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Abstract metaphorical classes: A perspective from distributed models of conceptual representations

Abstract: *This article looks at the semantic space of abstract and concrete concepts from the perspective of distributed models of conceptual representations. It focuses on abstract metaphorical classes and the mechanisms through which these concepts are processed. When the metaphor X is a Y is understood, X is included in the abstract metaphorical class of Y. This metaphorical class is abstract because the most of semantic features of Y are filtered out through a suppressive-oriented mode of processing. It is suggested that abstract metaphorical classes of living things are usually defined by a single or a very small set of semantic features. Therefore, such metaphorical classes are highly abstract. On the other hand, abstract metaphorical classes of nonliving things are defined by a relatively larger cluster of semantic features. Therefore, abstract metaphorical classes of nonliving things have a relatively higher degree of concreteness compared to those of living things. In other words, abstract metaphorical classes of living things and nonliving things are rather different in terms of nature and the structure of semantic space.*

Keywords: *distributed models, abstract concepts, concrete concepts, metaphorical class*

Introduction

The characterizing features of abstract concepts have been the subject of a large body of works in cognitive science and related fields. A number of features have been identified as the distinguishing properties of abstract concepts. Abstract concepts such as ‘freedom’ do not have concrete and easily identifiable referents (Borghi, Binkofski, Castelfranchi, Cimatti, Scorolli, & Tummolini, 2017). In other words, they do not refer to a perceptually bounded entity (Borghi, Barca, Binkofski, & Tummolini, 2018). Abstract concepts do not stand as an object that can directly be seen, heard, touched, tasted, or smelled. The five sensory channels cannot directly perceive abstract concepts. Although abstract concepts do not have easily perceivable features, they may have some concrete associations. For example, ‘Euro’ is mostly a concrete concept since its referent has concrete characteristics such as size, color, and weight; however, it has an exchange value that cannot directly be perceived through sensory channels (Guan, Meng, Yao, & Glenberg, 2013). Crutch and Jackson (2011) have suggested that the relationship between concreteness and semantic associations is not binary but graded. In other words, we can think of abstractness as something that ranges from ‘more abstract’ to ‘less abstract’. Abstractness and connectedness are not absolute. Abstract concepts may have some concrete dimensions attached to them. On the other hand, concrete concepts may have some abstract dimensions. On the one extreme side, some concepts are very abstract; on the opposite extreme side, some concepts are very concrete. The idea of abstractness/concreteness continuum is widely accepted by researchers working in cognitive science and related fields (Borghi et al., 2017).

Compared to concrete concepts, abstract concepts are more variable over time. They are more shaped by life experiences and situations (Barsalou, 1987). These can explain why there are a lot of disagreements among people when they are asked to define or produce associations of abstract concepts (Borghi et al., 2017). For example, the abstract concept of ‘self-sacrifice’ may have very

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different semantic associations for two individuals. In fact, this concept can have very different interpretations in two different situations or in two different cultural contexts. The connotations of many abstract concepts could be pretty different for two individuals living in the two different contexts of tribal areas and modern metropolitans. Over the time and as a result of developments in human life experiences, some abstract concepts may receive new semantic dimensions.

It has been suggested that abstract concepts are relational in nature (Barsalou, 2003; Gentner, 1981; Gentner & Boroditsky, 2001; Markman & Stilwell, 2001). In other words, they are characterized by their associations with external concepts rather than their intrinsic features (Wiemer-Hastings & Xu, 2005). According to this proposal, a concrete concept such as 'wood' is largely characterized by its own inherent features such as being solid and having a certain color. On the other hand, the abstract concept of 'freedom' is mainly understood on the basis of its associations with other concepts such as freedom of speech, voting, parliament, and democratic society. This abstract concept does not have intrinsic features such as size, color, and taste. These intrinsic features stand independently. On the other hand, the relational features cannot stand independently. They are reliant on the relationship between two or among several objects. To give another example, the abstract concept of 'democracy' does not have color, shape, sound, or weight; it cannot be kicked or bitten. This concept may be understood through its associations with other concepts such as majority and republic (Pecher, Boot, & Van Dantzig, 2011). In other words, this concept is understood in the context of a democratic society which has certain characteristics.

