Chapter 2: Review of Literature

Exploration of any human language demonstrates that language is an extremely complex, highly abstract and infinitely productive system (Falk, 1978). From a linguistic point of view, it is considered to be a mental phenomenon, involving knowledge about meanings, syntax and sounds. It has been in the interest of researchers to study what kind of knowledge underlies use of language and what enables individuals to interpret speaker's speech as the expression of meaning. Word meanings or lexical semantics is considered fundamental part of this knowledge, which facilitates comprehension and production of speech. Thus producing and comprehending verbal language involves selection of most appropriate words from the word store in the brain that best matches to the meaning of the thought that is intended to be spoken or heard (Levelt, 1989). This storage of words that are assumed to be in the brain and accessible during comprehension and production of language is termed as ‘mental lexicon’.

The mental lexicon cannot be considered as a mere collection of words, as it also concerns with the representation of meanings of the stored words, the activation, processing and access during language tasks. It also concerns with knowledge about objects and events that are formed through various sensory and motoric exposures in the environment of individuals. This knowledge is termed as ‘concepts’. The mental lexicon along with conceptual knowledge is assumed to be stored in semantic memory. Semantic memory is a type of long-term memory that is a highly structured network of concepts, words and images and is capable of making inferences and comprehending language (Collins & Quillian, 1969). Two lines of research have been conducted with respect to conceptual knowledge and mental lexicon. One is directed at the study of retrieval processes of words and their corresponding meaning from the mental lexicon while the other focuses on elucidation of the structure and semantic representation of words and concepts in the mental lexicon.
2.1 Conceptual Knowledge

Study of concepts and its categorization in the mental lexicon provides an invaluable insight with respect to its structure as the latter is assumed to be storing verbal information about the attributes that define concepts. Concepts are considered as the bodies of knowledge that are stored in the semantic memory and are used by our cognitive processes when we categorize, make inductions, understand languages and draw analogies (Machery, 2007). Concepts form the mental representations of the objects and events surrounding our environment. They bind our past experiences with the present situations of the world and enable us to infer the meaning out of each situation we come across in our daily living. For instance, a concept of dog is a body of knowledge about dogs that is used by default when we categorize entities as dogs, when we understand sentences that contain ‘dog’ and so on (Machery, 2007). Concepts thus are viewed as embodiment of our knowledge about the world helping us understand what each object is and what traits it consists of.

Categorization, on the other hand, is a process of determining whether or not some entity is a member of a category. Categorization thus allows understanding of new entities and to modify and update the existing concepts. Thus a category refers to a set of entities that are grouped together and they are characterized by members that share many features (E.g.: category of animals). Categories thus result from internal representations that capture the structure in the world. It is grouping of vocabulary within a language, organizing words that are interrelated and define each other in various ways. Categories, therefore consists of groups of concepts aggregated together because of the similarities and resemblances that is shared with each other.

There are at least three distinct levels of hierarchies in categories namely:

i) Superordinate
ii) Basic
iii) Subordinate

Superordinate categories are considered to be abstract ones. Members of this category share few similarities with other members (E.g. category Vehicle). Basic level categories store maximum information about the member of the category and share a great amount of similarity with its members (E.g. category Car). The
subordinate categories contain more additional specific information about the members compared to the basic level category (E.g. category Sports car).

Thus the basic level has more attributes in common among its members in comparison to higher-level categories (superordinate category). In comparison with the lower level categories (subordinate category) the basic level contains fewer attributes in common with it. The basic level categories are also of special interest to researchers as they are the fundamental level at which abstractions are made upon the world. Thus there are several levels of conceptual categories of which basic level yields most of the knowledge about the concept.

2.2 Concepts and Mental Lexicon

Concepts, more specifically basic level concepts are studied to describe and understand mapping of conceptual knowledge into lexical semantic knowledge termed as semantic representation. Thus word meaning or Lexical Semantics are assumed to be psychologically represented by mapping words onto conceptual structures (Murphy, 2002). This mapping facilitates easy access of conceptual knowledge through verbal language in the mental lexicon and this knowledge provides the critical information for our interactions with objects and our participation in events. This critical information forms the basis of understanding and producing language for communication. Literature survey proclaims the use of terms ‘word’ and ‘concept’ interchangeable by the researchers owing to considerable similarities between word meanings (lexical semantics) and concepts. Thus a word gets its significance by being connected to a concept or a coherent structure in our conceptual representation of the world. Hence a strong link can be assumed between concepts and word meanings. It can also be observed in the research relating to conceptual knowledge that the results obtained using words as stimuli are interpreted to be true for concepts as well. This is because word meanings and concepts are closely associated such that activation of semantic representations of words in turn activates corresponding conceptual knowledge (Vigliocco & Vinson, 2005). Various empirical evidences as discussed below also support this conceptual basis of word meaning.

The various properties of concepts used to explain structure of conceptual organization such as category membership effects and typicality effects provide a quantum of evidence for conceptual basis of word meaning. Category membership
effect refers to the phenomenon wherein members belonging to the same category are more related to one another than the members in different categories. Typicality effect refers to the phenomenon in which experimental participants respond quickly when typical members of a concept are presented (e.g., robin for the concept bird) as against atypical members (e.g., penguin). Studies have demonstrated these effects, which are well established for concepts, even in pure linguistic experiments such as semantic priming where words are used as stimuli (e.g., Federmeier & Kutas, 1999; Kelly, Bock & Keil, 1986). Hence it is assumed that concept and words are closely associated.

In contrast to this view, there are other factors that provide evidence that word meaning and concepts may not have a straightforward relation. Even though conceptual structure and word meanings have direct influence on each other they do not always share one to one mapping. This is evident in case of synonyms and ambiguous words where in the two words should be mapped onto a single concept in the former case and in latter case a single word should be mapped onto two different concepts. Also it is true that a language user has far more concepts stored in his brain which has no word associated with it. Hence it can be concluded that mapping of words onto concepts is incomplete and there is a distinction between concepts and word at least to a small degree. This is also supported by studies in neuropsychological literature where in semantic deficits have been documented as restricted to linguistic tasks alone (e.g., naming) and not observed for non-verbal tasks (e.g., using tools) (Cappa, Frugoni, Pasquali, Perani & Zorat, 1998; Hart & Gordon, 1992) which suggests only some aspects of concept is represented on a one to one basis with words. Nevertheless the empirical evidences obtained in these studies do not rule out close connections between concepts and word meaning. It is also true that conceptual properties exert great influence in linguistic tasks just as much as they do in nonlinguistic tasks. Hence any theory of one will serve to a large extent as a theory of the other (Murphy, 2002).

Consequently many researchers have studied mental lexicon and concepts by proposing numerous theories and models to describe the same. The structure and organization of concepts along with its corresponding words in the mental lexicon is particularly interesting as it is hypothesized to be a highly structured system and is
organized based on robust organizational principles. The following evidences support this hypothesis.

It is undisputable that the mental lexicon stores huge collection of words because any adult native speaker of a language with basic education has an approximate vocabulary of around 150,000 words, 90 percent of which are likely to be accessed during conversation (Seashore & Eckerson, 1940, in Aitchinson, 1994). Evidences derived through psycholinguistic studies of language involving words recognition, retrieval and speech shadowing task demonstrate that the process of recognition and retrieval of words for speech production and comprehension occurs within milliseconds of exposure to stimuli even before all syllables of the word being heard (Marslen-Wilson & Tyler, 1980, Marslen-Wilson & Tyler& Le Page, 1981 in Aitchinson, 1994). This speed and accuracy are also evidenced in tasks of lexical decision involving non-words suggesting the short duration of time required to thoroughly scan the mental lexicon. To facilitate such quick and efficient mechanism involving large number of words requires systematic organization of words. Hence there is evidence to say that there is an orderly pattern of storage of words in the mental lexicon based on certain principles. It also true that the use of mental lexicon and conceptual knowledge in our daily activities almost goes unnoticed as this process occurs so effortlessly and efficiently that its complexity is experienced only when it is attempted to understand the underlying phenomena, organizational principles and the processes involved.

One of the aspects of conceptual knowledge and mental lexicon that is of interest is its acquisition and learning of categorization of concepts and words into its relevant categories, which formed the initial focus of early research. The initial experimental research on acquisition and categorization of concepts was carried out in the beginning of twentieth century, which has contributed substantial insights into the same. Concepts were initially assumed in the earlier studies (e.g., Hull, 1920; Smoke, 1932) to be represented as ‘definitions’ in the semantic memory. Therefore defining a concept in terms of its characteristic traits formed the key component in meaning representation and categorization of concepts. Hence the acquisition and categorization of concept was viewed as conscious grasping of the specific attributes of an individual item and grouping the ones with same attributes together. Experimental studies demonstrated this learning of concepts and its categorization
using sets of artificial categories such as deformed Chinese letters (Hull, 1920) or meaningless visual stimuli (Smoke, 1932) as experimental stimulus. Learning of these artificial categories for regularities in properties that were useful in defining a concept was quantitatively analyzed for accuracy of categorization to predict the extent to which a category was learnt.

Thus earlier studies presumed concept to be consisting of definition, which is a set of necessary and jointly sufficient conditions of membership. This view of concepts based on definition was later termed as ‘Classical view of concepts’. The representation of concepts, according to this view is a summary description of an entire class, rather than a set of descriptions of various exemplars of that class (Smith & Medin, 1981). However, research mainly in 1960’s and 70’s refuted this classical view of concepts as these theories failed to explain general properties and phenomena such as category membership effects and typicality effects evidenced in behavioral studies involving concepts. Therefore studies involving alternate ways to describe concepts and meaning representation in mental lexicon were witnessed. Despite the attempt of these later proposed theories to describe semantic representation using word as stimuli their findings more directly applies to structure of conceptual knowledge assuming words and concepts to be closely related such that activation of semantic representations of words in turn activates conceptual knowledge mapped to the word.

