==
Language in India www.languageinindia.com ISSN 1930-2940 Vol. 17:9 September 2017
UGC Approved List of Journals Serial Number 49042
==

Effect of Semantic Relatedness on Magnitude of Priming

Deepak P. Master in Speech Language Pathology
Akshaya S. Master in Speech Language Pathology
Dr. Abhishek B. P., Ph.D. (Speech Language Pathology)
==

Abstract

Words in the lexicon are assumed to be organised in semantic fields or network. Every word in the lexicon is related to another word belonging to the same lexical category or sharing common features and this kind of relationship is called semantic relatedness. Further, a word in the lexicon is related to many words through semantic relatedness but extent of relationship between the words is not same. Purpose: The study aimed to determine influence of semantic relatedness through priming in adolescents. Method: Thirty participants (mean age fifteen years) participated. Sixty prime-target pairs were presented through DMDX Version 5.0. Thirty were semantically related and thirty semantically unrelated. Among thirty semantically related word pairs, eight pairs were super-ordinate pairs and category coordinate pairs, derivatives and functional coordinates were seven each. Semantic judgment was the task. Results: The mean reaction time and accuracy scores for only semantically related scores on the four ordinates were considered and it was found that mean reaction time and accuracy scores were better for super-ordinates followed by category coordinates, derivatives and functional ordinates. Conclusion: Based on the results of the study it's clear that the extent of relatedness would vary depending on the semantic distance.

Keywords: Super ordinates, Category-coordinates, Derivatives, Functional Ordinates

Semantic relatedness refers to the extent of semantic features overlapping between words (e.g. "apple-orange") as explained by Thompson-Schill, Kurtz and Gabrieli, 1998. Semantic relatedness can either be a reflection of the similarity in features shared or the overlap in features of two words (e.g. "apple-orange'' ''hen- turkey''). Four categories of semantic relatedness are often described. These include semantic relatedness in terms of Superordinate Coordinate (SC) (e.g., apple-fruit), semantic relatedness in terms of Categorical Coordinate (CC) (e.g., apple-pear), relatedness in terms of Functional

Coordinates (FC) (e.g. apple-sweet) and Derivational Coordinate (DC) (e.g., apple-red) Hutchison (2003) considered superordinate and categorical relations as “semantic relations” and others as “associative relations” Funtional relation was first studied by Moss et., al (1995). Processing of Distinctive features was investigated initially by Rips, Shoben and Smith (1973).

