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Concrete Nouns in Kannada: How Distinct Are their Semantic Features?

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Abstract

Understanding the representation of meaning of words in the mental lexicon has received considerable attention in research studies on Psycholinguistics, Speech language sciences, Cognitive linguistics and Neurolinguistics. Studies carried out in this regard have used semantic features as a key to understand the underlying processes of storage and organization. The meaning of words, which in turn denote concepts are assumed to vary depending on their distinctive features as well as shared features. Distinctive features are those that are unique to a small set of concepts whereas the shared features are present in abundance. In the field of Speech Language Pathology semantic features have been targeted in therapy techniques to decrease the semantic deficits in persons with aphasia and semantic dementia. Owing to the significance of semantic features in our understanding of semantic processing, the present

study was conducted to examine the nature of distribution of distinctive features of words in Kannada language. The study describes distinctive features generated for 60 concrete nouns of Kannada (30-living thing; 30- non living things) by 60 native adult speakers. The responses are analyzed using custom software and computer programs developed and written for this purpose. The results offer empirical evidence for the differences in the distribution of distinctive features of living and non living things. Implications of the results for treatment of semantic deficits have been discussed.

Key words: Semantic features, Distinctive features, Semantic representation, Semantic deficits

Meaningful Utterances

Understanding and producing meaningful utterances forms the basis of any communication. Language being the primary mode of communication serves as a medium to exchange thoughts and ideas. Words stored in the mental lexicon of individuals form the basic component of a language and word meaning provides the core information upon which all communication is built (Vinson, 2009). Among the different types of words, nouns being the largest group of content words in a language carry most of the linguistic information followed by verbs.

Each word stored in the linguistic repertoire of individual is presumed to represent a concept of the world. These concepts are acquired by individuals from infancy on employing active and passive learning from the environment and real world experiences. It consists of vast amount of knowledge about living and non living things gathered from seeing them, using them, observing others use them, talking and reading about them (Cree & McRae, 2003). This knowledge is assumed to be represented and processed in the semantic memory of individuals.

Research in the area of semantic memory has been focusing on studying how information about objects and entities are represented, organized and processed. Several models and theories have been proposed in order to gain insight about the structure and processes influencing semantic memory (Smith, Shoben, & Rips, 1974; Collins & Loftus, 1975).

Semantic Features

Semantic features have been considered as basic building blocks in most of the theories and models addressing semantic representation and conceptual knowledge in semantic memory

(Eg. Smith, Shoben, & Rips, 1974; Collins & Loftus, 1975; Minsky, 1974; Norman & Rumelhart, 1975; Medin & Schaffer, 1978; Smith & Medin, 1981; Jackendoff, 1992; Hinton & Shallice, 1991; Plaut & Shallice, 1993; Minda & Smith, 2002). Semantic features in its simplest definition refer to bundles of attributes related to a given word corresponding to a particular concept. The attributes reflect a particular type of knowledge/information about the word which is stored in the mental lexicon such that these attributes or semantic features combined together reflect the meaning of that particular concept.

Semantic features have been extensively collected and studied for their production norms in recent research relating to semantic representation (Rosch & Mervis, 1975; Ashcraft, 1978; Hampton, 1979; Devlin, Gonnerman, Andersen, & Seidenberg, 1998; Garrard, Lambon Ralph, Hodges, & Patterson, 2001; Moss, Tyler, & Devlin, 2002; Vinson & Vigliocco, 2002; McRae, Cree, Seidenberg, & McNorgan, 2005;Vinson & Vigliocco, 2008) as these features are known to provide valuable insight into various behavioral phenomena associated with language organization and processing. They have been considered to play a major role in studying conceptual organization and categorization in semantic memory which forms the basis of these behavioral phenomena.

The semantic feature generation task typically consists of listing of features for a concept which are considered to be salient by the participant. Feature norms are collected for various categories of nouns and verbs referring to numerous concepts believed to be stored in the mental lexicon. Feature norms are assumed to provide valid information not because they yield a literal record of semantic representations but rather because such representations are used systematically by participants when generating features (Barsalou, 2003). Thus when participants produce features in a norming task, they directly exploit representations that have been developed through repeated multisensory exposure to, and interactions with exemplars of target category (McRae, Cree, Seidenberg, & McNorgan, 2005).

