic markers will disappear with fuzzy sets and the fuzzy boundaries they induce between concepts. In our example 'the stone died', the anomaly resulted from the opposition of the semantic markers 'Animate' and 'Inanimate'. This opposition fades out if we allow the membership value of 'stone' in the set defined by 'Animate' to be different from 0 (False). As we already pointed out, membership values may then change. Through extensive use, the referents of a metaphor see the membership in their attributes move along the four ranges scale $0 < \beta < \gamma < \alpha < 1$. With time, the word 'stone' may increase its membership to the fuzzy set 'Animate' to such a degree that a new entry may eventually be entered for 'stone' designating a particularly unemotional person.

What is meant by interpreting a metaphor is thus determining the attributes of the referent that are "to be measured in terms of membership in the set defined by the literal meaning of that referent". For the same referent (e.g. 'stone'), we will then compare membership to two kinds of attributes; the ones given by the literal reading ('Inanimate'), and the ones given by a metaphorical reading ('Animate'). Because such memberships are degrees on a scale, just like 'John is tall and not tall' is no longer contradictory, 'a stone is animate and inanimate' will not be contradictory either. The anomaly of metaphor fades in this way, and the degree of membership of 'stone' to its semantic markers 'inanimate' and 'animate' fully represents its ambiguous
meaning, bringing down the metaphorical meaning to the same level as other literal meanings, but with different values in the degree of truth.

2.4.2 Semantic Markers and Prototypical Categories

Other theories of categorization have been developed. It is certainly useful to see MacCormac's approach among those in order to judge its legitimacy. Apparently opposed to the theory of categories defined by semantic markers are theories of categorization using the notion of prototypes [Rosch 77]. Prototypes are used to explain the formation and emergence of categories in different cultures, looking for certain universal principles of explanation. Such universal principles have already been proved to exist. In the vocabulary of colors, fixed patterns have been consistently found through different languages: all languages contain terms for white and black; if a language contains three terms then it has a term for the color red [Berlin 69]. In prototypical categories, one or several prototypes are used to define a category. Membership of an element to a category is judged in terms of degree of resemblance of the element with the prototypes: ostriches or penguins are further in distance from the concept of bird than are robins or sparrows. Categories are hierarchized: natural categories (e.g. 'bird') arise from basic objects; superordinate categories are above natural categories and are more abstract (e.g. 'animal'); subordinate categories are below natural categories and are less abstract (e.g. 'robin').

Prototypical categories may challenge a categorization based on semantic markers in two aspects. First, the mathematical introduction of fuzzy sets is an abstract notion that challenges the notion of 'natural' categories. We already emphasized that the notion of fuzziness is 'natural'.
Proponents of prototypical categories recognize themselves that there are no clear cut boundaries between categories. Fuzzy sets are an elegant way to account for that. Moreover, the very notion of closeness to a prototype, which defines the membership of an element to a category, is not that far from the notion of membership in a fuzzy set. To say that ‘robin’ is a prototype of ‘bird’, whereas ‘turkey’ is further from that prototype, can be precisely represented by two different values of membership. Using semantic markers is also a means of grounding that distance of resemblance, for if ‘turkey’ is further from ‘bird’ than ‘robin’ is, surely ‘robin’ possesses semantic features (‘fly’) that ‘turkey’ does not. Such a possibility of grounding analogy is certainly vital in a theory of metaphor since analogy seems to have a predominant role in understanding metaphor, as we will see in the next chapter. Fuzzy sets also allow membership in different sets: for a prototypical category theory, ‘whale’ is only far from the prototype of ‘mammal’; but in a fuzzy set representation, ‘whale’ has not only a membership in ‘mammal’, but also one in ‘fish’.

A second challenge presented by natural categories is that grounding a category either on a prototype or on a set of semantic markers may seem to be two completely opposite positions. However, the hierarchization of categories encompasses the existence of semantic markers. Semantic markers can therefore be considered as superordinate categories. To conclude, note that MacCormac’s approach and prototypical approaches correspond to two different tasks. Prototypical categories aim to account for how categories naturally arise in natural language, whereas MacCormac develops a descriptive theory of a natural phenomenon, metaphor, that does not necessarily need to be described only ‘in terms of natural language’ [MacCormac 85 p 98].
The lesson to draw from prototypical categories is the notion that a hierarchy must be established among semantic markers. This structure must be formal, but at the same time, able to involve relationships among semantic markers that are flexible enough to allow for semantic changes. We must keep in mind that the goal of such an organization or structuring of semantic markers is to allow new meanings to be formed from the association of old meanings. But before even attempting to understand how new meanings are formed, it is necessary to examine words which are normally associated and see how meaningfully linked these words are. We will first go through two different attempts at organizing semantic markers: semantic trees and the semantic differential. We will then study more specifically the structure adopted by MacCormac: a conceptual semantic space.

2.5 Hierarchization of Semantic Markers

2.5.1 Semantic Trees

Semantic trees are one of the most popular structures for representing of semantic markers. It is the one used by Levin in his approach. Semantic trees allow one to represent the link between words as a hierarchical structure. The nodes of the tree are words becoming less abstract as we get down to the leaves. These trees can get really intricate and complex.

The problem with trees arises from their very advantage: they are too rigid a structure. If we consider the word 'boy', we will have to hierarchize the following different semantic markers: 'Young', 'Male', 'Human'. One may endlessly argue whether 'Male' should be above 'Young', since there are males that are not young, or whether 'Young' should dominate
'Male', since there are young girls. Such considerations can be of extreme importance when comparing the two trees of the metaphorical referents. If the same semantic marker can appear at different levels depending on the way the tree has been designed, one can question the generality of such trees, since most rules for semantic shifts as we saw in Levin's approach are based on the relative positions of semantic markers in the trees. One way to solve this problem would be to construct a huge supertree where each semantic marker would be represented only once. The number of words and the branching factor would, however, become computationally unmanageable. Another way would be to build a new tree for each possible metaphorical usage, but this would considerably reduce the generality of the approach.

2.5.2 The Semantic Differential

The semantic differential is another way to get the semantic meaning of a word from its association with other words. Words are represented as dots in a semantic space [Osgood 57]. This space is of dimension 50; each axis corresponds to a pair of polar adjectives: 'good-bad', 'large-small', 'beautiful-ugly', 'yellow-blue', etc. People are asked to rank on a seven point scale each word according to each adjective of each pair. These rankings will give the coordinates of the word according to each axis. Computations are then made to reduce the 50 axes to 3 or 4 dimensions along which connotative values are given to the words (measure of affective meanings).

There are two advantages to this approach. First, it is very close to a semantic markers approach. The set of 100 adjectives can be considered as a predefined set of semantic markers, and the grading on the seven point
scale can be normalized into a value of membership of the word into the fuzzy set defined by the polar adjective. Second, compared to a semantic tree structure, a semantic space is less rigid and holds more information in a more condensed form. Where in a tree each link has to be established to exist, in a semantic space, only the coordinates of each word have to be known and then a distance between any pair of words can be computed. If a new word is introduced, nothing else needs to be modified. If a word’s position in the semantic space changes, there is no need to bend or to break branches of trees, but just to update the new coordinates. Unfortunately, these advantages carry with them the very limitations of the approach.

First, the choice of the 50 pairs of polar adjectives is arguable. Contrary to normal semantic markers, they do not necessarily represent the natural associations that people might find between words. People can certainly rate words like ‘dog’ on a ‘yellow-blue’ scale, and will probably scale it as closer to ‘yellow’ than to ‘blue’. Nevertheless, such ratings are eminently subjective and result more in a measure of affective meaning. But the semantic field of associations linked with ‘dog’, a notion that we will see used extensively in the next chapter, encompasses probably such notions as ‘domestic’, ‘fur’, ‘legs’, ‘tails’, and so on, which are none of the 50 polar adjectives. Allowing any word to be a dimension of the semantic space is no solution, as it would result in such a vast space that distances would not be tractable computationally and the semantic differential would collapse under its own weight.

Second, the very structure of space, although not as rigid as a tree structure, is still a very static structure, consequently, changes in meanings are not easy to account for. If a word has a new meaning, its coordinates have
to be changed on each axis, i.e. the new meaning of the word has to be reevaluated according to the 100 seven point scales. But this is possible only if the new meaning has become widely enough accepted by the readers to affect their ratings of the word. Accordingly, a striking new meaning of a word, resulting in a diaphoric metaphor cannot be interpreted in the existing axes. Moreover, even if one-word metaphors (e.g. 'tachyon') can be eventually scaled, although this is doubtful, a classical metaphor involves two referents. The semantic change of meaning of a word resulting from its anomalous association with another word cannot be represented in the semantic differential.

From the tree structure approach, we will retain the idea that semantic markers need to be organized into a hierarchy flexible enough to easily allow semantic changes. From the semantic differential, we will retain the idea that a semantic space enables a flexible representation of a word in a space where words can be gathered into clusters of meanings. These features will be used to design a more efficient representation in MacCormac's theory: a conceptual semantic space [MacCormac 85].

\[4\text{However, the emotive content of a metaphor may be measured as some operations combining the 3-space vectors measuring affective meanings.}\]
2.6 A Conceptual Semantic Space

2.6.1 Definition

In a conceptual semantic space, words are linked by vectors. Therefore each word originates an n-dimension space, where n is the number of words it is related to. The length of the vector linking two words is proportional to how closely in meaning those two words are related. Each word is mainly linked to its semantic markers. By this means clusters of meaning in the semantic space are delineated. A vector can be created to link any pair of words usually unrelated, thus allowing the creation of metaphors and new meanings. This creation of a new vector, a long one since it relates words so far unrelated i.e. ‘far’ in the space, corresponds at the level of the semantic representation to an underlying cognitive process that creates new meanings from the association of old unrelated meanings. Since the length of the vector is proportional to how close in meanings the words are, these values of lengths are the inverse of the values of membership in fuzzy sets defined by the semantic markers. For the closer a word is to another, the greater its membership to the fuzzy set defined by this other word. If we normalize the length of the vectors and subtract this normalized value from one, we will get the degree of membership. For example, if the normalized length of closeness between ‘stone’ and ‘inanimate’ is 0.1, then the degree of membership of ‘stone’ in the fuzzy set defined by ‘inanimate’ is 0.9. The whole semantic space can be represented by the use of an n-dimensional matrix.

Techniques have been developed to compute values of closeness between words. In decision theory, the analytic hierarchy process is a method
to scale two entities $A_1$ and $A_2$ with respect to a third superordinate entity $B$. In our example 'the stone died', the two items $A_1$ and $A_2$ respectively stand for 'stone' and 'person', and $B$ stands for 'animate'. Let's note here that, because of the symmetry inherent in a pair of polar adjectives such as 'animate'/‘inanimate', we will also get by the same token the symmetric values for the three entities 'stone', 'person' and 'inanimate'. The weight $\rho_1$ will represent the importance of $A_1$ to $A_2$ relative to $B$. This weight is a measure on a five degree scale with the following values for each value: 1 for 'equally important', 3 for 'weakly more important', 5 for 'strongly more important', 7 for 'demonstrably more important', and 9 for 'absolutely more important'. Consequently, the weight $\rho_2$ that represents the importance of $A_2$ to $A_1$ relative to $B$ is to be taken as $1/\rho_1$. Those weights $\rho_1$ and $\rho_2$ are then transferred into a matrix $\left( \begin{array}{c} (1 \ \rho_1) \\ \rho_2 \ 1 \end{array} \right)$. Normalization of the rows will provide values for the vectors relating respectively $A_1$ to $B$, and $A_2$ to $B$. The vector relating $A_1$ to $A_2$ is the normalized eigenvector of the matrix.

Once again, to those who may object to such operations that it is doubtful that people operate with matrices and eigenvalues to understand a metaphor, we must say that the goal of MacCormac's approach is 'to offer an explicit rational reconstruction of what occurs implicitly'. That the nature of what occurs implicitly, i.e. the cognitive process, is completely different, is not denied.

To end our description of conceptual semantic space, we still have to explain how this structure can support a flexible enough hierarchization, since we saw that such a characteristic was critical to being able to account

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efficiently for metaphoric changes of meaning. Hierarchy exists in conceptual semantic space, but the hierarchy involved is loosened by the introduction of relativism, an answer to the limitations of the rigidness of semantic trees. This is achieved by relaxing the notion of dominant node in a tree. Dominance is understood by level, so that a node not only dominates the branches below it, but also all the branches from all the other nodes at the same level. This relaxation weakens the notion of dominance, but is flexible enough to easily allow the creation of new links with a minimal perturbation of the already existing structure. Levels of categories are hierarchized only relatively since different metaphoric context may classify the same word in a superordinate category or a subordinate category. The hierarchical structure not collapse, however, for it is anchored by the existence of natural categories. Those categories are stable, unless under extreme metaphoric changes, for they are grounded in the natural world.

If a conceptual semantic space is an adequate representation, it should be able to represent ordinary unambiguous sentences, recognize and represent ambiguities, recognize anomalies, and enable metaphoric constructions.

2.6.2 Example of Conceptual Semantic Space

The following example is taken from MacCormac [MacCormac 85 p115]. The lexicon is limited to six words: 'chair', 'table', 'boy', 'move', 'the', 'to'. The lexical entries for those words, except for 'the' and 'to', are taken from *The Oxford English Dictionary*. 
Chair
noun
(a) an article of furniture used for sitting
(b) the leader of a meeting
verb
(a) to lead a meeting

Table
noun
(a) a flat piece of furniture on legs
(b) an assembled group at a meeting
(c) a list of words or numbers
verb
(a) a parliamentary action
(b) to put into a list

Boy
noun
(a) a male child below the age of puberty
(b) all lads still at school
verb
(a) to act as a boy in dramatic productions
(b) to have a boy play a woman's part

Move
verb
(a) to change
(b) a parliamentary action

Semantic markers include such entities as 'furniture', 'parliamentary procedures', 'person', 'physical object', 'acting', 'list'. Figure 2-2 is a representation in two dimensions of the conceptual semantic space constructed from the lexicon [MacCormac 85 p115]. Words related in meaning are close to each other and constitute clusters: the cluster associated with 'parliamentary procedures' is shown in dashed lines.

The following sentences taken from MacCormac will illustrate the possibilities enabled by a representation in a conceptual semantic space [MacCormac 85 p116].
Figure 2-2: A Conceptual Semantic Space

(1) The chair moves to table.
(2) The chair moves to the table.
(3) The boy moves to chair.
(4) The boy moves to the chair.
(5) The boy chairs the table.
(6) The boy tables the chair.
(7) The chair boys the table.
(8) The table boys the chair.

The pairs of sentences (1), (2) and (3), (4) show how a syntactic change, here the introduction of the word 'the', introduces a semantic ambiguity. (1) and (3) are ordinary unambiguous sentences. (2) and (4) are ambiguous, since the words 'table' and 'chair' once preceded by 'the' are ambiguous. This ambiguity is represented in the conceptual semantic space by the vectors pointing out to other words from 'table' and 'chair'. (7) and (8) are anomalous sentences. MacCormac unfortunately does not detail how those
anomalies can be detected in the conceptual semantic space. They can however at least be represented by the absence of corresponding vectors. (5) and (6) are the most interesting. For those two, a metaphorical interpretation is possible. We can imagine a physical activity (involving sawing, cutting, nailing) that would transform a chair into a table ('to table a chair') and one that would turn a table into a chair ('to chair a table'). This would result in a new lexical entry for each of the words. Consequently, new vectors would be created. This creation is only allowed by the space structure. The conceptual semantic space allows, but does not justify, semantic changes. It does not guarantee at all that the semantic change is meaningful. It is a cognitive process that allows a metaphorical meaning to be derived in (5) and (6), but not in (7) and (8), rejecting these two last as anomalous. This change of meaning is merely noted in the semantic representation, thanks to its flexibility.

The metaphorical interpretation affects the meaning by changes that can be represented, which does not mean simulated, by formal rules of semantic changes. These rules, such as those of Levin, will involve deletion, insertion, inversion, and creation of semantic markers. They are mediating devices between the semantic representation and the cognitive process underlying metaphors. In this frame, we still have to concentrate on metaphors and formalize how, in a theory of meanings defined by fuzzy sets, new meanings can be created from the association of old meanings.
2.7 New Meanings and Fuzzy Sets

2.7.1 Metaphorical Meaning

We will in the following use the statement ‘the stone died’ to illustrate the approach. The first step is to define a universe of discourse U. The reason to define U is to allow any concept from a specific set of concepts to be identified with a fuzzy subset of U. For example, if K is a kernel space (e.g. the set of objects) a universe of discourse will be generated by any combination of union, direct product of subsets or fuzzy subsets of K. Through these means, levels of meanings can be established, corresponding to an increase in abstractness such as ‘red’, ‘color’, ‘visual objects’, depending on the level of recursion used to generate U. K is of level 1, F(K) the set of all subsets of K, including fuzzy subsets, is of level 2, F(F(K)) is of level 3 and so on. To these sets correspond the conceptual clusters and their hierarchization in subordinate, natural and superordinate categories in the conceptual semantic space. The meaning of a term x, M(x), is a fuzzy subset of U, the universe of discourse. M(x) defines x. Its membership function is \( \mu(y|x) \), conditioned on x. ‘y’ is a generic element of U and is intended to be kept as a variable, which means that x is to be defined in terms of y. If x is the color ‘red’, we try to define ‘red’ in terms of the meaning of red. What happens in the case of metaphor is slightly different: ‘In a metaphor we seek to define a name in terms of some other name rather than in terms of the meaning of itself’ [MacCormac 85]. Such a view copies the attitude of theorists of interaction [Black 62]: ‘x is y’ means that x is seen through the filter of y or in terms of y. Our initial definition of meaning can be extended to define metaphor as follows. Let us consider a metaphor z involving two referents x with x in A, and y, with y in B, where A and B are subsets of U. Then
A \ast B maps each \( x \) in A into a \( y \) in B; BxA maps a \( y \) in B into an \( x \) in A. \( M(z) \) is defined as the union of these two maps with \( \mu(x|z) \) and \( \mu(y|z) \) defined by the minimum value of \( \mu(x|y) \) and \( \mu(y|x) \), respectively. [MacCormac 85 p93]

2.7.2 Example of a Metaphor Interpretation

Let us return to our statement ‘the stone died’. As we saw in Levin’s approach, a person can metaphorically be seen as a ‘stone’, and the action of ‘to die’ can metaphorically be used to mean ‘to disintegrate’. These four meanings give four possible interpretations for the sentence ‘the stone died’. In the formalism just described above, \( x \) will stand for ‘stone’ and \( y \) for ‘to die’. Then we will have

\[
\begin{align*}
K_1 &= \text{objects}, \\
K_1^2 &= \text{persons that die}, \\
A &= \text{stones}, \\
B &= \text{persons}, \\
C &= \text{to die}, \\
N &= \text{animate objects}, \\
I &= \text{inanimate objects}, \\
U &= K_1 \ast K_1^2 \ast A \ast B \ast C \ast N \ast I
\end{align*}
\]

\( \mu(x|y) \) is defined by the degree to which ‘stones’ are ‘persons’
\( \mu(y|x) \) is defined by the degree to which ‘persons’ are ‘stones’
\( M_1(z) \) is defined by the set defined by the union of \( \mu(x|y) \) and \( \mu(y|x) \).