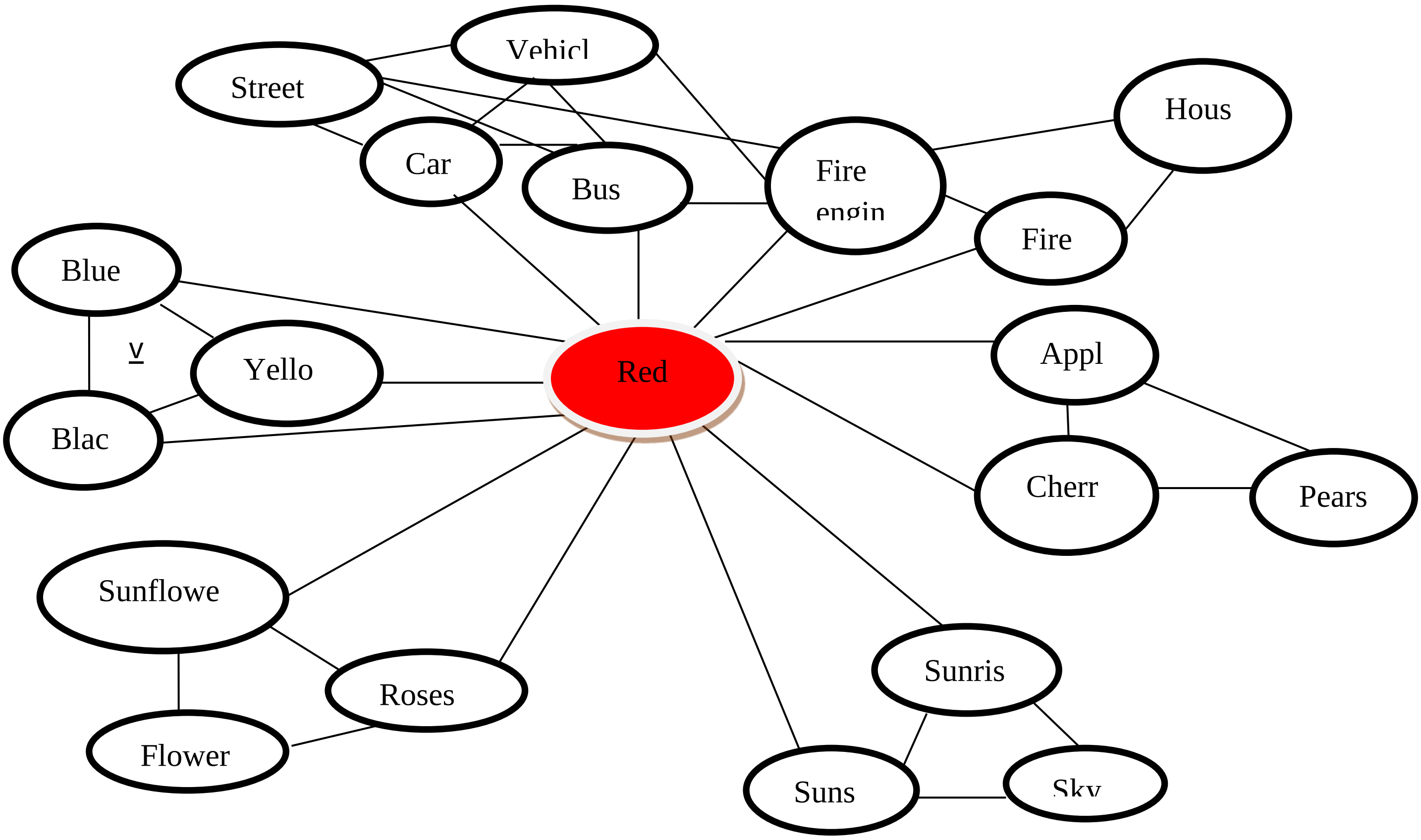
The distinctions between these semantic features are often studied through priming experiments. In the priming experiments, a semantically related or unrelated word before the target is shown to the participant first and the time taken to read or recognise the experimental stimuli is measured. These experiments suggest that participants respond faster to targets, when prime words share common semantic features (semantically similar) with the target word compared to those words, which do not share semantic relatedness with the target.

The distinction between the four variants under semantic relatedness is explored through semantic paradigm. Semantic paradigm is based on the principle of semantic priming. Semantic priming refers to the ease of recognising a word when a target word is followed by a semantically related word, when compared to an unrelated word (Neely, 1976, Fischler, 1977a).When a target is unexpectedly preceded by a related prime; it tends to be activated by the prime. Once the prime is activated then this facilitates the processing of the related target word.

Semantic priming principle can be explained through spreading activation theory. Collins and Quillian in 1972, attributed semantic activation to semantic memory, wherein they stated that a number of related entries in semantic memory are based on highly complex network comprising of concept nodes; each concept is connected to one another by means of links. The link which gains maximum activation be will recognized and relatedness will be established. Parallel explanation of semantic priming principle is provided through the concept of memory search (Quillian, 1967, 1968). According to this concept, initially the search begins at the level of node, in response to a stimulus and the concept specified by the stimulus, the search involves tracing out the parallel links from these nodes. In summary, according to this model, initially all the nodes linked to the initial concept node gets activated and converge with each other and finally based on the specific constraints imposed by the task, the specific path is processed. Further Collins and Loftus (1975) added assumptions related to processing. When a concept is processed, the activation spreads out along the paths in the network in a decreasing gradient. Therefore, the extent of activation becomes stronger with respect to time and distance. They also assumed that, if the properties of two concepts are common, then they are more proximally related and thus making the retrieval easy. In other words, if a prime is more closely related to the target then the activation of the target would be to a greater extent than with the prime which is not closely related. The proponents of this model also propose that the words, which are recently activated, can be retrieved readily compared to the words which are not activated recently.