As mentioned previously, semantic features have been used as the core ingredient in most of the influential models of word meaning and of concepts and categorization to understand lexico-semantic representation. A model based on speaker generated semantic feature norms was proposed for object nouns by McRae, et al. in 1997. A model for both words referring to object

(object nouns) and words referring to events (action nouns & verbs) called "*Featural and Unitary Semantic Space" (FUSS)* model was developed by Vigliocco, Vinson, Lewis and Garrett in 2004. The model was developed in order to describe how word meanings are represented in the semantic memory by implementing self-organizing maps. These maps are obtained based on semantic featural properties such as number of features generated for each concept, featural weights (number of participants who generated a feature for a particular concept) and correlation among features of different concepts. Thus, based on the semantic distances among the concepts, maps are generated along with semantic category boundaries to model the organization and representation of conceptual knowledge in the semantic memory.

Study of semantic features also has important implications in understanding of nature of semantic impairments seen in persons with semantic dementia and aphasia. Semantic deficits such as comprehension difficulties and anomia seen in persons with aphasia may be a result of their deficits in semantic feature knowledge. Hence semantic features form basis of many therapy techniques used to treat these word finding problems in aphasia. One such technique which has wide usage is the Semantic Feature Analysis (SFA) which focuses on improving retrieval of semantic knowledge by accessing semantic networks (Boyle & Coelho, 1995). The technique involves producing words that are semantically related to a target word (category, use, action, properties, location and association).There are several studies which have reported efficacy of semantic feature based treatments for aphasia (Boyle & Coelho, 1995; Coelho, McHugh, & Boyle, 2000; Conley & Coelho, 2003; Boyle, 2004; Rangamani & Prema, 2011) The overall results of these studies have suggested that a semantic feature based approach is efficacious in treating anomia in persons with aphasia. However the extent of generalization of naming skills for untreated items and into connected speech is reported to be equivocal (Boyle & Coelho, 1995; Coelho, McHugh & Boyle, 2000).

Distinctive Features vs. Shared features

Semantic features can be also studied by classifying them into different types of features namely distinctive and shared features. Distinctive features are those features which occur in only one or two concepts of a category hence they are unique to a small set of concepts. Shared features are those which are present across many concepts. While distinctive features are crucial

in discriminating among similar concepts, the shared features are presumed to provide stronger representation as they are present across many concepts.

Study of distinctive feature distribution has important implications in the treatment of semantic deficits associated with anomia and semantic dementia. As reported previously, treatment techniques involving semantic feature analysis (SFA) which uses shared feature as a basis to improve semantic knowledge has proven to be less effective in generalization to untreated items and to contextual speech. Treatment techniques based on distinctive features have been successfully employed to overcome this shortcoming. In other words, techniques facilitating enhancement of distinctive feature knowledge in individuals are found to be very effective in treatment. Evidence supporting use of distinctive feature in therapy has also been provided by researchers who have found better prognosis in naming skills of treated items along with better generalization to untreated items and to connected speech (Mason-Baughman, 2009; Kiran & Thompson, 2003).

Thus distinctive features can be assumed to play a crucial role in retrival of concepts during naming. Study of distribution of distinctive features across various categories of concepts can also provide valuable insights about the nature of semantic impairments seen in persons with Aphasia anad semantic dementia. Various case studies have reported that concepts and words related to living things (henceforth abbreviated as W-Liv) are more susceptible to impairment than those related to non living things (abbreviated as W-NLiv) in this population (Devlin, Gonnerman, Andersen, & Seidenberg, 1998; Garrard, Lambon Ralph, Hodges, & Patterson, 2001)**.** Thus a trend of differential semantic impairment has been reported in literature for the categories of living (W-Liv) and non living (W-NLiv) domains. Researchers have found correlation of this differential pattern of impairment with distribution of distinctive features among W-Liv versus W-NLiv. Detailed study of distribution of distinctive features in differential impairments was reported by Cree and McRae in 2003 who conducted analysis for 541 concepts of English language, belonging to 34 categories. Analyzing semantic feature norms in English language have thus provided evidence that W-NLiv have an advantage over W-Liv in terms of number of distinctive features (Cree & McRae, 2003; Randall, Moss, Rodd, Greer, & Tyler, 2004)**.** W-Liv , as reported in the previous studies have found to have less number of distinctive features which explains its susceptibility to increased degree of impairments in persons with

aphasia accounting for the differential trend of semantic impairment across categories (W-Liv Vs W-NLiv) seen in this population.