2.3 Theories and Models of Semantic Representation

The theories proposed to explain the principles of organization of concepts and word meaning can be broadly divided into two types based on their assumption of how word meaning is represented. One set of theories termed as ‘Holistic theories’ assume that word meaning are holistic and non-decomposable in nature. To understand organization, holistic theories stress the importance of types of relations among meanings of concepts. Another type of theories called as ‘Featural theories’ assume word meaning to be decomposable into features or attributes and organization of meaning is explained with respect to featural properties, featural overlap with other concepts (the models of semantic representation are also described in Prarthana & Prema, 2012)
2.3.1 Holistic theories and models.

2.3.1.1 The Hierarchical Network Model. The Hierarchical Network Model was developed by Collins and Quillian in 1969. This model is based on holistic view of meaning representation and is the first model describing in detail the semantic representation and retrieval of words from the mental lexicon. The model was developed employing Artificial Intelligence\(^3\) program written by Quillian in 1968 as an attempt to explain two fundamental factors of the mental lexicon namely its efficient storage of semantic and conceptual knowledge and access of relevant information from this knowledge based on inferential reasoning.

In order to explain the structure of mental lexicon, the model assumes that the concepts in the mental lexicon are arranged in the form of a network as depicted in Figure 1. Every node in this network represents a concept and these nodes are hierarchically organized. The concepts representing most generic ones are at the highest nodes and more specific concepts at the lower nodes of the network. The attributes distinguishing one concept from another at the same level and also from the concepts at higher and lower levels are reported at each node. The connections among concepts in this network is said to be governed by two logical relations namely category membership relation and property relation. Meaning of a concept is computed based on the total configuration of category membership relation and property relation each concept shares with other concepts.

\(^3\)Artificial intelligence is a technology and branch of computer science that studies, designs and develops intelligent machines and softwares using mathematical optimization, logic, methods based on probability and economics. These tools help to develop reasoning, knowledge, planning, learning, communication, and perception.
The model also proposes that one of the important organizational principles of mental lexicon is its property named ‘Cognitive Economy’. Cognitive Economy ensures that the attributes of a concept are represented at only one level of hierarchy in the network. The attributes common to several concepts of the category are represented only at the highest node of the category. For e.g.: the attribute ‘breathes’ is stored only at the highest node in the network namely ‘animal’ and not at the lower levels of hierarchy like ‘fish’. This property of cognitive economy is based on the logical relation that all animals breathe and ‘fish’ belonging to the category animals it breathes too. Hence, the attribute ‘breathes’ is stored at highest level only. Thus the cognitive economy determines the amount of information represented at every node in the network that explains the tremendous storage abilities of the mental lexicon. Also attributes which are applicable to one particular member of the category are stored separately as one of their properties, for instance penguin cannot fly but still belongs to the category ‘bird’. This property unique to the member penguin is stored only at this level.

The assumptions and predictions of this model were subjected to testing using behavioural experiments such as sentence verification and reaction time studies. However the results of the behavioural experiments could not account for the
principle of cognitive economy. The experimental data on the other hand concluded that the attributes are associated with each node in the hierarchy rather than just at the highest node. For example in a sentence verification task involving two sample sentences such as ‘an animal eats’ and ‘a bird eats’ the model based on the cognitive economy predicts that the first sentence takes less time to be verified than the second sentence. The results of such experiments however revealed that the time taken for verification of both the sentences is equal and hence refuted one of the important assumptions on which the model is built. It is also argued that the time required for verification is not dependent on the hierarchy or the levels of the concepts but is dependent on the amount of association present between the concept and its attribute (Conrad, 1972).

The model is also unable to justify the phenomenon of typicality effect seen for members of a category who are good exemplars of the category than others belonging to the same category. For instance, in a sentence verification study (Rips, Shoben & Smith, 1973) participants took less time to verify that ‘a robin is a bird’ than they took to verify that ‘a penguin is a bird’. ‘Robin’ being more typical member of the category ‘bird’ it was verified quickly than penguin, which is not so typical. The model also failed to justify why familiar concepts are verified faster than unfamiliar ones regardless of their level in the hierarchy as reported by studies (Smith, Shoben, & Rips, 1974) where it takes longer time to verify that ‘dog is a mammal’ (lower level) than to verify that it is an ‘animal’ (higher level). Thus, although the hierarchical network model provided detailed description of the structure and retrieval of concepts there were few drawbacks as the model failed to explain many behavioural phenomena associated with mental lexicon. The model nonetheless provided a strong framework for the future models of mental lexicon developed.

2.3.1.2 Spreading activation model. As described in the previous section the Hierarchical network model had shortcomings and was unable to account for the experimental evidences of behavioural studies. In an attempt to overcome these drawbacks, Collins and Loftus in 1975 developed the Spreading activation model by adding several other assumptions with respect to the structure and working of the Hierarchical network model. One of the major revisions made to the model was elimination of the strict hierarchy. Hence the spreading activation model assumes that direct connections are possible among any two concepts or attributes. The
interconnected units of information are called as nodes (Figure 2) similar to their previous model. The nodes are connected through links that are formed on the basis of association of each concept or attribute with another. The organization of concepts into close associations is proportional to the thickness and the length of the link. Unlike the previous, this model also assumes that the connections between concepts are not always based on logical relations but personal experiences despite being not logical can lead to the formation of links.

The processing and retrieval of information is initiated by spreading of a pulse of activation among the nodes of the network through their links. Thus, when a node is activated, there is spread of this pulse of activation to the nodes that are linked to it. These nodes further spread the activation to other nodes along their connections. The length of the link determines the strength of the activation. Longer the link between two nodes weaker is the activation reaching the other node. Activation is also weak as it passes over the farther nodes until it completely dissipates. This assumption of the model can explain the basis of semantic and associative priming in the lexicon and the model can also account for various phenomena namely familiarity effect, typicality effect, and concept-attribute associations.
Figure 2. Spreading Activation Model (source: Collins and Loftus (1975))

However the model was questioned for its assumption that personal experiences influence the connections in the mental lexicon. If this assumption were true then the organization of mental lexicon will be entirely idiosyncratic varying from one individual to another which is not practical. The model is also unable to account for the influence of phonology, syntax and morphological aspects of lexical items, which also play a vital role in the language processing. In order to account for these linguistic factors the revised spreading activation model was proposed by Bock and Levelt (1994) the structure of which is depicted in Figure 3.
2.3.1.3 The Adaptive Character of Thought (ACT) model. The ACT model was developed by Anderson (1976; 1983) as a general framework to describe the organization of knowledge in the brain. It is a computational model comprising of a production system that is responsible for carrying out higher-level cognitive operations utilizing declarative, procedural and working memory. This framework has been employed to understand organization of linguistic information in the mental lexicon. One of the assumptions of this model is that there are separate representations for concepts and their corresponding words in the brain as opposed to previous models discussed so far. This assumption is based on the argument that there can be concepts in the brain which cannot be lexicalized into words but there are no words which do not have a concept mapped to it (Fellbaum, 1998). Hence there may not be direct one to one mapping of concepts and words in the brain.

The model proposes that the information about a concept and its possible connections with other concepts is highly influenced by the contexts and environment in which the concept most frequently occurs. Hence this model is unique because unlike previous models, it is not dependent entirely on just the meaning and connections among words but it emphasizes that the organization is also dependent on the function and context of words. Therefore, according to this model the words are

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A computational model is a mathematical model in computational science that requires extensive computational resources to study the behavior of a complex system by computer simulation.
organized based on the real-world, practical relationships among words along with their meanings (Anderson, 1996).

2.3.1.4 WordNet model. Another important model proposed based on holistic theories of meaning representation is the WordNet model. The WordNet comprises of an electronic lexical database\(^5\) developed by Miller in 1995. This database consists of words that are arranged into group of synonyms called synsets. The synsets are further hierarchically organized to form a network as in Collins and Quillian’s model (1969). Since it is not possible to have exact synonyms for all the words the model proposes terms called hyponymy and hypernymy for such words with non-exact synonyms. For example in the word pair dog and animal, dog is the hyponymy and animal is its hypernymy. The main drawback of this model is that it does not consider context of occurrences of words and hence fails to adequately address concepts that are functionally related. Similar to the one developed for English language, a lexical database called ‘indowordnet’ (http://www.cfilt.iitb.ac.in/indowordnet/) has been developed for 18 Indian languages by Indian Institute of Technology, Bombay.

2.3.1.5 Computational and Statistical models. These sets of models were developed to describe organization and connections of words by employing various computational and statistical procedures which facilitates discovery of the relations words may possess. These models do not have any prior assumptions about the organizational principles. The most influential models based on this approach are Latent Semantic Analysis (LSA, Landauer & Dumais, 1997) and Hyperspace Analogue to Language (HAL, Burgess & Lund, 1997). These models compute word meanings based on the linguistic context and frequency of co-occurrence of words, which is determined employing large corpora of texts. The main drawback of these models are that they do not take into account real world experiences as they are focused on only certain limited aspects of relations among words.

The holistic theories proposed thus tried to explain the structure and organization of concepts assuming each concept to be non-decomposable units of information. The connections between these units played vital role in processing and storage of information. Every theory had its own set of assumptions and rules based

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\(^{5}\) The access to WordNet lexical data base can be obtained through this address https://wordnet.princeton.edu/wordnet
on which it was built. The holistic theories was quite successful in addressing the issues of organization, however most of them failed to accommodate the behavioural evidences obtained during testing of the predictions of their theories which was received as a severe drawback. For instance, the Hierarchical model was based on the assumption of cognitive economy which was unable to receive support using behavioural studies. The typicality effect seen for concepts also could not be explained based on the organization of hierarchical model. The spreading activation model was proposed assuming no strict hierarchies among concepts however they emphasized on the role of personal experience in the formation of links and networks among concepts which received criticism as it leads to idiosyncratic representation for each individual. Some of the theories such as LSA & HAL proposed were criticized for not taking into account the real world experiences. The holistic theories nonetheless provided an initial groundwork for studying mental lexicon. Featural theories propose to overcome the drawbacks of holistic theories. These theories were based on the assumption that word meanings are decomposable and are represented as sets of features/attributes that may be unique and/or shared by concepts.

