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Partial vs. Full Abstract Classes: A Review of Glucksberg's Class-Inclusion Model of Metaphor Comprehension

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Abstract Looking at metaphor comprehension from the perspective of Glucksberg's class-inclusion model, this article suggests that metaphors are understood by a mechanism of feature-loosing in which the majority of semantic features of the vehicle are attenuated. The result of this process is a partial abstract class of vehicle which is defined by a salient semantic feature and a small set of semantic features closely related to this central semantic feature. This partial abstract class is integrated into hierarchical taxonomy tree and is understood in the same way that natural literal classes are understood. The process of partial abstraction is different from full abstraction through which all concrete features of a class of phenomena are lost. Full or absolute abstract classes are primarily understood on the basis of relationship between a set of abstract entities. Full abstraction is a kind of homogeneity or deep structural similarity among a set of superficially different phenomena. Connecting this view to embodiment theories of cognition, this article suggests that partial abstract classes can be formed in the mind of a comprehender by the activation of those brain areas which are involved in one perceptual mode such as taste.

Keywords Metaphor comprehension, Class-inclusion, Semantic features, Embodiment

1. Introduction

The nature of metaphorical statements and the ways through which they are processed in the mind have been hot topics of discussion among researchers working in this field. Various theories have been suggested to offer a clear description of the processes involved in metaphor comprehension and interpretation. However, before going deep into the processes that are underway in the mind throughout metaphor comprehension, we need to understand what a metaphor is and how it differs from a literal statement, if it differs at all. We said '*if it differs at all*' because we are going to discuss a theory according to which interpretive processes of metaphor comprehension are not necessarily different from those involved in the understanding of literal statements [1]. It has been argued that communicative principles based on which metaphors are understood are exactly the same principles by which metaphors are comprehended [2]. Even, it has been suggested that comprehension processes of metaphors and those of literal statements are not essentially dissimilar (ibid). This laid the foundation for the Class-inclusion Theory which was then advanced by Glucksberg and his colleagues.

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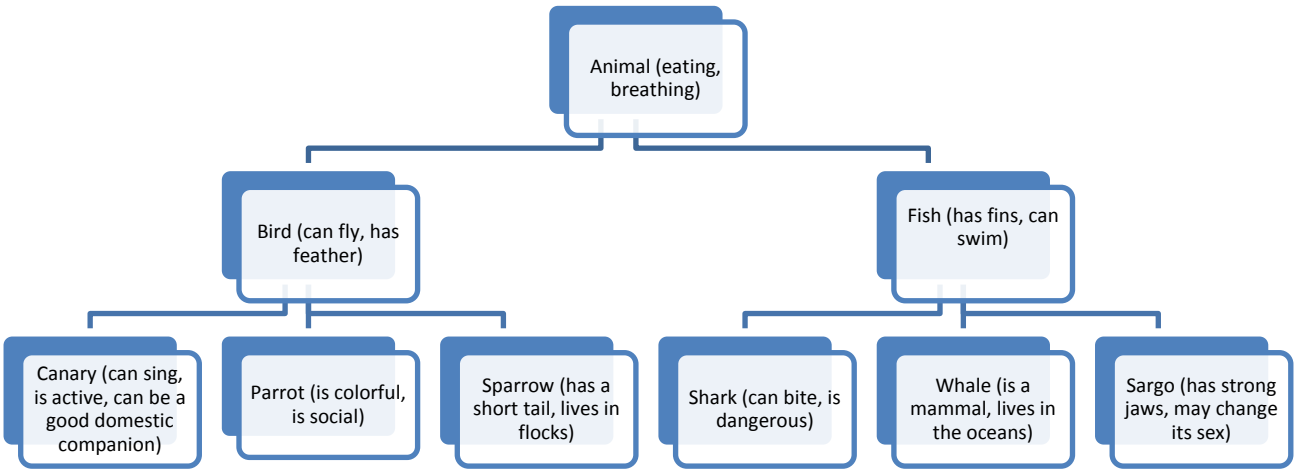
Before going into the details of this influential theory and looking at it from various perspectives, it is critically important to know what it means when it is said that literal class-inclusion expressions are inherently analogous to metaphorical class-inclusion expressions. Looking at this comparison from a semantic and then from a psycholinguistic perspective, the following section elaborates on such statements on the basis of semantic features and the ways that a given word class is formed by a set of semantic features.