Another feature of abstract concepts is diversity or heterogeneity of members that are linked to each other; therefore, context in which these concepts are understood play an important role in putting them in one category of related abstract concepts (Borghi et al., 2017). For example, a democratic society provides a context in which the abstract concepts of 'freedom, democracy, human rights, respects for various ideologies' are understood. Although these concepts are heterogeneous in many respects, all of them could be associated with each other in the context of a democratic society. This is also the case with members of concrete categories. For example, in the broad context of 'land', all members of the category of 'animals' coexist (Borghi, Caramelli, & Setti, 2005; Heit & Barsalou, 1996; Murphy & Wisnieski, 1989). Every category is represented by a general term under which all members are subordinated. The general term of 'animal' represents a very broad category that includes a large number of subcategories. One of them is the subcategory of birds. Even this subcategory itself has a number of subcategories. In this way, a very large tree diagram is created in which various categories of animals are included. Among members of every category, some are more typical than others (Carroll, 2008; Yule, 2006). In the category of animals, 'lion', for example, is one of the most typical or one of the most representative members in some cultures.

Defining features of classes in the hierarchical order

In the hierarchical tree of 'animals', some members are more general than others. In other words, some are superordinate of other categories. For example, 'animal' is the superordinate term for 'fish'. 'Fish' itself is the superordinate term for 'shark' and 'whale'. 'Shark' itself is a superordinate term for a variety of species of sharks such as 'hammerhead' and 'sand shark'. According to Khatin-Zadeh and Vahdat (2015), those members which are at lower levels in such tree diagrams are defined by a larger number of semantic features. In these tree diagrams, when we move downward, members become more specific. In other words, more specific members, which are in lower positions in the hierarchical tree, are defined by a larger number of semantic features. On the other hand, those members which are at higher levels are more general and are defined by a smaller number of semantic features. For example, the set of semantic features that define the category of 'animal' is much smaller than the set of semantic features that define the category of 'zebra'. In fact, the set of semantic features that define the category of 'animal' is a subset of the set of semantic features that define the category of 'zebra'. The logical statement 'Every zebra is an animal but every animal is not a zebra' expresses the same thing. In other words, every semantic feature of the category of 'animal' belongs to the category of 'zebra' but every semantic feature of 'zebra' does not belong to the category of 'animal'. The features of 'breathing', 'having eye', and 'having ear' belong to all animals, including 'zebra'. However, there are some features that are specific to 'zebra'. That is why more specific categories are defined by a larger number of semantic features. The highest category in every tree diagram, which is the most general category, is defined by the minimum number of semantic features.

Khatin-Zadeh and Vahdat (2015) suggest that abstract metaphorical categories have a similar characteristic. They add that every abstract metaphorical class is defined by a salient semantic feature. Therefore, any abstract metaphorical category can be seen as a general class in which a large number of concretely heterogeneous concepts are included. Although these concepts are concretely different in many respects, they share a salient semantic feature. This salient semantic feature is the defining characteristic of abstract metaphorical class. High degree of generality is a feature that is shared by general concrete concepts and abstract concepts. In fact, abstractness and generality can be considered to be equivalent. However, we should distinguish among different kinds of generality. When we closely examine general categories, we could see that generality has a variety of types. Identifying these differences among various types of generality can help us to acquire a deeper understanding of the processes through which concepts are comprehended. The following section discusses the various types of generality and the ways that these types of generality could be seen as abstractness.

Generality

The term *generality* could be interpreted in a number of ways. Various types of generality in mathematics and science have been discussed in the literature of various fields of science (Chemla, Chorlay, & Rabouin, 2016). Perhaps the most known of generality is in the classification of concrete objects such as animals, plants, and artifacts. In this type of classification, some salient semantic features define the general classes. For example, the general class of 'animal' could be defined by the semantic features of 'breathing', 'eating', and 'moving on the earth'. Less-general classes of animals are defined by a larger number of semantic features. The class of 'fish' has all features of animals plus 'living in the water'. The subspecies of fish still have some specific features. This type of generality and classification is based on the inherent features of members. Another type of generality and classification is based on the function. The classification of artifacts is usually based on their function. For example, the function of 'sitting' is the defining feature of a variety of tools that are used for sitting. 'Furniture', 'couch', 'desk', and 'armchair' are some of these classes of artifacts. The bases of these two types of classification are different. While the first one is based on the inherent features of members, the second one is based in what the members are used for. In both cases, it can be said that an abstract higher-level concept is realized in a variety of lower-level concepts. When we talk about 'animal' as a general category, we do not have any specific species with specific semantic features in our mind. We talk about a very general concept which is specified by a very small number of semantic features. This general concept is free from size, color, weight, and many other concrete features. This general concept has a higher degree of abstractness compared to lower-level specific concepts which are specified by a much larger set of semantic features. For example, the lower-level specific concept of 'elephant' has size, weight, color, and sound that can be perceived through our sensory channels.