2.3.2 Featural theories and models

2.3.2.1 Semantic Feature Comparison model. The models based on holistic theories described in the previous section were less capable as they were producing inconsistent and erroneous predictions for most of the behavioural phenomenon associated with the meaning representation in the mental lexicon. Hence with the aim of studying organization from a featural perspective Semantic feature comparison model was developed by Smith, Shoben and Rips in 1974. The model assumes that the concepts in the mental lexicon are represented as set of attributes/properties termed as semantic features (a detailed description of semantic features is presented in section 2.5 of this chapter). These semantic features add together to form the meaning of the concept (Smith et al., 1974). For instance, consider the concept ‘apple’ for which features such as red in colour, fruit, sweet, grows on trees can be present in the mental lexicon.

The model also assumes that these semantic features are of two types namely ‘Defining features’ and ‘Characteristic features’. Features that are very crucial to define a concept are termed as Defining features. Characteristic features on the other
hand are features strongly linked with a concept but which are not very crucial to the concept’s definition. The defining features are often relevant and present for all the members of the category, the characteristic features however are specific to only few members of the category. Example for defining features according to this model for ‘bird’ are has wings, lays eggs, and has feathers and the characteristic feature is ‘can fly’ because this feature may not be present for all birds (E.g., Ostrich) (Figure 4). Another assumption of this model is that the superordinate members of a category have less number of defining features compared to subordinate members.

![Semantic Feature Comparison model](source: Smith et al., 1974)

The predictions of this model were subjected to testing by employing behavioural measures such as sentence verification tasks. The tests involved analysis of time taken by the participants to verify whether a sentence such as ‘robin is a bird’ Vs. ‘ostrich is a bird’ is true or false. If the predictions of the model are correct, the statement ‘robin is a bird’ should be verified faster as it has higher featural similarity between its subject (robin) and predicate (bird) than with the sentence ‘ostrich is a bird’. The results of these experiments were in congruence with the predictions made by the model. The model’s predictions were also grounded to principles of meaning similarity and relationship between the subject and predicate. Hence this model has been highly successful in accounting all the main findings in the research of
behavioural experiments. However, the model nonetheless had few shortcomings in its predictions (Holyoak & Glass, 1975; McCloskey & Glucksberg, 1979).

In spite of its effectiveness in predicting behavioural phenomenon, this model received criticism that the assumption of semantic representation involving two types of features (defining and characteristic) may not be always true as defining features cannot be identified for all of the concepts present in the mental lexicon (Fodor, Fodor & Garrett 1975; Fodor, Garrett, Walker & Parke, 1980). Researchers also argued that if word meanings are decomposed the speakers always substitute superordinate category names for subordinate ones (animal for dog) (Roelofs, 1997; Levelt, Roelofs, & Meyer, 1999). To overcome this pitfall, a computational model was proposed by Bowers in 1999. This revised model has lateral inhibitory connections between two lexical items that facilitates accurate production of both subordinate and super-ordinate category members.

Another model based on same principle assumptions as semantic feature comparison model was proposed by McCloskey and Glucksberg (1979). This model is similar to semantic feature comparison model as it also considers semantic relatedness as a principle of organization and tests the predictions of model based on semantic similarity and relatedness. However, the difference between the two models is that, unlike feature comparison model, one of the assumptions of this model is that there is no distinction between defining and characteristic features and both the feature types are considered to lie in the extreme ends of a continuum. This overcomes one of the drawbacks of semantic feature comparison model as researchers have argued that it is not always possible to know exactly how to distinguish between the two feature types. The second difference is related to that of processing of information wherein the latter model assumes only one comparison stage for all features of the sentences that is used in prediction experiments as opposed to previous model where comparison was assumed to occur at two levels. First level for all features of both subject and predicate and second level for defining features only to generate a similarity index. The third difference is at the level of output, unlike previous model which uses similarity index generated, the latter model uses a
Bayesian decision\(^6\) mechanism to make rational decisions about the test sentences based on the output evidences from comparison process. This model has been quite successful in accounting for the predictions of verification experiments.

**2.3.2.2 Prototype theory.** One of the most influential theories which provided strong evidence against classical view was proposed by Rosch and Mervis in 1975 termed as Prototype theories. Refuting classical view, the theory proposes that most of the concepts are *not* organized in terms of necessary and sufficient conditions that would lead to a conjunctive definition of a category. Instead they are dependent on properties that are generally true for most of the members of the category but not true for every category member. The semantic knowledge about these properties of a concept is assumed to be stored in a set of *‘Prototypes’* for each category. These prototypes of a category thus specify properties that are most likely to be present in the category member.

Prototype theory also proposes that members of a category have a ‘family resemblance’ structure. The category membership of an exemplar depends basically whether the exemplar has enough characteristic properties to belong to the category (Smith & Medin 1981). According to this theory, not all category members are equally ‘good’ examples of a concept. The membership is based on characteristic properties and some members have more of these properties than others, so the ones with more properties better exemplify the category (Rips & Medin 1981). For instance ‘Robin’ but not ‘Penguin’ has most of the characteristic properties of category ‘Bird’. So ‘Robin’ would be typical exemplar for the category than ‘Penguin’, which is an atypical exemplar. Exemplars considered to be typical members are found to have many properties in common with other category members and few distinguishing properties, whereas the exemplars considered being atypical members have fewer properties in common and hence more properties unique to it. The theory was tested using various behavioral experiments to verify prototypicality of category members and family resemblances. The results showed that family resemblance within categories and lack of overlap of elements with contrasting categories were correlated with ease of learning, reaction time in

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\(^6\) Bayesian Decision Theory is a fundamental statistical approach that defines how new information should be combined with prior beliefs and how information from several modalities should be integrated to make optimal decisions (Kording & Wolpert, 2006)
identifying an item after learning, and rating of prototypicality of an item (Rosch & Mervis, 1975). The idea of family resemblances thus had greater implications in understanding conceptual categorization according to which natural clustering of members of a category occurs due to sharing of many characteristic features. This phenomenon is also known as co-relational structure of features. These theories thus played a vital role and were responsible to come up with the notion of categorization of concepts based on similarity in meaning.

Despite of the criticism against the assumptions of defining features in the feature comparison model (Fodor, Fodor, & Garrett 1975; Fodor et al., 1980), still various alternative types of featural approaches to study conceptual knowledge have been witnessed in the literature (E.g., Farah & McClelland, 1991; Devlin, Gonnerman, Andersen, & Seidenberg, 1998; Hinton & Shallice, 1991; McRae, et al., 1997; Vigliocco, Vinson, Lewis, & Garrett, 2004). These approaches assume that semantic features are the building blocks of semantic representation which are acquired by concrete interactions with the environment and that these conceptual features are grounded in perception and action (Vigliocco & Vinson 2007). Therefore these featural theories stress the importance of sensory (perceptual) and motor (action) information in conceptual organization.

2.4 Role of Sensory and Motor Information in Semantic Representation

A majority of theories of semantic representation assume that the sensory and motor information about a concept stored in the brain play a vital role in semantic representation. The sensory and motor information is accumulated in the brain during the process of learning these concepts through experience from the environment. The theories proposed to study semantic representation can also be differentiated on the basis of their assumptions with respect to the contribution of sensory and motor information in computing and representing meaning.

A set of theories proposed to study cognitive representation called the embodied theories of cognition adhere to the assumption that semantic representation and retrieval is entirely dependent on simulations in the brain (Barsalou 1999, Jeannerod, 2001; Hesslow, 2002; Gallese & Lakoff, 2005 in Meteyard & Vigliocco, 2008). In other words, these theories say that meaning representation for words is based on simulation involving activation of sensory motor systems in the brain areas.
that are involved during real life experience of these linguistic units. In other words, semantic content of a word form is assumed to be realized by recreating in weaker version, the sensory and motor activation generated during actual experience of the referents of the word (Meteyard & Vigliocco, 2008). According to these theories semantic representation occurs as a result of embodied content through Hebbain learning 7 where the sensory activation and motor activation together forms the representation of word/ linguistic unit leading to multimodal conceptual representation. Such theories that believe that the sensory motor modalities are directly and should necessarily be engaged to represent and retrieve meaning of words are referred to as stronger versions of embodiment. By direct engagement these theories rule out the mediation of other cognitive processes that helps the semantic system to access sensory motor modalities.

Weaker versions of embodiment theories (E.g.: Vigliocco et al., 2004; Jackendoff, 2002; Farah & McClelland, 1991; Tyler & Moss, 2001) believe that the semantic representation comprises of information from sensory and motor modalities however direct activation of these modalities are not always required. These modalities exert influence on semantic processing of linguistic units as they are strongly associated with both, the experience of those events and their semantic representation. Also, the activation of sensory motor system is mediated by cognitive processes such as attention or perceptual learning (Meteyard & Vigliocco, 2008) but this activation is not to the extent of simulation. Most of the featural theories of conceptual organization implicitly believe in weaker versions of embodiment. Featural theories thus assume that the semantic representation is mediated by a supra-modal representation that binds together modality related conceptual features (Vigliocco et al., 2004). Third set of theories propose an amodal semantic system which is independent of sensory motor systems (E.g.: Collins & Loftus, 1975; Levelt, 1989; Landauer & Dumais, 1997). The interactions with sensory motor systems is explained in these amodal theories to occur through indirect mechanisms outside the semantic system.