2. Literal and Metaphorical Class-inclusion Statements

Class-inclusion statements are in the general form of *X is a Y*. In terms of syntactic structure, *X* and *Y* can be replaced by any noun. However, not every pair of nouns produces a meaningful and logical sentence. In other words, it is not semantically possible to fill the positions of *X* and *Y* with every pair of nouns. If we are going to fill these positions with a pair of nouns, we have to do that on the basis of semantic features of the two nouns. For example, take the literal class-inclusion *A canary is a bird*. The word *bird* refers to a class of creatures which have certain semantic features such as being able to fly, having wings, having feathers, etc. Every creature which has all these semantic features is considered as a *bird* and is included in this class.

In this example, *canary* has some specific features which are not shared by other birds. This does not create any problem for the logicality of the sentence. What is important is that *canary* has all semantic features of birds in addition to a set of features that are specific to *canary*. At one level higher in the hierarchy of classes, take the literal class-inclusion sentence *Birds are animals*. In this case, the class of *animals* is defined by features such as being able to move, eating, breathing, etc. All *birds* have these semantic features. In addition to these semantic features that are shared by all animals, *birds* have some specific features. In other words, when we move toward the top of the hierarchy of word classes, the list of defining semantic features is made shorter and shorter. The list becomes shorter because words at the top of the network are more general. In fact more general classes are defined by shorter lists of semantic features. On the other hand, words at the bottom levels of hierarchy refer to specific classes that are defined by longer lists of semantic features. In this hierarchy, the list of features defining each level (each class) is a subset of the list of features defining its lower level (lower class). Figure 1 shows a hierarchical network model of semantic features related to animals [3]. In this hierarchy, each node represents a class of entities identified by a clearly-defined set of features. Such hierarchies are the bases for literal class-inclusion statements. Semantic network theory that originated from the works of researchers in 1960s is based on these hierarchical networks [3-5]. This theory was later challenged by parallel distributed processing models and word co-occurrence models [6]. According to connectionist model, we interpret the metaphor *X is a Y* as an explicit instruction to link two connectionist networks together [7]. Based on this model, *Life is a journey* does not seem to be metaphorical because the links between the networks that contain aspects of life and journey (semantic features of life and journey) are strong. This article does not intend to argue for or against semantic network theory. However, it uses hierarchical taxonomy networks to find how abstract metaphorical categories can be integrated in these networks.

Now, let's look at metaphorical class-inclusion statements and see whether such sentences can be understood by similar hierarchical taxonomies. In the metaphor '*X* is a *Y*', *X* is called topic and *Y* is called vehicle. The metaphorical sentence *My lawyer is a shark* refers to negative features of the lawyer's character. According to Figure 1, *shark* is a type of fish, which itself is a type of animal. Below the node of *shark* in the hierarchy, there are different types of sharks such as great white shark, tiger shark, hammerhead shark, etc. This hierarchical taxonomy cannot be a base for the understanding of the metaphorical sentence *My lawyer is a shark*. In this classification, nothing has been mentioned about the negative features of a bad entity (lawyer) such as viciousness and aggressiveness. Therefore, this metaphorical sentence must be understood by a different type of classification. However, whether these types of classification are essentially different or not and whether the processes involved in their understanding are different from each other or not are important questions that need to be answered. According to property attribution view and class-inclusion model of metaphor comprehension, *My lawyer is a shark* is understood as a class-inclusion assertion that includes the concepts of *my lawyer* and *shark* into a common category of animals and people that are vicious, aggressive, unpleasant, and tenacious [1, 8-13].