The above premise would require further evidence from different languages since languages differ in how they represent experience. The language that an individual learns influences how s(h)e talks about objects and events. Besides these, some languages offer more terms than others for particular domains (Clark, 2004). Language representation is also influenced by the cultural exposure and learning environment. The studies done till date are limited to English and other European languages (Cree & McRae, 2003; Randall, Moss, Rodd, Greer, & Tyler, 2004; Mason-Baughman, 2009; Kiran & Thompson, 2003) Studies in Indian languages, by virtue of the structure being different from the European languages are likely to enlighten our understanding of semantic representation by providing empirical evidence for distribution of semantic features. Hence the present study was conducted to investigate the distribution of semantic features in the domains of W-Liv Vs W-NLiv in Kannada language.

Method

The aim of the present study was to investigate distribution of semantic features for two set of nouns belonging to the domains of W-Liv and W-NLiv in Kannada language. For this purpose 30 concrete nouns belonging to the domain of W-Liv (category of animals) and 30 concrete nouns from the domain of W-NLiv (category of common objects) were selected. The complete list of words from both the domains (W-Liv and W-NLiv) considered for the study are given in IPA in the Appendix I.

The domains of living and non living things were selected for the present study as these domains demonstrated differential degrees of semantic impairments in the studies done previously with former domain impaired more often than the latter (Devlin, Gonnerman, Andersen, & Seidenberg, 1998; Garrard, Lambon Ralph, Hodges, & Patterson, 2001). These domains are reported to vary with respect to distribution of distinctive features (Cree & McRae, 2003; Randall, Moss, Rodd, Greer, & Tyler, 2004). Thus studying these domains in Kannada language for distribution of distinctive features would further provide insight to its relation to differential impairment.

The stimulus (60 nouns) was subjected to familiarity ratings by 3 qualified professionals (Speech language pathologist, Special Educator, and a Linguist). The three experts rated the words adapting a 3-point rating scale where 2 - very familiar 1-familiar and 0- less familiar. Words rated as very familiar and familiar (relatively unambiguous words or words with dominant meaning) were selected for the study. Eight out of 30 words in the domain of W-NLiv were borrowed English words which were also included as these words are very commonly used in day to day life by native speakers of Kannada and these words form an indispensible part of Kannada vocabulary. The stimulus employed for the study was part of a Doctoral study of the first author being carried out on semantic features norms collected for a larger sample of 200 nouns and 100 verbs belonging to different semantic categories.

The participants involved in the study were 60 (out of 300 participants from the main study) adult (18-30 years) native speakers of Kannada language who had a minimum of 10 years of experience in reading and writing in Kannada, with no history of any speech, language, psychological or neurological disorders. The participants were selected on a random basis from graduate and post-graduate colleges in urban areas of Mysore city, India

The participants were instructed to write down the semantic features that they think describe a particular target word. For example, for the target word 'cheetah' the semantic features that can be generated by the participants were <an animal>, <yellow>, <runs fast>, <has black spots>, <climbs trees>, <lives in forest>, <carnivores> and so on. The participants were also instructed explicitly to write down features which might help to distinguish target word from similar words. Written instructions along with four examples were also provided.

Analysis of Features

The data analyzed consisted of written responses on semantic features generated by the 60 participants. All the responses were entered into an electronic database using custom made software and interface developed for this purpose. Custom software and the interface design were developed with the help of a software consultant using Microsoft Access 2007 and Microsoft Visual Basic respectively. It allows easy data entry and various kinds of analysis over the stored response data.