7Hebbain learning is a neural phenomenon based on Hebb’s law, introduced by Donald Hebb, which states that when an axon of cell A is near enough to excite cell B and repeatedly or persistently takes part in firing it, some growth process or metabolic change takes place in one or both cells such that A’s efficiency as one of the cells firing B, is increased.
Various studies have been conducted in the field of behavioural sciences (E.g.: Tucker & Ellis, 1998; Richardson, Spivey & Cheung, 2001; Myung, Blumstein, & Sedivy, 2006; Meteyard, Bahrami, & Vigliocco, 2007; Siakaluk, Pexman, Aguilera, Owen, & Sears, 2008), neuropsychology (E.g., Neininger & Pulvermüller, 2001; Spatt, Bak, Bozeat, Patterson, & Hodges, 2002; Bak, Yancopoulou, Nestor, Xuereb, Spillantini, Pulvermüller, & Hodges, 2006; Boulenger, Mechtouff, Thobois, Broussolle, Jeannerod, & Nazir, 2008; Mahon & Caramazza, 2008) and neurosciences (Damasio, 1990; Damasio & Damasio, 1994; Pulvermüller, 1999, 2001; Tettamanti, Buccino, Saccuman, Gallese, Danna, Scifo, et al., 2005; Aziz-Zadeh, Wilson, Rizzolatti, & Iacoboni, 2006; Vigliocco, Warren, Arcuili, Siri, Scott, & Wise, 2006; Grabowski, Damasio, & Damasio, 1998; Chao & Martin, 2000; Gerlach, Law, & Paulson, 2002) to provide evidence for these three sets of theories. The summary of evidences from these studies point out clearly the importance of sensory and motor information in the semantic representation. These studies do not rule out strong connections between areas involved in experiencing sensory and motor information and representation of these information in linguistic forms, however the absolute necessity of simulation is still questionable which leads to believe in weaker embodiment as well. However the theories supporting amodal independent semantic systems received a severe drawback owing to lack of evidence to support the same. Therefore the theories proposing both strong and weak embodiment have equal evidences and call for more detailed and complex investigations to refute any one of them. Thus featural theories and models of conceptual organization proposed on the basis of semantic features which are based on weak embodiment received supporting evidence.

2.5 Semantic Features

The featural models of semantic representation as emphasized earlier are based on semantic features and the study of nature and properties of speaker generated semantic features provide valuable information about the semantic representation and organization. Semantic features form the basic component of various theories proposed to account for meaning representation of words in a language. Semantic features refer to sets of attributes related to a concept wherein each attribute/semantic feature has a part of information about the concept which is stored in the mental lexicon and these semantic features when added together
represent the meaning of their associated concept. Semantic features are evidenced to provide clearer and in depth understanding of the organizational principles of mental lexicon along with behavioural phenomena observed in the mental lexicon. Hence semantic features are collected for large sets of words and studied for their properties, which reflect crucial aspects of semantic representation and conceptual categorization.

The semantic features are typically collected from participants as lists of features for a concept/word, which the participant considers to be most salient. For instance, consider the concept ‘apple’, the semantic features that can be generated for this concept include, <fruit>, <red>, <sweet>, <grows on trees> etc. Semantic features are also collected in constrained conditions where in the participants have to fill in the set of simple sentences instead of freely listing the features. For example a dog is a ____; a dog has ___ where the examiner dictates the type of feature that is to be generated. The task of semantic feature collection thus depends on the nature of study. Features are collected for various categories of concrete nouns and verbs referring to numerous concepts that are present in the mental lexicon. These concepts are selected based on the familiarity and their usage in previous behavioral research so that they provide common ground for comparison.

Semantic features are considered to provide valid information not because they yield a literal record of semantic representations in the brain but rather because such representations are used systematically by participants when generating features (Barsalou, 2003). Thus when participants list semantic features, they directly exploit representations that have developed through repeated multisensory exposure to, and interactions with exemplars of target category (McRae, Cree, Seidenberg, & McNorgan, 2005). Hence during the process of feature generation for a particular target concept, participant refers to a mental imagery of the concepts, which includes the essential features in describing the target concepts and also those which help to distinguish the target concept from rest of the similar concepts. This mental imagery is assumed to be created online for the task of feature generation by the participants. Apart from the features listed during feature generation, there are certainly other aspects about the concepts that are stored in the lexicon which may not be easy to verbalize. For instance, the visuo- spatial relations associated with movement of an animal that is encoded in the brain in order to differentiate between similar ones may
be missing in the featural makeup generated verbally. Despite this drawback, the semantic features nonetheless provide an opportunity to understand important aspects of word meaning and its representation.

Apart from its implementation in developing models, semantic features norms have also been useful in conducting various behavioural tasks such as feature verification experiment, typicality studies, semantic priming studies and concreteness decision experiments. The behavioural experiments based on these tasks are conducted in order to support the predictions and assumptions of theories and models using empirical evidences obtained from these experiments. These experiments in turn explain various aspects of semantic processing and representation in the mental lexicon.

Acknowledging the importance and usefulness of semantic feature norms in understanding lexico-semantic representation, a look into the literature reveals that researchers have tried to establish these norms in languages such as English, Dutch, Italian and few others. To list a few, Rosch and Mervis (1975) collected semantic feature norms for 20 basic-level concepts from each of six superordinate categories and used them to explore typicality gradients. Ashcraft (1978b) collected norms for 140 living and nonliving things to use them for constructing feature verification experiments.

Hampton (1979) collected features for eight superordinate categories and used them to test Smith, Shoben, and Rips’s (1974) model of category verification and to predict verification latencies. Wu and Barsalou (2009) used feature norms to compare predictions derived from theories based on perceptual symbol systems versus amodal semantics. Devlin, Gonnerman, Andersen, and Seidenberg (1998 for 60 living and nonliving things) and Moss, Tyler, and Devlin (2002 for 93 living and nonliving things), Garrard, Ralph, Hodges, & Patterson (2001), used their norms to investigate accounts of category-specific semantic deficits.

McRae, Cree, Seidenberg, and McNorgan (2005) collected semantic feature norms from 725 participants for 541 living and nonliving basic-level concepts and have made them publicly accessible for use in research. Ruts, De Deyne, Ameel, Vanpaemel, Verbeemen, & Storms (2004) made an extensive set of semantic feature norm, gathered in the Dutch-speaking community for 13 superordinate categories,
encompassing a total of 338 target words. Vinson and Vigliocco (2008) have also provided a set of semantic features collected from 280 participants for 456 words (169 nouns referring to objects, 71 nouns referring to events and 216 verbs referring to events). They have further used these norms in research addressing questions concerning semantic representation of objects and events, the interface between semantics and syntax and influence of grammatical class in organization of mental lexicon.

Further, normative data for 15 semantic categories in Dutch language has been established by De Deyne et al. (2008). For all exemplars of the 15 semantic categories, typicality ratings, goodness ratings, goodness rank order, generation frequency, exemplar associative strength, category associative strength, estimated age of acquisition, word frequency, familiarity ratings, imageability ratings, and pair wise similarity ratings were also described. In Italian languages Kremer and Baroni (2011) have collected semantic features for 50 nouns and Montefinese, Ambrosini, Fairfield and Mammarella (2012) for 120 nouns and also from congenitally blind Italian participants by Lenci, Baroni, Cazzolli, & Marotta (2013) for 50 nouns and 20 verbs.

2.5.1 Semantic feature properties. The collected semantic feature norms are studied for the regularities of distribution of semantic feature properties using different statistical measures in order to understand semantic representation and organization of concepts based on semantic features.

2.5.1.1 Number of features and Featural weight. The semantic feature properties such as distribution of number of features across each concept, each category and domains have been studied (Vinson, 2009). The measure of number of features generated for a concept is associated with semantic richness in the representation of that concept. Presence of more number of features for a concept indicates greater semantic richness and vice versa. Another important property that has high significance in elucidating the featural makeup of a concept is featural weights. Featural weights are obtained by calculating the total number of participants in the semantic feature data who have generated a particular feature for a particular concept. Hence by investigating about this featural property, it is possible to know how much weightage each semantic feature holds in describing and representing a
concept. The significance of this analysis of featural weight is immense as it is based on the participant’s discretion on how salient a feature is for a concept.

2.5.1.2 Types of semantic features. The semantic features are studied by classifying the features into different types of features based on the information that they carry. The importance of studying types of features in the norms and the basis of this classification is the modality specific processing of information in the brain. According to embodiment theories discussed earlier, the knowledge about a concept is distributed as patterns of activation across modality specific processing areas of brain. This modality specific representation has been widely accepted as it has substantial empirical evidence over amodal, abstract way of semantic representation. Thus according to modality specific semantic representation, a concept’s representation is the sum of the activation across primary sensory-processing channels, motor/action areas, higher order abstract-knowledge areas, and mediating association areas (Cree & McRae, 2003). Whenever a participant attempts to generate features for a concept, he consults a summary of representation of the concept that is formed in the brain as a result of repeated activation through these sensory and motor modalities. This summary representation is also sometimes referred to as mental imagery. Participants extract features from this summary representation that are important to describe that particular concept and also features which help to differentiate the concept from similar ones. Hence based on summary representation across different types of modalities such as vision, touch and motoric areas various proportions of feature types may result in the semantic feature norm. Thus the study of feature types helps in elucidating representation and organization of conceptual knowledge and words in the mental lexicon as well as in understanding patterns of semantic impairment in persons with semantic deficits.

Initially the study of feature types in persons with semantic deficits on various semantic tasks were focused upon as they provide evidence to understanding of category-specific semantic deficits and in turn organization of concepts in healthy individuals. Category-specific semantic deficit refers to the phenomenon wherein patients exhibit differential levels of impairment across different semantic categories and domains (Warrington & Shallice 1984). The first report on such phenomena was given by Warrington and Shallice in 1984, who described four persons recovering from herpes simplex encephalitis who were disproportionately impaired in producing
and comprehending the names of living things as opposed to nonliving things. The opposite pattern wherein nonliving things are better comprehended and produced than living things have also been reported in literature. The distribution of different types of sensory and non-sensory features (functional and/or motoric features) has been studied as an important factor that may underlie such category specific deficits. This formed the basis which led to the study of classification of different types of features.

The features are generally classified into sensory and non-sensory/functional features. Accordingly, many theories of category-specific deficits have been proposed based on this classification namely Sensory/Functional theory (Warrington & Shallice 1984), and Sensory/Motor theory (Martin, Ungerleider, & Haxby, 2000). According to these theories, the living things tend to possess greater proportion of sensory features (e.g., dog, {has four legs}) and non-living have more prominent functional features (e.g., Scissors, {used for cutting}). Consequently, if brain damage disrupts sensory feature knowledge then features related to living things tend to be more affected and if there is disruption in the non-sensory feature knowledge then the features related to nonliving things are more affected. Deficits may reflect differential weighting of information from various sensorimotor channels in the representations of living and nonliving things and hence, the category deficits may not be living/nonliving category in nature, but rather, it would be sensory/functional (McRae & Cree, 2002) in nature.