Source: [3]

Figure 1. Hierarchical taxonomy of animals

To make the point clearer, it might be helpful to look at another metaphorical sentence. The metaphor *My job is a jail* assumes that *my job* is a special type of *jail*. Literally, there are various types of jail in the world. Criminals and sometimes innocent people might be jailed in solitary cells, collective cells, dungeons, concentration camps, etc. In such a literal classification, there is no place for *my job*. The question that is raised here is that how *my job* can be considered as a type of *jail*. This question has been answered by suggesting that *jail* belongs to several superordinate classes [1]. It belongs to the category of punishments, which includes other concepts such as fines, whipping, and spanking. It is also a member of the category of buildings, which includes hotels, apartments, and hospitals. When the word *jail* is used in the vehicle position of this metaphor, it is regarded as a class that includes all unpleasant and confining situations. In other words, *my job* and *jail* are included into a broad abstract class of all confining conditions.

It has been suggested that metaphorical reference of a word is mainly based on a certain semantic feature or a small set of semantic features closely related to a unique semantic feature [14]. That is, a certain semantic feature defines a broad metaphorical class in which a large set of words can be included. When the term *jail* is used in its metaphorical sense, the semantic feature of 'confining' is the only intended feature. In the literal sense, *jail* refers to a building that is used to isolate criminals and keep them away from society. This literal sense includes a large set of semantic features such as having walls, wards, guards, and bars. In the metaphorical sense, such features are not included. The metaphorical sense of the word (or its metaphorical class) refers to only and only one semantic feature: 'confining'. In other words, when the term *jail* is used in the metaphorical sense, its irrelevant features are kept away and not included in the process of comprehension. In this situation, *jail* represents a broad class of all confining conditions. There is no place for other semantic features in this metaphorical class. As has been suggested, when the metaphor *My lawyer is a shark* is processed in the mind of a comprhender, the literal features of *shark* such as living in the sea, swimming, and having fin are completely filtered out [8]. In fact, in this metaphor, *shark* does not refer to the beautiful but potentially dangerous creature that lives in the sea; rather, it refers to an abstract class of aggressive, tenacious, and ferocious entities that could harm people. The term 'suppression' has been used to refer to a similar process in metaphor comprehension [15]. The nature of abstract or metaphorical classes and the ways through which these classes are built in the mind are the questions that are dealt with in the following sections.

3. Dual Reference or Two Levels of Reference

Dual reference is a communicative strategy by which prototypical category member names are used to refer to non-lexicalized categories [16]. When the word *shark* is used in its metaphorical sense, it refers to an un-named category of vicious, aggressive, and predatory creatures. It has been proposed that this category can be referred to by other terms such as *snake* and *wolf* [14]. The selection of a term to refer to this abstract category depends on the culture and the language spoken in that culture; that is, while this abstract category is best represented by *shark* in western cultures, it can be best represented by *snake* or *wolf* in other cultures (ibid).

Table 1 lists the defining features of metaphorical class and literal sense of the word *shark* [16]. The set of semantic features defining category of the term includes a short list of closely-related semantic features. In fact, all of them center around the semantic feature of 'viciousness'. On the other hand, the set of semantic features defining the literal sense of the word includes a much longer list of various semantic features. In other words, while a short list of semantic features, which are closely related to the central unique feature of 'viciousness', define the metaphorical class (metaphorical sense of the word), a much longer and detailed list of various and unrelated semantic features defines the literal sense of the word. When the word *shark* is used to refer to its metaphorical class, the majority of its features, which are literal and irrelevant, are suppressed or inhibited. Through the inhibition of these semantic features, the metaphorical sense of the word is created. Therefore, it might be said that the underlying processes by which metaphors are understood are primarily suppressive- or inhibitive-based. On the other hand, literal statements are comprehended by a receptive-based mode of processing; that is, a long detailed set of semantic features are combined together to form the literal sense of the word. The following section discusses the position of abstract metaphorical classes relative to literal classes in the hierarchical networks of lexical categories.