According to spreading activation theory, for the target word *apple*, primes words would be *red colour* and *fruit*. These prime words are proximally related with respect to appearance and common features they share and the extent of activation. Whereas the activation would be to a lesser extent for the prime 'sunflower' as it is different in its appearance and has no common features with 'apple'(As seen in Figure 1).

Figure 1: Spreading Activation



The spreading activation theory was extended by Rosch in 1975, through three-step model for categorisation tasks. According to this model, the individual encodes the stimulus pair, then he/she determines if the pair matches with each other or not depending on the features the word pairs share and in the final step he/she retrieves the related semantic categories for the particular prime stimulus and judge if the prime and target are semantically similar or not. Another model of spreading activation to explain the effects of distance on priming is the Discrete Model: Exponential Distribution (Anderson, 1976). According to which the node is activated to greater extent if connection links are lesser in number and the node is less activated if the connection links are greater in number. In other words retrieval of the word becomes easier if there are fewer number connection links.

Continuous Flow Model is yet another model explaining semantic relatedness, according to this model, the extent of activation of a node is directly related to amount of activation occurring from the surrounding nodes in a continuous manner (McClelland, 1979; McClelland & Rumelhart, 1981). That is the rate of change of activation at a node is proportional to sum of the differences between the activation threshold at the node and surrounding nodes. According to Ratcliff and McKoon (1981), the farther the node activation, slower will be reaction time compared to the closer functions or nodes.

The automatic priming effect can be tapped when the experimental conditions allow participants to develop expectancies on the presence of semantically related words: with shorter Stimulus onset asynchrony's (SOA) (Neely, 1977) or a larger number of semantically related prime-target pairs (Tweedy, Lapinski, & Schvaneveldt, 1977). Posner and Snyder (1975) studied the effect of attention on processing of target in the presence of prime and postulated that at low levels of attention, a prime tends to produce only facilitating effects and at high levels of attention, it results in both facilitation and inhibition. The facilitative effect of a prime word on the respective pronunciation or recognition of a related target word was described both as an ''effect of association'' (Meyer & Schvaneveldt, 1971) and as a ''semantic facilitation effect'' (Neely, 1976) initially. Theoretical accounts of priming are often based on either associative relatedness or semantic similarity. Initially priming was known for facilitation of word recognition, as resultant of elevated activation of a target word after the passive spread of activation from the prime node to other word nodes linked in an associative network (Meyer & Schvaneveldt, 1971).

On the contrary, theories of distributed memory emphasis on semantic similarity, which is a product of distinct feature overlapping in featural representations. Distributed models of word retrieval elicit facilitative effects as a result of decrement in the amount of time necessary to ensure a shift in semantic space between similar words (Moore, & Fain J, 1995). In contrast to other models of priming, the dependence of the priming effect on semantic similarity is critical to distributed models of semantic memory. (Thompson-Schill et al., 1998). According to Thompson-Schill et al., (1998), the three models of priming—spreading activation, compound-cue, and distributed memory, all explain facilitation occurring due to a passive and automatic process reflecting the organization of semantic memory. Further, some studies also explain that priming as a resultant of non-semantic factors including grammatical class (Goodman, McClelland, & Gibbs, 1981), expectancies (Neely, 1976), and episodic memory (Ratcliff & McKoon, 1981). Evidence of non-semantic facilitation has led to the proposal of a "two-process theory of priming". Wherein, the proponents explained the mechanism of fast process as automatic, unintended or without conscious awareness, and the mechanism of slower process was explained as limited-capacity process requiring conscious attention (Posner & Snyder, 1975).