A one-to-one correspondence between parallel relations in two analogical systems can be the basis of another kind of generality. When an object with a higher level of electrical potential is connected to an object with a lower level of electrical potential by an electrical conductor, the electricity current moves from the first object to the second one. This system has a large number of analogical systems. For example, when a container with a higher gas pressure is connected to another container with a lower gas pressure, the gas moves from the first container to the second one. This system is analogical with the former system. Another example consists of an object with a higher temperature connected to an object with a lower temperature by a heat conductor. In this system, the heat moves from the first object to the second one (Falkenhainer, Forbus, & Gentner, 1989). There are many other systems that operate in the same manner (e.g. the movement of liquids from a high-pressure point to a low-pressure point, the movement of ions from point of a solution to another point). All of these systems are the low-level realizations of a high-level general system. In this high-level general system, the object *A* is connected to object *B* by a conductor. The value of a parameter in object *A* is higher than the value of the same parameter in object *B*. As a result of this difference, something moves from object *A* to object *B* through the conductor. This type of generality is a structure-based homogeneity among a set of concretely different systems.

The cases of generality that were discussed in this section indicate that high-level abstract concepts may be defined in a variety of ways, such as a certain feature (animate things), function of a group of things (artifacts), or the structure that is shared by a group of systems. Therefore, abstractness could be based on a variety of factors. This can explain why there is a variety of factors. The fine-grained differences among different types of abstract concepts have been examined in a number of studies that have employed new tools (Desai, Reilly, & van Dam, 2018; Ghio, Haegert, Vaghi, & Tettamanti, 2018; Rice, Hoffman, Binney, & Lambon Ralph, 2018) and in studies that have focused on sub-types of abstract concepts (Brookshire & Casasanto, 2018; Fingerhut & Prinz, 2018). The aim of these studies has been to explore the differences in the nature of concepts and their neural underpinnings (Borghi et al., 2018). The next section discusses the semantic spaces of animate and inanimate things. This is done by looking at the structural spaces of these categories from the perspective of distributed models of conceptual representations.

Distributed models of conceptual representations

Distributed models of conceptual representations are a group of models that have been suggested to describe semantic space of concepts. According to these models, meanings of concepts have a componential nature; that is, concepts are represented by smaller units of meaning which are called semantic features (Taylor, Devereux, & Tyler, 2011). These models assume that every semantic feature is represented by a node or a set of nodes in a connectionist network, and the processing corresponds to the co-activation of all those nodes that represent semantic features of that concept (Caramazza, Hillis, Rapp, & Romani, 1990; Masson, 1995; McRae, de Sa, & Seidenberg, 1997; Moss, Tyler, & Taylor, 2007; Tyler, Durrant-Peatfield, Levy, Voice, & Moss, 1996; Tyler & Moss, 2001; Tyler, Moss, Durrant-Peatfield, & Levy, 2000; Vigliocco, Vinson, Lewis, & Garrett, 2004). The conceptual structure account is one of distributed models of conceptual representations that claims correlational strength and distinctiveness determine how concepts are structured (Taylor et al., 2011). It has been argued that living and nonliving things have different internal semantic structures (Moss et al., 2007; Moss, Tyler, & Jennings, 1997; Tyler & Moss, 2001). Taylor et al. (2011) summarize the results of the mentioned studies and say that the internal semantic structures of living things have four main characteristics:

1) they have large clusters of highly-shared features,

2) the highly-shared features are strongly correlated (for example, ‹has eye› and ‹has nose›),
3) they have fewer distinctive features,
4) the distinctive features have a low degree of co-occurrence with other features (for example, the distinctive feature of ‹has stripes› has a low degree of co-occurrence with other features of tiger).

On the other hand, the internal semantic structures of nonliving things have these characteristics (Moss et al., 1997, 2007; Randall, Moss, Rodd, Greer, & Tyler, 2004; Taylor, Salamoura, Randall, Moss, & Tyler, 2008):

1) they have smaller clusters of features with relatively more distinctive features,
2) there is a strong form-function relationship between some semantic features (for example, ‹has blades› and ‹cuts›),
3) distinctive features are more strongly correlated.

