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A PROFILE OF VERBAL FLUENCY MEASURES IN INDIVIDUALS WITH NON – FLUENT APHASIA

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CHAPTER - I

INTRODUCTION

Language is a communication system. Human language is a specific example of a communication system characterized by the use of limited amount of articulated sounds (phonemes), which can be combined in different ways to create meaningful units (morphemes and words), grammar that refers to the rules governing language use (Morpho-syntax), the meaning of linguistic expression (Semantic) and use of language (Pragmatic) (Ardila, 2014).

Few tasks which require the use of implementation of complex neural networks related to semantic memory, working memory or executive functions.

Verbal fluency recruits two types of cognitive processes. One is linguistic, particularly efficient access to lexical-semantic representations. The other is executive processing, such as speeded strategic search, allocation of attentional resources, ongoing monitoring of task requirements and inhibition of previously generated responses (Troyer, Moscovitch, Winocur, Alexander and Stuss, 1998; Unsworth, Spillers and Brewer, 2011). Further, the strategic search involves two steps: identifying subcategories (e.g., farm animals) and generating examples of a subcategory, followed by switching to another subcategory after the initial subcategory exemplars have been exhausted (Faroqi-Shah, 2017).

Among individuals with Aphasia, one of the most common and persistent symptoms is word retrieval difficulty (Goodglass and Wingfield, 1997). A review of large number of literatures in aphasia indicates that the naming impairments vary substantially in their cognitive and neural underpinnings among individuals with aphasia.

Bose, Wood and Kiran (2016) suggested that search and retrieval process is less productive and more effortful in individuals with aphasia . Thus, difficulties with verbal fluency performance in aphasia have a strong basis in their lexical retrieval processes, as well as some difficulties in the executive component of the task.

With respect to the Indian context applicable to this study, the focus has only been on adults, geriatrics, persons with dementia, schizophrenia and right hemisphere damage (Krishnan and Karanth, 2013; Mathuranath, George, Cherian, Alexander, Sarma and Sarma, 2003; Ratcliff, Ganguli, Chandra, Sharma, Belle, Seaberg and Pandav, 1998; Sosa, Albanese, Prince, Acosta, Ferri, Guerra and Stewart, 2009).

Semantic memory is one of our most defining traits. It includes all acquired knowledge about the world and is the basis for nearly all human activity. More uniquely human has the ability to represent concepts in the form of language, which allows not only the spread of conceptual knowledge in an abstract symbolic form, but also a cognitive mechanism for the fluid and flexible manipulation, association and combination of concepts.

Thus, humans use conceptual knowledge for much more than merely interacting with objects. All of human culture, including science, literature, social institutions, religion, and art, is constituted from conceptual knowledge. We do not reason, plan the future or remember the past without conceptual consent- all of these activities depend on activation of concepts stored in semantic memory.

Most studies predominantly analyzes the patterns within and between the clusters. Very few studies have reported attempted to correlate the findings on verbal fluency tasks to the cognitive processes governing them.

Verbal fluency measure is a very short, yet highly sensitive test of verbal and cognitive functioning that is widely used in neuropsychological assessment, clinical practice and research. This study contributes to the literature on verbal fluency by reporting data on three verbal fluency tasks across subtypes and severity of aphasia. This study shows that verbal fluency is impaired in aphasia, even in mild aphasia.

To increase the usefulness of the verbal fluency measures in clinical and research settings and for better understanding of verbal fluency between the normal and Aphasic individuals, a need to create data for the Semantic Category Fluency tasks is imminent. Based on these observations, the present study attempts to apply both quantitative and qualitative analysis of verbal fluency and its comparison between the normal and Aphasic individuals.

CHAPTER - II

REVIEW OF LITERATURE

There are several ways in which the meaning of words may be related. Words do not have meanings in isolation; instead, the meaning of a word is usually related in important ways to the meanings of the words. Some of the most prominent of these relations in meaning are known collectively as sense relations, and there are several kinds.

Semantics and its representation

Semantics is the study of the meaning of linguistic expressions. Each word has a particular semantic field. The meaning of the words (and the concepts attached to the words) are organized hierarchically. For instance, canary is a bird, and a bird is an animal; but there are other birds, and there are other animals.

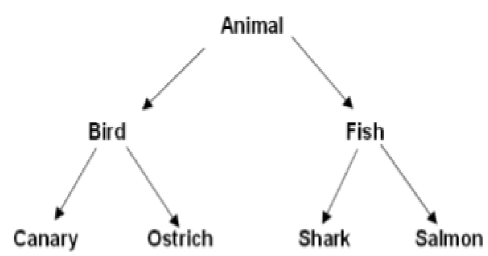

Figure 2.1: Shows the hierarchical organization of words and concepts. (Ref:Ardila, 2014, Aphasia Handbook page no. 51)

Semantic Relationships at Word Level

Semantic relationships are the associations that exist between the meanings of words (semantic relationships at word level), between the meanings of phrases, or between the meanings of sentences (semantic relationships at phrase or sentence level).

There are several kinds of sense relations as a result of the semantic relatedness between the form and meaning and between two meanings, they are:

Synonymy

Synonymy is the semantic relationship that exists between two (or more) words that have the same (or nearly the same) meaning and belong to the same part of speech, but are spelled differently. Synonyms are words with the same or similar meanings or are said to be synonymous. Examples of synonyms are, Big = large, Small = little. Pairs of words that are synonymous are believed to share all (or almost all) their semantic features or properties. However, no two words have exactly the same meaning in all the contexts in which they can occur.

Antonym

Antonyms are the word relationship that exists between two (or more) words that have opposite meanings. The pairs of words which have opposite meanings are called antonyms. Antonymous pairs of words usually belong to the same grammatical category (i.e., both elements are nouns, or both are adjectives, or both are verbs, and so on). They are said to share almost all their semantic features except one. The semantic feature that they do not share is present in one member of the pair and absent in the other (Fromkin and Rodman, 1998).

Hyponymy

Hyponymy is the state or phenomenon that shows the relations between more general term (lexical representation) and the more specific instances of it. The concrete forms of sets of word (the specific instances) are called 'hyponyms'.

Example: The lexical representation of: red, yellow, green, purple, black, is color. Thus, we can say that: "red is a hyponym of color", and so on.

Homophony

When two or more different written forms have the same pronunciation, they are described as "Homophones". For example: Bare – Bear, Meat – Meet, Flour – Flower. The term homonym is used when one form written or spoken has two or more unrelated meanings. For **example**: 1- bank= (of a river) bank= (financial institution).

Polysemy

If a word has multiple meanings, that is called polysemic. Relatedness of meaning accompanying identical form is technically known as polysemy. For example: The word "head" is used to refer to the object on the top of our body, on top of a glass of beer, on top of a company or department. Another word "foot" has multiple meanings such as foot of a person, of bed, of mountain etc.

Metonymy

There is another type of relationship between words based simply on a close connection in everyday experience. That close connection can be based on a container-contents relation (bottle- coke; can- juice), a whole- part relation (car- wheels; house-roof) or a representative- symbol relationship (king- crown; The President- The White House).

Collocation

Frequently occurring together is known as collocation. Words tend to occur with other words. For **example**: If you ask a thousand people what they think when you say 'hammer', more than half will say 'nail', if you say 'table' they will mostly say 'chair' and for 'butter- bread, for needle- thread, for salt- pepper. Some collocations are joined pairs of words such as salt and pepper or husband and wife.

Types and Applications of Verbal fluency tasks

The types of verbal fluency tasks include letter fluency (variously known in the literature as initial letter fluency, phonemic fluency, phonological fluency, formal fluency, letter-cue word generation) and category fluency (or semantic (category) fluency, semantic-cue word generation). For letter fluency, words must be produced according to phonemic constraints (i.e. exemplars beginning with a specified letter of the alphabet such as 'p'). For category fluency, words must be produced according to semantic constraints (i.e. exemplars which belong to a specified semantic category, such as 'vehicles').