This first interpretation based on the metaphoric interpretation of ‘stone’ gives the two following interpretations: ‘a stone died’ (in certain religions ‘stones’ may be alive) and ‘a person, metaphorically similar to a stone, died’. Remembering our 4 valued logic, we see here that, in our scale 0 \(< \beta < \gamma < \alpha < 1\), if \( \mu(x|y) \) is less than \( \beta \), then we will eliminate the first interpretation.
The two other interpretations are obtained by the following formalization:

\[ K_2 = \text{objects}, \]
\[ K_2^2 = \text{stones that disintegrate}, \]
\[ A = \text{to die}, \]
\[ B = \text{to disintegrate}, \]
\[ C = \text{stones}, \]
\[ N = \text{animate objects}, \]
\[ I = \text{inanimate objects}, \]
\[ U = K_2 * K_2^2 * A * B * C * N * I \]

\( \mu(x|y) \) is defined by the degree to which ‘to die’ is ‘to disintegrate’
\( \mu(y|x) \) is defined by the degree to which ‘to disintegrate’ is ‘to die’
\( M_2(x) \) is defined by the set defined by the union of \( \mu(x|y) \) and \( \mu(y|x) \).

Similarly, we get the two following interpretations: ‘a stone underwent an action metaphorically similar to dying, i.e. disintegrating’ and ‘a stone died’. According to the value of \( \mu(x|y) \) and \( \mu(y|x) \) in regard to \( \beta \), these interpretations will either be ruled out or accepted.

If we want to keep the ambiguity of the two interpretations, we will represent the new meaning as \( M(z) = M_1(z) \times M_2(z) \). Only context will allow us to determine precisely which meaning is to be chosen. The frame presented is purely descriptive of the results of the phenomenon called metaphor.

2.8 Conclusions

Semantic rules and conceptual semantic spaces do not account fully for the theory of metaphor and semantic changes, rather they can account only for one level of this theory. They are mediational devices to describe the effects on the linguistic expression level of an underlying cognitive process. This underlying process affects the surface level structure in such a way that
the transformations can be expressed through those semantic rules, although those rules do not simulate the cognitive process. Semantic rules can represent the personification occurring in 'the stone died' through the shift of the pair of polar semantic markers 'animate', 'inanimate'. But this level of explanation does not penetrate the deeper level where a very specific cognitive process occurs that captures similarities and dissimilarities between 'stone' and 'person'. That process is, however, certainly using semantic markers, i.e. using the characteristics of each referent as inputs, first to produce meanings (e.g. 'an unemotive person'), and second, by side effect, to perturb the semantic representation in a way accounted for by semantics of metaphor. The merit of semantic anomaly approaches is to make a clear distinction between these two levels. Most theories only account for one or the other. As we stated in the last chapter, the recognition criterion is vital for the first type of theory. We can now better understand why it is not such a critical component for the second type. For those theories that focus on the cognitive process of capturing similarities, it is not necessary to 'recognize' \( x \) as dissimilar or anomalous to \( y \), to compare or process them. Although these two levels are distinct, they are not completely independant. They interact with each other: the cognitive process affects the semantic markers through shift of meanings, and the semantic markers are used by the cognitive process as inputs. In the next chapter, we will concentrate on the cognitive process underlying metaphor, namely analogical reasoning.
Chapter 3

Metaphor and Analogical Reasoning: a Cognitive Process

By analyzing an underlying cognitive process the aim is to acquire a better understanding of how people get meaning from metaphors. Simply stating this presupposes two assumptions: first, that we can define precisely what is the ‘meaning of a metaphor’; second, that there is a way or a formula to ‘get’ this very meaning. Consequently, we will first study these two assumptions, replaceability assumption and formulaic assumption and then show how they emerge from a simple example of proportional metaphor from Aristotle.

To support the formulaic assumption, analogical reasoning is proposed as the underlying cognitive process to get meaning from metaphor. This account is thus related to comparison views. It is, however, distinguished from strict comparison views as it does not reduce metaphor to an implicit statement of comparison, but rather uses analogical reasoning as a guiding strategy. After giving psychological evidence of an underlying analogical process in metaphor understanding, a formalism is developed around a kernel provided by Miller’s study of metaphors and simile [Miller 79].

As Miller’s work is examined, the need for an expansion of his theory in two directions is shown. First, the transfer of knowledge that occurs
between the two referents of metaphor during the analogical processing must be more precisely accounted for: this will be the focus of chapter 4. Second, a general organization of metaphors is to be defined that allows broadening the notion of similarity beyond a simple matching and accounts for the creativity of the metaphor. Chapter 5 will be devoted to the creation of similarities through a metaphor.

3.1 Two Issues Raised by the ‘Meaning’ of Metaphor

Two main issues are to be addressed before developing a theory of the meaning of metaphor: the replaceability and the formulaic assumptions. Through its simplicity, a brief account of Aristotle's substitution view will clearly exemplify these two issues.

For Aristotle, metaphor is a mere substitute for a literal equivalent that constitutes the metaphor's meaning. By saying 'Richard is a lion', we mean 'Richard is brave'. The reasons for such a substitution are merely stylistic or aesthetic. Metaphor is a mere ornament and understanding metaphor is like solving a riddle or a puzzle. The goodness of a metaphor is then proportional to the difficulty and trickery of this puzzle. Sometimes, however, there is no literal equivalent for a metaphor: its purpose then is to plug a lexical gap. Black defines this role of metaphors as 'catachresis' [Black 62 p 33], since it is the extension of a meaning of one word to designate another. 'Tachyon', 'colored quarks' and 'leg of an angle' are such uses of metaphor.

Aristotle distinguishes four types of substitution metaphors. The first type is a substitution of species for genus: in 'here stands my ship', 'standing' is substituted for 'riding an anchor', since being anchored is a kind of
immobility shared by ‘standing’. The second type characterizes the substitution of genus by species: in ‘indeed ten thousand noble things Odysseus did’, ‘ten thousand’ is substituted for ‘many’. The third type covers the substitution of species by species: in ‘drawing off his life with the bronze’, ‘drawing off’ is substituted for ‘severing’. The fourth type designates ‘metaphors by analogy’, better named ‘proportional metaphors’: ‘Dionysus’s shield’ means ‘Dionysus’s cup’ since the cup is Dyonisus’s symbol just as the shield is Ares’s symbol.

The two important issues to be discussed emerge from that example. First, is there always a literal equivalent meaning of a metaphor? In this example, ‘cup’ is indeed the literal equivalent meaning of ‘shield’. Second, is there a formula to get the meaning of metaphor? In our example, this specific kind of metaphor is grounded on a proportional analogy \( \frac{a}{c} = \frac{b}{d} \). Hence, there does exist a formula to ‘compute’ the meaning of this metaphor. The shield (a) is to Ares (b) as (\( = \)) the cup (c) is to Dionysus (d), i.e. \( \frac{a}{b} = \frac{c}{d} \). So we will say ‘cup’ instead of ‘shield’ and ‘shield’ instead of ‘cup’, i.e. \( \frac{c}{b} = \frac{a}{d} \).

Before going any further, we will examine more precisely these two assumptions. The first, the replaceability assumption: a metaphor is replaceable by a literal equivalent that is its meaning. Second, the formulaic assumption: there exists a formula to get this meaning from the constituents of the metaphor.
3.1.1 Replaceability Assumption

In its strictest form, the replaceability assumption states that there always exists a set of literal sentences that constitutes an exact paraphrase of the meaning of a metaphor. By ‘meaning of metaphor’, we mean to designate here very generally what the writer intends to convey as information. This traditionally includes both an emotive and a cognitive meaning.

Strict replaceability, either of literal or metaphorical meaning is objectionable. Strictly speaking, no paraphrase can fully account for or be substituted for a word with an exactly equivalent meaning, whether in the same language or in a different one. Foreign speakers who use a dictionary know this phenomenon: there is, for example, no equivalent in French for the word ‘girlfriend’! A strict replaceability of metaphorical meaning is objectionable on those points which are precisely the two components of the meaning of metaphor. The emotive meaning of metaphor obviously cannot be equivalent to any literal paraphrase since its suggestiveness or emotion comes from the very tension between the two referents. This tension is a direct result of the precise location of the two referents in the semantic space. Accordingly, the same tension could be only produced by two synonyms placed in exactly the same relations in the semantic space. Neither can the cognitive meaning of metaphor be fully equivalently replaceable by a finite set of literal paraphrase. The literal equivalent either says too much or not enough. Not enough, since metaphorical meaning is clearly open-ended: to say ‘my life is a fairy tale’ may have a meaning which, if literally paraphrased, would require an entire book to express. Too much, since metaphors say things in a condensed and insightful format that are beyond the range of simple words and that in fact have no literal equivalent. To quote Black,
One of the points I most wish to stress is that the loss in such cases is a loss in cognitive content; the relevant weakness of the literal paraphrase is not that it may be tiresomely prolix or boringly explicit (or deficient in qualities of style); it fails to be a translation because it fails to give the insight that the metaphor did. [Black 62 p46]

Similarly, anti-replaceability is a position equally hard to hold. Only intuitionistic approaches to metaphor do so, and they do so without great success [Sheffler 79 p88]. Intuitionistic approaches make the distinction between metaphorical and literal meaning on the basis that metaphors have no literal paraphrase, since their meaning is caught through an act of 'intuition', whereas literal meanings are caught through an act of 'analysis'. As there are literal expressions that are not strictly replaceable by literal paraphrase either, this contrast of 'analysis' and 'intuition' based on a strict anti-replaceability position does not hold. Moreover, evoking intuition to describe how metaphor gets its meaning is only putting a label on a cognitive process without any positive explanation.

Accordingly, given the fact that both strict replaceability and anti-replaceability are undefendable, if we wish to support the replaceability assumption, we need to restrict our criteria of replaceability. We will not try to find directly an exhaustive literal paraphrase of the meaning of the metaphor. Instead, we will define principles to find a kernel, named the 'root', from which a literal paraphrase of the metaphor could potentially be generated. This 'root' is not the meaning of the metaphor, but a key, or better, a generic element of the equivalent paraphrase of the metaphor.

This generation process divides the replaceability assumption in two motions: depth and breadth motion. The depth motion is the construction of
the 'root' through a transfer of existing similarities (see chapter 4). The breadth motion is the potential induction, or creation of similarities, like ramifications from the 'root' (see chapter 5). By imposing this new dichotomy in the metaphoric process, we hope to clarify and delineate precisely this process. Thus, the construction of the 'root' results from a precise methodology. Therefore, to validate our approach, we need to examine the formulaic assumption.

3.1.2 Formulaic Assumption

The formulaic assumption postulates the existence of a formula or methodology to compute the meaning of metaphor. This formula will take as imputes the literal meanings of the two referents and possibly the world knowledge about these two referents, and result in an equivalent literal meaning of the metaphor.

The research for a systematic method of getting a non-literal meaning from constituents is shared by metaphor with other tropes. Irony, hyperbole, synecdoche and metonymy are other uses of non-literal language that are also based on systematic principles. Irony is based on a systematic opposition between what is said and what is meant: for example, 'That was really intelligent!' to mean 'That was very stupid!'. Hyperbole uses the principle of exaggeration: 'ten thousand noble things' for 'many'. Synecdoches are the use of one term for another. Both terms are taken from a predetermined hierarchy based on perceptual links (e.g. 'is a part of'). A more general term can be substituted for a more specific, or reciprocally on a basis of a prespecified relationship: 'une fine lame' (a fine sword) will designate in French a fine swordsman. Metonymy operates as synecdoche but with a
hierarchy based on functional links: cause-effect, actor-action, container-contained, and so on. ‘Remember the Alamo’ is a metonymy where the place is substituted for the event. Consequently, a formulaic approach occurs whenever a semantic change occurs for the writer: if his intended meaning was \( m \), he wrote \( f(m) \). For the reader, the task will be to compute the inverse function \( f^{-1} \) and to apply it to get \( f^{-1}(f(m)) = m \). That a literal \( m \) always exists for any \( f(m) \) is the replaceability assumption.

However, the formulaic approach and replaceability are in a way independent: formulaism cannot be refuted nor demonstrated by merely establishing or not establishing replaceability. Consequently, that there is a formal methodology to derive a literal equivalent of metaphorical meaning does not entail that such a literal equivalent always exists. Further, that anti-replaceability does not imply the anti-formula thesis is exemplified by Sheffler’s example of an artificial language \( L \) with a very limited lexicon: ‘John’, ‘Robert’ and ‘is a lion’ [Sheffler p96]. Although there is no literal equivalent within the language \( L \) of ‘John is a lion’, a formula can be constructed that gives a literal equivalent in another language \( L' \). This example, artificial as it is, can still be extended to considerations of translatability from one language to another. Computationally, our goal is to detail a formulaic approach: accordingly, it was important to state that such a result can be achieved independently of the attitude adopted above toward replaceability.

Supplementing metaphor with such a processing formula is an attempt to make clear the process of understanding metaphor without evoking spurious labels such as ‘intuition’. Of course, such guiding rules, principles or axiomatization can only be highly desired by computational
linguists. The 'formula' we want to provide for metaphor is analogical reasoning.

3.2 Metaphor and Analogical Reasoning

We present here a general description of how analogical reasoning can apply to the metaphorical process. From this basis, the next section will focus on the link between analogy and metaphor in order to eventually formalize the transfer of similarities induced by metaphor.

3.2.1 Some Terminology

The different terms 'analogical reasoning', 'analogy', 'comparison' and 'similarity' have often been used indiscriminately. Before beginning our discussion, a more precise definition of these terms as they are used throughout this work is given. The process proposed here as a candidate formula is analogical reasoning. This term is preferred over 'similarity' or 'comparison' as it is more evocative of a cognitive process. However, in the case of metaphor, analogical reasoning has its own specificity, and one could even speak of 'metaphorical reasoning' or 'metaphorical thought'.

The term analogy is not to be confused with analogical reasoning. An analogy is a structure resulting from analogical reasoning. Analogical reasoning is a mental process consisting in 'making' analogies. For example, 'simple analogy' designates a proportional analogy $x:y :: x':y'$.

Similarity is constrained here to designate the specific link that exists between two similar entities, whatever the degree of similarity found between the two. Thus, in our definition similarity is understood as a relation
that will apply indifferently to the referents of the metaphor, or to specific features of these referents. In the rest of the text, it will be denoted as the two arguments predicate SIM.

Comparison is here the mental process by which similarities and dissimilarities are discovered between two entities. The term 'comparison' often induces an implicit emphasis on 'similarities', it must be noted that in the case of metaphors, 'dissimilarities' can be equally important. Comparison is only one component of analogical reasoning.

3.2.2 What is Analogical Reasoning?

Since we chose analogical reasoning to underly metaphor, we need first to define this process more precisely. Analogical reasoning is a promising problem solving technique in Artificial Intelligence. It consists of transferring knowledge from a known domain, the base domain, to a less known domain, the target domain, on the basis of similarities discovered between the two domains. This process encompasses four components: recognition, elaboration, evaluation and consolidation [Hall 84]. Each of these components of analogical reasoning is defined and examined with respect to metaphor.

Recognition consists in finding a base domain similar enough to the given target domain so that a successful transfer of knowledge can occur. In the case of metaphor, the two domains, i.e. the referents are always present in the syntactic form, either explicitly ('x is y'), or implicitly ('G(x) where G is a predicate of the y referent). Hence, the recognition step is considerably reduced.

Elaboration is the most critical component of analogical reasoning. It
decides which parts of knowledge from the base must be transferred to the target. In metaphor, this is the construction of the ‘root’, i.e. the construction of a set of relevant SIM relations between the two referents. We will call it the transfer problem, since not all attributes can be transferred (chapter 4). When saying ‘John is an elephant’, the attribute ‘over-weight’ is transferred, ‘has-tusks’ is not, and ‘mammal’, although shared with ‘John’, is not, since it is irrelevant.

Evaluation validates this transfer. General knowledge and the inferencing from the context of the metaphor are critical in this component. In Rutherford’s solar system model of the hydrogen atom, only experience can validate the predicted transfer of a formula involving an inversed squared distance. Sentences following ‘John is an elephant’ can confirm that we meant ‘he is overweight’ and not ‘he has a huge memory’, or that we actually meant ‘he has very long canines’. Consequently, elaboration and evaluation are not clearly distinct, but rather closely intertwined.

Consolidation allows learning from the transfer. For example, transferred structures can be stored or generalized to facilitate further transfers. Carbonell’s model outlines a system which understands metaphors using other metaphors taken from a set of ‘basic metaphors’ [Carbonell 85].