Previously not much of studies have concentrated on the effect of semantic relatedness across the semantic categories (namely super ordinate, categorical, function and derivative coordinates). In other words there is dearth of research in the study of semantic relatedness considering the above mentioned sub categories of semantics. Furthermore; there can be variations in measures of semantic relatedness from one language to the other language. Hence, there arises a need to explore the effect of semantic relatedness in Kannada speaking children in Indian context, which the present study purports to. The study aims at understanding the semantic organisation.

Objectives of the Study

To measure mean reaction time and accuracy scores across the four coordinates of semantics; namely superordinate, categorical, functional, derivative coordinates in adolescents and to find the effect of semantic distance across four different categories.

Method

Participants

In the study, 30 participants (15 boys and 15 girls) were randomly selected. The mean age of the participants was 15 years (SD+0.8). All the participants were native speakers of Kannada and were able to read and write Kannada. While selecting these participants it was made sure that the participants were free from any neurological, psychological illness and visual deficits through administration of Mini Mental State Examination (MMSE). All participants were taken willingness consent to participant in the study and further this research was approved by our institute All India Institute of Speech and Hearing, Central Government body, under Ministry of Health and Family welfare. Hence on this grounds all participants were cared in an established and ethically- approved manner.

Stimulus

Totally 60 pairs of words were prepared as stimuli for the study. All the stimuli were in Kannada. While 30 pairs were semantically related, the other 30 set of word pairs were semantically unrelated (e.g., apple- blue). The semantic relatedness was defined through the four categories of relatedness. These were semantic related in terms of Superordinate Coordinate (SC) (e.g., apple- fruit), Categorical Coordinate (CC) (e.g., apple – pear), Functional Coordinates (FC) (e.g., apple- sweet) and Derivative Coordinate (DC) (e.g., coconut- coir). (The operational definitions of these terms have been described in appendix section). Of these 30 related word pairs, 8 pairs were related in terms of superordinate coordinate, 8 pairs were categorically related and rest 14 (7 each) were functionally and derivatively related.

Procedure

60 word pairs were presented to the participants orthographically, displayed through laptop screen. DMDX Auto-mode, (Version 5.0 software) (Jonathan and Ken Forster) was used to perform this task. The stimuli comprised of 60 word pairs, wherein the first word of each pair was the prime word and the next word was the target and these 60 pairs were randomised in the program. Further the prime word duration and inter stimuli duration was set to 500ms and the stimulus duration for target word was set to 4000ms in the program for each word pair.

The participants were instructed to press “1” in the keyboard if the word pairs were related and press “0” if the word pair was unrelated. Participants were instructed to follow this for all the 60 word pairs. Then the program was run using DMDX and at the end of the task, the software automatically computed the reaction time and accuracy for each subject which was saved as respective output file for each participant. From the output files the mean reaction time and mean accuracy for each semantic coordinate (i.e., SC, CC, FC and DC) was calculated for every individual who participated in the study and then these scores were subjected to statistical analysis.