Tests of verbal fluency or word list generation are frequently used for clinical and experimental research to study the cognitive function in humans. In general, these are operationalized as the number of words produced within a restricted category and within a given time limit (Spreen and Strauss, 1998). Verbal fluency is most commonly used to index the organization and integrity of lexical and semantic memory representations (Marczinski and Kertesz, 2006; Tröster, Salmon, McCullough and Butters, 1989) and executive functions (Chiappe and Chiappe, 2007; Rende, Ramsberger and Miyake, 2002).

Semantic Category Fluency task

In the semantic task, subjects are given one minute to generate as many words as possible belonging to a certain category (e.g., food items or animals). The semantic category fluency test relies heavily on the integrity of semantic associations within the lexicon (Rohrer, Salmon, Wixted and Paulsen, 1999). As such, this test is good indicator of semantic memory, a subsystem of human memory dealing with knowledge of concepts, meanings, and associations (Goñi, Arrondo, Sepulcre, Martincorena, Mendizabal, Murtra and Villoslada, 2011). Semantic fluency deficits have been associated with damage to the frontal and temporal lobe regions (Mummery, Patterson, Hodges and Wise, 1996).

The more words in the category that exist in their mental lexicon, the larger their total number of responses. Additionally, responses often reveal how the lexicon is organized. Through activation of neighboring words and through strategic searching, the responses are often well organized: consecutive words are semantically related to one another (Troyer, Moscovitch and Winocur, 1998).

Spreading Activation Model of semantic memory

Spreading Activation Model (Collins and Loftus, 1975) of semantic memory organization deals with the manner in which words are organized. They assumed that words are represented in the internal lexicon in a network without strict hierarchical organization. The organization is closer to a web of inter connecting nodes, with the concepts stored in terms of attributes or characteristics. For **example**, a word such as 'lion' may get grouped with collection of highly similar words such as 'tiger', 'leopard', 'cheetah' to form the semantic network of animal category. Similarly, during the process of semantic activation of farm animals, the concept 'cow' may get more strongly activated than animals belonging to category of wild animals.

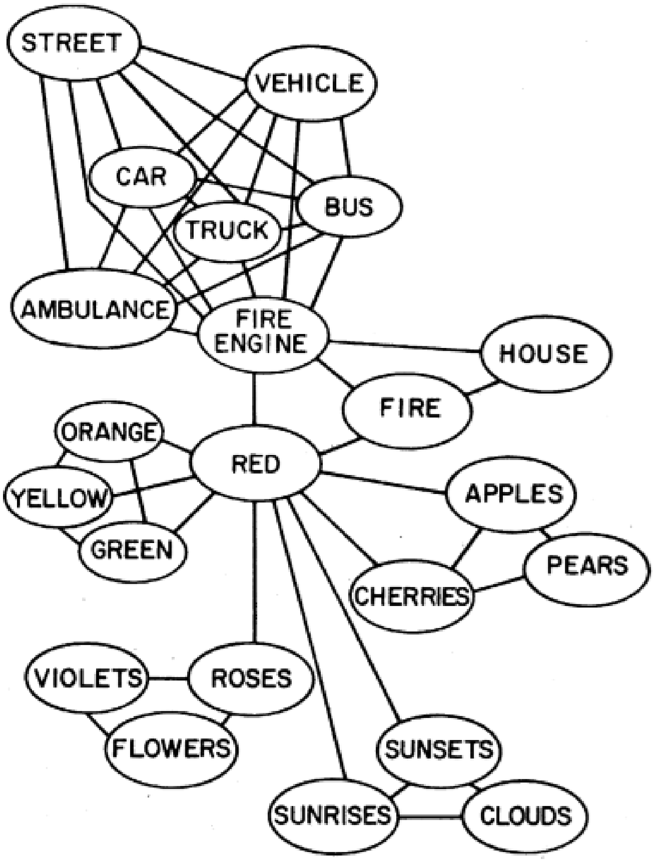

Figure 2.2: A schemantic representation of concept relatedness in a stereotypical fragmant of human memory (where a short line represents greater relatedness).(Ref: Collins and Loftus, A spreading activation theory of semantic processing. Psychological Review, Pg. 412).

The brain areas, such as frontal lobe (left dorsolateral prefrontal gyrus, right inferior frontal gyrus), temporal lobe (left inferolateral temporal lobe, superior- middle temporal gyrus), left superior parietal cortex, anterior cingulate gyrus of the left hemisphere and subcortical regions (thalamus, basal ganglia) perform coordinated activities during the semantic fluency task (Mummery, Patterson, Hodges and Wise, 1996; Thames, Foley, Wright, Panos, Ettenhofer, Ramezani and Hinkin, 2012).

Aphasia and its types

Aphasia is an acquired impairment in language production and comprehension and in other cognitive processes that underlie language. It is secondary to brain-damage and is most frequently caused by stroke (Murray and Chapey, 2001).

Aphasia is created by damage to areas of the human brain that are intimately involved in dealing not only with linguistic operations, but also with the nervous system areas that are intertwined with thinking, memory, control of information processing, and other cognitive functions. (A.D.A.M., US. National Library of Medicine, 2002).

The basic subtypes of aphasia across different multidimensional classification schemes to fall into the categories of 'fluent' 'non-fluent,' and 'other' aphasias.

An individual may appear to be non-fluent for any of a variety of reasons, or according to any of a large array of measures. Generally, persons with aphasia are considered fluent if they are able to speak in spontaneous conversation without abnormal pauses, abundant non-meaningful filler phrases, or long periods of silence. Non-fluent patients tend to have a reduced rate of speech and to express less communicative content per unit of time than normal speakers do. Of course, patients who are completely nonverbal are non-fluent. Damasio (1998) presents an excellent synopsis of the various categorical terms used throughout the history of the study of aphasia.

The three basic types of fluent aphasia are conduction aphasia, Wernicke's aphasia, and transcortical sensory aphasia. The critical features of Wernicke's aphasia are impaired auditory and reading comprehension and fluently articulated but paraphasic speech (Goodglass, Kaplan and Baressi, 2001) in which syntactic structure is relatively preserved. In many cases, patients with Wernicke's aphasia present with logorrhea, or press of speech, characterized by excessive verbal production. Paraphasias are most often in the form of sound transpositions and word substitutions (Goodglass, Quadfasel and Timberlake, 1964). Patients with Wernicke's aphasia experience naming difficulty that is severe in relation to their fluent spontaneous speech (Goodglass et. al., 1964). Neologisms are frequent. Those who produce frequent neologistic expressions are often unintelligible and are sometimes referred to as having 'jargon aphasia' (Wepman and Jones, 1961). Patients with Wernicke's aphasia also have difficulty reading, writing, and repeating words (Damasio, 1998). They often demonstrate a lack of awareness of their deficits, especially compared to patients with other types of aphasia. Some authors and many clinicians use the term 'receptive aphasia' to refer to the disability of patients with Wernicke's aphasia because of their primary deficit in the area of linguistic comprehension. Likewise, because lesions that lead to this form of aphasia tend to be located in the temporal lobe, Wernicke's aphasia represents a classic form of 'posterior' aphasia.

A hallmark feature of persons with conduction aphasia is impaired repetition of words and sentences relative to fluency in spontaneous speech, which is often normal or near normal. Auditory comprehension is also relatively spared (Goodglass et. al., 2001). Most patients repeat words with phonemic paraphasias, but often they will omit or substitute words, and they may fail to repeat anything at all if function words rather than nouns are requested (Damasio, 1998). Literal paraphasias repeatedly interfere with speech.

Individuals with TSA have fluent, well-articulated speech with frequent paraphasias and neologisms (Goodglass et. al., 2001). Global paraphasias occur more frequently than phonemic paraphasias (Damasio, 1998). A key feature that differentiates TSA from conduction aphasia is intact repetition ability. Auditory comprehension is generally poor. Confrontation naming is impaired, and the patient may offer an irrelevant response or echo the words of the examiner (Goodglass et. al., 2001).