However this dichotomous classification was criticized as having very limited scope to account for the pattern of deficits as it has only two degrees of freedom with only two types of features. It also does not consider substantial amount of information that is stored in other types of features. The demerits of this classification were overcome by detailed classification of semantic feature types given by Wu and Barsalou in 2009. According to this classification each feature is considered to reflect a type of knowledge that is stored in the semantic representation of the concept. Therefore, feature types are referred to as knowledge-type and this classification of features is termed ‘knowledge type taxonomy’. The following factors are accounted for in the development of knowledge-type taxonomy (as described in McRae and Cree, 2002)
1) The set of feature types is designed to cover the tremendous variety of features that subjects generate when describing conceptual content.

2) It is designed to capture the wide variety of information found in ontological kinds (i.e. higher level categories e.g., Keil, 1989), and in event frames and verb arguments (e.g., Barsalou, 1992; Schank Abelson, 1977; Fillmore, 1968).

3) It is designed to correspond systematically to the modality-specific regions of the brain (e.g., motor, somatosensory, and visual cortices).

4) The feature types for entities reflect well-established channels of sensory information in perception (e.g., shape, surface, occlusion, movement).

5) The feature types reflect aspects of introspective experience, as well as aspects of sensory-motor experience.

Based on the above factors, semantic features are classified into 4 major classes namely Entity, Situation, Introspective and Taxonomic. Each of these classes is again subdivided leading to a total of 28 feature types. This classification of features is also adopted by researchers (McRae et al., 1999; McRae & Cree 2002) with suitable modifications (used 21/28 feature types) and additions of feature types (1 feature type) to understand their semantic feature norms generated. It is used to develop stimuli for experiments and to study category-specific semantic deficits. The feature type analysis is also very useful to understand the contribution of semantic feature in categorization of concepts based on salience of each feature type (McRae et al., 1999).

The classification given by Wu and Barsalou is very detailed and useful but it is basically developed as a part of studying perceptual simulation and not semantic feature norms. It is also not clear how all of these feature types can correspond to brain regions. Classification of feature types that helps to map features onto specific areas of processing in the brain can provide more valid information for researchers who are studying differentially damaged mental lexicon and conceptual knowledge. With this view, Cree and McRae in 2003 have developed a knowledge type taxonomy linking featural information to processing regions of the brain. Their semantic feature classification consisted of nine knowledge types. The three of the feature types corresponded to visual information, four to other perceptual modalities, one corresponding to functional/motor information describing the interactions and uses of
the entities and the last type corresponding to all other knowledge types. Therefore
the nine different feature types are labeled as follows:

1) Visual– colour
2) Visual–parts and surface properties
3) Visual–motion
4) Smell
5) Sound
6) Tactile
7) Taste
8) Function
9) Encyclopaedic

This classification is based on the assumption that semantic knowledge

The semantic features are also classified into five similar categories to study
distribution of semantic information in the sensory and motor modalities using
semantic feature norms for object nouns, action nouns and action verbs (Vinson,
2009). The five categories are:

1) Perceptual features- visual features
2) Perceptual features- others
3) Functional
4) Motoric
5) Other features

The first category is termed ‘Perceptual features’, as described by Vinson (2009) which includes features that describe information gained through sensory modality, including body state and proprioception. Perceptual features are further divided into two types namely ‘Visual Features’ and ‘Other Perceptual Features’. The visual features include features that describe information gained through visual modality and ‘Other Perceptual Features’ included features that describe information gained through any other sensory modalities Third category of features are classified as ‘Functional’ which refers to features addressing the purpose of a thing, "what it is used for", or the purpose or goal of an action. Fourth category is ‘Motoric’ which include features describing "how a thing is used, or how it moves", or any feature describing the motor component of an action and the fifth, the ‘Other Features’ include those features meeting none of the previous classifications. Some of the features classified as ‘Other Features’ are encyclopedic (e.g., [comes from] <Africa>); while others refer to relationships among meaning components, (e.g., ISA <animal>; PART OF <face>).

Based on the distribution of the types of features researchers have gained insight about importance of each type of feature in the representation of meaning. Disruption with respect to each feature type and its impact on the resulting impairments are also studied by developing computational models using feature types as basis of conceptual organization. One such model was constructed by Farah and McClelland (1991) for words belonging to both living and nonliving entities. The semantic feature distribution is found to vary in these entities with living things possessing more visual-perceptual features and nonliving things having more of functional features. This difference in featural distribution were derived from an experiment where in participants were asked to rate individual elements of meaning in terms of sensory/perceptual or functional content. The model was lesioned targeting visual-perceptual and/or functional features to demonstrate different types of category-specific semantic deficits. Hence classification of features generated during norming task into different types has been considered a significant issue for investigation.
2.5.1.3 Distinctive features and shared features. Semantic features can be also studied by classifying the features into distinctive and shared features. Distinctive features are those features that occur in only one or two concepts of a category and therefore, are unique to a small set of concepts. Shared features are those that are present across many concepts. While distinctive features are crucial in discriminating among similar concepts, the shared features are presumed to provide stronger correlation as they are present across many concepts and thus are crucial for formation of categories.

Distinctive features are very essential in providing cues to identify their corresponding concept and are vital in describing patterns of errors in persons with semantic deficits as well as organization of concepts in healthy individuals. Studying distinctive features has thus been given much importance and studied extensively under different terms namely cue validity (Bourne & Restle, 1959), distinguishingness (Cree & McRae, 2003), distinctiveness (Garrard, Lambon Ralph, Hodges, & Patterson, 2001) and informativeness (Devlin, Gonnerman, Andersen, & Seidenberg, 1998). Distinctive features have also been viewed as a continuum in which truly distinctive features lie at one end and highly shared features at the other (Cree, McNorgan, & McRae 2006).

Distinctive features, in terms of cue validity, is measured as the probability of a feature appearing in a concept divided by the probability of that feature appearing in all relevant concepts (Bourne & Restle, 1959). Distinctive features, according to this definition are supposed to be possessing higher value in cue validity measure compared to shared features as it occurs in only one or two concepts (Rosch & Mervis, 1975). Shared features on the other hand, tend to appear in many concepts hence possesses very low value in cue validity measures. The cue validity measures are considered critical in categorization of concepts in the mental lexicon. The category membership is described in terms of cue validity as those items with features most distributed among members of a category and least distributed among members of contrasting categories. These form the most valid cues to membership in the category (Rosch & Mervis 1975). Distinctive features are also described as informativeness that each feature may provide to identify a particular concept as some of the features of a concept are more relevant and informative than others to categorize it (Devlin et al., 1998).
Further, distinctive features are considered critical in unfolding the differences in nature of representation between living and nonliving concepts in the mental lexicon (Garrad, Lambon, Ralph, Hodges, & Patterson, 2001). Distribution of distinctiveness, which is a measure equal to the proportion of concepts, for which a feature is present, is reported to vary for living and nonliving domains. The domain of nonliving things has more distinctive features than non-distinct for feature types sensory, functional and encyclopedic. On the other hand, for living things only the encyclopedic features have more distinctive features compared to sensory and functional features (Garrad et al., 2001). With respect to categories of animals (living things) and tools (nonliving things) distinctive features are reported to be more significantly correlated for animals than those for tools (Vinson, 2009) in concord with the findings by Garrad et al. (2001). Similar trend is also reported in Kannada (Prarthana & Prema, 2013) where nonliving things tend to possess more number of distinctive features compared to living things. Thus distinctive feature distribution varies with respect to domains and hence, is vital in explaining categorization of concepts into domains.

Distinctive features are also employed in developing models of semantic representation. One of the influential models based on distinctive features was the Conceptual Structure Account (Tyler & Moss, 2001) which supports distributed connectionist system for semantic representation. According to distributed system, each concept is composed of several units corresponding to the concept with no explicit category boundaries between the concepts. Each concept is assumed to activate overlapping patterns across units representing that concept. The semantic features vary in the degree to which they are distinctive for a particular concept or shared with other concepts and the frequency with which they co-occur with other features. This gives rise to the internal structure of the semantic system. Shared features thus are important in indicating category membership whereas distinctive features are critical for identification of concept. The model also claims that in the domain of living things presence of a distinctive feature does not strongly predict the occurrence of other properties. In other words living things have less correlation

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8Connectionist models is type of neural network made up of interconnected simple processing devices which include a set of processing units, a set of modifiable connections between units and a learning procedure which is suitable to model mental/behavioural phenomenon.
among distinctive features but high form function correlation (e.g., wings (form) - used for flying (function)) compared to nonliving things.

The predictions of conceptual structure account were tested to support the model with empirical evidences by conducting series of behavioural experiments (e.g., Randall, et al., 2004) using speeded feature verification tasks. The conceptual structure account as described by Randall, et al. predicted that the distinctive features of living things tend to be activated more slowly in the normal system based on the assumption that these features are weakly correlated relative to shared features of living things and both distinctive and shared properties of nonliving things. The experiments support the prediction where in for living things, the more distinctive a feature is, the slower the reaction time in speeded feature verification task and no such effect was seen for nonliving things (Randall et al., 2004).

The speeded feature verification latency however is greatly influenced by the production frequency of the distinctive and shared features studied (Cree, McNorgan, & McRae, 2006; Lamb, 2012). Also, the length of feature names and frequency of occurrence of feature names have significant effect on verification latency. Experiments with these variables controlled and aiming at testing the role of distinctive features in semantic representation were conducted. Contrast to the previous findings (Randall, 2004), it was demonstrated that distinctive features strongly activate their corresponding concepts than shared features.

The distinctive features also aid in interpreting the various trends of semantic deficits seen in patients with category-specific semantic deficits. Inaccessibility to these distinctive features that are informative in distinguishing between two concepts is contemplated to be one of the reasons leading to errors of naming. Computational model have been developed (e.g., Devlin, 1998) based on the distinctive features’ informativeness in order to simulate category specific semantic impairments resulting from varying degrees of focal and diffuse brain damage. The model generated to simulate focal and diffuse brain damage was highly influenced by this informativeness (distinctive features) property of semantic representation. Therefore distinctive feature loss was predicted to produce severe behavioural consequences than the loss of shared features. The analysis of distribution of distinctive features for each concept can indeed predict the likeliness of impairment of that particular
concept, in case of brain damage (Cree & McRae, 2003). With respect to percentage of distinctive features, the domain of living things consists of a low percentage of distinctive features than the domain of nonliving things which provides evidence for the pattern of deficits where living things are more likely to be impaired than nonliving things.