In conclusion, these four components of analogical reasoning seem to closely approximate the metaphorical process. Moreover, the choice of analogical reasoning to account for the metaphorical process is a natural choice which casts metaphor understanding as an integral part of the whole process of text understanding.
3.2.3 Why Choose Analogical Reasoning?

Analogical reasoning is both a traditional and a natural candidate process for metaphor. Since Aristotle, for whom metaphors by analogy only designated the fourth type of metaphor, the status of metaphor has been inverted. Metaphor is now traditionally seen as an emanation of analogical thinking. Defined in Merriam Websters dictionary, metaphor is

a figure of speech in which a word or phrase denoting one kind of object or action is used in place of another to suggest a likeness or analogy between them: an implicit comparison in contrast to the explicit comparison of the simile.

The use of analogical reasoning is integral to the nature of the general process of text understanding, since both consist in relating new knowledge to old knowledge. While reading, new knowledge results from the current sentence read. Old knowledge consists in the knowledge already accumulated from the processing of the preceding text and our general knowledge or beliefs. To successfully relate old knowledge to new knowledge\(^1\), we assume that what we read is true in the model of the writer (truth assumption as defined by Miller), even if it is conflicting with our model of the world. This explains how we can successfully read science fiction or fantasy. In the case of conflict, it is our model of the world that we have to construe to approximate the writer's model. Metaphors are such conflicts since they force us to link two unrelated and cognitively distant referents. The analogical process therefore construes our world by making the two referents closer. By exploring their similarities, we view them as alike and no longer distant. In the newly construed world, the 'anomaly' of metaphor has

\(^1\)This act has sometimes been called 'apperception' [Miller 79].
disappeared as we 'really' see $x$ as $y$. In other words, this is a 'cartoonist view', where in the world construed, mountains do have legs, and walls do have ears.

If an author says that $x$ is $y$ when we know in fact that $x$ is not $y$, we must try to imagine a world in which $x$ is $y$. This act of imagination is facilitated if, in the real world, $x$ is like $y$ in some respects, for then we can take their similarities as the author's ground for saying that $x$ is $y$. [Miller 79]

Before formalizing the transfer of similarities that makes the two referents of metaphor closer, the following supplementary evidence that analogy does indeed underly metaphor on the basis of psychological experiments can be presented [Sternberg 80].

3.3 Testing Analogical Reasoning and Metaphor

To compare the processes involved in metaphor and underlying analogy, Sternberg and Nigro presented subjects with proportional metaphors, e.g. 'Ares's shield is Dionisus's cup' and their underlying simple analogies $x:y :: x':y'$ [Sternberg 80]. They recorded the time required (latencies) to infer a missing term of a proportional metaphors and the latencies to infer the corresponding missing term in the underlying simple analogy. Ratings of aptness and comprehensibility on a 1-9 scale, and reaction time to make these ratings were also recorded.

In a first experiment, they tested the possibility of a similar process occurring for both proportional metaphors and simple analogies, by comparing reaction time to 'understand' them both. In a second experiment, they showed the potential existence of an interaction between specific terms
of the analogy. To do so, they used different formats of proportional
metaphors involving an increasing number of missing terms and compared the
rating of aptness and comprehensibility of those metaphors. These ratings
also supported evidence of the adequacy of analogical reasoning to account for
the goodness of metaphors.

3.3.1 Proportional Metaphor and Simple Analogy

The first experiment consisted of presenting both the analogy and
the metaphor with a single term to be inferred:

1. Tombstones in a graveyard are teeth in a
   (a) mouth
   (b) chair

1'. tombstones:graveyard :: teeth:
   (a) mouth
   (b) chair

All the terms were carefully chosen to vary the semantic distances
between them. These distances measure the difficulty of the metaphor: given
\( xy :: x' y' \), the distance between \( x \) and \( y \) gives the evaluation difficulty,
whereas the distance between \( x \) and \( x' \) gives the transfer difficulty. The times
to make choices were measured in both cases, and corresponded to the two
following processes.

The steps to process the underlying analogy (e.g. 
\textit{Tombstones:graveyard :: teeth:mouth}) follow the description of analogical
reasoning given earlier. They can be simplified into two steps. First step,
elaboration: extract a mapping by using specific knowledge from the terms of
the base domain (from 'tombstones:graveyard' infer 'is-
planted(tombstones,graveyard)'). Second step, evaluation: apply the mapping
'is-planted(X,Y)' in the new domain 'teeth:mouth'. The mapping is transferred without any change since the ':' of the simple analogy indicates a strict similarity, that is an '⇒'. The evaluation is successful if the transferred mapping holds in the new domain: 'is-planted(teeth,mouth)'. Furthermore, if a valid mapping has been transferred, it allows one to infer missing arguments: 'is-planted(teeth,x)' gives by using our specific knowledge 'x=mouth'.

Exactly the same components can be defined for the underlying metaphor 'Tombstones in a graveyard are teeth in a x'. This does not mean that the difficulty of the two processes has to be similar. The additional verbal material in the metaphorical statement is expected to increase both the latency and the comprehensibility.

The times to infer the missing term for proportional metaphor and for underlying analogy were found to be the same which confirmed the hypothesis that the components involved were globally the same and of comparable difficulty. However, the second experiment showed some distinctions in the possibility of an interaction between certain terms of the metaphor.

### 3.3.2 The Possibility of an Interaction

To test this possibility, a second experiment used proportional metaphors presented under 5 different formats with missing terms and various orderings of the terms left explicit. The five following formats are possible [Sternberg 80]:

1. A lion among beasts is a king among people
2. A lion among beasts is a king
3. A lion is a king among people
4. A lion is a king
5. A lion is a king among beasts

It should be noted that the familiarity of the subject with the analogy was not considered, although this may have affected the comprehensibility: 'a lion is a king' is more comprehensible than the corresponding format 'a shield is a cup'. Since the point was to compare formats, this factor should not have affected the results if the ratings were consistent for each format through all the various examples, which was the case.

These five different formats were presented to the subjects. They were asked to rate the aptness and the comprehensibility of the metaphor on a 1-9 scale. Reaction time to make these ratings was also recorded. From formats 1 to 4, the two ratings and the reaction times increased, since the amount of inferencing increased with the number of missing terms to be generated to reconstruct and understand the metaphor. However, Format 5, 'A lion is a \textit{king} among \textit{beasts}', was rated as most apt with an intermediate latency. The peculiarity of format 5, as compared with the analogy 'A lion among \textit{beasts} is a \textit{king} among people', is the switch of 'beasts' and 'king'. The result of this switch was to bring in (5) the vehicle \textit{x} 'king' closer to the tenor \textit{x} 'lion'. This strongly suggests that the metaphorical process is facilitated by the juxtaposition of the two referents with the effect of stimulating the interactive imagery. Ratings by the subjects of 'how vivid the interaction was between the two principles nouns' confirmed a best rating for format 5.
In conclusion, proportional metaphors differ from analogy by the absence of some terms made implicit, and by an 'interaction' between the first and third terms, topic and vehicle. This interaction results from the fact that the two referents must be taken from two different subspaces of the conceptual semantic space in order to give a valid metaphor. For example, \textit{lion:wolf :: cat:dog} is an acceptable analogy, whereas the corresponding proportional metaphor \textit{a lion is wolf among cats} is trivial and uninteresting [Sternberg 80]. Sternberg and Nigro, however, while not claiming a complete theory applying to the understanding of all kinds of metaphors, at least, legitimatize the use of analogical reasoning.

As a last test for analogical reasoning, Sternberg and Nigro also explore how this process could provide adequate criteria for the goodness of metaphors.

3.3.3 Goodness of Metaphors in Terms of Analogy

Factors in goodness of metaphors can be multiple and subjective: rhythm of the words, particularly striking alliterations, emotive content of the referents, and so on. We wish to find here, in terms of analogical reasoning, criteria to account for two components of the quality of metaphor: comprehensibility and aptness.

Sternberg and Nigro used the ratings of comprehensibility and aptness from the second experiment we described [Sternberg 80]. Correlations between the two ratings were computed and indicated that aptness and comprehensibility are clearly related. Comprehensibility is obviously a necessary but not sufficient condition for aptness. The interesting discovery is that the correlation varies along with the five formats inversely with the
ratings of aptness and comprehensibility. Consequently, there appears to be a stronger relation between these two components when the metaphor is ‘difficult’, that is, aptness is then essentially judged in terms of comprehensibility; whereas for ‘easy’ metaphors aptness relies less on comprehensibility and other facts of aesthetics can hence intervene.

We still need to justify these results in terms of analogical reasoning. Underlying metaphoric process by a transfer of knowledge between two domains provides two criteria: first, the distance between the two domains; second, the nature of the transfer (amount of new knowledge and degree of matching). Sternberg and Tourangeau [Sternberg 81] made some studies to test these two criteria. A first group of subjects rated the degree of similarity between various pairs of referents, in order to evaluate the first criterion, called ‘congruence’. A second group rated each referent on certain scales to produce a rating of agreement with their beliefs, in order to study the second criterion ‘agreement’. Proportional metaphors were made with various congruence and agreement values between their referents. Subjects rated how much they liked these metaphors. A negative correlation was found between congruence and likeability, and a positive correlation between agreement and likeability. Better metaphors are obtained from distant referents between which the transfer does not contradict our beliefs. Consequently, metaphors increase their aptness as they succeed in relating distant referents and their comprehensibility increases with the agreement factor.

The psychological experiments we saw used proportional metaphors to access more easily a potential underlying analogical reasoning. They indeed showed that analogy can underly a metaphor. From this first step, Miller developed a formalization that promotes the role of a preexisting
underlying analogy in any kind of metaphor. The view we want to develop extends this approach by focussing on the construction of this analogy (the 'root'), i.e. structured similarities transferred through a strategy: analogical reasoning. Where Miller says there preexists an underlying analogy, we say analogical reasoning produces a complex analogy that constitutes in fact the meaning of metaphor.

3.4 A Theory of Metaphor Issued from Comparison Views

A comparison view cannot consist in the mere reducing of a metaphor into a simile, for this substitution would not be more informative: 'The main objection against a comparison is that it suffers from a vagueness that borders upon vacuity' [Black 62 p37]. One might better think of simile, literal comparison, analogy and metaphors as different syntactic realizations of the same thought process: analogical reasoning. Thus, 'similarity functions as a comprehension strategy, not as a component of meaning' [Searle 79]. Consequently, the theory of similarity developed will have to account for simile and metaphor and characterize them as distinct parts of a continuum.

To show what is specific about metaphor, a contrast is made here between metaphors and simile. This is followed by a study of a formalization by Miller [Miller 79]. By exploring how meaning is produced in this formalism, and it can be seen how this approach can be extended in two directions, studied in the two following chapters.
3.4.1 Metaphor and Simile

Simile and Metaphors are manifestations of the same underlying process. The goal is not to equate nor reduce one to the other. However, by contrasting them, the intention is to build a theory of comparison valid enough to firmly ground metaphor on it.

A metaphor 'x is y' can be turned into a simile by the insertion of 'like'. The two forms are not equivalent: 'His wife is his mother' is a stronger claim than 'His wife is like his mother'. The copula 'like' is the explicit signal that triggers a comparison process; lacking this signal, metaphor can only call our attention to similarity. All similes cannot be turned into metaphors, and such is not our goal. Although similes are usually considered to lack the impact and creative power of metaphor, striking similes do exist, such as in the following example from 'Madame Bovary' by Flaubert:

Human language is like a cracked kettledrum on which we beat out a tune for bears to dance to, when all the time we are longing to move the stars to pity.

Conversely, the deletion of 'like' in a simile rarely results in a valid metaphor. To obtain a valid metaphor, one often needs to add 'in a certain way', which shows a modification in the truth value assigned to the statement. Alternatively, one might modify one of the referents to augment the dissimilarities: to transform 'the hydrogen atom is like a solar system' into a metaphor, the statement 'the hydrogen atom is a reduced solar system' is preferable. This modification tends to focus and ease the implicit analogical process.

Although distinct, metaphors and simile are parts of a continuum.
Directionality increases from literal comparison, simile to metaphors: ‘Raspberries are like blackberries’, ‘Encyclopedias are like dictionaries’ and ‘Encyclopedias are like goldmines’ are not all reversible to the same degree. Directionality exists even in mathematical equality: \( y = ax + b \) traditionally imposes in our culture a right to left directionality, from known to unknown variables. In metaphors, this directionality usually goes from vehicle to tenor as the transfer of knowledge goes from well known to less known. As the two referents of similarity can be both vehicle and tenor, the two directions may coexist. In the following example ‘the brook smiled’ ([Levin 79 p129]), we can both envision a personification of ‘brook’ and a depersonification of ‘to smile’. Interaction in metaphor can be considered as resulting from this bidirectionality. Additionally, truth values also vary from literal comparison to metaphor: ‘Encyclopedias are like dictionaries’ might be assigned a ‘better’ truth value than the simile ‘Encyclopedias are like goldmines’ since people might tend to judge the latter as true ‘only in a certain way or to a certain extent’ [Ortony 79]. The existence of this above continuum must result in a common account for simile and metaphor. On this basis, Miller’s account for similarity and the formalization of metaphor resulting from it will now be examined.

3.4.2 A Formalization of Similarity

Miller distinguishes three instances of comparison statements: literal comparison, simile and analogy. Literal comparison and simile differ in that the grounds of similarity should be ‘less obvious’ in the case of simile, i.e. more features are shared for literal comparison than for simile. Miller’s choice is inefficient because unprecise. The given example of ‘literal comparison’, ‘John’s wife is like his mother’ contrasted with the ‘simile’, ‘John’s wife is like
his umbrella’, is arguable. Both examples have a literal comparison and a simile interpretation. A preferable distinction might involve the nature of these features (e.g. physical or not) and their salience [Ortony 79] as we will see in the next chapter. However, the third class of comparison statements, analogies, is clearly recognizable: they involve four referents, e.g. ‘Tombstones in a graveyard are teeth in a mouth’ and involve the underlying schema $x:y :: x':y'$.

Miller's formalizes similarity with the relation SIM which applies here to sentential concepts: ROOT-OUT(fault) is the representation of the sentential concept ‘root out your faults’. Similitude is achieved when two sentential concepts $F(x)$ and $G(y)$ share some features, but not all of them. This similarity is denoted: $SIM[F(x),G(y)]$. Therefore, understanding a similarity statement consists in retrieving values for $F$ and $G$, assuming that ‘$x$ is like $y$’. This reconstruction process can be symbolized as:

$$(S) \quad SIM(x,y) ----> (\text{Some } F)(\text{Some } G) \{SIM[F(x),G(y)]\}$$

Example: ‘The brain is like a machine’
$$SIM(\text{brain}, \text{machine}) ---->$$
$$SIM[\text{think}(\text{brain}), \text{compute}(\text{machine})]$$

This formalism also applies for proportional analogy $x:y :: x':y'$ by using as sentential concepts $x:y$ and $x':y'$. In this case, we see that the same relation $F$ holds in the two domains. $(S)$ becomes $(S')$:

$$(S') \quad SIM[(x:y),(x':y')] ----> (\text{Some } F) \{SIM[F(x,y),F(x',y')]\}$$

Example: ‘Tombstones in a graveyard are teeth in a mouth’
$$SIM[(\text{tombstone:graveyard}), (\text{teeth,mouth})] ---->$$
$$SIM[\text{is-planted}(\text{tombstone,graveyard}), \text{is-planted}(\text{teeth,mouth})]$$

Miller's reconstruction is here clearly unsatisfying. The existing similarities between ‘tombstone’ and ‘teeth’ are not explored, neither is the induced similarity between ‘graveyard’ and ‘mouth’ (see chapter 5).
(S) is a mere translation of the syntactic form. SIM is here no more precise and just as evocative as 'is like'. The arrow in the formula translates the shift to the underlying cognitive level, represented by an underlying existing analogy. Although the critical part of the process is the computation of values for F and G, Miller's approach lacks an efficient account for how to compute these values. However, it does have the merit of stating the existence of those values, that is, affirming that behind a comparison statement is an underlying preexisting structural analogy. Since we account for simile and metaphor by a same process, the underlying SIM[F(x),G(y)] must also apply to metaphors.

3.4.3 A Formalization of Metaphors

A classification of metaphors in three types can be build from the underlying structure SIM[F(x),G(y)]. Out of the five elements of this structure, two are always omitted, and two of the three left have to be explicit to enable the reconstruction. SIM is always omitted, since it translates a copula of similarity that is always omitted in metaphors. F is also always omitted since it corresponds to the 'literal' equivalent of the predicate: for example, 'to disintegrate' is the F corresponding to the G 'to die' in 'the stone died'. The three possible choices for the two explicit terms in the set \{x,y,G\} give a classification of metaphors into three kinds, summarized in figure 3-1.