Three basic types of non-fluent aphasia: Broca's, transcortical motor, and global aphasia.Broca's aphasia is the most classic form of non-fluent aphasia. The essential characteristics of Broca's aphasia include awkward articulation, restricted vocabulary, agrammatism and relatively intact auditory and reading comprehension (Goodglass et. al., 2001). Typically, writing is at least as severely impaired as speech.

Persons with Broca's aphasia are usually aware of their communicative deficits, and are more prone to depression and sometimes catastrophic reactions than are patients with other forms of aphasia. Some authors and clinicians use the term 'expressive aphasia' to refer to the disability of patients with Broca's aphasia because of their primary deficit in the area of language formulation and production. Likewise, because lesions that lead to this form of aphasia tend to be located in the frontal lobe, Broca's aphasia represents a classic form of 'anterior' aphasia.

In patients with TMA, repetition is intact relative to 'otherwise limited speech' (Goodglass et. al., 2001). Such patients exhibit phonemic and global paraphasias, syntactic errors, perseveration, and difficulty imitating and organizing responses in conversation (Damasio, 1998; Goodglass et. al., 2001). Confrontation naming is usually preserved, but auditory comprehension is impaired.

Global aphasia is a disorder of language characterized by impaired linguistic comprehension and expression. It is often considered a combination of both Wernicke's and Broca's aphasia. Patients with global aphasia tend to produce few utterances and have a highly restricted lexicon. They have little or no understanding in any modality and little or no ability to communicate effectively (Jones and Wepman, 1961).

Anomic aphasia is a form of aphasia characterized primarily by significant word retrieval problems (Damasio, 1998; Goodglass, 1993; Goodglass and Wingfield, 1997). It is differentiated from the symptom of anomia or dysnomia, which is typical in most forms of aphasia. Speech is generally fluent except for the hesitancies and pauses associated with word- finding deficits. Grammar is generally intact.

Neuro anatomical correlates of verbal fluency in adults

Wagner, Sebastian, Lieb, Tuscher and Tadic (2014) studied coordinate-based activation likelihood estimation (ALE) functional MRI meta- analysis of brain activation during verbal fluency tasks in healthy control subjects. The study included 28 participants who were right handed, healthy adults (<60years) of both sexes. The task was to generate a word after they had heard an acoustic cue or seen a fixation cross on a monitor. The results of a coordinate-based ALE meta-analysis of the brain activation during phonemic and semantic verbal fluency tasks in healthy volunteers showed main clusters of brain activation in the left frontal lobe, specifically the Inferior Frontal Gyrus (IFG) and medial frontal gyrus (Broadmann's area 6,9,44,45,47), as well as in the anterior cingulate gyrus (ACC) (BA 24,33). These results confirm that the brain regions primarily in the left prefrontal gyrus, particularly in the LIFG and LMFG, are involved in the word production and speech processing in verbal fluency tasks. Regarding the ACC, phonemic verbal fluency tasks predominantly activated the left (BA 32, 24) and right ACC (BA 32), semantic verbal fluency tasks only the left ACC (BA 32). The left parietal precuneus (BA 7) was activated in the processing of phonemic and semantic fluency tasks. The precuneus (BA 7) is involved in phonemic discrimination, working memory and was repeatedly associated with the processing of phonological information.

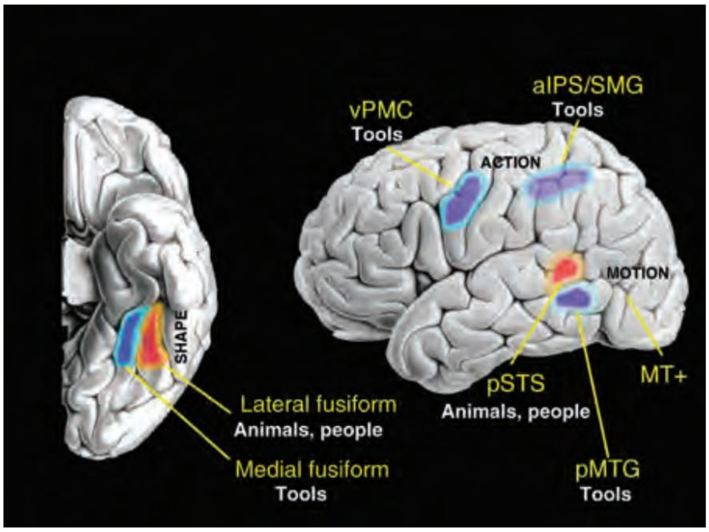

Figure 2.3: **Cortically distributed representations of the shape, motion, and motion, and motor features of object concepts (Ref: Modified from a figure provided by Alex Martin, Kemmerer, Cognitive Neuro-science of Language, Pg. 279).**

Neuro-anatomy of verbal fluency in Stroke

Studies have investigated the anatomical correlates of semantic and phonemic fluency by lesion-symptom mapping in patients with ischemic stroke (Biesbroek, Zandvoort, Kappelle, Velthuis, Biessels and Postma, 2015). The study aimed at testing the neuro-psychological behaviors in stroke patients, which consisted of 93 ischemic stroke individuals. CT and MRI tests were used to rule out ischemic stroke. Boston Naming Test and the Token test were administered to screen the participants for Aphasia. Neuro cognitive examination was carried out one month after stroke in which the task was to generate word fluency (animals) and two letter fluency (A and N). The subjects were categorized into 7 groups on the basis of their education. Pearson’s correlation was used to compare the relation between semantic and letter fluency tasks. The results indicated that 18 participants had impaired semantic fluency, 29 of them had impaired phonemic fluency and 13 had both impaired semantic and phonemic fluency. Impaired semantic and phonemic fluency was most prevalent in left hemispheric lesion. Infarct volume within the left inferior frontal gyrus and left insula inversely correlated with both semantic and phonemic fluency. Infarct volume within the left rolandic operculum and left medial frontal gyrus inversely correlated with phonemic, but not semantic fluency. The infarct volume within the left putamen inversely correlated with semantic, but not phonemic fluency.

The findings of the current study indicate that semantic and phonemic fluency have partially shared and partially distinct neural underpinnings. Anatomical correlates overlap in the left inferior frontal gyrus and insula, reflecting shared underlying cognitive processes. The partially shared and partially discordant anatomical correlates of semantic fluency reflect the involvement of multi-component cognitive processes. The shared correlates in the left inferior frontal gyrus and insula are likely to reflect word production and processing.

The findings indicate that both semantic and phonemic fluency depend on left frontal structures, while left medial temporal and right dorsolateral frontal structures are involved in semantic, but not phonemic fluency. The involvement of left medial temporal regions in semantic fluency most likely reflects retrieval of appropriate responses from semantic memory. Phonemic fluency depends more strongly on left peri-sylvian regions which might reflect retrieval of responses from phonological memory. The involvement of right dorsolateral frontal regions in semantic, but not phonemic, reflects the application of a spatial strategy.

Performance of Aphasics in Verbal Fluency Measures

Faroqi-Shah and Milman (2017) conducted a comparison study of animal, action and phonemic fluency in Aphasia. The aim of the study was to investigate the effect of post-stroke aphasia, elicitation category and linguistic variables on verbal fluency performance.28 individuals with aphasia with a single left- hemisphere lesion and 40 age- matched neuro-typical adults were administered three verbal fluency tasks; 2 semantic (animal and action) and one phonemic (letters ‘F’, ‘A’ and ‘S’). Data analysis included comparison of total scores, clusters and perseverations. Individual responses were coded for frequency of occurrence, age of acquisition and syllable length to investigate qualitative differences in word generation.

The results showed that individuals with aphasia performed worse than neuro-typical participants across all verbal fluency tasks, and animal fluency scores were farthest from neuro-typical performance. PWA’s animal and action fluency were correlated with other language measures, while phonemic fluency was uncorrelated with language measures. While some PWAs showed dissociations between verbal fluency tasks, the dissociations did not pattern along with aphasia fluency. PWA produced fewer clusters and responses with higher word frequency across all three verbal fluency tasks. Responses had earlier age of acquisition and shorter word length for animal and phonemic fluency, but not action fluency. The study concluded that Verbal fluency, particularly animal fluency, is sensitive to even mild aphasia. PWA produced lexically simpler responses than their neuro-typical peers. This study identifies the relevance of qualitative analysis of verbal fluency responses.