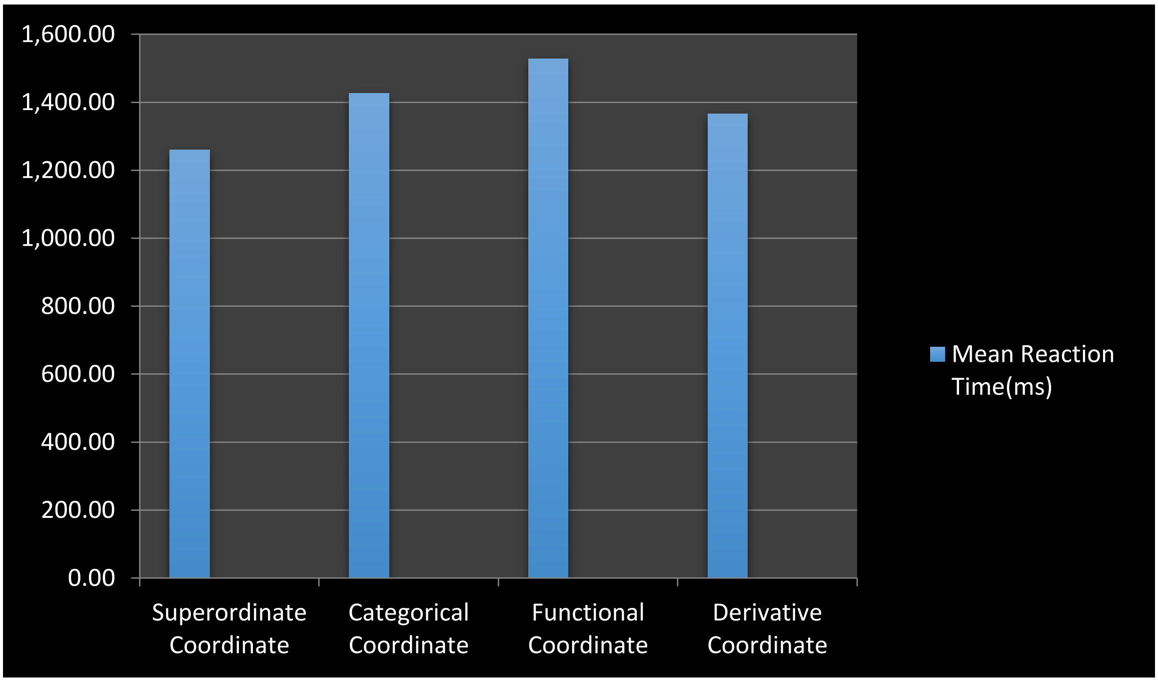
Results and Discussion

The primary objective of the present study was to measure reaction time and accuracy across four coordinates of semantics, namely superordinate, categorical, functional, derivative coordinates in adolescents. The second objective was to find the effect of semantic distance across four different categories.

Reaction time

Data obtained for analysing mean reaction time across the above mentioned coordinates of semantics was subjected to statistical analysis, wherein the data was verified for skewness using Shapiro-Wilk’s test which indicated that the data was not skewed ($p<0.05$) and hence abided the properties of normal distribution. Descriptive statistics was applied after verifying the skewness and the overall mean reaction time for each of the semantic coordinates. Here the four semantic coordinates were treated as the independent variables and the mean reaction time was the dependent variable. The mean reaction time for superordinate coordinate was 1260.54ms, for categorical coordinate was 1426.75ms, for functional coordinate was 1528.60ms and for derivative coordinate it was found to be 1366.209ms. Mean Reaction Time was less for Superordinate coordinate followed by Categorical coordinate followed by Functional coordinate followed by Derivative coordinate (As seen in Figure 2).