- 1. *Nominal metaphors*: the two referents x and y are kept, F and G must be inferred, which gives formalization \((M_1)^2\):

\[ (M_1) \text{BE}(x,y) \rightarrow (\text{Some F}) (\text{Some G}) \{\text{SIM}[F(x),G(y)]\} \]

Example: 'Sally is an icecube'

\(^2\text{Miller also shows that proportional metaphors of the type 'x is the x' of y' can be reduced to the form given by (M_1).}\)
![Table showing the types of metaphors](image)

**Figure 3-1:** Three Types of Metaphors

\[ \text{BE(Sally,icecube)} \rightarrow \text{SIM[UNEMOTIVE(Sally),COLD(icecube)]} \]

- 2. *Predicative metaphors*: \( x \) and \( G \) are kept explicit, leading to rule \((M_2)\).

\[
(M_2) \ G(x) \rightarrow (\text{Some F}) \ (\text{Some y}) \ \{\text{SIM}[F(x),G(y)]\}
\]

Example: ‘Root out your faults’

\[
\text{ROOT-OUT(fault)} \rightarrow \text{SIM[ELIMINATE(faults),ROOT-OUT(weeds)]}
\]

- 3. *Sentential metaphors*: \( G \) and \( y \) are explicit. Thus, the whole tenor is to be inferred from the vehicle \( G(y) \).

\[
(M_3) \ G(y) \rightarrow (\text{Some F}) \ (\text{Some x}) \ \{\text{SIM}[F(x),G(y)]\}
\]

Example: ‘he lost his marbles’

\[
\text{LOST(marbles)} \rightarrow \text{SIM[LOST(sanity),LOST(marbles)]}
\]

In the following sentential metaphors are disregarded, since it seems impossible that terms of the vehicle can be reconstructed when the tenor is completely absent from the syntactic structure. Someone unfamiliar with
English will most likely have to ask the meaning of 'to lose one's marbles'. However, this third category does not contain only idioms. Examples can be built from any metaphor by using only terms referring to the vehicle. From 'Sally is a block of ice', we can build the following sentential metaphor 'the block of ice melts' to mean that she finally surrendered to love, which is perhaps by itself not reconstructable. In the specific case of idioms, the underlying analogical structure may even have been forgotten. Few still remember that 'to kick the bucket' comes from the slaughtering of pigs in Northern England. Pigs used to have their back legs tied to a beam called the 'bucket' that they would 'kick' while being slaughtered. Given the first two types of metaphors, understanding them will rely on correctly inferring implicit terms from the explicit terms.

3.4.4 A Reconstruction of Meaning

Understanding consists here of two steps corresponding to the elaboration and evaluation component of analogical reasoning: reconstruction and interpretation. Reconstruction is the inference of a set of possible values for the implicit terms in SIM[F(x),G(y)]. Interpretation is the selection of plausible values among the possible values. Miller does not address the problem of interpretation. In this section, we examine the reconstruction of the two types of metaphors, nominal metaphors and predicative metaphors.

In the case of nominal metaphors, F and G are to be inferred from x and y. This task is eased by the fact that SIM can here be very often understood as 'EQUAL'. Among possible similarities between concepts x and y is very often a perfect match of attributes. Consequently, possible values for F' and G correspond to any common feature 'feat1': F=G=HAS-FEAT1.
This is notably inefficient, since it results in too many irrelevant values. Chapter 4 will explore strategies to efficiently transfer only relevant features from \( y \) to \( x \).

In the case of *predicative metaphors*, \( F \) and \( y \) must be inferred from \( G \) and \( x \). To select values for \( y \), Miller suggests taking the most generic argument of which \( G \) is a predicate. In our example ‘Root out your faults’, we have to infer \( y \) from the part of the underlying structure \( G(y) \), i.e. ‘\( \text{ROOT-OUT}(y) \)’ to obtain \( y = \text{‘weed’} \). To infer \( F \), we cannot use this strategy since the number of predicates of which \( y \) is an argument is unmanageable. Hence, we must use \( G \) to infer \( F \) and validate the choice made by checking the validity of \( F(x) \). As a general rule, the four components of the underlying structure must stay coherent. However, in the case of predicative metaphors, we cannot view SIM as a strict equality, the way we did for nominal metaphors. For example, in \( G(x) = \text{ROOT-OUT}(\text{fault}) \), the reconstruction would give then \( F(x) = G(x) = \text{ROOT-OUT}(\text{fault}) \), which would not elucidate the metaphor. Miller suggests that \( F \) can be constructed from \( G \) by deletion of certain semantic features of \( G \) and the use of context. It is certain that rules for semantic changes as detailed in chapter 2 would be a good complement to add, for what we have here fits exactly our example ‘the stone died’ of chapter 2, where we had to use a construal rule to get the shift of meaning from ‘to die’ to ‘to disintegrate’. In the case of predicative metaphors, SIM must be viewed less strictly and be accounted for by rules for semantic changes, unless the SIM relation is encoded for each related \( F \) and \( G \) as \( \text{SIM}(F,G) \) in the knowledge base. This corresponds to a dictionary that would give ‘to eliminate’ as a meaning of ‘to root out’. Such an approach is obviously inefficient since the range of metaphorical meanings is potentially infinite.
We suggest that predicative metaphors should be treated as satellites of nominal metaphors. Nominal metaphors are more properly viewed as metaphorical themes 'see \( x \) as \( y \)'. Applying to \( x \) predicates \( G \) which are usually applied to \( y \), results in a predicative metaphor. Consequently, to process a predicative metaphor once the \( y \) referent is reconstructed, the same process of transfer defined for nominal metaphors applies on the single attribute \( G \) to be transferred. Thus, in the following we will focus on describing transfer between the \( x \) and \( y \) referents.

3.5 Conclusions

Miller provides an adequate framework for the elaboration component of analogical reasoning and a realistic account of the relationship between the surface form of metaphor and a preexisting underlying analogical structure. Miller’s contribution is also to suppress the recognition step: metaphors do not need to be recognized first to be understood. All sentences \( \text{BE}(x,y) \), 'John is a vegetable' as well as 'A tomato is a vegetable', go through the same process, i.e. the reconstruction of a structure of the type \( R[F(x),G(y)] \). Through this reconstruction \( R \) will be inferred as a SIM or as a ISA, which recognizes metaphor as an after-effect. Metaphor is, in this case, the result of a 'category mistake'.

However, Miller’s approach leaves us unsatisfied on three points. First, \( F,G \) are not only relations but more generally predicates of the referents \( x \) and \( y \). Referents can be represented by a propositional network. The nodes are the concepts, and the predicates express propositions between the nodes. Predicates are attributes (one argument) or relations (two or more arguments). Predicates are therefore any property, connotation or association
that is known or believed about one thing and that structures its internal representation. This includes physical attributes, functional properties, behavioral attributes, causal links and so on.

Second, the clean dichotomy made by Miller between elaboration and evaluation comes from too strict an account for the notion of similarity. This is inefficient as it provides too many irrelevant values when comparing the two referents. Consequently, our first expansion will be to develop in the next chapter, strategies to ‘discover similarities’ that are relevant, i.e. transferable between the referents. This set of discovered similarities, because of the net structure given to the referents, is a mapping structure. This objects to the existence of a single preexisting structure SIM(F(x),G(y)) to be filled with several possible values, each resulting structure being one meaning of metaphor. The ‘root’, or ‘mapping structure’, is a whole subnet structure emptied of its nodes. The predicates of the mapping structure are ‘paired-arcs’, i.e. predicates in a SIM relation, e.g. in Miller, F-G is a paired-arc. In most cases, the paired arc is simplified into a simple arc such as F=G. Gentner argues that this is the case notably for relations [Gentner 83a].

Third, Miller’s approach relies only on preexisting encoded similarities. SIM(F,G) has to be encoded, unless F=G, since no room is provided in the theory to infer a similar F from G. F and G are predicates of the referents and can be defined in terms of attributes, so that SIM$^3$ between F and G could be defined also in terms of attributes shared. This recursive possibility of defining metaphorical similarity is called metaphorical shift. Chapter 5 will present how a SIM relation between predicates creates a SIM

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$^3$The SIM relation applies to both referents and predicates names. Consequently, we can encode both SIM(theory,building) and SIM(cold,unemotive).
relation between the corresponding arguments of the predicates. The SIM relation is a vital element of the theory and some basic similarities must be preencoded which will result in a taxonomy that allows creativity.

Understanding metaphor is the process of building the mapping structure through analogical reasoning. This construction is named the *transfer problem*, and will be explored in the next chapter.
Chapter 4

Some Similarities Are Discovered ...

The transfer problem addressed here is the most challenging part of analogical reasoning: which part of knowledge is to be transferred? Since not all similarities between the two referents are to be transferred, comparison must be thought of as a strategy. The comparison strategy must also account for all comparison statements as a continuum encompassing literal similarity, simile and metaphor. To do so, a theory of comparison can be grounded on the salience and the nature of attributes. The use of an attribute's salience as a discriminating means for transfer was developed by Ortony [Ortony 79]. This approach is further extended by Carbonell into a hierarchy of invariance that orders attributes according to their nature and their probability of being transferred invariantly [Carbonell 82]. This will enable the transfer of complex mapping structures. The whole transfer component has a general flow of control [Winston 78] and can be incorporated in a general schema of understanding metaphors [Carbonell 82].
4.1 Transfer and SIM Relation

4.1.1 Defining Similarities

The transfer problem can be divided into two issues. First, the search for the SIM relations between the two referents, i.e. what does it mean that x is similar to y? This operation is like the one performed by a cartographer comparing the coastline of South America with that of Africa [Tourangeau 82]. Both coastlines do not exactly match, neither totally nor partially. Hence, rather than a perfect match, the cartographer performs an operation of 'parallelism' or 'complementation'. What corresponds to Brazil is not land, but a gulf. Accordingly, our definition of similarity must not be too strict, otherwise we would not find anything similar to anything else. It must not be too loose either, or we would end up finding everything similar to everything in some respect. We must then define similarity between referents as a matter of degree of similarity between the attributes of the referents. For most approaches, similarity of referents is achieved by simply sharing attributes, i.e. a SIM relation understood as a mere equality. Ortomy only hints at the possibility of metaphorical similarity in the case of the transfer of relations in complex analogies like 'schools are zoos' [Ortomy 80 p14]. Consequently, it seems promising to broaden the SIM relation and to define two referents to be similar when they have attributes in a SIM relation. SIM is either a perfect match, a pre-encoded SIM pair existing in the knowledge base, or a metaphorical similarity. Metaphorical similarity can be recursively reduced until a base preencoded SIM relation is reached. This ultimate reduction can be either a match of attributes: SIM(hot,red) can be reduced to SIM(COLOR(red),COLOR(hot-iron)); or a reduction to a cultural preexisting and encoded similarity SIM(mourning,black), or a similarity created with
respect to a metaphor processed before. This new account of similarity does not challenge the existing approaches, but by allowing a broadening of our SIM relation we will account for metaphorical shifts and creativity (see chapter 5).

4.1.2 Selecting Similarities

The second problem which arises from the transfer problem is the most challenging: only relevant SIM relations between the two referents must be transferred. The output of the transfer component is therefore a mapping structure or 'root', i.e. a set of SIM(F,G) pairs where F and G are predicates of respectively the referent x and the referent y. In this sense, the term 'transfer' is misleading, since G is not really transferred, but put into a SIM relation with an attribute of x. The term 'transfer' takes on its customary meaning when the corresponding attribute in x does not yet exist and is introduced through the metaphor: 'John is an elephant' introduces the attribute 'big' for John. Black's contribution was to claim that attributes of x put into a SIM relation with attributes of y are no longer pure attributes of x, but a merge of the related pair resulting from the interaction of the two referents [Black 62]. Selecting the relevant SIM pairs is made on the basis of the nature of the attributes put into similarity. Such an account is the very means that allows a strong theory of similarity: comparison statements are differentiated according to the nature of the attributes transferred but yet grounded on the same transfer principles that make them part of a continuum. Such principles are of increasing complexity and will ultimately involve the coherence of discourse, since in certain cases, only context will determine the transferability of certain similarities. The principles studied in the following are based on the notion of salience and lead to the building of an hierarchy of attributes left invariant according to their nature.
4.2 Transfer of Salient Attributes

4.2.1 A Rule for All Comparison Statements

The rule given by Ortony in [Ortony 79] to account for both literal comparisons and simile while discriminating between them is the following: only highly salient attributes of $y$ are put in a SIM relation with attributes of $y$. The distinction between the two is determined by the nature of the attributes of $x$ that are kept. In the case of literal comparisons, highly salient attributes of $y$ are in a ‘SIM’ relation with attributes of $x$ that are also highly salient. In the case of similes, highly salient attributes of $y$ are in a ‘SIM’ relation with minimally salient attributes of $x$ (but salient enough). If either of the two cases applies, $x$ and $y$ are not perceived as ‘similar’ and the judgment of similarity between $x$ and $y$ is said to be anomalous.

For example, ‘raspberries are like blackberries’ is a literal comparison, since all shared attributes (‘are-berries’, ‘conic-form’ and so on) are highly salient for both referents. ‘Lectures are like sleeping pills’ is a simile, since ‘soporific’ is of higher salience for ‘sleeping pills’ than for ‘lectures’ yet not unsalient either [Ortony 80]. ‘Life is like a mushroom’ is anomalous, as long as you do not succeed in making sense of it, i.e. as long as you do not find SIM pairs allowed by the rule.

Ortony’s rule raises three questions. First, how do we define a word’s attribute? Second, how do we define the salience of an attribute? And third, what is meant by sharing an attribute, i.e. how do we intend SIM?
4.2.2 Attributes, Salience and Matching

By attribute, Ortony intends a much broader notion than the strict notion of semantic feature. His notion of attribute corresponds therefore to any predicate of the network representation structuring the referent (see chapter 3). Attributes include both physical attributes and functional properties, but also behavioral attributes, causal links and so on. In the following we will keep Ortony's notation, unless we specifically want to designate real attributes, i.e. one place predicates. It seems that Ortony over emphasized the real attributes by his unfortunate terminology: relations challenge Ortony's account. In his very example 'Encyclopedias are like gold mines', the relation 'find something valuable in it' seems equally salient for both although the example is not a literal comparison. Ortony's rule can be kept, by observing that a similarity is created between the corresponding arguments of the invariant relation: 'Information extracted from encyclopedias is like gold extracted from gold mines'. Consequently, these two attributes 'information' 'gold' are in a metaphorical similarity that can be recursively reduced by applying Ortony's rule: 'valuable' is a highly salient attribute of 'gold' that is moderately salient of 'information'.

Some of these attributes are usually perceived as more important. They correspond to salient features and allow us to define and recognize the object or concept. They are characteristic of a prototypical object defining a natural category and are part of our conceptualization of the world (see chapter 2). The more an attribute is characteristic of an object, i.e. shared by fewer objects, the higher will be its salience. Salience is, however, strongly subjective. It can vary from one culture to another and from one person to another, since it also depends on past experiences and beliefs. Thus, translations of metaphors cannot consist of mere translations of the referents:
concepts must be translated, that is, the salience of attributes must correspond to a concept and its translation. Examples are numerous. Donkeys are for today essentially stubborn and stupid, whereas in the Middle Ages they symbolized chastity and humility. French pigs are more perverted than dirty; French cabbages are stupid but not door knobs and you may have an American frog or a French cat in your throat. As the salience of the same attribute can vary from one person to another, what is perceived as a simile by one person can be perceived as a literal comparison by another. And for the same person, saliences can vary with changes of conceptualization, as they can occur after a new metaphor. Accurate ratings of salience are therefore difficult to obtain. Such ratings have, however, been successfully recorded during psychological experiments [Ortony 79] and the results can be used to represent knowledge in a system.

The third question concerns the ‘matching’ of attributes. As we saw, identity is only an extreme case, and the ‘Encyclopedias are gold mines’ example showed the need for metaphorical shifts. This justifies our assumption of a SIM relation as defined above, i.e. not limited to mere matches but that also encodes culturally perceived similarities in the knowledge base. Furthermore, if we allow similarities to be created through a metaphor, the processing system must be conceived as a learning system and dynamically encode the new similarities as they can serve as a basis of similarity for other new metaphors (see chapter 5).

Given this account for all comparison statements, Ortony applies it also to metaphors which highlights two specific roles of the transfer process in the influence of metaphor on our representation of concepts: the promotion and introduction of attributes.
4.2.3 Metaphors Promote and Introduce Attributes

In the view of Ortony, simile and Metaphor are grounded on the same theory of comparison and are emanations of the same analogical process. To justify this, to the psychological experiments we saw and to Miller's formalism, Ortony added evidence taken from the production of so-called metaphors by children. Children show difficulties in comprehension of metaphors, although they seem to produce them very easily. The mechanism proposed by Ortony resolves this paradox. Children do not have the same conceptualization of the world as adults and what are low salience facts for us may be highly salient for them. Accordingly, what a child produces is a literal comparison that adults perceive as a metaphor. The same argument of relativity of salience apply between anomalous and non anomalous statements: a statement valid for one person can be perceived as as anomalous by another person if this person does not perceive the transferred attributes as either highly salient or not salient enough. Note that if the person finally manages to understand the metaphor, the person's conceptualization of $x$ will have to change since the salience of the attributes transferred will have increased.

Accordingly, there is undeniably a promoting role of metaphor. Just like communicating jugs, when a low-salience attribute of $x$ is put into a SIM relation with a highly salient attribute of $y$, the salience of the attribute of $x$ is raised. Seeing $x$ as $y$ is promoting ignored aspects of $x$. To confirm this point, we can artificially raise the salience of an attribute by explicitly citing it. According to the theory, this should turn a simile into a literal comparison. 'His face is like a beet' is a simile, whereas 'his face is red like a beet' is a literal comparison. This promoting role corresponds to a natural tendency to force the metaphor into being seen as a literal comparison. It corresponds
exactly to a construal of the world to really see ‘x is y’, for we really change
our conceptualization of x by raising or promoting the salience of one of its
attributes. At the extreme, the salience will be raised to such a point that x
will really be y. This is what happens through dead or frozen metaphors.

A second more important role of metaphor is to introduce new
attributes in the current representation of the referent. So far we have
assumed a certain knowledge of the tenor x (e.g. a certain knowledge about
‘encyclopedia’s’). But to come back to the literal notion of transfer we must
also consider the extreme case where the tenor x, more than having attributes
of undetermined salience that a metaphor will structure, has an attribute of y
introduced. The creativity part and the insight of metaphor resides in this
predicate introduction property. When, in The Maltese Falcon, Spade is
introduced as a ‘blond Satan’ (example taken from [Tourangeau 82]),
although the reader does not know any attributes of Spade besides the one
inherited from ‘is a person’, he can transfer from the metaphor a set of highly
salient attributes of ‘blond Satan’. Note that the combination of ‘blond’ with
‘Satan’ interacts here to promote the salience of certain attributes and to
lower that of others in order to select only the highly salient attributes to be
transferred: ‘dreadful appearance’ is lowered, and ‘seductive’ is promoted.