Impact of cognition on verbal fluency

Impact of Cognitive Factors on Verbal Fluency Studies have investigated the influence of cognitive factors such as verbal intelligence, speed of information processing, word knowledge, verbal long-term memory and attention on verbal fluency measures (Bolla, Lindgren, Bonaccorsy and Bleecker, 1990; Bryan, Luszcz and Crawford, 1997; Dromey and Shim, 2008; Elgamal, Roy, and Sharratt, 2011; McDowd, Hoffman, Rozek, Lyons, Pahwa, Burns and Kemper, 2011; Ruff, Light, Parker and Levin, 1997; Troyer, Mosocovitch, Winocur, Alexander and Stuss, 1998). A positive influence of intelligence quotient on the semantic category and phonemic fluency performance has been reported in literature (Bolla, Lindgren, Bonaccorsy and Bleecker, 1990). A significant correlation (0.30 at $p < 0.05$) was found between verbal fluency and verbal intelligence quotient and full scale intelligence quotient of Wechsler Intelligence Scale for Children-Revised (WISC-R). Based on their findings, the authors hypothesized that traditional intelligence tests do not appropriately evaluate executive function (Ardila, Pineba and Rosselli, 2000).

With respect to clustering and switching, only switching was reported to be decreased by an attention demanding secondary task (Troyer, Moscovitch, Winocur, Leach and Freedman, 1997). Kraan, Stolwyk, and Testa (2013) suggested that while phonemic fluency is associated with intellectual function and processing speed, the semantic fluency task is associated to working memory and semantic word retrieval.

Effect of hearing impairment on verbal fluency in comparison to normal hearing individuals

Classon, Lofkvist, Rudner and Ronnberg (2014) conducted the study on Verbal fluency in adults with post-lingually acquired hearing impairment. The aim of the study was to investigate the variation of verbal retrieval in moderate to severe acquired hearing impaired (HI) individuals from that of the normal hearing adults. The study included 31 individuals with hearing impairment and 30 normal hearing participants. The tasks given were, 2 letter fluency task (‘F’ and ‘A’) and one semantic fluency task (animals). The responses were recorded on a digital voice recorder. The total number of correct words generated in letter and category tasks were scored. Clustering and switching scores were carried out for the tasks. Mean cluster size was also calculated. Analysis of covariance (ANCOVA) was used for the comparisons between the groups. It was noted that hearing impaired individuals generated fewer words than the individuals with normal hearing. Errors were found to be rare among both the groups. In letter fluency, switching was more highly correlated with total output than number of clusters in HI. The strength of the relationship between switching and total performance did not differ between HI and normal hearing adults. Category fluency performance was equally associated with mean cluster size and number of clusters. The absolute number of words organized in clusters did not differ between groups in either task. In letter and category fluency tasks, there were no significant difference between the groups in the number or size of clusters. Phonologically based verbal retrieval was reduced in HI. Thus, it hypothesized that letter fluency was sensitive to hearing loss.

HI generated significantly fewer words than normal hearing individuals in the letter fluency task, while the two groups performed on a par in category fluency. Because letter fluency requires manipulation of phonological information (Rende, Ramsberger and Miyake, 2002) an ability known to be influenced by hearing acuity (Anderson, 2002; Lyxell, Andersson , Borg and Ohlsson., 2003) this was expected.

Earlier work by Anderson, 2002; Lyxell et. al., 2003 suggest that phonological loop functions such as encoding and articulatory rehearsal tend to be intact in individuals with acquired hearing impairment while phonological representations are impoverished. Thus, the findings concludes that HI individuals had less flexible phonology than the typical group.

Impact of individual difference on verbal fluency

It was observed that individuals who are open, extroverted, and emotionally stable obtained higher fluency scores on verbal fluency tasks. Individuals prone to symptoms of anxiety and depression depicted lower performance scores on category fluency. In a 4,790 community sample aged 14-94 years, the personality-fluency associations were also shown to be consistent across the lifespan and not age-dependent (Sutin, Terracciano, Kitner-Triolo, Uda, Schlessinger and Zonderman, 2011). These studies show the positive impact of personality traits on verbal fluency.

Studies on Verbal Fluency Measures in Indian Scenario

Impact of age , education and gender on verbal fluency

Mathuranath, George, Cherian, Alexander and Sarma (2003) conducted the study on Effects of age, education and gender on verbal fluency. This study included 153 elderly participants between the age ranges of 55-84 years. The samples were drawn from the urban areas with their native language as Malayalam. The cognitive impairments were ruled out with the administration of Mini Mental Status Examination. Under the procedure, the tasks given were to generate verbally as many words beginning with the Malayalam letter /pa/ as a part of letter fluency task. Participants were instructed to generate the names of animals (the multiple forms and same root words were excluded) as a part of semantic fluency task.

The subjects were grouped on the basis of gender (2 groups viz, male and female), education levels (Group I-Illiterates, Group II-Primary education (1-3years), Group III-Upper primary and secondary (4-12years and Group IV-University (>12years)), age (Group I – 55 to 64 years , Group II- 65 to 74 years and Group III - 75 to 84 years). The task scores were compared between the gender, education and age groups using Kruskal Wallis test.

The authors had reported that there were no significant differences between male and female participants. The category fluency scores were significantly higher than letter fluency for both male and female participants.

In education wise analysis, the scores in both the tasks increased with the increase in education, this is due to the association between phonological awareness and literacy (Ratcliff, Ganguli, Chandra, Sharma, Belle, Seaberg and Pandav, 1998). In age-wise analysis, with the increase in age the category fluency task scores were reduced, and no differences in letter fluency was observed because the letter fluency function is probably resistant to age related changes. The degradation in semantic representation in various neurological diseases such as Vascular dementia, Parkinson's disease or Huntington's diseases is leading to impairments on category fluency. Another observation made from the was that the scores were reported to be higher for semantic fluency than letter fluency because the search strategies utilizing semantic cues are thought to be more effective and faster than those employing phonological cues (Rosser and Hodges, 1994).

The study concluded by stating that the verbal fluency measures were significantly influenced by the clusters, word length, mono-multilingualism on the performance among the participants.

Verbal fluency in children

Analysis of Verbal fluency output on semantic categories of food and vehicle in typically developing Malayalam speaking children by (John, Rajashekhar and Guddattu, 2018) included 1015 school going children. The participants were grouped into five groups (Group I- I to II grade, Group II- III to IV grade, Group III -V to VI grade, Group IV- VII to VIII grade, Group V- IX to X grade). All the participants were from middle socio-economic status. Children with neurological problems, special needs were excluded. The participants were instructed to name the items belonging to the category of 'food' and 'vehicles'. The responses were recorded through a digital recorder and offline analysis was carried out.

The objectives of the studies were Total number of correct words, clustering measures (number of clusters, mean cluster size) and switching measure (Number of switches). Intrusions, Perseverations, Morphological variants were excluded in the study. Each correct item was scored one.

Statistically significant increases in the total number of correct words produced, number of clusters (except group III vs. IV) and number of switches (except group III vs. IV) were noted with respect to age. Nelson (1974) described the tendency of increase in productivity with the increase in age due to the ability to retrieve greater number of words from the mental lexicon. Sauzeon (2004) stated it is due to the expansion of hierarchical organization f the category knowledge and access with an increase in age. They also reported that with the increase in age results in increasing semantic network activation which promotes faster exploration, better organization and quicker word retrieval from the semantic store. The mean cluster size score was constant across the age groups except for an increase in scores by group IV on food fluency .This findings shows that there was increase in the number of subcategory items and acquisition of new word meaning in children. This is due to the increase in the efficiency of the retrieval mechanism.