Distinctive features therefore occupy a special status in semantic representation as they form indispensable part of concept organization in the mental lexicon. Categorization of concepts into different semantic fields, into domains of living and nonliving things has been influenced by distribution of distinctive features. Various models explaining semantic organization are also based on distinctive features. The distinctive features even contribute as a significant factor in the explanation for semantic deficit patterns recorded in persons with semantic impairments. Therefore, study of distinctive features is considered imperative in understanding semantic representation.

Shared features on the other hand are defined, contrasting distinctive features, as those features which occur in the featural makeup of two or more concepts. They provide valuable information about the relationship among concepts. They also influence performance in various behavioural experiments such as semantic priming. They play crucial role similar to distinctive features, in many theories (E.g., Rosch & Mervis, 1975; Tyler & Moss, 2001; Smith, Shoben, & Rips, 1974) proposed to explain semantic organization and category specific semantic deficits. Concepts sharing many features in common with other concepts are considered to be semantically similar to each other. The concept similarity in terms of featural overlap is a primary organizational principle of mental lexicon and hence, it is said that the featural similarity is one dimension along which the semantic network is organized (McRae & Boisvert, 1998; Collins & Loftus 1973). It is also true that concepts with many shared features have a large number of strong associative links through them (McRae & Boisvert, 1998).

Analysis of distribution of shared features in the semantic feature norms, similar to distinctive features facilitates understanding of semantic representation in the mental lexicon. The distribution of shared features across different semantic fields with respect to concrete objects (Cree & McRae 2003; Vinson 2009) and actions
Vinson (2009) has been studied. The occurrence of shared features may vary with respect to specific semantic categories. But, the proportion of shared features when categories are not considered, tend to be less in nouns compared to verbs representing actions. Since shared features occur in greater proportions in the semantic structure of numerous concepts adding to their semantic similarity, they are very crucial in categorization of concepts. Few researchers have viewed distinctive features and shared features on a continuum using a single metric of measurement called distinctiveness (Cree & McRae, 2003) and have classified features present in many concepts as shared features that possess low distinctiveness value.

The effects of shared features in behavioural experiments aimed at studying properties of concept organization are also very informative. Recent findings have suggested that shared features play crucial part in semantic processing. Presence of greater number of shared features in target concepts was seen to produce faster lexical decisions. This effect was even more enhanced for concreteness decision tasks (wherein the participant is asked to decide whether a target concept is concrete in nature or not) that depend largely on semantic properties of target concepts (Grondin, Lupker, & McRae, 2009). Hence both shared features and distinctive features are differentially important depending on the task under consideration.

2.5.1.4 Feature correlation. Another property of semantic features that is considered valuable is featural correlation. Correlation is defined as the extent of co-occurrence of features in the environment and the probability of one feature predicting the presence of another (e.g. things that have beaks usually also have wings and can fly) (Tyler & Moss, 2001). Featural correlation similar to shared features and distinctive features has been studied for its contribution in representation and computation of word meanings.

The patterns of feature correlation in the domains of living and nonliving things have also been assessed using connectionist models and behavioural experiments. The domain of living things has been reported to have shared functional and perceptual features that are highly intercorrelated compared to distinctive features. For the domain of nonliving things, the stronger correlation is present for distinctive perceptual and functional features compared to shared features (Tyler & Moss, 2001). However, a contrasting trend has also been witnessed in which, for
living things the proportion of significant intercorrelation was greater for distinctive than shared features. Also for non-living things it was the reverse pattern observed wherein the overall proportion of significant feature correlation was very small and distinctive feature of living things were more correlated than any of the features of the nonliving concepts (Garrad et al., 2001).

Featural correlation have been focused in order to interpret the way in which they might be learnt using connectionist models and their role in word recognition using behavioural experiments (McRae, de Sa, & Seidenberg, 1997). Behavioural experiments involving on-line semantic processing such as semantic priming tasks are highly influenced by featural correlation. This effect is more prominently seen for living things than nonliving things when the degrees of featural correlation among the semantic features of prime and target were varied. Featural correlations have also been considered as an important variable in lexically based semantic task such as feature verification (McRae, Cree, & Westmacott, 1999). It is also demonstrated that, using the connectionist models featural correlation is learnt through experience from the environment (McRae, Cree, & Westmacott, 1999).

Featural correlation has been studied in persons with semantic breakdown occurring as a result of progressive neurological conditions by simulating connectionist models. The progressive deterioration of semantic knowledge has been predicted by the nature of intercorrelation of features within their semantic representations (E.g.: Gonnerman, Anderson, Devlin, Kempler, & Seidenberg, 1997). Also, predicted patterns of semantic impairments have been simulated using connectionist model by incorporating intercorrelation among form and function properties of concepts (E.g.: Tyler, Durrant-PEATFIELD, Levy, Voice, & Moss, 1996). It has also been reported by Tyler and Moss (2001) that the features that co-occur frequently during training of connectionist model mutually activate each other and thus are more resilient to damage compared to weakly correlating features.

To obtain deeper insights into the conceptual knowledge using speaker generated features norms, researchers have employed properties of semantic feature norms such as featural weight, featural correlation and featural similarity to develop models of mental lexicon. The models developed using speaker generated norms are far more ideal in representing conceptual knowledge as the featural characteristics
that are assumed to influence the formation of models have been decided directly by
the norms generated by participants eliminating investigator’s biases. Models based
on the two basic assumptions namely componential nature of word meaning and
similarity or overlap of semantic features have been accepted to be far more suitable
for models of semantic representation as they have provided plausible explanations to
the behavioural phenomena seen in psycholinguistic studies of healthy individuals
and are also capable of elucidating the trends of semantic deficit patterns reported in
persons with semantic deficits (Devlin, Gonnerman, Anderson, & Seidenberg, 1998).
Hence quite a number of contemporary models rely upon the componential nature and
similarity to explain internal structure of mental lexicon. Thus study of relation of one
word with respect to another based on their semantic featural properties provides
valuable tool for modeling the structure of mental lexicon.

A model directly based on componential nature and similarity of semantic
features without making any assumptions about properties of features beforehand was
proposed for object nouns by McRae, et al. in 1997 and McRae, et al. in 1999. It is a
connectionist model which examines the role of featural correlation in computing
word meaning. It utilizes an attractor network based on correlational learning
algorithm that aids the model to investigate the influence of correlated features in
processing of word meaning. According to this model each concept is represented as
distributed patterns of activation over sets of units. Each unit here corresponds to the
features generated by the participants. The model was then made to learn the pattern
of correlation among features for a set of concepts using correlational learning
algorithm. The model learnt the patterns of featural correlation for a concept through
multiple processing cycles before a pattern of activation gets stabilized for the
concept. This model was utilized to study various aspects of semantic representation
and issues related to category-specific semantic impairment.

Another model for representing words referring to object (object nouns) and
words referring to events (action nouns and verbs) called “Featural and Unitary
Semantic Space” (FUSS) model was developed by Vigliocco, Vinson, Lewis and
Garrett in 2004. This model is based on the assumption that the word meanings are
directly linked to conceptual knowledge, which in turn is made up of semantic feature
like representation that is organized according to modality. Second assumption is that
the semantic featural representations are present in a separate level of lexico-semantic

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representation this level creates the interface between the conceptual knowledge and other linguistic information such as syntax, morphology and phonology. The model is based on semantic feature norms generated by participants and these features help the model to better predict the representation as it is grounded to the real world experiences of the participants. This model implements a computational technique called self-organizing maps on the semantic feature norms. These maps are trained to be sensitive to various semantic featural properties namely number of features, featural weights and feature correlation unlike McRae’s et al. model, which is based only on featural correlation. The self-organizing map thus captures the different influences of each of the semantic feature property in organization of concepts, based on the characteristics of the semantic field for which it is generated. The maps obtained depict the categorization of different concepts into their corresponding semantic field along with clear boundaries separating these concepts from others belonging to different semantic fields. The maps of object nouns tend to possess smooth boundaries indicating well-defined semantic field boundaries (Figure 5). However for words representing events no such clear boundaries among different fields is generated (Figure 5). Thus, based on the semantic distances among the concepts obtained from feature norms, maps are generated that model the organization and representation of conceptual knowledge. Results of the behavioural studies based on the model provide further evidence that this model predicts semantic effects seen in behavioral experiments.
Figure 5. Two-dimensional representation of semantic proximity in FUSS (Vinson & Vigliocco, 2002; Vigliocco, et al., 2004 in Vigliocco & Vinson 2007).

It is evident from the literature that the semantic features and its properties have been an integral part of studies carried out in understanding mental lexicon and conceptual knowledge. Theories and models proposed, based directly on semantic feature norms have been successful in capturing the principles of representation and categorization of words in the mental lexicon. This is because the basis of these models comes from analyzing data directly obtained from participants, which capture the saliencies of the real world experiences to a great extent. The models have also accounted for the fundamental phenomenon such as semantic relatedness, typicality effect, concreteness effect, semantic priming in lexical decision seen in behavioural experiments. Thus semantic feature norms invariably provide immense contribution to the knowledge of mental lexicon.
2.6 Semantic Features of Nouns and Verbs

Nouns and verbs form major part of vocabulary of any language. Researchers focusing on meaning representation in mental lexicon have almost always studied various categories of concrete nouns. Even though verbs are also a significant part of mental lexicon, they have received much less attention in research. Although nouns and verbs can be grouped into category of content words, there are significant differences between the two entities. The main difference is that the meaning of objects is static in nature and is comprehensible even when the concept names are produced in isolation whereas the meanings associated with verbs are not static but relational as they are highly dependent on linguistic context and environment in which they can occur, consisting of dynamic entities that unfold in time (Vinson & Vigliocco 2008).