The data analyzed in the current study was a part of database from the main study as mentioned earlier. From the database, responses for 30 W-Liv belonging to the semantic field 'animals' and responses for 30 W-NLiv from the semantic category 'common objects' were extracted using a computer program. The computer program was written using Python programming language. The computer program thus developed, enumerated all features generated per word by the 60 participants. A feature was considered for further analysis only if it was generated by three or more participants. This was done by modifying the program, in order to eliminate idiosyncratic responses. The program was further modified to isolate all the *distinctive features.* A feature was considered *distinctive* if it was generated for a maximum of two target words (i.e. two concepts). Thus the distinctive features for both domains were extracted from the database which was further subjected to statistical analysis.

Results

The distinctive features extracted from the data indicated that in the domain W-Liv (animals) the range of number of distinctive features varied from 7 to 1. The number of semantic features and distinctive feature obtained for both domains W-Liv (animals) & W-NLiv (common objects) are depicted in Table 1. The target word /kɑ'θɛ/ (*Donkey)* had the highest number, a total of 7 distinctive feature out of total 38 semantic features listed by 30 participants whereas the target word /mola/ (*Rabbit)* had the lowest number, 1 distinctive feature out of total 46 semantic features listed. In the domain of W-NLiv (common objects) the range of distinctive features varied from 11 to 3. The target word /gɑdiyɑ:rɑ/ (*Clock)* had the highest number, a total of 11 distinctive feature out of total 44 semantic features listed whereas the target word /bɑ:ket/ (*Bucket)* had the lowest number, 3 distinctive feature out of total 45 semantic features listed by 30 participants.

In order to study the distribution of distinctive features we calculated the percentage ratio of number of distinctive features to that of total features for every target word. This task was again done with the help of a computer program written in Python script. The percentage ratio of distinctive feature obtained for both domains W-Liv (animals) & W-NLiv (common objects) are also shown in Table 1. The mean percentage ratio of distinctive features was then calculated (Table 1). Results indicated that the mean percentage ratio of distinctive features for domain W-

Liv was 8.10% (SD=4.08) whereas that for W-NLiv was 14.15 % (SD= 5.33). The domain of W-Liv possessed a low percentage of distinctive features compared to W-NLiv.

To investigate whether the difference in mean percentage scores between the two domains was statistically significant, Independent t- test (2 - tailed) was carried out. Statistically significant difference (t = 4.93; df = 58; p=0.00) in distribution of distinctive features for the two domains was obtained on t-test. In summary, in the present study the domain of W-Liv possessed a significantly low proportion of distinctive features ranging from 18.47 to 2.17 compared to W-NLiv which possessed distinctive features in the range 25.00 to 6.67.

Table 1

Percentage Ratio and Mean Ratio of Distinctive Features for Domains W-Liv and W-NLiv

Living Things				Non-Living Things			
Word	Total Features	Distinctive Features	Ratio	Word	Total Features	Distinctive Features	Ratio
Mola	46	1	2.17	Bucket	45	3	6.67
Kuri	46	1	2.17	Kaagada	43	3	6.98
Kaage	33	1	3.03	kasada butti	41	3	7.32
Hasu	52	2	3.85	Belli	49	4	8.16
Gini	48	2	4.17	Pusthaka	49	4	8.16
Chirathe	56	3	5.36	Baachanige	44	4	9.09
Huli	54	3	5.56	Kitaki	41	4	9.76
Kappe	54	3	5.56	Nalli	41	4	9.76
Thola	36	2	5.56	Daara	51	5	9.80
Simha	53	3	5.66	Cheela	57	6	10.53
Koli	52	3	5.77	Kapaatu	46	5	10.87
Jinke	51	3	5.88	Vajra	45	5	11.11
baathu koli	48	3	6.25	Phone	62	7	11.29
Karadi	57	4	7.02	Mane	66	8	12.12
Goobe	42	3	7.14	Bottle	49	6	12.24
Naayi	55	4	7.27	Meju	56	7	12.50
Alilu	39	3	7.69	black board	39	6	15.38
Chitte	26	2	7.69	Porake	32	5	15.63
Haddu	51	4	7.84	Pen	51	8	15.69
Ili	56	5	8.93	Fan	36	6	16.67
Menu	64	6	9.38	Hoddige	57	10	17.54
Bekku	51	5	9.80	Pencil	33	6	18.18
Kogile	38	4	10.53	Kannadaka	49	9	18.37