No clinically significant differences between the gender groups were noted for all the measures except for females scoring higher score in the category of food fluency (in group V). This findings shows that difference between genders is prominent in adulthood, due to the increased exposure to the environment.

The total word output was relatively greater in the food fluency tasks as compared to vehicle fluency task. In terms of the number of clusters, mean cluster size and number of switches, the score was higher for food followed by vehicle. This results hypotheses that different tasks impose different demands on the search and retrieval mechanism on the basis of need of a person. Goldberg, Perfetti and Schneider (2006); Mummery, Patterson, Hodges and Wise (1996); Vitali, Abutalebi, Tettamanti, Rowe, Scifo, Fazio and Perani, 2005) provided evidence for category specific anatomical specialization in brain for different tasks of semantic fluency.

Verbal fluency measures in Individuals with Right hemisphere damage

Krishnan and Karanth (2013), investigated verbal fluency performance in 22 individuals with right hemisphere damage. Clustering, switching and time course analysis of verbal fluency task was done using eight semantic fluency categories (animals, vegetable, birds, fruits, vehicle, clothes, furniture, & verbs) and three phonemic categories. The authors reported impaired lexical retrieval with lower scores on semantic and phonemic tasks with reduced number of clusters (in semantic task) and smaller mean cluster size. The subjects with right hemisphere damage exhibited similar temporal pattern of retrieval with performance on number of switches similar to control group.

Need for the study

Semantic memory is one of our most defining traits. It includes all acquired knowledge about the world and is the basis for nearly all human activity. More uniquely human has the ability to represent concepts in the form of language, which allows not only the spread of conceptual knowledge in an abstract symbolic form, but also a cognitive mechanism for the fluid and flexible manipulation, association and combination of concepts.

Thus, humans use conceptual knowledge for much more than merely interacting with objects. All of human culture, including science, literature, social institutions, religion, and art, is constituted from conceptual knowledge. We do not reason, plan the future or remember the past without conceptual consent- all of these activities depend on activation of concepts stored in semantic memory.

Most studies predominantly analyze the patterns within and between the clusters. Very few studies have reported attempted to correlate the findings on verbal fluency tasks to the cognitive processes governing them.

Verbal fluency measure is a very short, yet highly sensitive test of verbal and cognitive functioning that is widely used in neuropsychological assessment, clinical practice and research. This study contributes to the literature on verbal fluency by reporting data on three verbal fluency tasks across subtypes and severity of aphasia. This study shows that verbal fluency is impaired in aphasia, even in mild aphasia.

Aims and Objectives of the study

The present study aims at investigating the differences in verbal fluency between the typical groups and the individuals with Aphasia. The study objectives were the comparison of Frequencies, Clusters, Mean values of Cluster Size, Cluster Ratio and Cluster Size Ratio in semantic verbal fluency task between the two groups.

CHAPTER - III

METHOD

The aim of the study was to compare the performance of verbal fluency tasks between the group of individuals with Non-Fluent aphasia and the control (normal, typical) groups and also to explore their underlying cognitive underpinnings.

Participants

For the current study, a purposive sample of Individuals with non-fluent aphasia and the normal individuals without any neurological impairments were taken as the participants. The table 3.1 gives the description of the participants.

Group I		Group II	
Normal/Typical Males	Normal/Typical Females	Aphasic/Clinical Males	Aphasic/Clinical Females
8	12	11	2

Table 3.1: Description of the participants.

The participants were classified into 2 groups in which Group I was the controlled group and Group II consisted the individuals with Non-Fluent Aphasia. The language spoken by all participants of the present study was Tulu, one of the languages spoken in Coastal regions of Karnataka. The age group of the participants were between 35 years to 60 years.

Selection Criteria

Inclusion criteria

The diagnosis of the participants was the basis of selection. A strict selection criterion was used for the inclusion of the participants. The study included participants who were above the age of 30 years. Group - I had the participants with the history stroke for 28 days (4 weeks) diagnosed as chronic stage of Non-fluent aphasia. The participants with their first language as Tulu and residing at the coastal regions of Karnataka were considered in the study. Only the individuals with the non-fluent aphasia were considered.

Exclusion Criteria

The individuals with complicated medical conditions were excluded in the study. The subjects with cognitive deficit, degenerative disorder such as primary progressive aphasia, parkinsonism, were not taken into consideration. The study excluded mixed type of aphasia, Fluent aphasia and Dysarthria. The clients in the acute stage of recovery (less than 28 days post stroke) were excluded. The subjects below the elementary education were not taken into account in the current study.

Instrumentation

For the recording of verbal responses, *Praat* software (Version 6.0,2015, Boersma and Weenink) was used and was analyzed using Goldwave Software. A stop watch was used for the scheduling of time. A time window of 60 seconds as response time was used in the study.
Modified data analysis sheet was used for the purpose of analysis of various selected verbal fluency measures.

Verbal Fluency Measurement

All testing were conducted in Tulu language and each participant were tested individually in a vacant room. Each participant performed three *semantic fluency* tasks. The subtasks considered for the study were:

Task 1: Semantic Category Fluency tasks - Animals

In *Semantic Fluency task*, the participants were given the task of generating lexical category of Animals.

Instruction for the task

"I want you to name as many names of the items belonging to a particular category as you can in 1 minute. It doesn't matter what letter they start with. You have to name all the animals you can think of in one minute".

Task 2: Semantic Category Fluency tasks –Vegetables

In Semantic Fluency task, the participants were given the task of generating lexical category of Vegetables.

Instruction for the task

"I want you to name as many names of the items belonging to a particular category as you can in 1 minute. It doesn't matter what letter they start with. You have to name all the Fruits and Vegetables you can think of in one minute".

Task 3: Semantic Category Fluency tasks - Vehicles

In *Semantic Fluency task*, the participants were given the task of generating the names of Vehicles

Instruction for the task

"I want you to name as many names of the items belonging to a particular category as you can in 1 minute. It doesn't matter what letter they start with. You have to name all the Vehicles you can think of in one minute".

These specific categories were chosen as it is concrete, rational, and familiar and known to the participants in the Indian context. Most of the studies have also reported of category fluency being dependent on regional, environmental and cultural differences (Brucki and Rocha, 2004; Kempler, Teng, Dick, Taussig and Davis, 1998).

The order of administration of verbal fluency task was constant across participants, within Semantic Verbal Fluency of Animals, Semantic verbal fluency of Fruits and Vegetables and Semantic verbal fluency of Vehicles.

The total duration of testing was approximately 10 minutes per individuals.

Procedure

Each task of verbal fluency was timed using a stopwatch. The examiner recorded the participant's responses in *Praat* Software. Using the *GoldWave* software the examiner documented the responses later into the recording form for further offline analysis. The analysis for the recorded verbal fluency was carried out.

Analysis of the data

The Total number of Correct Words produced during each type of fluency task was calculated by excluding

a) Intrusions (words not an exemplar of the category specified),
b) Perseverations (repetitions of any correct words already given as a response),
c) Morphological variants (example: bus, buses),
d) Language variation (a word named in other languages after it has been named in some other language).

For the scoring purpose, the raw score of total number of correct words obtained was retained, instead of being converted to percentage scores. This was done as the percentage of the correct words generated did not provide meaningful information on fluency performance, as compared to the reporting the raw number of words generated (Troyer, 2000). For example, if the child says "cat, dog, cow, buffalo, ox, cat, lion", the total number of correct words was considered as six.

Cluster scoring

The number of clusters and mean cluster size were calculated according to the scoring rules defined initially by Troyer, Moscovitch, Winocur, Alexander and Stuss (1998), Troyer (2000). These two indicators were calculated for all the three semantic subcategories identified in each fluency task.

Clustering measures (Number of clusters; Cluster size, Mean cluster size)

Clusters are defined as the successively generated words belonging to the same semantic subcategory. Semantic clusters were defined as successively generated words belonging to the same semantic sub categories, such as Pet animals, Farm animals, Wild animals, Water animals and belonging to individual zoological categories, such as birds, insects and so on.