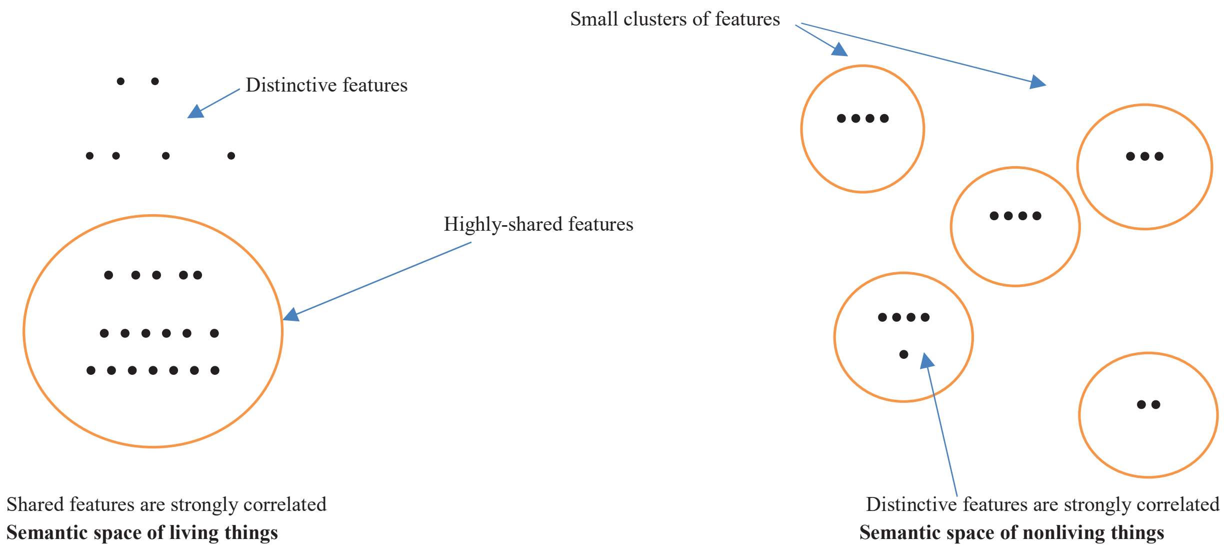
The difference between internal semantic spaces of living things and nonliving things could explain why general classes of living things are different from general classes of nonliving things. The semantic spaces of living and nonliving things have been shown in Figure 1.

In the semantic space of living things, the highly-shared features have been shown inside the circle and distinctive features have been shown outside the circle. If the general class is defined by one feature that is outside the circle, all of the features that are inside the circle are filtered out. This is particularly the case with the understanding of metaphors. Most theories of metaphor comprehension look at metaphors from a general perspective. These theories do not distinguish between various types of metaphors. Consequently, the processes that are involved in the understanding of special metaphors are not described by these theories. In the metaphor *X is a Y*, *X* is called the topic and *Y* is called the vehicle. As mentioned previously, semantic spaces of living and nonliving things are different. Therefore, the processes that are involved in the understanding of a metaphor with a living vehicle may be different from the processes that are involved in the understanding of a metaphor with a nonliving vehicle. Although the general processes involved in the understanding of these two types of metaphor could be described by classic theories in metaphor comprehension, these theories do not offer a detailed picture of the possible differences. The understanding of some special types of metaphors may involve special sub-processes. In order to acquire a comprehensive understanding of metaphor comprehension, we need to distinguish between various types of metaphors and offer a picture of the sub-processes through which special types of metaphors are comprehended.

It has been proposed that metaphors are understood through a mainly suppressive-oriented mechanism of processing (Gernsbacher & Robertson, 1999; Glucksberg, Newsome, & Goldvarg, 2001; Keysar, 1994). According to this proposal, when the metaphor *X is a Y* is processed, the metaphorically-irrelevant features of vehicle (*Y*) are filtered out or suppressed. Then, topic (*X*) is included in a metaphorical class of *Y* (Glucksberg, 2003; Glucksberg & Keysar, 1990). This metaphorical class is defined by metaphorically-relevant features of *Y*. Drawing on this proposal, Khatin-Zadeh and Vahdat (2015) suggest that abstract metaphorical classes are defined by one or at most several semantic features. If the vehicle of the metaphor is a living thing, all highly-shared features of living things, which are inside the circle, are filtered out. This is a special kind of abstraction in which highly-shared features of living things are filtered out. What remains is a partially-abstract general class that is defined by one or at most several semantic features.

In the semantic space of nonliving things, there are smaller clusters of features which are highly correlated. Therefore, the general classes of nonliving things are usually defined by a small set of several highly correlated features. In fact, since degree of correlation among features in every circle of semantic space is high, the whole set

Figure 1. Semantic spaces of living and nonliving things



of features in one of the circles becomes the defining set of semantic features of the general class. If the vehicle of a metaphor is a nonliving thing, one circle of features defines the general metaphorical class and the rest of circles, which are metaphorically irrelevant, are filtered out. Since a set of semantic features defines every metaphorical class, degree of abstractness is lower compared to degree of abstractness of metaphorical classes of living things. In other words, general abstract classes of living things are different from general abstract classes of nonliving things in that the former classes are more abstract than the latter. Abstract general classes or metaphorical classes of living things are usually defined by a single highly-distinctive feature. Abstract general classes or metaphorical classes of nonliving things are usually defined by a set of concrete features that are highly correlated. Since the number of concrete semantic features of nonliving things is usually larger than the number of concrete semantic features of living things, metaphorical classes of nonliving things have a higher degree of concreteness. The following section looks at the degree of abstractness of general metaphorical classes from the perspective of distributed models of conceptual representations.