Verbs of a language differ from nouns, as summarized by Vinson (2009), in terms of the semantic featural make up and properties. Nouns, which represent objects possess more number of features referring to narrow semantic fields. Verbs representing action, on the other hand possess more features that broadly apply across wide range of semantic categories. Semantic features are very strongly correlated to the semantic category with respect to nouns than that of verbs. In case of nouns, distinguishing between different levels such as superordinate, basic and subordinate is relatively simple and they can be easily organized into hierarchies with many shared correlated properties. On the other hand, it is very difficult to create comparable sets of hierarchies for verbs as they form matrix-like structure where many semantic properties are orthogonally related rather than correlated (Huttenlocher & Lui, 1979; Graesser, Hopkinson, & Schmid, 1987; as in Tyler et al., 2001). Also the hierarchy that exists for verbs possess fewer levels with very less distinctions at the superordinate levels (Keil, 1989). However, verb taxonomies do show a basic level structure but a less sharply defined and less stable structure than in noun taxonomies (Morris & Murphy, 1990). It is also true that distinction between close semantic neighbours differ across the domains of nouns and verbs. It is noticeable that for many categories of basic level concrete objects, close neighbours offer true distinctions while this is not true in many verbs that seem to overlap to a great extent (Vinson 2009).
The processing of verbs is also considered more complex than nouns even though they may have similar organization (Krishnan, Tiwari, & Bellur, 2009). Verbs play an important role in sentence processing. They contain grammatical information contributing to the structure of the sentence such as the thematic roles of agent, patient, the arguments of the verb and semantic information contributing to its core meaning. Thus the syntactic information embedded in verbs are often richer compared to nouns. Investigators have used data from normal individuals, persons with semantic dementia as well as from aphasia to understand how verbs are stored but it still remains unclear how they may be organized in the mental lexicon.

2.7 Neuroimaging Studies of Mental Lexicon

Apart from theories and models proposed to explain organization and storage of concepts in the mental lexicon, a great amount of knowledge has been imparted through neuroimaging studies. With advent of new technology, increasing number of functional brain imaging studies of concept and category representation in normal as well as persons with semantic deficits has been witnessed. Neuroimaging and electrophysiological studies have provided evidence that language related processing seem to be widely distributed in the brain regions than previously assumed. Word meaning is not confined to just specific brain regions but is distributed in a systematic way throughout the entire brain (Martin, 2007).

Substantial research evidences have implicated that the posterior region of the left temporal lobe (left fusiform gyrus) is critical site in representation of concrete objects and has a significant role in conceptual organization and processing (Mummery, Patterson, Wise, Vandenberghe, Price, & Hodges, 1999; Sharp, Scott &Wise, 2004; Wig, Grafton, Demos, & Kelley, 2005). Studies have been carried out which provide information about representational content of brain areas in terms of features of the objects that might be stored in a particular brain area. The ventral temporal cortex is evidenced to be storing information about object colour (Wiggs, Weisberg, & Martin, 1999; Chao & Martin 1999) and studies report activity in the sensory or motor processing areas of the brain for tasks involving access of corresponding sensory or motor features (Goldberg, Perfetti, & Schneider, 2006). For verbs depicting actions, activation in the posterior middle temporal gyrus was prominent during task of action naming (Tranel, Martin, Damasio, Grabowski, &
Hichwa, 2005b). Also, in a task involving reading of specific action verbs related to specific body parts such as lick (tongue); pick (finger); kick (leg) activated premotor cortical regions in the brain that are also activated from actual movements of these parts (Hauk, Johnsrude, & Pulvermuller, 2004).

Neural representation of semantic categories has also been studied using tasks involving categorization of target stimuli. It has been noted that the regions associated with representing object properties are differentially engaged as a function of object category membership (Martin, 2007). The occipito-temporal cortex has been identified as a structure that plays a major role in object categorization. Distinct category related patterns of activation have been consistently recorded that discriminate between relatively large numbers of object categories and these patterns are reported to be stable both within and between subjects (Cox & Savoy, 2003; Haxby, Gobbini, Furey, Ishai, Schouten, & Pietrini, 2001; Spiridon & Kanwisher, 2002). For the category of animals an increased activation is observed in lateral regions of fusiform gyrus, bilaterally whereas for the category of tools, heightened activation was seen bilaterally in the medial region of fusiform gyrus. Thus the evidences provided by neuroimaging studies, similar to insights obtained from semantic feature norms support that specific sensory and motor-based information of objects are stored in regions adjacent to sensory and motor areas. Therefore, the neuroimaging studies augment our knowledge about semantic representation and also provide strong supporting evidences for the claims made using semantic feature norms for the distribution of knowledge in different sensory and motor modalities.

2.8 Category-Specific Semantic Deficits

Word meanings represented in the mental lexicon, as witnessed in the earlier sections, allows comprehension and expression of our knowledge about objects and actions taking place around us. Impairments of semantic representations are extremely debilitating which may be as a result of several types of neuropathology such as Alzheimer’s disease leading to dementia, herpes simplex encephalitis and cerebrovascular accidents such as stroke-induced aphasia. Research involving semantic deficits also enables better understanding of normal semantic representation. With the objective of testing the efficacy of models and theories developed to understand semantic representation, they are damaged systematically based on the
patterns of impairment to simulate such conditions. The behaviour of models under such simulations resembling semantic impairments provides further insight into the nature of processes in specific brain areas, damage to which may lead to deficits. Studying semantic impairment patterns in these conditions are essential to improve therapeutic approaches for better management and prognosis.

It is intriguing that the semantic deficits documented in literature shows a set of specific patterns in which the impairment manifests itself. The pattern shows prevalent regularities in the group of concepts that may be affected by the brain damage over rest of concepts. This phenomenon is termed as category-specific semantic deficits. The most common pattern of impairment seen is differential semantic abilities for the domain of creatures, fruits/vegetables and nonliving things. It has been noted that persons with semantic deficits may experience difficulties of naming items from one domain for instance, creatures while exhibiting no such difficulties in naming items from other domains such as fruits or nonliving things or vice versa. In the literature it is very evident that despite numerous differences in the methodology of studies of category-specific semantic deficits, it is possible to witness these consistent trends in the sets of categories that are susceptible to be impaired/spared together (Cree & McRae, 2003). There are seven prominent trends in the deficit pattern seen in the persons with semantic deficits as reported by Cree and McRae (2003) that are listed below:

1) The categories of creature cluster together and this cluster can be disrupted separately.
2) The categories of nonliving things cluster together and can be disrupted separately. These exclude musical instruments and foods.
3) The category fruits/vegetables group together and can be separately affected.
4) Fruits/vegetables can cluster with either the creature or the nonliving things.
5) Nonliving foods can be disrupted together with living things.
6) Musical instruments can be impaired together with living things.
7) Impairments of living things are more frequent than nonliving things.

Various theories have been proposed to explain these trends (Tyler & Moss, 2001; Devlin, Gonnerman, Anderson, & Seidenberg, 1998; Gonnerman, Anderson, Devlin, Kempler, & Seidenberg, 1997; Caramazza & Shelton, 1998; Humphreys &
Forde, 2001; Caramazza, Hillis, Rapp, & Romani, 1990; Dixon, Bub, & Arguin, 1997, 1998; Gaffan & Heywood, 1993; Warrington & Shallice, 1984; Martin, Ungerleider, & Haxby, 2000) and one method that has been very effective in providing relevant evidence is study of semantic feature norms. Distributional statistics carried out on the various properties of semantic feature norms such as featural similarity, distinctiveness, shared features, feature types and featural correlation have been successful in addressing most of the trends of category specific impairment patterns documented as these factors influence the representation and computation of concepts (Cree & McRae, 2003). Thus semantic feature norms as discussed previously are very useful for understanding category specific semantic deficits and in formulating treatment strategies based on the factors influencing such patterns can be highly beneficial.

2.8.1 Semantic impairment in aphasia. Brain damage as a result of cerebrovascular accidents may lead to loss of language skills termed as aphasia. Comprehension impairments are more commonly observed along with other language impairments of Aphasia. The impairment is usually associated with lesions in the temporo-parietal and prefrontal regions in the left hemisphere. On the other hand in persons with semantic dementia damage usually occurs in the anterior temporal lobes, bilaterally. This region is rarely damaged due to stroke in persons with Aphasia as they are supplied by two major arteries besides which bilateral lesions in these regions due to stroke are extremely rare.

Patient profiles of persons with Transcortical Sensory Aphasia (TSA), which is associated with fluent speech and good repetition skills, appears superficially similar to the deficits associated with semantic dementia. Studies have reported Aphasia similar to semantic dementia that can lead to multimodal semantic deficits even though the anterior temporal lobes remain intact. Many a times, persons with aphasia experience problems with the relationship between objects and their names. This naming deficit has been attributed to their inability to retrieve the correct word from the mental lexicon and match the target object that is labeled as retrieval deficits (Goodglass & Geshwind, 1976; Weigel- Crump & Koenigsnecht, 1973). However, there has also been an alternative hypothesis proposed to explain their deficits in comprehension and expression which is attributed to the disruptions in the semantic
representations contained in the mental lexicon labeled as semantic deficits (Caramazza & Berndt, 1978).

There have been several evidences (Grober, Perecman, Kellar, & Brown, 1980; Grossman, 1978; Lhermitte, Derouesne, & Lecours, 1971; Zurif, Caramazza, Myerson, & Galvin, 1974) to support the latter hypothesis that there is a semantic deficit associated with Aphasia. It is common phenomenon that persons with anomic aphasia often produce semantic paraphasias in spontaneous speech (Geschwind, 1967). The production of semantic paraphasias provides evidence that there is an underlying impairment of the semantic organization in the mental lexicon. Also, the semantic paraphasias that is produced will necessarily violate some of the semantic aspects of the word that is intended (Caramazza, Berndt, & Brownell 1982). Semantic based errors were also noted during object selection task using semantically similar distracters (Gainotti, 1976). Further support to this hypothesis has been obtained from person with Wernicke’s Aphasia tested for semantic relatedness and categorization. Evidence of semantic deficits in terms of broadening of semantic field boundaries have been noted during categorization as they inappropriately group words of clearly different meanings (Lhermitte, Derouesne, & Lecours, 1971). Similar results have been reported by Grossman (1978) who found that persons with Wernicke’s Aphasia had difficulty correctly naming category members for superordinate categories (E.g.: ‘furniture’). Difficulties have also been reported during naming of atypical category members compared to typical members (Grossman, 1978; Grober, Perecmen, Kellar, & Brown, 1980; Buhr, 1980). Thus it is evident that lesions in the brain can result in selective disruption of the semantic organization of the mental lexicon in persons with aphasia that can manifest as naming deficits.