Cluster size was counted from the second word of each cluster (e.g., a 3-word cluster was counted as a cluster size of 2) for example, if the child says “cow, buffalo, ox” the cluster size is 2.

The number of clusters therefore involved categorization into cluster groups and calculating the total number of clusters produced per trial. For example, if the child says “cat, dog, lion, Elephant, cow, ox, Buffalo”, the total number of clusters produced was considered as three (pet animals, Wild Animals, bovines / cow variants).

Mean cluster size was calculated by dividing the total number of words in clusters by the number of clusters produced.

$$\text{Mean cluster size} = \frac{\text{Cluster size}}{\text{Total number of clusters}}$$

(Ref: Aswathi, 2016. A study of verbal fluency output in Malayalam speaking children aged between 12-16 years).

For example, if the participants said “Rabbit, Cow, Cat, Dog, Buffalo, and Ox”, for the first cluster (“cat, dog and rabbit”) the cluster size is 2 and for the second cluster (cow, buffalo, ox) it is 2. As two clusters were produced by the client, the mean cluster size was obtained by dividing cluster size (2+2) by total number of clusters (2), thereby obtaining a mean cluster size score of 2.

As each score (clusters, or cluster size) depended on the number of words generated, a ratio was computed by dividing each score by the total number of words generated.

$$\text{Cluster ratio} = \frac{\text{Number of clusters}}{\text{Total number of words}}$$

$$\text{Cluster size ratio} = \frac{\text{Cluster size}}{\text{Total number of words}}$$

(Ref: Aswathi , 2016. A study of verbal fluency output in Malayalam speaking children aged between 12-16 years).

The ratio is considered to reflect categorical search efficiency. Thus, a ratio of 'one' reflects maximum efficiency. The more the ratio exceeds one, the more inefficient the search processes.

Statistical Analysis

The mean values of the above mentioned verbal fluency measures were tabulated for the purpose of comparing the differences among the individuals in two groups.

Descriptive statistics for the data was obtained by using SPSS statistical program (IBM 20.0 version). Analysis of variance (ANOVA) test was carried out to document the mean and standard deviation.

A non-parametric 'Mann Whitney U' test was carried out and the statistical significance with values of '< 0.05' were considered to be significantly different.

CHAPTER - IV

RESULTS AND DISCUSSIONS

The study was carried out among group of individuals with aphasia to profile their abilities with respect to verbal fluency and to compare it with respect to the typical population.

The primary objectives of the study were to document the various measures of verbal fluency for selected semantic verbal fluency tasks which included mainly the aspects of Frequency, Semantic Paraphasia, Phonemic Paraphasia, Repetitions, Clusters, Mean Cluster Size, Cluster ratio and Cluster Size Ratios for the lexical categories of 'Animals', 'Vegetables' and 'Vehicles'.

The findings of the same are discussed under the following.

Frequency Count

Semantic frequency count is a listing of the words of a language, with the several meanings of each word, and the relative frequency of occurrence of each meaning in general and/or specified contexts.

The Total number of Correct Words produced during each type of fluency task was calculated by excluding

a) Intrusions (words not an exemplar of the category specified),
b) Perseverations (repetitions of any correct words already given as a response),
c) Morphological variants (example: bus, buses),
d) Language variation (a word named in other languages after it has been named in some other language).

For the scoring purpose, the raw score of total number of correct words obtained was retained, instead of being converted to percentage scores. This was done as the percentage of the correct words generated did not provide meaningful information on fluency performance, as compared to the reporting the raw number of words generated (Troyer, 2000). For example, if the child says "cat, dog, cow, buffalo, ox, cat, lion", the total number of correct words was considered as six.

The frequency scores of the category tasks of animal, Vegetable and Vehicles were lower for Group II with mean values of 8.54, 12.92 and 8.15 respectively. Whereas, the mean values of Group I were 11.90, 16.70 and 9.65 for Animal, Vegetables and Vehicles category respectively. It is suggestive of higher values for Group I. Further statistical values reveals that there was significant difference (with 'p'< 0.05) in the mean values of the Animal and Vegetable category.

For the typical population the frequency of semantic fluency for all the three categories were comparatively greater than that of the clinical population. The findings implies that the typical population had better performances due to their intact neurological structures and their physiology.

Differentiating between aphasic and non-aphasic stroke individuals using semantic verbal fluency measures reported that there was significant increase of the reaction time in aphasic individuals. Due to the increase of the reaction time the rate of frequency decreases. Hence, the frequency score in aphasic individuals is lower than the typical group.

Baldo, Schwartz, Wilkins, and Dronkers (2006) reported that letter fluency engages frontal circuits, whereas category fluency relies predominantly on temporal cortex, as suggested by neuroimaging and patient studies.

Parameter: Frequency	Groups	Mean	Std. Deviation	F value	Statistical Significance Level ('p')
Animals	Typical/ Normal	11.90	11.567	8.989	0.005
	Clinical Population	8.54	2.22		
Vegetables	Typical/ Normal	16.70	4.37	5.855	0.022
	Clinical Population	12.92	4.38		
Vehicles	Typical/ Normal	9.65	3.18	2.008	0.166
	Clinical Population	8.15	2.57		

Table 4.1: Showing Mean and SD scores of Frequency Count for Semantic category tasks in the given groups.

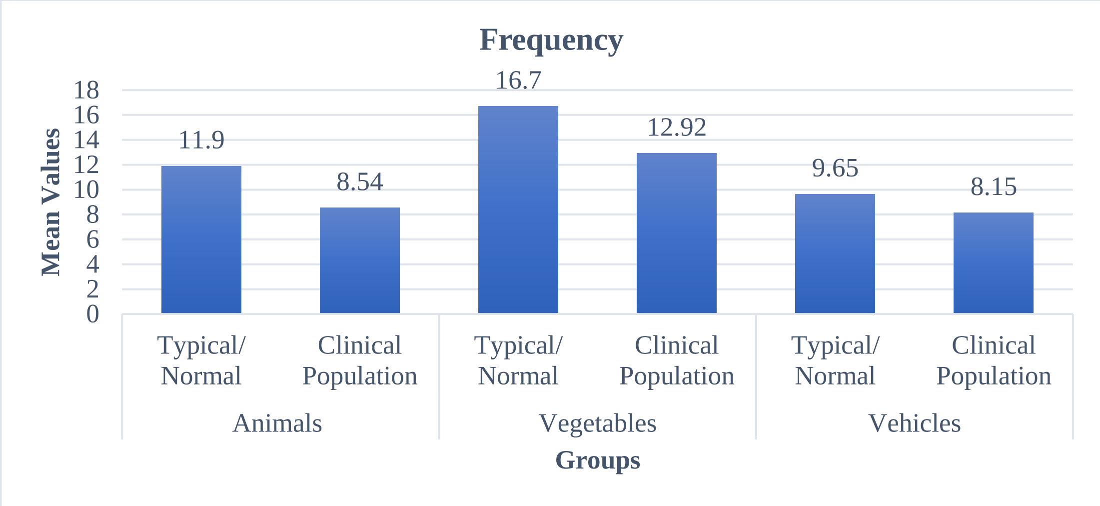

Figure 4.1: Showing Mean of Frequency Count for Semantic category tasks in the given groups.

Cluster 1

Word clustering is a technique for partitioning sets of words into subsets of semantically similar words. It is commonly used technique in information retrieval, and knowledge discovery for finding hidden patterns or objects from a data of different category (Naik, Prajapati and Dabhi, 2015).

The two cluster groups for the 'Animal' category task were 'Domestic' and 'wild' animals. The 'vegetable' and 'vehicle' category tasks were grouped as 'familiar' group and 'unfamiliar' groups. The mean value of cluster 1 for animal category was 4.40 among normal group and 3.38 among the clinical population. This showed no significant differences ('p' = 0.144) between the two groups. For the 'vegetables' category task, the mean value of cluster 1 was 11.05 and 9.31 for typical and clinical population groups respectively, with the significance level of 0.168, which showed no difference between the two groups. For the category of 'vehicle' task, the mean value of cluster 1 was 5.45 and 6.08 for the typical and clinical population groups respectively, which showed no significant difference with the significance level of 0.263 among the two groups.