Degree of abstractness of general metaphorical classes

As was mentioned, some evidence suggests that no clear-cut distinction can be made between abstract and concrete concepts. In fact, we can talk about a continuum ranging from highly abstract concepts to highly concrete concepts (Borghi et al., 2017). Between these two extremes, there is a very large number of possibilities. As we move toward the extreme side of abstractness, concepts become increasingly abstract; on the other hand, as we move toward the extreme side of concreteness, concepts become increasingly concrete. Distributed models of conceptual representations could explain why some concepts are more concrete than others. For example, if a concept has visual, audio, haptic, tasting, and olfactory features, it would have a high degree of concreteness. Each one of these five main components (features) may have a large number of subcomponents. For example, the visual component could have many semantic subcomponents (sub-features) related to color, size, and shape of an object. Even these subcomponents (sub-features) could have a large number of minor subcomponents (sub-features). Degree of concreteness of a concept is dependent on the number of features that combine to form the whole of that concept.

The same view can be applicable to general metaphorical classes of concepts. In other words, some general metaphorical classes could be more abstract than other classes. As was mentioned, abstract metaphorical classes of living things are usually defined by a single or a very small set of several semantic features. For example, in the metaphor *My lawyer is a shark*, the metaphorical class of ‘shark’, in which ‘my lawyer’ is included, is defined by the semantic features of ‹being aggressive› and ‹being tenacious›. These semantic features have a very low degree of correlation with other features of living things, as there are a very large number of living things that do not have these two features. Since abstract metaphorical classes of living things are defined by one or a small set of several semantic features, they have a high degree of abstractness.

Since the semantic space of nonliving things is different from the semantic space of living things, the abstract metaphorical classes of nonliving things have a rather different nature. These classes are usually defined by a small cluster of highly-correlated distinctive features; that is, the number of semantic features of such metaphorical classes is usually larger than that of living things. The semantic features that define metaphorical classes of nonliving things are mainly related to the function of nonliving things. The semantic features of ‹having blade›, ‹cuts›, ‹cause of bleeding›, ‹cause of injury›, and ‹cause of pain› are a set of concrete semantic features that are highly correlated. The metaphorical class that is defined by this cluster of features has a relatively higher degree of concreteness compared to those metaphorical classes that are defined by a single semantic feature of a living thing. In other words, we have to distinguish between abstract metaphorical classes of living things and those of nonliving things. These two classes have different semantic spaces and their degrees of abstractness/concreteness are different.

Conclusion

Abstract concepts have some characterizing features that distinguish them from concrete concepts. A number of theories have been suggested to describe the nature of abstract concepts and the processes through which they are comprehended. Degree of concreteness of a concept is dependent on the number of concretely perceivable features that combine to form the whole of that concept. Therefore, we can assume that there is a wide range of abstractness/concreteness between the two extreme points of highly-abstract and highly-concrete. This proposal was generalized to abstract metaphorical classes. It was suggested that abstract metaphorical classes of living things have a high degree of abstractness. Abstract classes of living things are highly abstract because they are usually defined by a single or a very small set of semantic features. Therefore, when the vehicle of the metaphor *X is a Y* is a living thing, topic of the metaphor is included in a metaphorical class which has a high degree of abstractness. On the other hand, abstract metaphorical classes of nonliving things have a lower degree of abstractness. Abstract metaphorical classes of nonliving things are less abstract because they are characterized by larger sets of distinctive features. In fact, degree of abstractness of a metaphorical class is dependent on the nature of semantic space of the concept. When the metaphor *X is a Y* is understood, *X* is included in the metaphorical class of *Y*. Depending on whether *Y* is a living thing or a nonliving thing, degree of abstractness/concreteness of the metaphorical class varies. A metaphor with a living vehicle is understood through a highly-suppressive mechanism. On the other hand, the mechanism through which a metaphor with a nonliving thing is understood is less suppressive. That is why the metaphorical class of such metaphor is less abstract. The implications of this proposal for the understanding of metaphors with living vehicles or nonliving vehicles is a subject that can be investigated in future studies.

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