In conclusion, the improvement brought by Ortony’s theory is to
acknowledge that similarities are not so much recognized as constructed by
rules to fit the metaphor. The rule given by Ortony, i.e. the transfer from y
to x of highly salient attributes of y that are also of low salience for x is to be
understood much more as a general principle than as a precise rule. If we
view again Miller’s example ‘John’s wife is like his umbrella’, we argued that
such a statement could be understood both as a literal comparison (‘she is
very thin’) or as a simile (‘she is protective’). Ortony would certainly account for this distinction by attributing a higher salience to the attribute ‘protect’ of ‘umbrella’ than to the attribute ‘thin’. Thus, ratings of saliences can be generalized according to a categorization of attributes. The measure of salience becomes then a measure of priority of transfer among attributes that are therefore organized into a hierarchy of decreasing invariance through the transfer process, as developed below.

4.3 Hierarchization of Predicates Left Invariant

4.3.1 A Pilot Study

Categorization of attributes is usually done through psychological experiments. Fraser designed a pilot study to answer the question of zero-context meaning of metaphor [Fraser 79]. Subjects were asked to paraphrase metaphorical statements of the type ‘$x$ is $y$’, where $x$ was either ‘he’ or ‘she’, and where $y$ was taken from a list of things chosen as unsystematically as possible (‘compass’, ‘ripe banana’, ‘octopus’). The goal was to formalize any observed systematicity of interpretation. There was unfortunately no consistency of interpretation among the subjects. This simply points out the relativity of salience perception among people: one of the only consistent examples, ‘$x$ is a snail’ seems to indicate a universally high salience of ‘is-slow’. It is also notable that the $x$ was only vaguely structured (‘he’ or ‘she’) and the type of metaphoric operation involved was consequently mostly attribute introduction. More consistency would have probably been found if ‘predicate promotion’ had been favored through the use of $y$ referents highly structured by relations, such as ‘war’ or ‘disease’. However, a certain systematicity was found in the type of attributes preferably introduced. This
discovery was enabled by the very high importance of the attributes in the structure of the vehicles \( y \) chosen. They were all objects or animals. Such referents have very typical attributes. Experimentally, three categories of attributes emerged: physical attributes, behavioral attributes and functional attributes. For \( y \) taken as ‘a woodchuck’, Fraser obtained the following variations:

1. **Physical**: has buckteeth, is ugly, is fat, is hairy;

2. **Behavioral**: is industrious, is an introvert, is shy, eats continually, waddles, is always digging, is a careful eater, is plodding, is persistent;

3. **Functional**: None, but a possibility would be "predicts spring". [Fraser 79 p183]

Fraser does not rank, however, those three categories. It seems that salience increases from physical attributes to functional ones. This would confirm our interpretation of ‘John’s wife is like his umbrella’ as being more literal when the attribute ‘thin’ is transferred than when the attribute ‘protective’ is transferred. This affirmation of a predominance of salience of functional attributes is also supported by the current interest for purpose directed analogy in research about learning through analogical reasoning [Kedar-Cabelli 85], which emphasizes a characterization of objects by functional attributes. This claim is not contradicted by the fact that, in the specific example above, there is no interpretation for the functional category. There may not be such an attribute in the vehicle \( y \) domain, or it may not be applicable in the tenor \( x \) domain. In such a case, the next lower category of salience is tried. This hierarchy can be refined to become a more useful filter that successfully mediates the transfer of more complex structures than objects or animals.
4.3.2 Invariance Hierarchy to Map Complex Structures

Carbonell explored more extensively different kinds of predicates and especially the relation predicates such as causal links, goals, associated actions or plans [Carbonell 82]. This approach emphasizes the complex net structure of concepts which was a notion only potentially present in Ortony’s definition of attributes. The transfer problem consists here in transferring a substructure of a whole net, the source domain, i.e. the vehicle $y$, to a goal domain, i.e. the tenor $x$. In this transfer, Carbonell focuses on a very specific part, the part of the substructure that is left invariant through the transfer. Once again, this corresponds to an interpretation of the SIM relation as an equality. The regularity provided by the hierarchy has been observed through the analysis of 200 metaphors. This hierarchy of attributes is ordered in decreasing expectation of invariance, i.e. decreasing salience.

- 1. **Goals for animated actors:** goals are transferred invariantly. In chapter 5, we will support the intuition that the transfer of such a relation induces or creates a SIM relation between the agents involved. In the example ‘Inflation is a disease’, the goal predicate ‘to be cured’ is mapped invariantly and induces the similarity SIM(doctor,government).

- 2. **Planning strategies between subgoals:** the ordering of subgoals solving is invariant. If a marketing manager says ‘this advertising campaign will not be a Waterloo’, he means that he will not transfer the losing strategy of Waterloo. When we say ‘John is a fox’, we transfer a planning strategy attribute: ‘is-clever’.

- 3. **Causal structures:** in our ‘inflation is a disease’ example, the invariance of the causal link ‘to cure’ will also result in inducing a similarity: SIM(economic-measures,medicine). Scientific analogies abound in such preserved causal structures.

- 4. **Functional attributes:** if a director says ‘John is my right arm’, it implies that the valuable functional attribute of ‘right arm’ has been transferred to John.
5. *Temporal orderings*: planning sequences when transferred keep invariant their temporal ordering. An obvious example is 'Life is a journey'.

6. *Natural tendencies*: scientific analogy uses many natural tendencies. 'Heat is like water' will transfer the natural tendency of flowing from one recipient to another. 'John is a pig' transfers the natural tendency of pigs to get 'fat' or 'to eat'.

7. *Social roles*: agents are not always preserved. In 'inflation is a disease', 'doctor' and 'government' do not coincide perfectly, although the metaphor makes them similar; however, the social relation between 'doctor' and 'patient' is kept invariant as transferred between 'government' and 'citizen'. 'Citizens' will have to trust the 'omniscient doctor'.

8. *Structural relations*: in the solar system model of the atom, the formula involving an inverse square is kept. When saying 'Bulgaria is a satellite of Russia', such a formula is not kept but the directionality in a ratio of strength and attraction is kept. When a French author, Patrick Cauvin writes about a girl wearing thick lenses and braces: 'When she smiles, she was a real cadillac of the 50's', none of the objects is transferred invariantly, but the whole structure (relative places of the elements) is. Note that here too, the corresponding objects, although not transferred invariantly are put into a SIM relation that can be recursively proved (metaphorical shift): SIM(thick-lens,car-light) and SIM(braces,radiator-grid).

9. *Descriptive properties*: they are usually unlikely to be transferred. 'Bulgaria' though a 'satellite of Russia' is not made of iron. Vehicles taken from the animal kingdom will transfer physical properties. Some of these animals ultimately became symbols of a particular physical attribute. 'John is a giraffe' means he is very 'tall'. However, it does not imply that he has two horns. Inside each category, attributes have different saliences: being tall is more salient for giraffes than having horns.

10. *Object identity*: objects are almost never mapped to identical objects. In 'inflation is a disease', pills, scalpels and hospitals are
not transferred. One reason is certainly that sharing an object will bring two structures too close to each other to enable a successful metaphor.

For a metaphor out of any context, the transfer stops as soon as an entry in the hierarchy is found: if we transfer ‘dirty’ as the social role of pigs in the kingdom of animals, we will not transfer the lower attributes ‘is-pink’ and ‘has-curly-tail’. However, any attribute, whatever its salience, can be promoted and transferred according to its priority by being explicitly cited in the rest of the discourse. This promotion of salience is similar to the phenomenon observed with the sentence ‘His face is [red] like a beet’. Although scalpels are not transferred as identical in the metaphor ‘inflation is a disease’, they can be mapped through a SIM relation induced by the metaphor, like in the following two sentences: ‘Inflation is a cancer. Our new measures will be the scalpels that will cut it out’.

Through the invariance hierarchy, we clearly transcend the mere transfer of physical attributes. Transferring strategies or plans, makes metaphor a powerful tool that can map complex structures.

4.3.3 Mapping Structures and Scientific Analogies

The invariance hierarchy allows the characterization of the mapping structures in terms of richness, systematicity and abstractness. The richness of mapping structures can be judged by the number of predicates transferred, their systematicity by the degree of constraint imposed on the transferred predicates by the others, and their abstractness by the hierarchical level of the transferred predicates [Gentner 82].
Scientific analogies use such complex mapping structures. That scientific analogies are really metaphors can be argued: the transfer process for the scientific analogy 'Heat is like water' [Gentner 83b] operates on a much more complex representation of 'water' than the one needed for the metaphor 'your love is the water of my life'. Moreover, the transfer process in scientific analogy operates in an unknown target domain: the predicates mapped are mainly predictions or suggestions that need validation by further experiments. However, scientific analogies, like metaphors are emanation of analogical reasoning. Therefore, the study of such complex analogies, i.e. of complex transfers, can also provide the study of metaphor with precious insights. Gentner's studies on scientific analogies resulted in the two following principles

(a) Relations between objects, rather than attributes of objects, are mapped from base to target; and (b) The particular relations mapped are determined by *systematicity*, as defined by the existence of higher-order relations. [Gentner 83a p155]

These two principles are perfectly reflected into the hierarchy given by Carbonell: the higher the order of the predicate, the higher its chances to be transferred invariantly. Underlining the specific role played by relations among predicates is a most important step in the theory of metaphor. The transfer component must rely on such definite principles. To be further defined and implemented it also needs to be internally structured and to be incorporated into a general flow of control of the metaphorical process.
4.4 A General Flow of Control

The flow of control sketched out here is taken from Carbonell and incorporates a transfer component designated as 'A Transfer Mapping, analogous to Winston's Transfer Frames' [Carbonell 82 p417]. This transfer mapping is described now and provides us with an internal structure to be given to the transfer process.

4.4.1 Creating Transfer Frames

Winston's study tends more to the side of machine learning than to a strict study of metaphor [Winston 78]. However, because of its generality, it gives guidelines to incorporate the principles of transfer described above in a general framework. The transfer is conveyed from source to destination by a structure of knowledge built from both the vehicle and the tenor: the transfer frame. The transfer frame encodes the knowledge contained in the set of attributes of \( x \) transferred from \( y \) according to the principles described above. The mechanism of transfer includes the previously mentioned two steps, elaboration and evaluation, which are in Winston's terminology 'hypothesizing' and 'filtering'. The two components are clearly separated in this framework, although they both rely on the same mechanism. To the principles already seen, this mechanism adds the analysis of information contained in the comparison of the referents with their immediate relatives. Winston's methodology does not explicitly give values of salience to the attributes, but rather gives a hierarchy of methods to infer the importance of these attributes. Before detailing this mechanism further, we must concentrate first on the representation of this information to be transferred.

Knowledge about the two domains or referents can be represented
by the means of frames. The slot value combination allows the encoding of the attribute names of the referents and their value. Values can themselves be pointers to other frames. Examples of such entries for the frame 'fox' are: (CLEVERNESS VERY-HIGH), (COLOR RED) and (ISA SMALL-MAMMAL). A third element can be added to these pairs to encode the salience of the slot, so that the principle given above can be incorporated in Winston's work.

The first step of the transfer is elaboration (hypothesizing). Slots are collected according to a hierarchy of methods, like a pile of filters of increasing resolutions. First, slots are collected with values such as VERY-LOW or VERY-HIGH. This is a means of detecting high salience of attributes relative to other related concepts. A second method of detecting high salience is to look for slots which are described by a frame which itself contains the value VERY-HIGH for the slot IMPORTANCE. For example the slot PURPOSE of a frame can be described by a frame classifying it as an instance (ISA) of a FUNCTIONAL-PROPERTY of VERY-HIGH (slot value) IMPORTANCE (slot name). By this means, the salience of slots according to global knowledge is computed. The two last methods for detecting high salience are ways to find high salience of slots with respect to sibling frames: high salience can be achieved if a slot is present that no other sibling has, or if a slot is filled with a value that no other sibling has. The principles we saw above can also be incorporated into this hierarchy of methods. Winston's approach is to be viewed as a search for a general flow of control in the process of transfer. Finally the slots are gathered into candidate transfer frames.

The second step of the transfer is the evaluation or filtering. The process follows the same schema as for the first step: successive filtering
according to a hierarchy of methods. Three methods are proposed. First, keep slots that are also present in the typical instance of the tenor. This corresponds to the perfect match of SIM. Second, keep slots that siblings of the tenor have. This is a use of knowledge to ‘introduce’ slots that are not present, but are, however, ‘natural’. Third, if a transfer has already occurred between the vehicle and the tenor, keep slots belonging to the same group as the ones already transferred. This third method includes a learning component in the comprehension process that would need further consideration.

This flow of control is summarized in figure 4-1 [Winston 78 p357] It gives us a general guidance in the design of a comprehension component of metaphor. It emphasizes the attribute (slot) introduction property of metaphor, since this property focuses on a transfer of knowledge. Although the example given by Winston is excessively simple, the addition of saliences and the invariance hierarchy in that schema should provide an effective algorithm.

4.4.2 Schema for a General Process of Metaphors

The computational model described [Carbonell 80] applies only to a class of metaphor: metaphors issued from a kernel of about 50 general metaphors common to our culture, such as ‘more is up’, ‘less is down’, ‘theories are buildings’ [Lakoff 80]. The mapping structures associated with these general metaphors are part of the knowledge base. Therefore, the schema given stays valid for novel metaphors, provided that an efficient algorithm is designed to compute completely new mapping structures.

By using a small set of pre-encoded general metaphors, Carbonell
Figure 4-1: Flow of Control

moved the process of metaphors from a reconstruction to a more efficient and easy recognition task. Because most of the metaphors encountered in a text
are instances of conventional metaphors, this approach is justified. Knowledge about the general metaphors consists in codifying the four following components:

• 1. a recognition network: information to recognize a metaphor as an instance of a general metaphorical theme (e.g. a discrimination network).

• 2. a basic mapping: the mapping structure associated with the general metaphor that will be inherited for any instantiation of the general metaphor. For example, ‘more is up’ encodes an increase of quantity for the entity ‘going up’.

• 3. an implicit-intention component: encodes the reasons why a specific metaphor is used and therefore adds information about the referents involved in the metaphor. ‘Love is a madness’ implies impulsive or uncharacteristic behavior from the lovers.

• 4. a transfer mapping: a transfer frame component a la Winston to determine the supplementary mapping to be added to the basic mapping, depending on the different possible instantiations. For example ‘Prices are soaring’ adds to the basic mapping of ‘more is up’ the additional mapping of ‘high’ and ‘fast’.

This encoded knowledge is then used by a metaphoric process conceived as a recognition task involving six steps:

• 1. Recognition of a metaphor occurring as a semantic case-constraint violation. This criterion is not universal (e.g. ‘My love is a tree’) but covers most of the instantiations of general metaphors.

• 2. Recognize the general metaphor of which the processed metaphor is an instance using a discrimination network.

• 3. Use the associated basic mapping to construct the mapping structure of the processed metaphor.
• 4. Complete this mapping structure with the information given by the transfer mapping process.

• 5. Add the information provided by the implicit-intention component.

• 6. Remember the processed instantiation of the general metaphor and the transfer mapping built since it can be used as a basis for further elaboration by another metaphor.

This schema can be further elaborated in the two following directions. First, a strong transfer process should allow new metaphors to be processed and then incorporated in the knowledge base. This suggests a second direction of research: incorporating a learning component. Such a component can intervene at two levels: when recognizing the metaphor as an instance of a general metaphor and when constructing the mapping transfer. At the instantiation step, recognition rules can be built from the examples processed. Typical instantiations can also be used to build a hierarchy of often-encountered mappings. In the mapping transfer, all the examples of mappings issued from the different instances of a same general metaphor can be generalized to give a basic invariant mapping. In the next chapter, we will show that the set of conventional metaphors can be structured by a taxonomy that allows a powerful inheritance of mapping structures and grounds the possibility of metaphorical shift and the resulting creativity.

4.5 Conclusions

Two points need to be stressed from the preceding. First, by exploring a transfer component, we asserted an effective computation of a meaning of metaphor out of any context. This ‘root’ of metaphor is a mapping structure consisting of similar predicates taken from the two
referents and put into a SIM relation. These similarities are mostly perfect matches, although enough room was left in the theory to extend the sense of the SIM relation. It is therefore our claim that there is always a 'default meaning' of metaphor. We do not object to the fact that put back into context a metaphor can be followed by any sentence focused on any feature of the vehicle \( y \), whatever its salience. We want to emphasize that, although this following may or may not help in selecting transferred attributes, the meaning of a metaphor as a 'root' exists independently of this following. For example, when saying 'Spock is [as clever as] a fox. He even has pointed ears', we certainly do not want to restrict the meaning of the metaphor Spock/fox to the sharing of the attribute 'has-pointed-ears'. That persons are inconsistent in the interpretation of the same metaphor, or may fail to perceive similarities is not an objection either as long as each person is consistent in their process. Computing the 'root' of the metaphor gives a set of discovered similarities that may structure the rest of the discourse; reciprocally, inferences from the rest of the text can help select predicates to transfer by raising their salience.

The second point to be stressed is the priority of invariance given to the relations in the transfer. It seems insightful to note here that the invariant transfer of such relations often results in an induced or created similarity between the corresponding arguments of the relation. Gentner gives the example of A. E. Housman's comparison 'I could no more define poetry than a terrier can define a rat' and rejects the possibility of intended inferences such as 'a poet is like a terrier' and 'poetry is like a rat' [Gentner 83a p182]. On the contrary, we assert that if the referents 'terrier' and 'rat' have been chosen, and not any pair \( x, y \) such as CANNOT-DEFINE(\( x, y \)), it is not only because other relations can also be transferred, but because this
comparison induces a metaphorical shift SIM(poet,terrier) and SIM(poetry,rat) that can be recursively grounded given an adequate taxonomy of existing metaphorical themes.