Parameter: Cluster1	Groups	Mean	Std. Deviation	F value	Statistical Significance Level ('p')
Animals	Typical/ Normal	4.40	1.984	2.251	0.144
	Clinical Population	3.38	1.758		
Vegetables	Typical/ Normal	11.05	3.31	1.995	0.168
	Clinical Population	9.31	3.68		
Vehicles	Typical/ Normal	5.45	1.57	1.299	0.263
	Clinical Population	6.08	1.49		

Table 4.2: Showing Mean and SD scores of Cluster 1 for Semantic category tasks in the given groups.

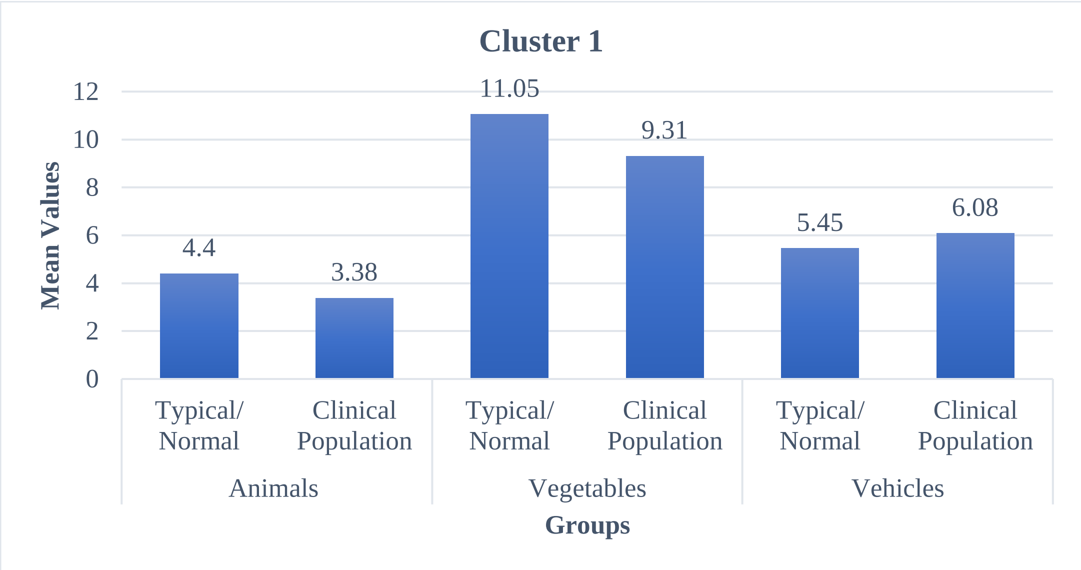

Figure 4.2 : Showing Mean scores of Cluster 1 for Semantic category tasks in the given groups.

Cluster 2

The mean values of cluster 2 for the category fluency of 'animals' was 7.50 and 5.15 for the typical and clinical population respectively, which showed no significant difference. The mean value for the typical and clinical population was 5.65 and 3.62 respectively for the cluster 2 in 'vegetable' fluency task , which showed significant difference ('p' = 0.046). For the 'vehicle' category task, the mean values of cluster 2 were 4.20 and 2.08 for the typical and clinical population, which showed significant difference ('p' value = 0.011).

PWA (People with Aphasia) produced fewer clusters than neuro-typical adults, but there was no difference in the number of perseverations. PWA's responses were more lexically accessible, characterized by higher frequency of occurrence and earlier age of acquisition. Their responses were also phonologically simpler, as measured by the number of syllables per word (Faroqi-Shah and Milman, 2017).

Parameter: Cluster2	Groups	Mean	Std. Deviation	F value	Statistical Significance Level ('p')
Animals	Typical/ Normal	7.50	3.99	3.406	0.075
	Clinical Population	5.15	2.76		
Vegetables	Typical/ Normal	5.65	3.21	4.328	0.046
	Clinical Population	3.62	1.75		
Vehicles	Typical/ Normal	4.20	2.54	7.333	0.011
	Clinical Population	2.08	1.49		

Table 4.3 : Showing Mean and SD scores of Cluster 2 for Semantic category tasks in the given groups.

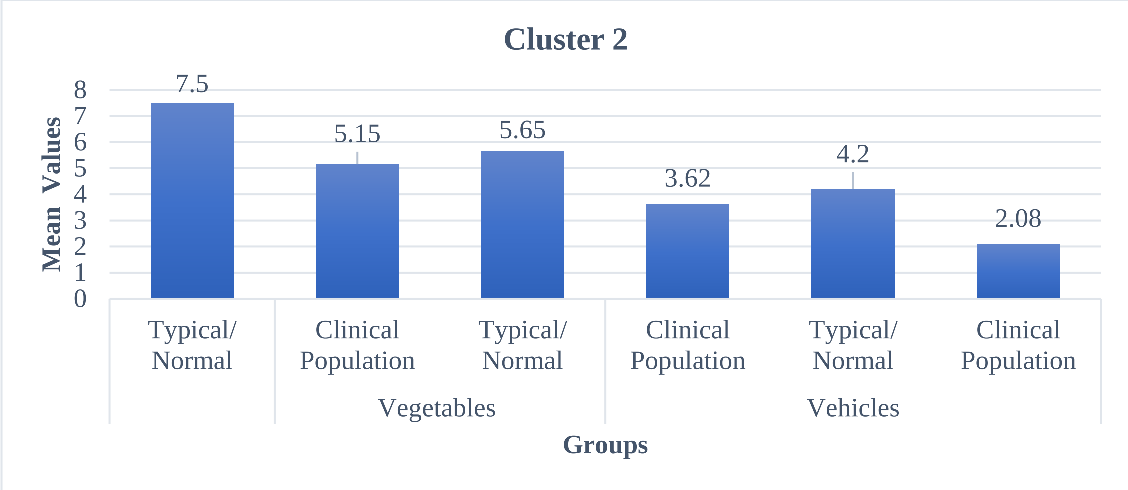

Figure 4.3 : Showing Mean scores of Cluster 2 for Semantic category tasks in the given groups.

Mean Cluster Size

The mean values for the cluster size of Group I for ‘animal’, ‘vegetable’ and ‘vehicles’ category were 5.00, 7.35 and 3.75 respectively. On comparison with the mean values of Group II which were 3.15, 5.38 and 3.00 for animal, vegetable and vehicles category respectively. The mean values are statistically significant for the ‘animal’ and ‘vegetable’ category with the significance level of ‘p’< 0.05. For the vehicle category the two groups showed no difference among the groups.

Findings showed that the mean cluster size was greater in Group I than that of Group II.

The clustering and switching in the course of 1 minute for PWA the search and retrieval process was less productive and more effortful. This is indicated by smaller cluster size, fewer switches associated with increased between-cluster pause durations, as well as overall slowed retrieval times for the words. This shows that the difficulties with verbal fluency performance in aphasia have a strong basis in their lexical retrieval processes, as well as some difficulties in the executive component of the task.(Bose, Wood and Kiran, 2016).

The mean cluster size associated with temporal lobe functions reflects the extent of the knowledge network for a given subcategory (Troyer, Moscovitch, Winocur, Alexander and Stuss, 1998).

Parameter: Mean cluster size	Groups	Mean	Std. Deviation	F value	Statistical Significance Level ('p')
Animals	Typical/ Normal	5.00	1.71	11.611	0.002
	Clinical Population	3.15	1.14		
Vegetables	Typical/ Normal	7.35	2.27	5.766	0.023
	Clinical Population	5.38	2.32		
Vehicles	Typical/ Normal	3.75	1.51	2.090	0.158
	Clinical Population	3.00	1.35		

Table 4.4 : Showing Mean and SD scores of Mean Cluster size for Semantic category tasks in the given groups.