Aane	84	9	10.71	Lipstick	31	6	19.35
Kothi	49	6	12.24	Deepa	62	12	19.35
Nona	37	5	13.51	Gombe	53	11	20.75
Kudure	58	8	13.79	Computer	56	12	21.43
Halli	43	6	13.95	Tv	51	11	21.57
Navilu	37	6	16.22	Sooji	43	10	23.26
Katthe	38	7	18.42	Gadiyaara	44	11	25.00
		Mean Ratio =	8.10			Mean Ratio =	14.15
		SD=	4.08			SD =	5.33

Note. W-Liv - words denoting living things
W-NLiv -words denoting non living things

Discussion

The study aimed at describing the distribution of semantic features for a set of 60 concrete nouns in Kannada language. The target words belonged to the category of animals and common objects. These categories were selected as they formed good exemplars for the domains of W-Liv and W-NLiv respectively. These domains have been reported in the earlier studies to have differential semantic impairments owing to their differences in distribution of distinctive features (Devlin, Gonnerman, Andersen, & Seidenberg, 1998; Garrard, Lambon Ralph, Hodges, & Patterson, 2001). Hence these domains were selected in our present study to see the nature of distribution in Kannada language. The method involved generation of written semantic feature for the target words from 60 participants. Semantic feature norms were collected from participants in order to obtain features which participant think is psychologically salient in describing the particular concept. The semantic features thus obtained also provide valuable substrate to describe organization of concepts based on semantic featural weights (Vigliocco, Vinson, Lewis, & Garrett, 2004).

The written semantic features obtained were analyzed for distribution of distinctive features. Results showed that the domain of W-Liv had significantly low proportion of distinctive features compared to W-NLiv. The ratio of distinctive features for the category 'animals' from the domain W-Liv ranged from a minimum of 2.17 to a maximum of 18.42 whereas the ratio for the category 'common objects' from the domain W-NLiv ranged from a minimum of 6.67 to a maximum of 25.00.

The mean proportion of distinctive features for W-Liv in the present study was 8.10% which is drastically less than the distinctive features generated for the domain of W-NLiv which was 14.15%. This difference in the distribution of distinctive features observed in the present and previous studies in literature (Cree & McRae, 2003; Randall, Moss, Rodd, Greer, & Tyler, 2004) may be attributed to the differences in the representation of concepts belonging to these domains. W-Liv share many features in common with the other members of their category and hence may have stronger representation of shared features than distinctive features. W-NLiv consists mostly of common objects which do not share many features with their category members which can be the reason for the greater number of distinctive features in their representation.

Similar trend in distribution of distinctive features was reported by Cree and McRae in 2003 who conducted analysis for concepts of English language, belonging to 34 categories. In their study the domain of 'creature' (W-Liv) was reported to posses lesser percentage of distinctive features (range: 15.7 to 26.4) than the domain of W-NLiv (range: 29.3 to 49.1). Similar results have been reported in literature for English language by few other researchers (Devlin, Gonnerman, Andersen, & Seidenberg, 1998; Garrard, Lambon Ralph, Hodges, & Patterson, 2001; Randall B. , Moss, Rodd, Greer, & Tyler, 2004). Hence the present study which was done in Kannada language replicates the trends seen in the literature for English language despite the vast differences in the language environment. This supports the notion that all the languages share a similar way of representation at least for the basic levels of concepts which are common to most of the languages.

The results of the study provide further evidence why certain categories such as that of W-Liv are more susceptible to impairment than others. These categories of W-Liv (animals in our study) have less correlation with other members of the same category due to limited number of distinctive features, leading to weaker connections among them. Presence of weaker connections makes them more susceptible to disruptions which in turn make it more difficult to access in case of impairment. Previous studies have reported a common trend in patients tested for semantic deficits where in W-Liv tend to be more impaired compared to W-NLiv. The present study provides supporting evidence from Kannada language along with studies in English language suggesting that distribution of distinctive features in turn corresponds to the patterns of semantic impairments reported in literature. The domain of W-Liv possesses lower

proportion of distinctive feature which explains its susceptibility to severe impairments than that of W-NLiv.