These two points correspond to the two moves of metaphorical process given in chapter 3. First, a 'root' is constructed through a depth motion that discovers encoded similarities. Then, this root is extended through a breadth motion that creates similarities between the elements mapped by the root. The following verse by Verlaine exemplifies these two moves:

Votre ame est un paysage choisi
Que vont charmant masques et bergamasques
Jouant du luth et dansant et quasi
Tristes sous leurs deguisements fantasques¹.
Your soul's a landscape infinitely rare
Which masqueraders charm with roundelay
Of flutes and dancing, while a half-sad air
Shows through the odd disguises of their play².

Although the second referent of the metaphor is here unusually long (actually the eight following verses are still its continuation), what we call 'root' here is: SIM(soul,landscape), a similarity preencoded as one of the favorite metaphorical themes of the French romanticism³. The breadth motion consists in the creation of similarities guided by the following verse and grounded by the metaphorical theme. It is this ability to induce similarities through metaphorical shifts which will now be explored.

¹From Clair de Lune in Les Fetes Galantes.


³cf. Baudelaire's verse 'Vous etes un beau ciel d'automne, clair et rose!' translated by Richard Howard as 'Fresh as an autumn morning you may be'.
Chapter 5

... And Other Similarities Are Created

5.1 Why Expand the SIM Relation?

In the preceding chapters we detailed a theory of metaphorical meaning related to comparison views. The meaning of a metaphor is generated from a set of transferred predicates SIM(pred1,pred2), where ‘pred1’ is a predicate of the tenor and ‘pred2’ a predicate of the vehicle. Chapter 4 detailed this transfer, i.e. the construction of a ‘root’ of the metaphor. This chapter focuses on the SIM relation. By broadening the notion of similarity, classical criticisms of the comparison view are answered, while allowing the notion of creative insight raised by the interaction view.

Criticisms of views based on similarity are of two kinds. The first one attacks only the crudest comparison views that simply reduce metaphors to similes. Such surface attacks (see [Searle 79]) are avoided in the framework developed since analogical reasoning was carefully used as an underlying strategy and not as a component of meaning. We do not reduce metaphors to simile, but propose a theory that makes both of them distinct emanations of the same kind of thought.

A second more pernicious criticism questions the existence of similarity underlying metaphors and therefore challenges the use of analogical reasoning. However, provided SIM is not intended as a strict equality,
apparent examples challenging similarity can be accounted for. Challenging
examples are examples of metaphors not based on similarity, either because
they are based on dissimilarities, or because they do not rely on any similarity
or dissimilarity at all. It seems impossible and contradictory to the very
nature of metaphor to find examples of metaphors where the resulting
meaning consists only in enlightening a dissimilarity. At least a similarity
needs to be transferred. Consequently, examples can be constructed by
explicitly constructing the dissimilarity. Such examples are: ‘a horse is a
zebra without stripes’, ‘she is a rose without thorns’, ‘fool is an endless
maze’. It is not possible in these examples to simply delete the attributes
‘stripe’, ‘thorn’, ‘end’ from the representation of the vehicle and then operate
a regular transfer. For by deletion of the attribute, we would remove the
information given by the very deletion of the attribute. Since this information
is a ‘negation’, what must be transferred is this negation. Our account allows
us to do that. If the negated attribute is not directly transferable1, transfer
the attribute unnegated to a similar attribute in the tenor. That is, transfer
‘has-thorn’ into ‘is-protected’. Only then, transfer the negation and negate the
transferred attribute: negation of ‘is-protected’ gives ‘unprotected’. Consequeantly, dissimilarities can be successfully transferred in this framework,
provided an adequate account of the SIM relation.

More challenging is the case of metaphors apparently not based on
similarity, that is actually, not based on strict literal similarity. The most
used example is from Searle ‘Sally is a block of ice’ [Searle 79]. There is no
literal similarity between ‘cold’ and ‘unemotive’, the two attributes to be
paired by SIM. A first solution consists in encoding the similarity

1If it is directly transferable, then we obviously transfer or introduce it. It is the case with
‘horse’, since a horse has the attribute ‘no-stripe’.
SIM(unemotive,cold). We will incorporate this possibility by describing a coherent structure of preexisting similarities. A second solution consists in saying that the similarity between ‘cold’ and ‘unemotive’ is itself metaphorical and can be ultimately reduced to something like ‘they both emit low-wave radiations’. This possibility of a recursive process of metaphor is very powerful and will be incorporated in the metaphoric process under the name of metaphorical shift. Of course, metaphorical shift can be valid only if base cases for the recursion, i.e. encoding of pre-existing similarities is provided (the first solution).

We will conclude that the above account withstands attacks against the notion of similarity, provided SIM is extended in two directions. First, a system of basic metaphors must be provided to encode preexisting similarities. Second, metaphorical shift must be allowed and, to avoid circularity must be grounded on the structure given to this system of basic metaphors. An important consequence of metaphorical shift is that it allows the creation of similarities by metaphor. Consequently, to show how this creativity view is allowed in the present framework, it will be compared to Black’s theory of interaction [Black 62]. As a result, it appears that the structure given to the system of basic metaphors is a vital element for both metaphorical shifts and creativity. This structure results from a taxonomy which is an extension of Lakoff’s and Johnson’s work [Lakoff 80]. Finally, it is shown that creativity can be formalized in the structured set of metaphors that can be dynamically enriched by the encoding of newly created metaphors processed.
5.2 Interaction View: a Framework Allowing Creativity and Metaphorical Shift

Max Black's theory is described here, since it is traditionally associated with the notion of similarity created by metaphor. As Black vigorously rejects comparison views such as the one detailed earlier, it is critical, in order to broaden the SIM relation validly, to see more accurately if Black's position really excludes comparison views. If not, Black's study will highlight the expansions needed. His notion of metaphorical shift and his obscurities about creativity will, at least be a start forcing us to develop a precise and coherent structure organizing metaphorical themes that grounds metaphorical shifts and creativity.

5.2.1 Interaction View Versus Comparison View

Black's theory starts on the following controversial quote: 'It would be more illuminating in some of these cases to say that the metaphor creates the similarity than to say that it formulates some similarity antecedently existing' [Black 62 p37]. To account for this creation, Black proposes an interaction view, that he opposes to comparison views. His theory is developed around the earlier statement by Richards:

In the simplest formulation when we use a metaphor we have two thoughts of different things active together and supported by a single word, or phrase, whose meaning is a resultant of their interaction. [Richards 36 p93]

Black's theory elaborates this quote with five claims. To challenge the comparison view we espoused, each of these five claims is examined and answered in 'comparison view' terms.
• **Claim 1**: a metaphorical statement involves a *focus*, i.e. words used non-literally, and a surrounding literal *frame*.

• **Answer 1**: we claimed that all metaphorical statements can be reconstructed as ‘*x* is *y*’. Nominative metaphors ‘*x* is *y*’ obviously are so; predicative metaphors ‘*G(x)*’ are *satellites* of an ‘*x* is *y*’, where *y* is reconstructed from *G* (see chapter 3). The terms tenor and vehicle were adopted instead of focus and frame. The tenor is used nonliterally only in the sense that its representation changed through the promotion or introduction of predicates from the frame. The frame is literal since no attributes are introduced in it.

• **Claim 2**: the frame is to be seen as a ‘system of things’ rather than a ‘thing’.

• **Answer 2**: defining attributes of an object as any component structuring this object enforces such a claim. The hierarchization given by Carbonell (Chapter 4) categorizes the attributes into precise components of highly structured nets: goals, causal links and so on. Accordingly, the frame is here also seen as a structure that imposes its coherence on the focus through a detailed transfer (temporal orderings, strategies).

• **Claim 3**: the meaning of metaphor arises from the projection upon the focus of ‘a set of “associated implications” comprised in the implicative complex, that are predicable of the secondary subject’. This notion of implicative complex replaces in Black’s second paper [Black 79] the set of ‘commonplaces and associated implications’ of the first paper [Black 62], but without any further justification.

• **Answer 3**: what is here just called ‘projection’ has been detailed as a transfer and filtering of attributes guided by principles and rules in chapter 4.

• **Claim 4**: the projection results in selecting, emphasizing, suppressing and organizing features of the focus ‘by applying to it statements isomorphic’ with the elements of the implicative complex.
- **Answer 4**: This is an exact description of the two components of the transfer problem: introducing and promoting attributes. 'Isomorphic' is just another way to say 'similar'.

- **Claim 5**: the interaction between the referents results from (a) the focus imposes on the frame a selection of properties, (b) from these properties, a parallel 'implication complex' is built to fit the focus, (c) through this construction parallel changes are conducted in the frame.

- **Answer 5**: since interaction is the 'new' element brought up by Black, it is interesting to see that our account had already incorporated it. Ortony's rule accounted for (a) since only highly salient attributes of the frame corresponding to lowly salient attributes of the focus are transferred. (b) corresponds to the flow of control we detailed in chapter 4. 'parallel' and 'to fit' are just Black's efforts not to say 'similarities' or 'analogical model'. Concerning (c), we do not think that any fundamental change occurs in the frame, since the transfer of structures goes from frame to focus. However, through extensive use of a metaphor, a frame can be modified to enter the metaphorical meaning of a focus: for example, a new entry can by added to 'cold' designating 'unemotive'.

Accordingly, an interaction view can be largely accounted for in terms of a comparison view. Moreover, Black himself, in his reformulation of interaction view [Black 79] reconsiders fundamentally the possibility of analogy and sounds then surprisingly close to the comparison view he initially rejected. Black finally agrees to see the implicative model as an analogical model for the vehicle, which is the crux of our account.

However, Black's temporary disdain for analogy is not fruitless: it gives a new direction to broaden our SIM relation: *metaphorical shift*. By comparing the reformulation of interaction with the initial proposal, what was abandoned by Black can be saved: allowing attributes to be metaphorically
similar and not requiring a literal match, and accounting for the creativity it entails.

5.2.2 Metaphorical Shift Broadens the SIM Relation

The importance of metaphorical shift was almost nullified by Black as he came closer to a comparison view. The goal is to show what is exactly necessary to incorporate in our view, without any conflict, metaphorical shift and the insight of creativity allowed by a broadening of the SIM relation.

The SIM relation so far applies to predicates that perfectly match. We want to extend it to attributes that are 'metaphorically' similar. Consequently, the metaphorical process is allowed to be recursively applied on the predicates. But circularity also needs to be avoided. Therefore, to be valid, such an approach needs to provide a set of terminal cases, i.e. similarities that are pre-encoded and that are perceived similarities, such as SIM(unemotive,cold). The similarities recursively computed rarely involve more than one level of recursion. They encode similarities that exist only with respect to a main superordinate metaphor. Consequently, we can say that these similarities are induced or even created by the main metaphor. Let's take the example 'man is a wolf'. Among other attributes, the transfer of the attribute 'hungry' is a metaphorical shift since the hunger of wolves and the 'hunger' of humans, i.e. their ambition, are only metaphorically similar (a similarity induced by the main metaphor). Accordingly, we recursively process the satellite metaphor 'a man's ambition is a wolf's hunger'. It is then reduced to a 'root' of shared attributes 'unsatisfied', 'driven'. Most of the metaphorical shifts will, however, be based on conventional existing metaphors: in French 'a man's hunger is a wolf's hunger' is part of the
cultural existing metaphors since it appears in idioms such a ‘j’ai une faim de loup’ (I have a wolf’s hunger).

As mentioned, creativity results from the possibility of metaphorical shifts. A main metaphor induces similarities. There is no preexisting similarity between ‘memories’ and ‘ashes’. However, these two attributes can be put into a created SIM relation induced by a superordinate metaphor. Let us consider the following example: ‘le vieil homme, plus que jamais semblable a un foyer etouffè par les cendres, etait enfoui dans son passe’ (the old man, more than ever resembling a fire snuffed out by ashes, was embroiled in his past). Knowing that ‘old man’ refers to an old genius writer, we have the main metaphorical theme ‘a genius is a fire’, i.e. SIM(genius,fire), which recursively induces SIM(memories,ashes), through the transfer of SIM(smother,snuff-out), itself grounded on attributes shared.

In conclusion, the notion of metaphorical shift is the very notion that enables incorporating the creation of similarity in our view. However, to anchor such a view, circularity must be avoided and a set of terminal base cases for induced similarities must be provided. To do so, the structure to be given to this set of preexisting metaphors will be examined. This will in turn demonstrate how this structure precisely allows the creation of novel metaphors and similarities through a dynamic process of encoding similarities.

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2Jean D’Ormesson: *Mon Dernier Reve Sera pour Vous*. 
5.3 A Basic Set of Conventional Metaphors Structures our Conceptual World

The notion of a basic set of 'similarities' perceived is justified by the need to have a final case in the recursion induced by metaphorical shifts. A 'pool' of such similarities, i.e. a simple list of terminal cases of the form SIM(unemotive,cold) would be too limited. Accordingly we will detail a structuring of this basic set, taken from [Lakoff 80], coherent enough to allow a dynamic encoding of new similarities created through new metaphors.

While studying the transfer of attributes between the referents, a top-down approach was employed, from the referents to the similarities between attributes. Adopted here is a bottom-up approach: starting from basic metaphors, i.e. encoded perceived similarities between attributes, more and more elaborate and creative metaphors will be built using these basic metaphors as a basis. That is, the succeeding metaphors will inherit more and more detailed mapping structures from the superordinate metaphors of the defined taxonomy. Accordingly, a hierarchy of metaphorical themes 'x is y': orientational, ontological and structural metaphorical themes, can be defined [Lakoff 80]. The coherence of this hierarchy is enforced by the increasing complexity of associated mapping structures. From orientational metaphors to structural metaphors, the vehicle y imposes or 'projects' upon the tenor x an increasing coherence or structuring.

By structuring fuzzy undelineated concepts in terms of better defined concepts, we assume that some concepts are primary concepts which are directly emergent. This affirmation needs to be validated by grounding the proposed system in our perceptual world. This last step will confirm our position; these three points, the hierarchy of the system, the increasing
coherence imposed on our conceptual world, and the grounding of the system firmly assert a framework that allows both metaphorical shift and the creation of similarities.

5.3.1 Classes of Metaphorical Themes

Three classes of a hierarchy of metaphorical themes are defined here: orientational, ontological and structural metaphorical themes [Lakoff 80], to which a fourth class, novel metaphorical themes, will be adjoined. The hierarchization of these four classes and the coherence implied will be studied in the following section.

Metaphorical theme designates here the generic metaphoric statement ‘x is y’, where x is the tenor and y the vehicle. From such a theme, various different metaphorical realizations of the theme can occur. The metaphorical thought symbolized by ‘x is y’, or better ‘see x as a y’, can affect the syntactic surface in various realizations. Predicative metaphors involve combinations of predicates of a referent with arguments taken from the other referent. For example, the metaphorical theme ‘flamme = passion’ (flame = passion) induces in classical French ‘satellite metaphors’ such as: bruler de passion (to burn with passion), se consumer d’amour (to consume oneself with love), les cendres de l’amour (the ashes of love) and so on. Note that the similarities in the satellite metaphors are induced by the metaphoric theme: SIM(dead-love,ashes) is a similarity that is perceived or created only with respect to the metaphorical theme. What we point out here is that it is the very structure of the hierarchy that will allow such similarities to be created. Associated with the metaphorical theme is the corresponding mapping structure. In the next section, by imposing a taxonomy on the metaphorical themes, it will enable mapping structures to be inherited.
In the following, the term of metaphor is often used instead of metaphorical theme, unless it is ambiguous to do so\(^3\). Definitions and examples for each of the four classes are now given.

**Oriental orientations**: the vehicle \(y\) is one of the following polar adjectives: up-down, in-out, front-back, on-off, deep-shallow, central-peripheral. An extensive number of examples of metaphors built from the pair up-down are given by Lakoff [Lakoff 80 p 15]: happy is up (that boosted my spirit); sad is down (I fell into a depression); virtue is up (she is upright); depravity is down (that was a low trick). Examples for uses of front-back can be found in our western conceptualization of time: future is in front (the weeks ahead of us); past is behind (look back at your childhood To this set, we would personally join any other polar adjectives that allow structuring concepts on a scale, since the similarity seen between the two scales is only perceived and must be preexisting: unemotive is cold; emotive is hot; cold is blue; hot is red (see the water taps!); transparent is understandable; opaque is not; feminine is soft; masculine is tough. By this means we do not confine orientation to only spatial orientations, but to any orientation of scale. Note that the vehicles can be permuted (internal coherence) as long as the dominant orientation is respected: for example, emotive is transparent; unemotive is opaque (his emotions are transparent).

**Ontological metaphors**: the vehicles \(y\) are chosen from entities and substances: e.g. entity, container-objects, container-substance or personification [Lakoff 80]. The \(x\) that can be conceptualized in terms of \(y\)

\(^3\)As we go down the taxonomy of metaphorical themes, the 'theme' tends to become a mere 'metaphor' i.e. the number of possible syntactic realizations of the theme decreases to be finally reduced to the 'theme', or a match of attributes: compare 'Theories are buildings', 'relativity is a cathedral', 'inferencing is mortar'.
are: events, activities, emotions, ideas or states of mind. Such metaphorical themes result in syntactic realizations such as prepositions that Lakoff and Johnson reactively see as metaphorical: 'Activity is a substance' sustain 'he is immersed in washing the windows right now'.

Structural metaphors: these result from ontological metaphors since most vehicles for metaphors are instances of objects, entities, substances or persons. However, some vehicles can be abstract concepts such as 'war'. In any case, the vehicle must be more structured than the tenor, since structural metaphors structure the tenor along the vehicle through the transfer we studied. Orientational and ontological metaphors organize whole systems of concepts, whereas structural metaphors structure one concept in terms of another. The vital point here is the claim of the existence of a basic set of metaphorical themes common to a culture. Lakoff and Johnson list more than 25 examples [Lakoff 80 p45]: theories are buildings (your argument collapsed), ideas are plants (plant that idea in your mind), love is a physical source (his whole life revolves around her) and so on.