Table 1. Semantic features of metaphorical and literal sense of the word *shark*

Metaphorical *shark*	Literal *shark*
	Vicious
Vicious	Predatory
Threatening	Aggressive
Pugnacious	Can swim
Cruel	Has gills
Predatory	Has fins
Aggressive	Has cartilaginous skeleton
etc	Has several sets of teeth
	Has keen olfactory senses
	etc

Source: [16]

4. Abstract Categories in Hierarchical Networks of Words

In the hierarchical taxonomy networks like that one in

Figure 2, every word is a special type or a hyponym of its superordinate word. Every word has all semantic features of its superordinate word. In this network, when we move upward, words become more general and the lists of defining semantic features become smaller and smaller. Since canary is a special type of bird, the list of semantic features by which canary is defined is a subset of semantic features list by which bird is identified. In the same way, the list of semantic features by which bird is identified is a subset of semantic features list by which animal is defined. This hierarchical taxonomy is based on literal semantic features of each word. Every word represents a class of entities. A question that might be raised here is the position of abstract categories in such networks. As was mentioned before, the abstract category of 'viciousness' could be best represented by *shark* in western cultures although it might be properly represented by other terms such as *snake*, *wolf*, *hawk*, etc in non-western cultures [14]. This abstract class, which is defined by the central semantic feature of 'viciousness' and some closely-related features not inherently different from this central feature, is the superordinate term for words such as *shark*, *snake*, *wolf*, *hawk*, etc. Therefore, similar to literal general terms, abstract metaphorical classes are located at the upper nodes of the hierarchical network.

A question that might be raised here is the issue of typicality or prototypes. While the words *canary*, *dove*, *flamingo*, *parrot*, and *robin* are all equally co-hyponyms of the superordinate *bird*, they are not considered to be equally good examples of the category *bird* [17]. *Robin* is the most representative member of this category. On the other hand, *penguin* and *ostrich* are significantly less representative. Even some people might not regard them as birds. The same argument can be made about metaphorical classes. The metaphorical class of 'vicious' can be represented by various terms, although all of these terms are not at the same level in terms of typicality. Metaphorical categories are not inherently different from literal categories. Metaphorical classes are created in the mind at a conceptual level and can be referred to in exactly the same way that literal classes are referred to.