Analysis of semantic features, therefore, has significant clinical implications in developing treatment techniques for semantic deficits prevalent in persons with semantic dementia and aphasia. As evidenced in the review, the disruption of semantic knowledge in the mental lexicon is predicted to result in comprehension and naming deficits in persons with aphasia. Hence several treatment strategies used to treat anomia and other semantic deficits focus on strengthening the semantic feature knowledge. One such treatment technique that is widely employed is the Semantic Feature Analysis (SFA). This technique emphasizes on enhancing the retrieval
abilities of semantic knowledge through accessing semantic networks (Boyle & Coelho, 1995). This is achieved by asking the individuals to produce list of words that are semantically related to a target word. Semantic relations may be in terms of their category, use, action, properties, location and association. This treatment technique has been proven to be highly efficient in treating semantic deficits prevalent in persons with aphasia (Boyle & Coelho, 1995; Coelho, McHugh, & Boyle, 2000; Conley & Coelho, 2003; Boyle, 2004; Rangamani & Prema, personal communication). The cumulative results of these experimental studies have thus provided empirical evidences for efficacy of semantic feature based treatments. However one drawback these approaches face is the limited generalization of learnt skills for untreated words and to connected speech (Boyle & Coelho, 1995; Coelho, McHugh, & Boyle, 2000).

Use of distinctive features obtained from semantic feature norms however is proven to overcome the problems of generalization of naming skills. The semantic feature analysis (SFA) technique uses shared features and semantic relatedness to enhance the semantic knowledge. Semantic deficits can be addressed more effectively with techniques facilitating enhancement of distinctive feature knowledge in individuals. This is because it has been evidenced that distinctive features play vital role in naming skills. For instance, during the task of picture naming or identification of named picture from a set of pictures, the individual has to identify the feature that distinguishes the target picture from rest of the similar ones that requires usage of distinctive feature knowledge. It also true that loss of distinctive feature knowledge has severe behavioural consequences than loss of shared features. Thus treating persons with semantic deficits for distinctive feature knowledge enhances the chances of improvement in the naming skills. Evidence supporting use of distinctive feature in therapy has also been provided by researchers (Mason-Baughman, 2009; Kiran & Thompson, 2003) who have found better prognosis in naming skills of treated items along with better generalization to untreated items and to connected speech. Hence it is evident that knowledge of semantic feature norms and their properties can enhance our skills in the management of persons with aphasia and semantic dementia.

To summarize, there has been immense amount of research carried out in the recent years involving the mental lexicon. The study of semantic feature norms has been very useful in providing a window to understand rather complex organization
and meaning representation in the mental lexicon. Semantic feature norms are also building blocks of many theories and models discussed in the literature. Various models have been developed using newer computational techniques and artificial neural networks such as attractor networks, self organizing maps etc. These models have been tested for its predictions of brain mechanisms using behavioural studies which in turn provides empirical evidences for the models. Advancement in Neuroimaging techniques have further enhanced our knowledge to correlate predictions of models, behavioural evidences and evidences from patient data with actual brain regions using more sophisticated functional imaging studies. The norms as such are very useful to track down the statistical regularities such as distribution of different feature types, shared features, distinctive features, featural correlation across semantic categories that play crucial role in organization of mental lexicon. Semantic feature norms also help to understand semantic deficits in persons with dementia and aphasia and in developing treatment techniques for the same. Thus semantic features contribute immensely to our knowledge about mental lexicon.

2.9 Need for the Study

During the past three decades, as witnessed in the literature, research related to semantics and mental lexicon has been extensively carried out in English and other non-Indian languages. In Indian languages, with respect to semantics, norms have been established for limited aspects of semantic components, restricted to the purpose of particular study under consideration. Such norms have been established in Kannada (Karanth 1984), Hindi (Monika Sharma 1995), Malayalam (Asha 1997) and Telugu (Suhasini 1997) for Linguistic Profile Test developed to assess language comprehension and expression. Ranganatha (1982) has established norms for relative frequency of phonemes and morphemes in Kannada. However, lexical semantic representation in adult speakers of Kannada, with particular reference to the semantic features has not been studied till date. There is an immense need for studies focusing semantic modeling based on the empirically derived semantic feature data that enhance our knowledge in terms of semantic representation and organization in Indian languages. It is also true that studies of mental lexicon in non-Indian languages cannot be directly generalized to Indian languages such as Kannada (language spoken in Karnataka, South India) as it varies to a great extent in terms of origin, structure and linguistic properties.
English is a Germanic language belonging to Indo-European language family whereas Kannada is one of the four major Dravidian languages. The Indo-European languages originated mainly from a common language spoken in southeastern Europe whereas Dravidian languages originated from Brahmi and is mainly spoken in the southern parts of India. Although both English and Kannada share a few borrowed words from Sanskrit language, the linguistic structure and word order is different between the two languages. One important linguistic property of Kannada is its agglutinative nature i.e. words are formed by adding suffixes to the root word in a series leading to several morphophonemic changes. The word order is relatively free in Kannada with verb final order (SOV) being the most prevalent one contrasting English, which has fixed word order containing subject verb and object (SVO). Kannada is also highly inflected language wherein the root word is affixed with several morphemes to generate thousands of word forms. As a result of highly agglutinative nature, it is very difficult to mark word boundaries, more so in the case of verbs. It is evident that the structure and these linguistic properties of a language exert control on the meaning representation in the mental lexicon.

It also true that there is pervasive diversity in mapping of word meanings across languages as there are differences across languages in terms of their word meaning inventories. The diversities noted in the mapping of word meaning in different languages can be attributed to the fact that each language is highly selective and arbitrary in choosing elements of experience they encode in the form of words leading to many possible ways to map between the words and corresponding concepts (Wolff & Malt, 2010). The words of a language have significant impact in molding the conceptual knowledge, as acquisition of conceptual knowledge is heavily reliant on language of the individual. It is also true that the mapping of conceptual features into linguistic features can vary across languages. Languages also differ markedly in how they partition by name many domains including colour, space, body parts, motion, emotion, mental states, causality and ordinary household containers (Wolff & Malt, 2010). For instance, there is difference in mapping of concepts onto words between languages such as English and Italian to that of Japanese. There are two different words for the concept ‘foot’ and ‘leg’ in English and Italian but there is only one word ‘ashi’ in Japanese which refers to both ‘foot’ and ‘leg’ (Vigliocco & Vinson, 2005). Similar variations are also noticed for English and Hebrew languages.
as they have numerous words representing different manners of jumping as against Italian and Spanish languages (Slobin, 1996b). This variability in mapping of concepts to words across languages can be assumed to have important implications in conceptual knowledge representation. Thus, the disparities in the semantic structures of a language have consequences on the structuring of concepts too. Hence studying semantic representations in different languages is imperative as it enhances our knowledge about influence of linguistic variability on organization of mental lexicon.

Language is also greatly influenced by the socio-cultural factors of the language user. As the acquisition of words in the mental lexicon depends greatly on the physical and cultural environments of a language community, languages tend to vary in how many distinctions within a domain are encoded in words (Wolff & Malt, 2010). India is a multicultural and multilingual nation. The ethno-cultural aspects have great influence on the linguistic environment of an individual in molding his/her language composition. With regards to Indian linguistic scenario it is not uncommon to find coexistence of two or three languages in a person’s linguistic environment almost throughout the country. Exposure to many languages by an individual can be predicted to influence the meaning representation and organization of the mental lexicon.

Kannada is a Dravidian language spoken in South India predominantly in the state of Karnataka by around 70 million people. Despite the fact that it is one of the 40 most commonly spoken languages in the world, literature review reveals that studies related to representation and organization of mental lexicon of this language, is still in its infancy. Also there is lack of comprehensive database enumerating characteristics of words and concepts in terms of their semantic features. It is also true that each language is assumed to be formed as a means to meet the cultural and social demands of the community. Exposure to multilingual and multicultural environment may influence the representation of languages in the mental lexicon as culture and language have been influencing each other’s structure from times immemorial. In depth understanding of these aspects of semantic representation and organization in the mental lexicon can be obtained by studying properties associated with semantic features. Thus, there is an indisputable need to establish such data in Kannada. Literature survey sheds light on the numerous ways in which semantic feature norms can be used as a means to understand semantic representation of nouns and verbs in
normal individuals as well as in person’s with semantic dementia and aphasia. This can in turn help us to formulate more efficient therapy techniques to treat these individuals. The models developed to simulate representation of nouns and verbs also utilize semantic featural weights and other properties obtained from norms. Hence study of semantic features is found to be very useful. Therefore, there is an immense need to develop such semantic feature data in Indian languages including Kannada, in order to gain insights about the mental lexicon in these languages.

2.10 Aims and Objectives of the study

The aim of the present research was to explore the lexical semantic representation and organization in Kannada for a set of nouns and verbs by studying semantic features generated by native speakers of Kannada

1. The primary objective of the present research was to describe semantic features of nouns and verbs in Kannada.

2. The secondary objective was to develop a framework for a model of lexical semantic representation and organization in Kannada.

3. The tertiary objective of the study was to compare the lexical semantic representation and organization of nouns and verbs in Kannada and English.

2.11 Research questions of the study

1. Are there any differences in the distribution of semantic feature properties across the domains of nouns and verbs in Kannada mental lexicon?

2. Are there any differences in the distribution of semantic feature properties across the semantic categories in Kannada mental lexicon?

3. Are there any differences in the distribution of semantic feature properties between Kannada and English language?

2.12 Hypotheses of the study

The following hypotheses have been proposed to answer the research questions by analyzing semantic features obtained from the study.

1. There is no statistically significant difference in the distribution of semantic feature properties between nouns and verbs under study.
2. There is no statistically significant difference in the distribution of semantic feature properties across the semantic categories under study.

3. There is no statistically significant difference in the distribution of semantic feature properties between Kannada and English language