What is vital here in that hierarchy is the very point that motivated the study: the metaphorical theme creates the similarities. There is no similarity a priori between 'theories' and 'buildings', i.e. there is no physical, literal similarity between the two referents. On the contrary, our culture created a similarity between the two, makes us see theories as buildings, and allows the sharing of predicates: accordingly we build theories and we also build buildings. When we understand a metaphor through the transfer process, we 'rediscover' the sharing of the attribute 'buildable', i.e. perceive the similarity that was originally created.
Novel metaphorical themes: it seems necessary to add this new category to designate new and understandable associations of referents, which are therefore not yet part of our culture. Novel metaphorical themes are not to be confused with new metaphors: 'classical theories are patriarchs' is a new metaphorical theme, but 'relativity theory is a cathedral' is a new metaphor satellite of an old metaphorical theme, i.e. 'theories are buildings'.

These four types of metaphorical themes form a coherent system. This coherence is further reflected in our conceptualization of the world and in the grounding of the system.

5.3.2 Metaphorical Themes Form a Coherent System

Although Lakoff and Johnson do not give any precise structuring, a structure can be given to the set of conventional metaphors, and that also leaves a place to novel metaphors. The proposed structure is sustained by a taxonomy inherent to nouns such as the categorization in natural categories described in chapter 2 [Rosch 77]. Since metaphorical themes have a format 'x is y', a taxonomy of the y's results in a structuring of the metaphorical themes and their mapping structures. Therefore, conceptual networks of the referents, mapping structures and metaphorical themes are part of a single network. The resulting structure looks like a solar system. An example of this structure is given in figure 5-1.

The stars in the solar system correspond to the upper level of the taxonomy, i.e. the y referents of ontological metaphors: entity, containers-objects, container-substances, persons and so on. Around each of these stars revolves planets, i.e. subordinate categories: building ISA container-object, consequently 'theories are buildings' revolves around 'ideas are objects'. This second layer corresponds to structural metaphors.
Each planet, i.e. each structural metaphorical theme has numerous satellites. Each of these corresponds to a specialization along an IS-A-KIND-OF link of the taxonomy. Around the planet ‘theories are buildings’ is the satellite ‘relativity is a cathedral’. Note that either of the two referents can be specialized. If the tenor \( x \) is specialized (‘relativity’ ISA ‘theory’) the mapping structure of the planet is merely inherited. If the vehicle \( y \) is specialized (‘Cathedral’ ISA ‘building’) we obtain a new metaphor (see below). Note also that the more we specialize along the taxonomy, the more metaphorical themes tend to be precise and converge to mere nominal metaphors: for example, from ‘theories are buildings’ we specialize until ‘axioms are bricks and inferencing is mortar’. Ultimately, we reach the level of attributes, and the corresponding satellite metaphors ‘axioms are bricks’ are actually our SIM relation: \( \text{SIM}(\text{axiom},\text{brick}) \). This particularly enlightens how the similarity between ‘axiom’ and ‘bricks’, i.e. a metaphorical shift between attributes, has been created through the planet metaphor. Consequently, the SIM relation is the base recursive step that cements the whole structure. This places in our structure orientational metaphors since they encode similarities such as \( \text{SIM}(\text{better},\text{up}) \).

To conclude, ontological metaphors organize structural metaphors through a taxonomy of the referents, and orientational metaphors are the base layer of this recursive structure.

In this schema, we still have to place novel metaphors and novel metaphorical themes. New metaphorical themes, i.e. new associations of referents can theoretically appear any place in the structure. However, they tend to be more rare in ontological metaphors: radical changes in our spatialization of the world, unless ubiquity or travel in time become part of
our culture, are rare. Novel ontological metaphors correspond to new ways of perceiving fundamental entities, and correspond therefore to radical turns in philosophical history: for example, seeing time as a dashed line instead of a continuous line (Descartes), seeing the center of our system as the sun instead of the earth or improvement of surgery which saw the ‘container’ of the feelings move from the liver (Greeks) to the heart (romantics) and the brain (scientists).

Novel structural metaphors are the more current. We distinguish three kinds of creation of novel metaphors corresponding to three different levels in the planetary system of structural metaphors.

- 1. Creation of a planet: ‘classical theories are patriarchs’ in ‘classical theories are patriarchs who father many child, most of whom fight’ [Lakoff 80].

- 2. Creation of a satellite by exploring the conceptual net of the planet: from ‘theories are buildings’ use ‘rooms’ and ‘corridors’ (‘his theory has thousands of little rooms and long, winding corridors’ [Lakoff 80]). Satellites of an existing satellite can also be created by extending the associated mapping structure: from ‘the walls of his theory’ build ‘these facts are the bricks and mortar of his theory’. Along this extension move, the number of metaphorical shifts (and therefore of created satellite metaphors) tends to decrease and to become a mere preexisting SIM between attributes (e.g. both ‘mortar’ and ‘facts’ make coherent a theory or building).

- 3. Creation by ISA specialization: ‘Cathedral’ is a ‘building’. Therefore a new metaphor is built from ‘theories are buildings’. The salient part of the mapping structure is here the one that is not inherited, i.e. what is new about the ISA vehicle. For example, if we specialize ‘Cathedral’ into ‘Reims cathedral’, the salient fact is that this cathedral is missing one of its towers. The similarity with ‘tower’ is inherited from ‘theories are cathedrals’ and then negated.
If we recall our notion of a 'root' of a metaphor, i.e. a set of preexisting similarities, or what Lakoff calls 'the used part of a metaphor', we see that the creations of satellite and sub-satellite correspond respectively to instances of unused part of the existing similarities (but not 'seen' yet) such as 'rooms' or 'corridors', or to extensions of a used part such as 'bricks' and 'mortar' that extend the classically used 'wall'. This creation of new metaphors can be outlined by the following algorithm (see also figure 5-1):

1. Given a vehicle, find its relation to the main referent: for example given 'cement', find 'what holds the bricks together'.

2. Transfer this relation invariantly: in the 'theory' domain, 'inferencing holds the axioms together'.

3. Induce metaphorical shifts between the corresponding arguments: SIM(inferencing,cement) and SIM(axioms,bricks).

4. Use the transfer process to check the induced similarities (satellites metaphor) and enrich the mapping structure: in this example there is no further grounding besides the sharing of the relation 'hold-together'.

Step 2 is particularly important and corresponds intuitively with the way we force the interpretation of a metaphor and always try to make sense of it. Given 'What could be designated by the gargoyles of a theory?', somebody answered: 'Gargoyles are useless and ugly things put by architects to frighten demons, therefore gargoyles designate useless details that the writer puts there to frighten his readers!'. In figure 5-1, new similarities can be created in the example 'the theorist plastered the cracks of his theory'. The similarity induced by the metaphorical shift SIM(weakness,crack) can here be further checked by the transfer process: both 'weakness' and 'crack' challenge the stability of the theory-building, and occur in the frame.
Figure 5-1: Example of Structuring of Metaphorical Themes

Figure 5-1 shows an example of the structure given to the
metaphorical themes represented as ovoids: 'Ideas are objects', 'theories are buildings', 'relativity is a cathedral' (not yet created), 'theorists are builders', 'theorists are masons' (already created). The predicates in full ovoids can be applied to both referents. The encoded structure is then a powerful tool of recognition: 'the theory collapsed', 'the remains of the theory', 'the theorist is a mason who constructed shaky foundations', 'axioms are part of the frame' can be here recognized. Predicates in isolated right halves only apply to the vehicle; and predicates in isolated left halves only apply to the tenor.

The coherence of the system of metaphorical themes then, was presented as organized into a solar system. Another element of the coherence of this system is provided by the increasing coherence it gives to our conceptual world.

5.3.3 A Coherent System that Makes Our Conceptual World Coherent

The coherence of the system studied above resulted mainly from the taxonomy provided for the y vehicles. These vehicles project their structure on the x tenors by the means of associated mapping structures: they make our abstract world, i.e. the tenors more coherent. Since the taxonomy of the vehicles orders them by increasing complexity of structure (e.g. from 'building' to 'Reims cathedral'), the complexity of the associated mapping structure is also increasing. It will be shown that this increase of complexity corresponds to our hierarchization from orientational metaphors to structural metaphors. That is, the coherence or structure imposed on the tenor by the vehicle increases from orientational metaphors to structural metaphors with the increasing complexity of the associated mapping structures. This increase confirms the coherence of the system of metaphorical themes.
Orientational metaphors have only an exterior effect on \( x \) referents. They do not structure them internally, but give them a general orientation, common to a whole class of \( x \)'s: ‘happy’, ‘health’, ‘more’, ‘good’ are seen as ‘up’, whereas their converses are seen as ‘down’. An overall systematicity emerges here, since ‘general well being’ is ‘up’.

Ontological metaphors also allow one to handle concepts from the outside. Because they are abstract, undelineated and fuzzy concepts, seeing them as physical objects allows one to manipulate them as such. Categorizing, grouping, quantifying, referring and identifying are operations made possible by this transfer of coherence from physical to abstract world.

Structural metaphors get their name from the ability of the vehicle to structure the tenor. A vehicle is structured in a complex net structure [Carbonell 82] and part of this structure is transferred (chapter 4) on the tenor that is organized according to the mapped structure. The same tenor can be organized by different vehicles, which results in different ways of seeing the same concept: compare ‘life is a journey’ with ‘life is a story told by an idiot’. Through the transfer of structure, we understand the less structured in terms of the more structured, just like ontological metaphors impose the coherence of the physical world on abstract concepts.

The system of metaphorical themes then, is a whole that is internally coherent, but that also imposes its coherence on the conceptual world. By structuring it, it both imposes and creates ways of seeing: it encodes existing similarities but also allows others to be created. But before examining more precisely how its structure enables this creativity, our structured system needs to be validated by being grounded in the physical world.
5.3.4 The Grounding of the System

We just saw that some concepts (tenor) are structured and understood in terms of others (vehicle). Accordingly, we may wonder if there are concepts (y vehicles) that are understood directly. Such concepts will be defined as directly emergent from our physical experience. Here again, it will be shown that the coherence of the system is reflected in this grounding. Ranging from orientational to structural metaphors, vehicles emerge from experience that is less and less physical and more and more cultural. Orientational metaphors emerge from our purely physical experience, ontological metaphors from mixed experiences and structural metaphors emerge from entirely cultural experiences.

Vehicles of orientational metaphors emerge directly from our physical experience. Up-down, in-out or warm-hot are concepts directly emerging from our spatial and sensory experiences. Consequently, these concepts are named ([Lakoff 80]) emergent concepts and the corresponding metaphors, emergent metaphors. The association of the two referents into a metaphorical theme is itself grounded on direct experience. ‘More is up’ is correlated to the increase of level of a pile to which more substance is added. By directly encoding SIM(better,up), we package series of inferences that have been forgotten. The basis of the encoded similarity may, in certain cases, be unpacked: Victorian people, by covering the ‘legs’ of tables with clothes were doing so by resurrecting the grounding of SIM(leg-table,leg) and transferring their highly salient attribute ‘indecent’!

Ontological metaphors are also directly emergent, since objects, substances or containers correspond to our physical experience with the world and, therefore, are directly emergent concepts. However, no physical
experience can be made completely pure of cultural presuppositions: ontological metaphors can vary from one culture to another. Lakoff and Johnson give an example of a different spatialization in Hausa culture: whereas we perceive ‘x’ in front of ‘y’, they perceive ‘y’ in back of ‘x’ [Lakoff 80 p161]. Such cultural differences often result in a different use of prepositions. Because in French ‘Time is seen as space’, the preposition ‘where’ is used instead of ‘when’: ‘the day when I arrive’ is translated as ‘le jour ou (where) j’arrive’.

Thus, there are some experiences which are more physical than others, and some that are more culturally related. ‘War’, ‘building’, ‘machine’ do not emerge directly from our physical experience with the world, but from our cultural experience. Consequently, structural metaphors are not directly emergent metaphors. Therefore, they will also be more variable across different cultures: ‘I love you like my brother’ will have a different meaning if uttered by a man, a woman, the wife of the pharaoh of an ancient Greek. Novel metaphors are also not directly emergent as they are mainly instances of structural metaphors, since novel ontological metaphors, i.e. fundamental changes in our direct perception of the world, are almost impossible.

By referring to concepts that emerge from our physical experience versus concepts that emerge from cultural experience, Lakoff and Johnson are joining Eleanor Rosch [Rosch 77] and her notion of categorization into prototypical natural categories (see chapter 2). In this view, language that is usually seen as literal is revived as metaphorical: ‘Harry is in the Elks’ is an ontological metaphor, since ‘the Elks’ are seen as a ‘container-object’. The part of pure literal language is here reduced to its extreme limit: ‘Harry is in
the kitchen' is literal\textsuperscript{4}. Since the very word 'emergent' referring to a concept is metaphorical and not directly emergent, MacCormac points out that

\begin{quote}
... this rejection of the literal pushes them [Lakoff and Johnson] into the almost impossible position of trying to use language that they have shown to be metaphorical ... to describe language that they claim is not metaphorical (concepts that emerge directly).
[MacCormac 85 p69]
\end{quote}

In our sense, this objection does not challenge the edifice of the system of metaphorical themes. Arguing that this structure is half or only one tenth immersed in their realm of literalness does not change its coherence. Saying that 'I am feeling down' is literal, metaphorical, a dead metaphor or a reactivated metaphor does not change the fact that there is a similarity SIM(sad,down) that is perceived and that is part of a whole coherent and powerful structure which we have described.

5.3.5 A Powerful System

From the encoding of perceived similarities, i.e. orientational metaphors, we built a coherent system of metaphorical themes. Therefore, the SIM relation, along which transfer of attributes between tenor and vehicle was performed (chapter 4), can be extended to encompass any perceived similarity and no longer the mere match of attributes. This allows metaphorical shift between attributes to be transferred. Consequently, we have grounded here, the existence of a default meaning of metaphor issued from a 'root' which consists in a set of all the SIM(X,Y) pairs preexisting, i.e. discovered in the system of metaphorical themes through the process of transfer.

\textsuperscript{4}The French equivalent is metaphorically ambiguous: 'il est dans la cuisine' means both 'he is in the kitchen' and 'he is into cooking'.
A second advantage and more important point brought up by the study of this structure is that metaphor is not only understood but also recognized as a part of the structure. When saying 'relativity is a cathedral', we recognize this statement as an instance of the theme 'theories are buildings'. In that very sense, metaphors preceded the perception of similarity and therefore create it. SIM(relativity,cathedral) is induced and grounded by the preexisting SIM(theory,building). It is because, in our culture, there is a theme 'passion is a flame' that we can say 'he burnt with passion'. Even novel metaphorical themes are recognized since they are instances of ontological metaphors. Our structure could therefore support the generation of metaphors, a topic ignored so far, by exploring the taxonomy: given a tenor such as 'relativity', recognize it as an instance of a concept 'theory' structured by a theme 'theories are buildings'; accordingly, find an instance of 'building' knowing the attributes to be transferred to 'relativity'.

By asserting the existence of a coherent structure grounded on both physical and cultural experience, we assert that the reader of a metaphor is only rediscovering or recreating similarities that are potentially present in the structure. Through metaphors we are seeing things in a new way; we are discovering their hidden side. But this side was already existing in the structure, otherwise the metaphor would be anomalous and would not be understandable. The creativity of metaphor is in great part a discovering of something existing we did not perceive. It is this very coherence of our structure that allows us to account for the creativity of metaphor. What is pointed out here is the importance of the representation adopted for the conceptualization; the more adequate it is, the more it potentially encodes and the more that can be rediscovered through metaphor. The hierarchy of metaphor described associated with the conceptual semantic space of chapter
2 is such an adequate representation grounded on natural categories. This hierarchy of metaphor is now firmly grounded to permit creativity. This notion of creativity provided by metaphor can be now refined.

5.4 Metaphor Creates Ways of Seeing and Similarities

The creativity of metaphor occurs on two levels: a global level corresponding to the creation of ways of seeing, and an inner creativity level corresponding to the creation of similarities between attributes of referents. We will here first define what is implied by ways of seeing and then explore these two levels of creativity.

5.4.1 Metaphors are Ways of Seeing

Metaphors are ways of seeing because the vehicle imposes its structure on the tenor: \( x \) is \( y \) means that \( x \) is seen as \( y \) because it is filtered by \( y \). This filtering can even impose the only way of seeing a tenor in a given culture: it is the case for orientational metaphors but also for certain structural metaphors. ‘Time is a resource’, ‘rational argument is a war’ are both inherent to our western culture. The filtering not only promotes certain aspects but also can hide others, or even deform our vision of a concept, just like mural maps make us forget the rotundity of the earth. ‘Time is a resource’ prevents us seeing inactivity as productive. Saying ‘inflation is a war’ imposes strategies and attitudes more active than saying ‘inflation is a disease’ which presents inflation as a fate that must be passively accepted or treated.

Abstracting oneself out of these ways of seeing imposed by our culture may be extremely difficult. Reddy studied the conduit metaphor, that
is, how we see words as containers transporting meaning [Reddy 79]. He showed the impact of this frame on our conceptualization of communication, and the difficulty of abstracting from it. Combating the influence of certain ways of seeing often leads to important changes in human history. Gaston Bachelard, a French philosopher, named this impediment caused by a way of seeing to be overcome by ‘obstacle epistemologique’ (epistemological impediment). Before Edison, light was seen as combustion. Edison had to overcome this way of seeing since the problem of the filament was to find a non-combustible but yet light producing material. Metaphors are definitely ways of seeing. But more important is that new metaphors therefore create new ways of seeing.