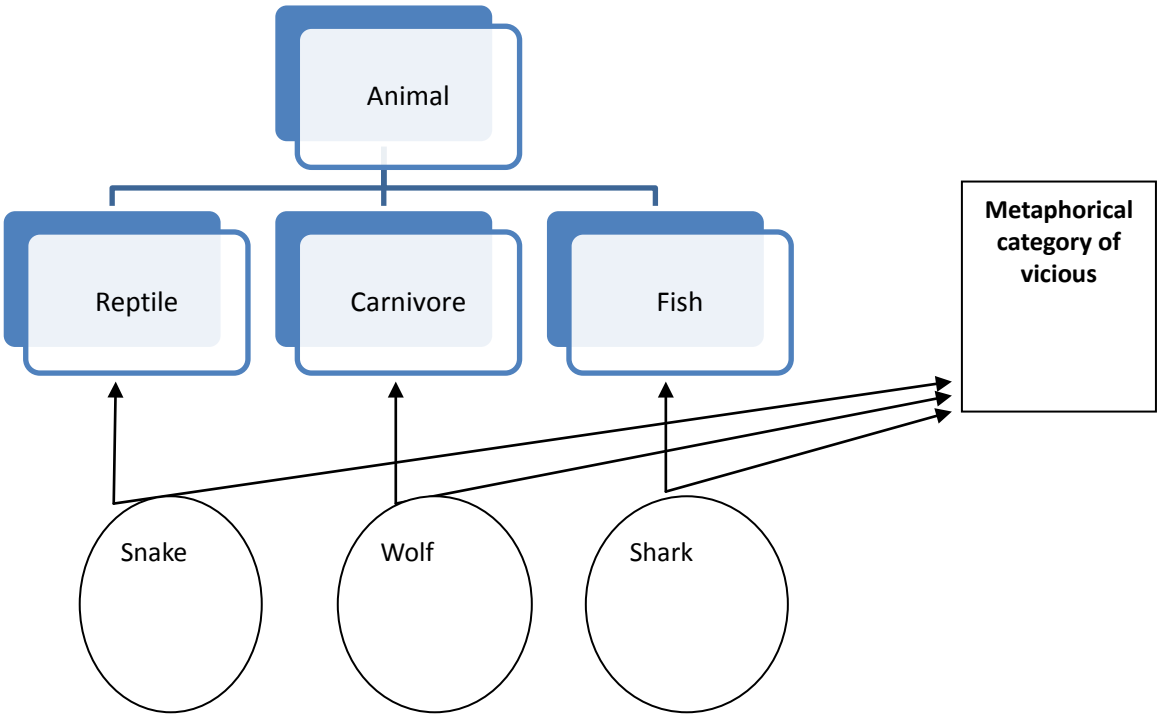


Figure 2. Position of metaphorical class in the hierarchical network

Studies in neuroscience have suggested that every word is understood by an experienced-dependent functional network [18]. This network is built by interconnected neurons in those areas of the brain which are involved in the processes of learning [19, 20]. Results of several experiments have shown that upon reading the word *cinnamon*, those brain regions processing odor and taste are activated, even though the person participating in the experiment does not smell or taste cinnamon in that environment [21, 22]. It has been noted that when a child acquires the word *cinnamon* for this concept, s/he collects multisensory experiences, which include olfactory, gustatory, touching, and visual perceptions as well as other properties of this concept [23]. Therefore, it might be said that when a term is used in its metaphorical sense, those brain regions involved in the processing of a certain aspect (relevant property) of the term are readily activated while other neural activities are suppressed. For example, in Persian, the metaphorical term *pepper* is used to refer to someone who is active and nimble. The hot and pungent taste of pepper causes people to move quickly or

become active. Therefore, it can be said that when this word is used in its metaphorical sense, those neural connections which are involved in the processing of taste and movement become activated. The pattern of activation in neural networks is the result of comprehender's past experiences. This is the position taken by embodiment theory, according to which cognition is mainly based on restatements of external and internal states and also bodily actions that produce simulations of pervious experiences [24]. Embodied theories of cognition emphasize "the degree to which minds are embodied and how they are distributed across brains, bodies, and the world" [25, P. 114]. This theory holds that perceptual and motor systems support conceptual knowledge; that is, some degree of sensory or motor simulation is involved in retrieving a concept [26]. Results of a number of empirical studies have supported embodied theories of cognition. In one of these studies, participants were faster in understanding a metaphorical phrase, such as *Push the argument*, when they had previously just made an appropriate body movement, or imagined making a specific body action than they first made no movement [27]. The metaphorical sense of pepper refers to the category of objects that cause people to become active. It is exactly this category that is referred to by metaphorical pepper; other features of pepper such as color, shape, and size are suppressed. This categorical reference can be the result of an imagined rapid action that is caused after eating a very hot pepper.

5. Time of Metaphor Processing

Although some early studies [28] suggested that literal meaning is easier and faster to comprehend than figurative meaning, subsequent studies found that we do not necessarily need additional time to extract the figural intentions of metaphors [29-32]. Such observations could be explained from various perspectives. According to career of metaphor hypothesis, conventional metaphors are understood via categorization, but novel metaphors are comprehended through a comparison-based mode of processing [33-37]. This hypothesis assumes a shift in mode of mapping from comparison to categorization as metaphors are conventionalized [38]. Based on this view, it might be said that metaphorical classes are not normal natural classes from the beginning; rather, they become natural throughout the process of conventionalization. In this process of conventionalization, the irrelevant features (irrelevant in metaphorical sense) are lost. What remains is a metaphorical class defined by a central semantic feature and a small set of features that are closely related to that central feature. After this process of change or shift, this class is regarded in the same way that natural literal classes are regarded.