Also, distinctive feature forms the knowledge of the individuals which is required to discriminate among similar concepts. This ability to discriminate plays crucial role which is tested in most of the tasks (picture naming, word- picture matching, defining and naming from definition) used to diagnose semantic deficits (Cree & McRae, 2003). Hence deficit in distinctive feature knowledge is reflected in the poor performance on the semantic tasks. Thus present study has important implications in understanding the nature of semantic impairments seen in patients with semantic dementia and aphasia.

The study also provides supporting evidence for using distinctive features in the treatment of semantic deficits in aphasia. The treatment techniques using semantic features, as discussed earlier, usually employ semantic relatedness as basis to stimulate the access of semantic information (Boyle & Coelho, 1995). This procedure has been found to be efficacious in many patients but has reported poor generalization to connected speech (Boyle & Coelho, 1995; Coelho, McHugh, & Boyle, 2000; Rangamani & Prema 2011)**.** However few studies have shown that patients with aphasia have difficulty selecting the target word from a set of semantically related distracters (Butterworth, Howard, & Mcloughlin, 1984; Pierce, Jarecki, & Cannito, 1990) suggesting defects in distinctive feature knowledge. Treating such patients with techniques employing distinctive features may result in better outcome in these individuals. This view has been tested by few researchers who have found good improvement in naming skills of treated items along with better generalization to untreated items and to connected speech (Mason-Baughman, 2009; Kiran & Thompson, 2003). Thus training distinctive feature knowledge may improve semantic representation in patients with aphasia to a greater extent. The present study therefore helps in understanding the nature of semantic representation, semantic impairment and has utility in designing treatment paradigms and techniques for semantic deficits in persons who are native speakers of Kannada language.

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Appendix I

Living things (W-Liv)			Non living things (W-NLiv)	
Sl no	Target word	IPA transcription	Target word	IPA transcription
1.	Rabbit	/moʟa/	Bucket	/bɑ:ket/
2.	Sheep	/kuri/	Paper	/kɑ:gɑðɑ/
3.	Crow	/kɑ:ge/	Dustbin	/kɑsɑðɑbu'ti/
4.	Cow	/hasu/	Silver	/be'ɭi/
5.	Parrot	/giɳi/	Book	/pusθɑkɑ/
6.	Cheetah	/tʃiɾɑθe/	Comb	/bɑ:tʃɳige/
7.	Tiger	/huli/	Window	/kitɑki/
8.	Frog	/kɑ’ pe/	Tap	/nɑ'li/
9.	Wolf	/θo:ɭɑ/	Thread	/ðɑ:ra/
10.	Lion	/simhɑ/	Bag	/tʃi:lɑ/
11.	Hen	/koɭi/	Cupboard	/kɑpɑ:tu/
12.	Deer	/jinke/	Diamond	/vɑdzrɑ/
13.	Duck	/bɑ:θukoɭi/	Phone	/fon/
14.	Bear	/kɑrɑdi/	House	/mɑnɛ/
15.	Owl	/gu:be/	Bottle	/bɔtl/
16.	Dog	/nɑ:e/	Table	/mɛdzu/
17.	Squirrel	/ɑɭilu/	Black board	/blɑk bord/
18.	Butterfly	/tʃitɛ/	Broom	/porɑke/
19.	Eagle	/hɑðu/	Pen	/pɛn/
20.	Rat	/ili/	Fan	/fɑn/
21.	Fish	/mi:nu/	Blanket	/ho’ðige/
22.	Cat	/bɛku/	Pencil	/pɛnsil/
23.	Cuckoo	/kogilɛ/	Spectacle	/kɑ’nɑdɑkɑ/

24	Elephant	/a:nɛ/	Lipstick	/lipstik/
25	Monkey	/ko:θi/	Lamp	/de:pɑ/
26	House fly	/noŋɑ/	Doll	/gombe/
27	Horse	/kuðurɛ/	Computer	/kɑmpiuter/
28	Lizard	/hɑ'li/	TV	/tv/
29	Peacock	/nɑvilu/	Needle	/so:dzi/
30	Donkey	/kɑ'θɛ/	Clock	/gɑdiyɑ:rɑ/

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