5.4.2 Metaphors Create Ways of Seeing

Does the metaphor create or does it enlighten what already existed. By proposing a structure where existing similarities and metaphors are encoded, we tended to the second solution, while structuring the creativity of novel metaphors. However, this very enlightening is by itself creative.

The global creativity we want to explore here is achieved as the referents of the new metaphor are successfully made closer through the metaphorical process. Consequently, the metaphors enlighten a link that was already existing in the structure, but that was not perceived. This process is creative. Black supports the plausibility of this creativity thesis by considering questions of the type: ‘Did X exist before it was perceived?’ [Black 79], where ‘X’ is ‘the other side of the moon’, ‘genes’ or ‘the slow motion of a galloping horse’. In that sense, metaphors are globally creative as they open new perspectives: they ‘enable us to see aspects of reality that the metaphor’s production helps to constitute’ [Black 79].
In that sense, metaphor is a 'peephole' through the very nature of things. Its function is comparable to that of art. Oscar Wilde, in 'Intentions', claimed that it is nature that copies art and not the contrary, since it is only since impressionists paint misty blue fogs that we see such fogs in nature. In the same way, metaphors allow us to access a new vision of the world that goes beyond the mere restructuring of attributes. That is what is pointed out by the poem by Baudelaire quoted in our dedication: 'The pillars of Nature's temple are alive / and sometimes yield perplexing messages'. Through the correspondances or 'pillars' i.e., through the mapping of intercorrelated attributes ('the sounds, the scents, the colors correspond'), we can discover, i.e. transfer knowledge from another world. It is certainly right here that literary metaphor finds its power [Levin 79].

This global creativity can, however, be successful, only if the attributes of the referents have been successfully made closer into a SIM relation. At that level too, similarities are created by the metaphor.

5.4.3 Metaphors Create Similarities

We have constantly pointed out how the structure given to metaphorical themes had the effect of presupposing metaphors as existing before the similarities. Consequently, the processes of transfer between referents see some similarities that are encoded and rediscover some others. It is that rediscovering that is, just like for global creativity, an inner creativity of similarity.

We formalize this creation of SIM between attributes as the following rule. During the transfer process between referents, among attributes transferred, there are some predicates with their arguments. The
predicates are transferred along a preexisting similarity, such as a perfect match or an encoded SIM of the structure. The corresponding arguments of the predicates put into a similarity relation are not similar, but a similarity between them is induced, created through the preexisting similarity of the predicates.

For example, in the metaphor 'inflation is a disease', the predicate 'effect' is transferred since it is shared by both referents: SIM(EFFECT(inflation,X),EFFECT(disease,Y)). As a side effect, a similarity is created between the arguments of the two predicates: SIM(inflation,disease) is the similarity currently processed, and a new similarity is created SIM(X,Y) that is SIM(nation,patient). The similarity induced corresponds to a successful binding of variables. The new similarity needs to be encoded in the existing structure. It exists only with respect to the main metaphorical theme SIM(inflation,disease). Therefore, this new similarity is validated and successfully grounded. If we recursively apply the transfer process to 'the nation is a patient', we find that the attribute 'affected-by-disease' is transferred on the condition of the metaphorical shift SIM(inflation,disease), since this similarity is preexisting and preencoded, the recursive metaphorical shift stops there, and the SIM(nation,patient) is grounded (algorithm section 5.3.2.).

Consequently, we showed here that our structure of metaphorical themes provided an adequate frame for metaphorical shifts and for the creation of new similarities. The specific rule given here corresponds to a general principle that sustains the whole structure and justifies its validity and coherence: perceived correlations induce similarities. This principle gives its ultimate coherence to the system of metaphorical themes in terms of creativity.
Oriental and ontological metaphors: the correlations perceived on the basis of physical experience force us to perceive similarities. Our perception of a correlation between 'happy' and 'up' induces a similarity SIM(happy,up). That this correlation can be further explained does not prevent this 'compilation' of SIM: the similarity between 'cold' and 'unemotive' may be further reduced (see section 5.1.). However, people directly perceive the 'compiled' similarity.

Conventional structural metaphors correspond to similarities culturally induced. We are used to seeing theories as buildings, and our language to handle both concepts consequently developed in a way that shares predicates between the two. This asserted similarity is the ground for inducing new similarities according to the rule we gave above.

Novel metaphorical themes are valid only if attributes are successfully transferred, i.e. are put into a SIM relation, whether directly, or after a metaphorical shift. In both cases, an existing SIM of the structure is the base case which then validates, i.e. creates all the similarities that need to be shown including the starting 'x is y'. Created SIM pairs are then encoded and inserted in our structure. 'Relativity is a cathedral' is a new metaphor grounded on 'theories are buildings': once the transfer process completed, the resulting mapping structure is added to the taxonomy. New satellite metaphors also create similarities, through metaphorical shifts between their attributes (algorithm of section 5.3.2.).

The creation of SIM pairs is therefore a byproduct of the assertion of metaphorical themes in a coherent structure. As new metaphors are produced, new similarities 'rediscovered' need to be encoded and inserted in the
structure, along with the new mapping structures resulting from metaphorical shifts. This dynamic encoding of metaphors to help understand them is similar to a learning component. Through the taxonomy imposed to metaphorical themes, metaphors are partly recognized and partly reconstructed. As more metaphors are processed, the taxonomy is enriched and more metaphors are recognized, an easier task than reconstruction.
Chapter 6

Conclusions

Our approach spiralled from the exterior of the phenomenon of metaphor, its syntactic surface, to finally terminate in a concrete basis, a structured system organizing a network of concepts into metaphorical themes associated with their mapping structure. Although we certainly did not exhaust the topic of metaphor, the points presented correspond to an outline of what should be a complete theory of metaphor and the proposal of a hierarchy of metaphorical themes is a basis for further research.

6.1 Summary

A more precise definition of metaphor can now be given. Metaphor is the syntactic realization of a cognitive process that makes closer two cognitively distant referents \( x \) and \( y \) previously unrelated: \( x \) is seen as \( y \), since \( y \) projects part of its structure on \( x \) through the transfer of a mapping structure built from preexisting or induced similarities between the two referents. The two referents need not be explicitly cited and may just break the syntactic surface under the form of one of their associated predicates.
6.1.1 Literal Versus Metaphorical

On the syntactic surface, a metaphor is therefore recognized as the two referents involved are cognitively distant. In all the cases when there is a metaphorical meaning, there is an anomaly resulting from that distance: even ambiguous cases such as ‘Trees are plants’ include this anomaly in the metaphorical interpretation (‘trees’ and ‘factories’ are cognitively distinct). However, the perception of this anomaly must be seen as an after-effect of the metaphorical process and metaphorical meaning is a case of ambiguity. Out of all the possible interpretations, the most natural, i.e. the most expected, is tried first: that the first interpretation is the literal one is objectionable. Psychological experiments have shown that the metaphorical meaning and the literal meaning of the same sentence, even a frozen metaphor or idiom, are processed in the same amount of time, provided there exists a prior context raising sufficient expectations [Ortony 78] and [Glucksberg 83].

Out of context, our expectation depends on our acquaintance with the sentence: for dead metaphors or idioms we will expect a metaphorical meaning; for novel metaphors, we assume a literal meaning first, and if ‘anomalous’, try a metaphorical one. This three-step schema, however, is challenged by the above psychological experiments, as it does not integrate well into the general schema of text understanding. The choice of a metaphorical versus literal interpretation should therefore result from the coherence of the discourse. The same disambiguation process must account for this. This does not prevent the existence of a specific component processing the part of discourse ‘x is y’, whatever its interpretation. Analogical reasoning is such a component. It naturally integrates the discourse process since it relates old knowledge to new knowledge and therefore is part of the coherence and coreference part of the discourse. It also allows the processing of all
statements 'x is y' as part of a continuum: from categorial statements, e.g. 'Tomatoes are vegetables', to metaphors, 'John is a vegetable', including literal similarities, e.g. 'raspberries are like blackberries' and simile, e.g. 'libraries are like goldmines', both distance between referents and directionality increase.

Metaphor and discourse do interact. Preceding context clearly affects metaphor. Psychological experiments have shown that the time to understand metaphors decreased when the metaphor was preceded by a sentence activating the ground of the metaphor [Glucksberg 83]. Through preceding context, the salience of some predicates of the referents is raised, which results in their prioritized transfer during the metaphorical process. The metaphorical sentence is then successfully linked to the preceding discourse as the 'meaning' of metaphor meets the expectations raised by the preceding context. Conversely, metaphor influences the following discourse. The mapping structure output of the process encodes not only attributes, but goals, strategies, temporal orderings, and expectations that may give coherence to the rest of the discourse. Metaphor focuses further inferencing in the discourse process, and is determinant in the focus of the text [Grosz 77]. However, integrating metaphor into a theory of discourse should not modify the internal metaphorical process, but should enrich the theory of discourse.

6.1.2 Syntactic Surface

This underlying process is apparent on the syntactic surface only by the presence, explicit or not, of the referents and the anomaly created by their juxtaposition. This anomaly resides in the 'clash' of semantic markers from each of the referents: 'libraries' are not 'goldmines' and 'stones' do not
die, since only 'human', 'animals' or 'plants' do so. To overcome this 'semantic impertinence', the conflicting pair of markers must be construed to be merged into a new meaning: construing 'human'/'mineral' forces the meaning of a 'stone as if human'. However, not all conflicting pairs should be validly construed since there are obviously anomalous statements, e.g. 'penguins are raspberries'. Therefore, an adequate semantic representation should allow one to recognize anomalies, and to recognize and represent ambiguities including metaphorical meanings.

Rules can be defined that regulate the construal of pairs of conflicting markers [Levin 77]. These rules must be part of a general framework that allows semantic changes. Since the construal rules effect the semantic representation of words, the critical component is an effective, i.e. flexible enough, hierarchization of semantic markers. Prototypical categories [Rosch 77] divided into natural, superordinate and subordinate categories may be one basis to develop an adequate conceptual semantic space. Adding the use of fuzzy sets provides an elegant means of representing ambiguities and metaphorical meanings by loosening the membership links [MacCormac 85].

However, the construal rules only describe in their own formalism the effects on the semantic surface of an underlying process. They only relax constraints to suppress a surface anomaly. Allowing one to see a stone as a human by only shifting a semantic marker 'human' does indeed suppress the anomalous use of 'to die' for 'stones', but it does not provide any insight into the very meaning of the metaphor. However, the importance of such rules

\[1\] Here the sentence is anomalous with respect to our current conceptualization of the world. However, this conceptualization can be modified: a context can be built to make sense of this statement, i.e. predicates can be introduced by preceding context and salience may be raised to enable the transfer of similarities.
must not be disregarded. First, they are an effective means of representing ambiguities and complementing the parsing of ill-formed input [Fass 83]. Second, they may become an important part of the general schema of metaphor understanding: they allow one to recognize a metaphor as an instance of a metaphorical theme, that is the pair of conflicting markers. This results from the use of the taxonomy of concepts (hierarchization of semantic markers) to structure the set of metaphorical themes. By the means of construal rules, we pierce the semantic surface and recognize the inputs, i.e. the ‘x is y’ metaphorical theme, of the underlying cognitive process.

6.1.3 Metaphorical Process

When ‘x is y’, we actually act as if x were y, even if it is not literally the case. Metaphor is the result of a category mistake and all ‘x is y’ are treated by the same process of text understanding: we relate y to x since the text says so [Miller 79]. Analogue reasoning relates old knowledge to new knowledge and sees a new problem as an old one: it is therefore a legitimate candidate for the metaphorical process.

Analogue reasoning operates on the two referents, i.e. the tenor and the vehicle, structured as propositional networks. The vehicle y is usually more structured than the tenor x, since by seeing x as y we want to achieve a better understanding of x. This improvement in understanding of the concept results from the projection on x of a mapping structure which is the ‘root’ of the metaphor. This mapping structure is a subnet of the vehicle and is interactively built from the two referents. The mapping structure encodes a set of similarities (SIM pairs) between the two referents. Since not all similarities are relevant, the transfer of only valid similarities is the heart of
the metaphorical process. This transfer problem is attacked by defining a hierarchy of prioritized transferred predicates of $y$ ordered by decreasing salience [Carbonell 82].

Analogical reasoning receives currently much interest in machine learning [Kedar-Cabelli 85]. Metaphor is only one area where one can apply analogical reasoning. Further work in techniques of transfer in complex structures should have their impact in the metaphor domain. Models and analogies must be studied with a special attention to principles to transfer only valid relations [Gentner 83b].

6.2 Metaphorical Shift

Carbonell's theory, like most current theories, assumed that predicates can only be transferred invariantly, that is to have similarity defined only as identity. However, the focus of this work, allowing a broader sense of similarity is a new insightful position that extends Carbonell's work. His hierarchy and the transfer process based on it can be retained while allowing the $y$ predicates to be linked by a SIM relation with $x$ predicates. In this case, it is the SIM pair that is 'transferred' on a priority yielded by Carbonell's hierarchy defined on the $y$. The transferred SIM relation is either a pre-encoded similarity such as a cultural preexisting similarity, e.g. SIM(unemotive,cold), or a new metaphorical similarity. That is, the predicates of the referents of the metaphor currently processed can be themselves metaphorically similar and become the referents of a new satellite metaphor. This recursive movement is called metaphorical shift: if 'theories are buildings', the two attributes 'weakness' and 'cracks' are a metaphorical shift: they are metaphorically similar and induce a satellite metaphor 'weaknesses
are cracks'. If the metaphorical shift is successful, this induced similarity is encoded and added to the pre-existing similarities, e.g. $\text{SIM}(\text{weakness,crack})$.

### 6.2.1 A Structured System of Metaphorical Themes

Since metaphorical shift is a recursive use of the metaphorical process, circularity must be avoided. Metaphorical shift is allowed in the transfer process by defining a structure of metaphorical themes 'x is y' that provides terminal cases for the metaphorical shifts. Since metaphorical shifts can be considered satellite metaphors induced by a metaphor, this account is also an account of the creativity possible through metaphor.

Metaphorical themes 'x is y' are associated with their corresponding mapping structures and are organized by the taxonomy given in the conceptual semantic space to the y referents. The resulting structured system encompasses four classes: orientational, ontological, structural and novel metaphors. When a new metaphor is processed, these metaphorical themes are pre-encoded similarities that provide terminal cases for metaphorical shifts. The coherence of the hierarchization of the four classes is provided by three elements: the taxonomy imposed on the y referents, the increasing complexity of the associated mapping structures and the increasing part of the cultural influence versus the physical one in the perception of similarity.

There are two important elements in this structuring of the metaphorical themes. First, the metaphorical themes of the hierarchy are connected by ISA links, which allows one to define the inheritance of mapping structures (creation by ISA inheritance). Second, for a given metaphorical theme, new similarities can be created between the predicates of the referents by metaphorical shifts, which results in nesting new satellite mapping structures in the main mapping structure (creation by extension).
6.2.2 Exploiting the Structured System

Even before the creation it induces, this system is a powerful recognition tool. First, by encoding existing mapping structures it allows one to recognize various instances of the metaphorical themes. Encoding ‘theories are buildings’ allows one to recognize ‘the foundation of a theory’, ‘he constructed the frame of this theory’ and so on. Second, the mapping structure can be inherited by a specialized tenor. Because ‘relativity’ ISA ‘theory’, all the above instances can be also recognized for ‘relativity’. Third and more interesting is the inheritance by ISA specialization on the vehicle side. Because ‘mason’ ISA ‘builder’, we can recognize ‘he plastered the shaky foundations of the theory’. What is reached here is a creation of metaphor.

ISA inheritance is the first mode of creation allowed by the system. ‘Cathedral’ ISA ‘building’, which grounds the creation of ‘relativity is a cathedral’. In this new metaphor, the transfer process does not have to reconstruct the whole mapping structure: part of it is inherited from ‘theories are buildings’ and the new part is built from the transfer component (transfer of what is specific about that kind of building). By ISA inheritance, mapping structures spread through the structured system. A second mode of creation is the satellite metaphors resulting from metaphorical shifts between predicates of an existing metaphorical theme. These shifts generally occur between the corresponding arguments of a transferred relation. From ‘theories are buildings’, the satellite ‘weakness are cracks’ is created through the transfer of ‘weaken theory-building’. The new mapping structures are nested in the main mapping structure and enrich it.

The new mapping structures resulting from these creations enrich the structured set of metaphorical themes, which increases the performance of
the overall process. This overall process is based on this structured system augmented by a transfer component. What makes this combination powerful is that metaphors are then more 'recognized' than 'reconstructed'. First, the metaphorical statement must be recognized as an instance of a metaphorical theme of the hierarchy. In our account, this always succeeds, since all metaphors are at least ontological metaphors ('x is an entity'). Second, the mapping structure is built using the transfer component and the inheritance from the hierarchy. Third, the new mapping structure including the metaphorical shifts induced is inserted in the hierarchy, which will decrease the work of the transfer component in the future. The hierarchization of metaphorical themes is therefore the crux of the metaphorical process. This promising structure and the notion of metaphorical shift it allows is a vital complement to a complete theory of metaphor and provides an efficient basis for an implementation that promises great generality.
Appendix A.

We give here the original French text of the poem translated by Richard Howard and presented in the dedication.

Correspondances

La Nature est un temple ou de vivants piliers
Laissent parfois sortir de confuses paroles;
L'homme y passe à travers des forets de symboles
Qui l'observent avec des regards familiers.

Comme de longs échos qui de loin se confondent
Dans une tenebreuse et profonde unité,
Vaste comme la nuit et comme la clarte,
Les parfums, les couleurs et les sons se répondent.

Il est des parfums frais comme des chairs d'enfants,
Doux comme les hautbois, verts comme les prairies,
- Et d'autres, corrompus, riches et triomphants,

Ayant l'expansion des choses infinies,
Comme l'ambre, le musc, le benjoin et l'encens,
Qui chantent les transports de l'esprit et des sens.

Les Fleurs du Mal - Charles Baudelaire
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