The un-necessity of additional time to interpret figurative statements can be explained by the nature of processes involved in their understanding. As was mentioned earlier, metaphor comprehension processes are primarily inhibitive-based. The term 'suppression' has been used to describe these processes [15]. Suppression has been defined as "a general, cognitive mechanism, the purpose of which is to attenuate the interference caused by the activation of extraneous, unnecessary, or inappropriate information" (p.1619). This mechanism has also been discussed under the rubric of 'elimination' [39]. Elimination has been described as the suppression of contextually inappropriate alternative. It has been proposed that literal and metaphorical interpretations are often activated in parallel (ibid). If both literal and metaphorical interpretations are simultaneously activated in the mind of comprehender, and if comprehender does not need any additional time to understand the metaphorical meaning of a statement, it can be suggested that inhibition, suppression, or elimination of irrelevant information does not need any additional time. In other word, literal interpretation involves only one mode of processing (receptive-based mode of processing). This mechanism includes a large set of semantic features that are received and processed in the mind. On the other hand, metaphorical interpretation involves two modes of processing (receptive- and inhibitive-based mode of processing). These two mechanisms of processing are conducted in parallel. Whether we use one mechanism to understand the literal meaning or both mechanisms to comprehend the metaphorical intention does not lead to any change in the time needed to interpret a statement.

6. Two Types of Abstraction

The term 'abstraction' is widely used in various fields. However, there is not a full consistency about the meaning of this term. Different people might use this term to mean pretty different things. Suppose we have a set of concrete entities. An abstraction of this set can be defined as a general form that is shared by all these entities. This general form can be seen as a core feature shared by all elements of the set. The general form is the defining feature of the set. Any entity can be identified as a member / non-member on the basis of having / not having the core feature. Since metaphorical category is created by the exclusion of the majority of semantic features and maintaining a central feature (a small set of semantic features which are closely related to it), this abstract metaphorical category can be considered as a partial abstraction of literal category. It is partial abstraction because not all literal or concrete semantic features are excluded. On the other hand, in the process of full abstraction, all concrete features are lost.

Tree diagrams, which are used to describe syntactic structures of sentences, are made via the full abstraction of language structures. Each tree diagram describes how the components of a sentence are related to each other. In such structures, the concrete features of components are not important. The surface phonological representations and the meanings have no role in these diagrams. The only point that matters is the way that syntactic categories (free from any concrete feature) chain together to create a structure. To give

a pretty different example, we might refer to Newton's third law, according to which 'for every action, there is an equal and opposite reaction'; that is, in every interaction, there is a pair of forces on the two interacting objects. The sizes of the objects, their mass, their shape, etc are not important. These are irrelevant features. This law states an abstraction of a physical phenomenon. In fact, every law in Physics is an abstraction of an infinite number of phenomena. These are cases of full or absolute abstraction. Full abstraction states the nature of relationship between a set of entities without referring to their concrete features. Full abstraction is a kind of homogeneity or deep structural similarity among a set of superficially different phenomena. It is the extraction of a deep structure that underlies a set of concretely (superficially) different phenomena.

7. Summary

Metaphors are understood by a primarily inhibitive-based mode of understanding. Through such an inhibitive mechanism, the majority of semantic features of the vehicle of metaphor is lost. The result of this process is the metaphorical class (metaphorical reference) of the vehicle. The metaphorical class is mainly defined by a very salient semantic feature [14] and a small set of other features that are closely related to it. These metaphorical classes are integrated into hierarchical taxonomy networks and are regarded in the same way that natural literal classes are understood. Similarly, the process of conventionalization, by which a shift from comparison to categorization takes place (career of metaphor hypothesis), can be seen as a feature-loosing process.

Metaphorical classes are created by a partial abstraction process. This process is different from full abstraction or absolute abstraction through which all semantic features are lost. While partial abstraction leads to the creation of metaphorical classes, full abstraction leads to the formation of absolute abstract classes or abstract concepts in the mind. Absolute abstract classes are understood on the basis of relationship among a number of entities. Tree diagram of syntactic structures and Newton's third law are examples of abstract classes that represent concrete relationships or concrete phenomena at an abstract level.

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