Figure 2: Mean Reaction Time for the different ordinates

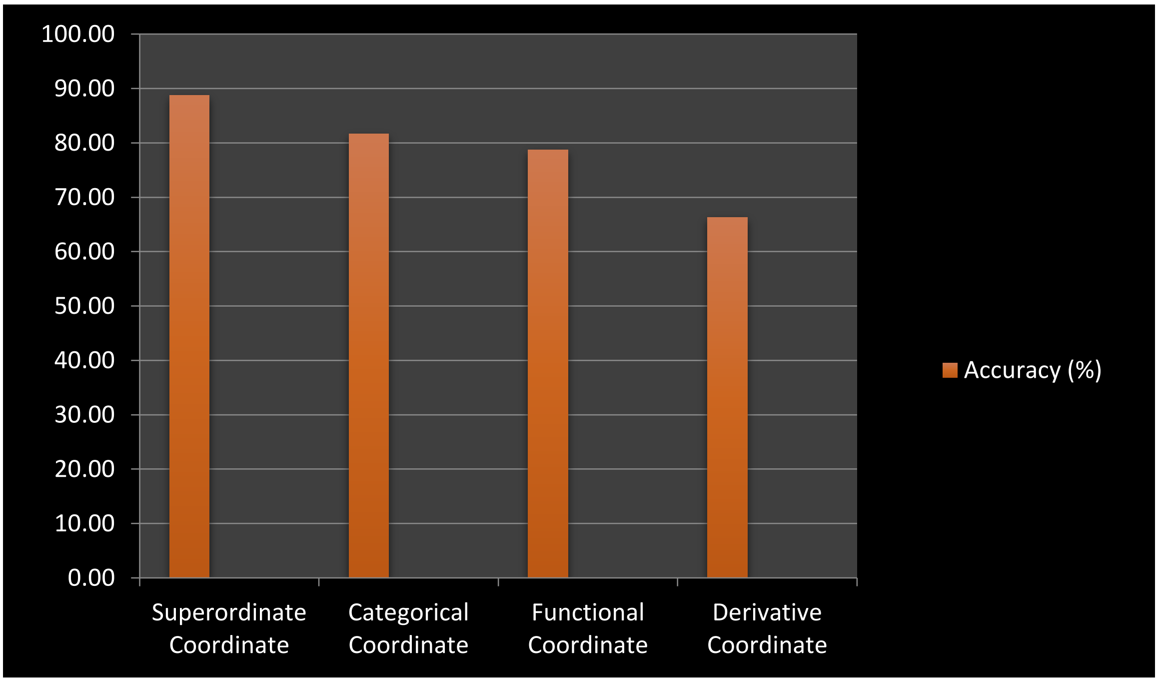


Further in order to see if there was any significant difference between the four semantic coordinates, ANOVA was used and parametric t-test was applied on the data to measure within subjects' effects for reaction time within the four semantic coordinates with reference to <0.05 p value. The analysis revealed significant difference in the mean reaction time within the four coordinates (f= 4.280, α= 0.05, p= 0.007). To observe the difference in mean reaction time across the semantic coordinates, pair-wise comparison was done using Bonferroni test and the test revealed significant difference between the mean reaction times of superordinate coordinate and functional coordinate (α= 0.05, p= 0.01).

Accuracy

Similarly, data obtained for analysing accuracy across the above mentioned coordinates of semantics was subjected to statistical analysis and properties of normality was satisfied. The four semantic coordinates were treated as the independent variables and the accuracy scores were considered to be the dependent variable. Descriptive statistics was applied after verifying for skewness and the overall accuracy for each of the semantic coordinates was measured. The mean accuracy for superordinate coordinate was 88.75%, categorical coordinate was 81.66, functional coordinate was 78.75% and derivative coordinate was found to be 81.25 % (As seen in Figure 3).

Figure 3: Accuracy scores for different ordinates



Further ANOVA was used and parametric t-test was applied to measure the effect of within subjects on accuracy. Results revealed no significant difference across any of the semantic coordinates (f=3.672, α= 0.05, p=0.15) and significant difference was seen in between semantic coordinates (f=2202.72, α= 0.05, p= 0.000).To measure the difference in accuracy across the semantic coordinates, pairwise comparison was done using Bonferroni test and the test revealed significant difference between the accuracy for super-ordinate coordinate and categorical coordinate (α= 0.05, p= 0.047) and super-ordinate coordinate and functional coordinate (α=0.05, p=.018). The accuracy scores were greater for superordinate coordinate followed by categorical coordinate followed by functional coordinate followed by derivative coordinate.

From the above-mentioned results, it is clear that the mean reaction time and accuracy scores of the participants were better for superordinate coordinate compared to categorical coordinate, followed by functional and derivative coordinate. This may be because the participants could judge that prime and target were related when the prime was superordinate i.e. name of the lexical category. This was in consensus with Spreading Activation theory (Collins and Loftus, 1975), where the proposers justified for least reaction time in judging super ordinate relationship due to stronger connections between two concepts and thus are more closely placed in the mental lexicon. Therefore, in their study, they implied that when category name was presented first, the activation immediately sweeps to the category members. Since the category name and category members are closely related, the time required to judge the relationship between these two nodes is least or fastest. Also, it could be because the words considered for the study ranged from more to less in terms of frequency of usage, the name of the lexical category itself would facilitate recognition for a word list which would vary in terms of frequency of usage. Similar results were noted in study by Warrington (1975) on aphasic individuals. This was also supported by Spreading Activation Theory (Collins and Loftus, 1975). The theory suggested that high frequency words triggered faster processing than low frequency words. When super ordinate is the prime, it activates the target with relative high frequency, which means more activation spreads to the related target word, and hence it needs less time to reach the threshold for an intersection. In other words the semantic distance was least for superordinate.

The reaction time was more and accuracy scores were less for categorical coordinate compared to superordinate coordinate and this may be because the participants had to associate with the categorical items based on shape, size, colour and related features and respectively match with prime word. Hence, this required longer time to ascribe relationship between the prime and target. This can also be attributed to interference effect in the process of activation. That is, when two concepts have a common superordinate, it takes longer time to verify if both fall into same superordinate category and then judge the relationship among them. This was in support to study by Becker (1980). On comparison with functional and derivative coordinate, the mean reaction time and accuracy scores were better in categorical coordinate. This can be attributed to the ease of judgment in deciding the categorical items directly than judging based on the specific features and function of the prime word. For example, when prime is dog, ideal participants will activate other coordinate members (cat or cow). This occurs through the process of searching the category animals and then the members. Hence expectancy plays crucial role in faster activation of categorical items faster and easier. Thus subject takes less time to process category coordinate pairs compared to functional and derivative coordinate pairs.

The mean reaction time and accuracy scores for functional coordinate were better compared to derivative coordinate. This could be because the prime and target pairs are related with respect to functions associated, whereas in derivative coordinate the prime and target pairs are related with respect to specific feature which is comparatively more time consuming/ taxing for participants to judge on the basis of features. Hence scores were better for functional coordinate compared derivative coordinate. Mean reaction and accuracy scores for functional coordinate was poorer compared to superordinate and categorical coordinate, which can be attributed to complexity of task in judging the relatedness between prime and target word functional coordinate pairs. The mean reaction time was more and accuracy scores were least for derivative coordinate compared to superordinate, categorical and functional coordinates. This could be due to the complexity involved in relating specific features to a lexical item. Distinguishing the properties make it harder to reach the positive connection or judgment when there are other connections like superordinate and categorical relations. Therefore, this slows down the process. Another factor responsible for poorer performance in judging derivative word pairs could be due how the person weighs the various properties and judges the link between the pair. According to Warrington (1975), specific features of words are represented at lower levels and are prone to be lost first, since the connections are weak. This was attributed to frequency of usage. Hence, when the individual looks into a word, most frequently used features are activated sooner, and to judge the connection between the distinctive or derivative pairs, (s)he has to inhibit other activations and then establish the link. This becomes more time consuming and cognitively taxing task.

Future Implications

- Since the present study concentrated on fewer numbers of participants, future research can be extended to larger population.
- Further gender differences can be considered in the future studies. Similar study can be done by considering wider age range
- The effect of semantic relatedness the stimuli can be presented in auditory modality.

- The future research can be extended to different clinical population like aphasia, specific language impairment and mental retardation and hearing loss.

Limitations

The study was conducted on smaller population and hence the findings cannot be generalised. Not many studies have been carried out in this line of research to support or negate findings obtained in the present study.

===

Acknowledgement

We cordially thank all our participants for their support and cooperation while conducting the study.

Declaration of Conflicts of Interests:

The author(s) disclosed no potential conflicts of interest with respect to the research, authorship and /or publication of this article.

==

References

Anderson, J. R., 1976. *Language, memory, and thought*. New York: Halsted.

Becker, C. A. (1980). Semantic context effects in visual word recognition: An analysis of semantic strategies. *Memory & Cognition*, 8, 493-512.

Collins, A. M., & Quillian, M. R., 1972. Experiments on semantic memory and language comprehension. In L. W. Gregg (Ed.), *Cognition in learning and memory.*

Collins, A. M., &Loftus, E. F., 1975. ASpreading-Activation Theory of Semantic Processing. *Psychological Review*, 82, 407- 428.

Fischler, I. 1997. Semantic facilitation without association in a lexical decision task. *Memory and Cognition,* 5, 335-339.

Hutchison, K. A. (2003). Is semantic priming due to association strength or feature overlap? A Microanalytic review. *Psychonomic Bulletin & Review*, *10*(4), 785-813.

Jonathan and Ken Forster, DMDX Auto-mode Version 5.0 software, Department of Psychology, University of Arizona.

McClelland, J. L., 1979. On the time relations of mental processes: An examination of systems of processes in cascade. *Psychological Review*, 86(4), 287-330.

McCleclland, J. L., &Rumelhart, D. E., 1981. An Interactive Activation Model of Context Effects in Letter Perception: Part 1. An Account of Basic Findings. *Psychology Review*, 88 (5).

Meyer, D. E., & Schvaneveldt, R. W., 1971. Facilitation in recognizing pairs of words: Evidence of dependence between retrieval operations. *Journal of Experimental Psychology*, 90, 227- 234.

Moore, J, D and Fain J, 1995. Proceedings of the Seventeenth Annual Conference of the Cognitive Science Society. University of Pittsburg, UK.

Moss, H. E., Ostrin, R. K., Tyler, L. K., & Marslen-Wilson, W. D. (1995). Accessing different types of lexical semantic information: evidence from priming. *Journal of Experimental Psychology: Learning, Memory, & Cognition*, 21, 863-883.

Neely, J. H. 1977. Semantic priming and retrieval from lexical memory: Roles of inhibitionless spreading activation and limited capacity attention. *Journal of Experimental Psychology*: *General.* 106(3), 226-254.

Posner, M. I., & Snyder, C. R., 1975. Attention and cognitive control. *Information processing and cognition*, 55-85.

Quillian, M. R. Word concepts: A theory and simulation of some basic semantic capabilities. *Behavioral Science*, 1967, 12, 410-430.

Quillian, M. R. Semantic memory. *Unpublished doctoral dissertation*, Carnegie Institute of Technology, 1966. (Reprinted in part in M. Minsky [Ed.], Semantic information processing. Cambridge, Mass.: M.I.T. Press, 1968.)

Ratcliff. R. & McKoon. G., 1981. Sequential Effects in Lexical Decision: Tests of Compound- Cue Retrieval Theory. *Journal of Experimental Psychology: Learning, Memory and Cognition*, 21(5), 1380-1388.

Rips, L. J., Shoben, E. J., & Smith, E. E. Semantic distance and the verification of semantic relations. Journal of Verbal Learning and Verbal Behavior, 1973, 12, 1-20.

Rosch, E., 1995. Cognitive representations of semantic categories. *Journal of Experimental Psychology: General*, 104(3), 192-233.

Thompson-Schill, Kurtz. K. J., Gabrieli. D. E., 1998. Effects of Semantic and Associative Relatedness on Automatic Priming. *Journal of Memory and Language,* 38(4), 440-458.

Tweedy, J. R., Lapinski, R. H., & Schvaneveldt, R. W., 1977. Semantic-context effects on word recognition: Influence of varying the proportion of items presented in an appropriate context. *Memory & Cognition*, 5 (1), 84-89.

Warrington, E. K. (1975). The selective impairment of semantic memory. *The Quarterly Journal of Experimental Psychology*, *27*(4), 635-657.

==

Deepak P.
Speech Language Pathologist
Master in Speech Language Pathology
All India Institute of Speech and Hearing
Mysuru 570006
Karnataka
India
deepakaryan064@gmail.com

Akshaya S.
Master in Speech Language Pathology
Research Officer (Speech Language Pathology)
All India Institute of Speech and Hearing
Mysuru 570006
Karnataka
India
akshayaslp92@gmail.com

Dr. Abhishek B. P., Ph.D. (Speech Language Pathology)
Lecturer in Speech Language Sciences
All India Institute of Speech and Hearing
Mysuru 570006
Karnataka
India
abhiraajaradhya@gmail.com