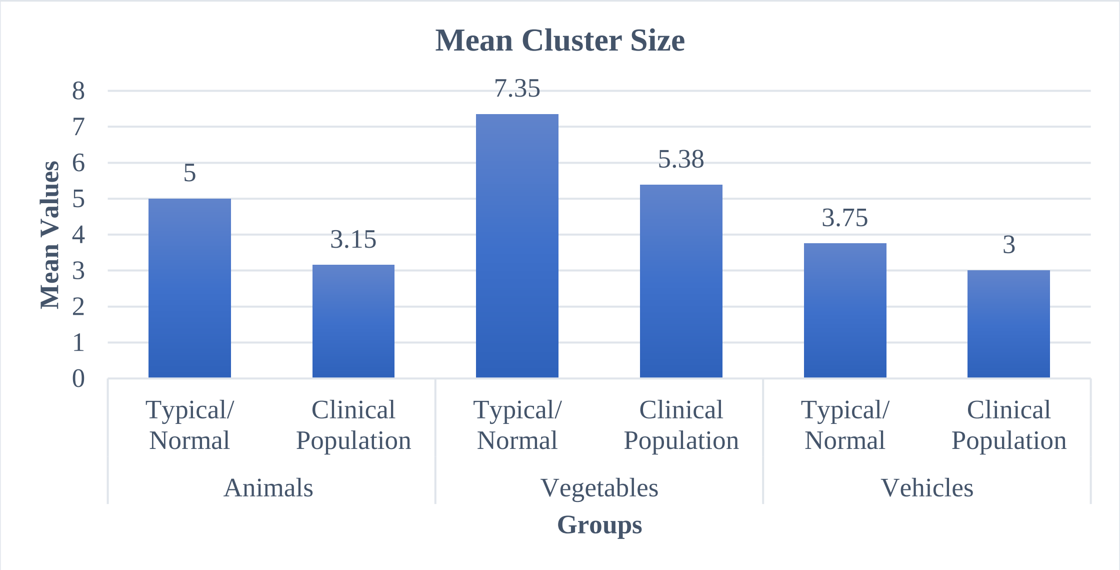

Figure 4.4 : Showing Mean scores of Mean Cluster size for Semantic category tasks in the given groups.

Cluster Ratio

Cluster ratios are the number of clusters per total number of words. The samples were analyzed and the mean values were calculated for each parameter under each task. A statistical measure Mann Whitney U test was carried out to compare the means of the two groups namely Group I and Group II.

The values of significance level lesser than 0.05 were considered as statistically different. The mean values of cluster ratios were calculated across the group for various verbal fluency parameters and same is depicted in the table 4.5.

From the table 4.5, it is noted that in the Animal fluency task, the mean of Cluster Ratio (CR) is higher in Clinical population (0.24) as compared to the Typical group (0.18).The mean value of Typical group (0.12) was lesser than that of the clinical population (0.17) for Vegetable and fruits category. For the category of Vehicle, the mean value among clinical population was greater (0.27) compared to the typical group (0.22).

Comparison of mean values and standard deviation reveals that the Cluster ratio for all the three categories were higher for Group II than Group I. The higher the frequency of the specified category, lower are the cluster ratio values. Since the performance of the typical population was good, the cluster ratio values are lower.

The analysis of the differences of group mean shows that both the groups are significantly different in their mean values of Cluster ratio in the animal and vegetable-fruits task only. In the vehicle category task the differences of the means are not statistically significant ('p' > 0.05).

Individuals with Aphasia produced smaller cluster sizes, pause longer between clusters and produce fewer clusters than neurotypical adults (Bose et al., 2016; Kiran, Balachandran and Lucas, 2014).

Parameter: Cluster Ratio	Groups	Mean	Std. Deviation	F value	Statistical Significance Level ('p')
Animals	Typical/ Normal	0.18	0.04	12.462	0.001
	Clinical Population	0.24	0.06		
Vegetables	Typical/ Normal	0.12	0.03	5.471	0.026
	Clinical Population	0.17	0.07		
Vehicles	Typical/ Normal	0.22	0.06	2.603	0.117
	Clinical Population	0.27	0.09		

Table 4.5 : Showing Mean and SD scores of Cluster Ratio for Semantic category tasks in the given groups.

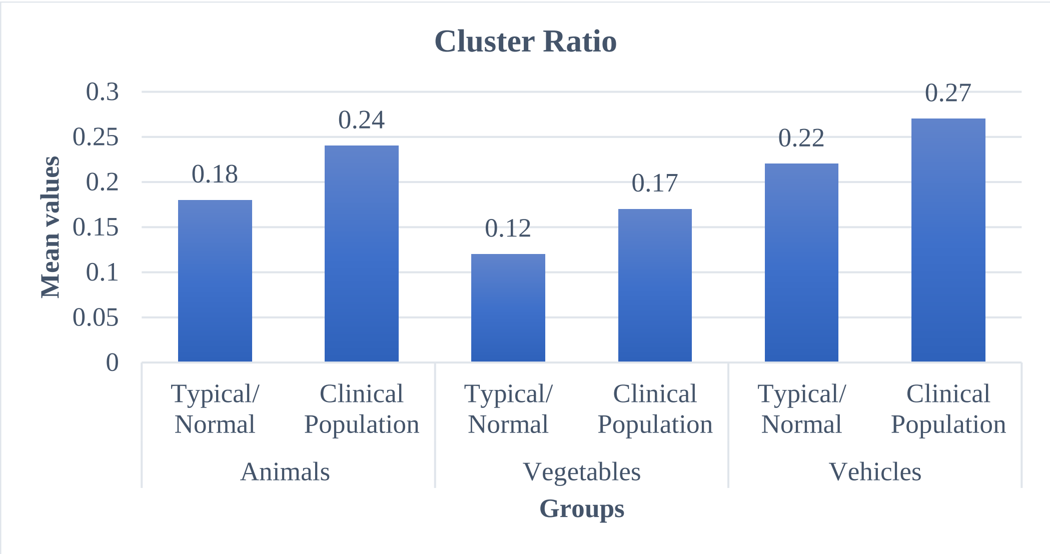

Figure 4.5 : Showing Mean scores of Cluster Ratio for Semantic category tasks in the given groups.

Cluster Size Ratio

The Cluster size ratio indicates the Cluster size/total number of words. The mean values of cluster size ratio was calculated and compared among the two groups. The values were as shown in the table 4.6.

In the animal fluency task, the mean of the cluster size ratio is higher for the typical group (0.41) then the clinical population (0.38). In the vegetable-fruits category task, the mean of the cluster size ratio is higher for the typical group (0.43) as compared to that of the clinical population (0.41). the mean value was higher for clinical population (0.37) than the typical group (0.34) , for the vehicle category.

The analysis of the differences of scores of group mean shows that both the groups are significantly different in their mean values of Cluster size ratios inn the animal and vegetable-fruits category. In the vehicle category task the differences of means are not statistically significant (‘p’ > 0.05).

The finding that points to weak lexical-semantic networks in PWA is their smaller cluster size compared to neuro-typical adults, which is consistent with prior findings in aphasia (Faroqi-Shah and Milman, 2017). The smaller cluster size is indicative of less success with lexical search strategies, presumably due to weakened connections between words in the mental lexicon. In fact, regression analyses showed that cluster size was the only significant predictor of performance for all three verbal fluency tasks.

Parameter: Cluster size ratio	Groups	Mean	Std. Deviation	F value	Statistical Significance Level ('p')
Animals	Typical/ Normal	0.41	.02	10.605	0.003
	Clinical Population	0.38	0.03		
Vegetables	Typical/ Normal	0.43	0.01	4.269	0.047
	Clinical Population	0.41	0.04		
Vehicles	Typical/ Normal	0.34	0.12	0.730	0.399
	Clinical Population	0.37	0.04		

Table 4.6 : Showing Mean and SD scores of Cluster Size Ratio for Semantic category tasks in the given groups.

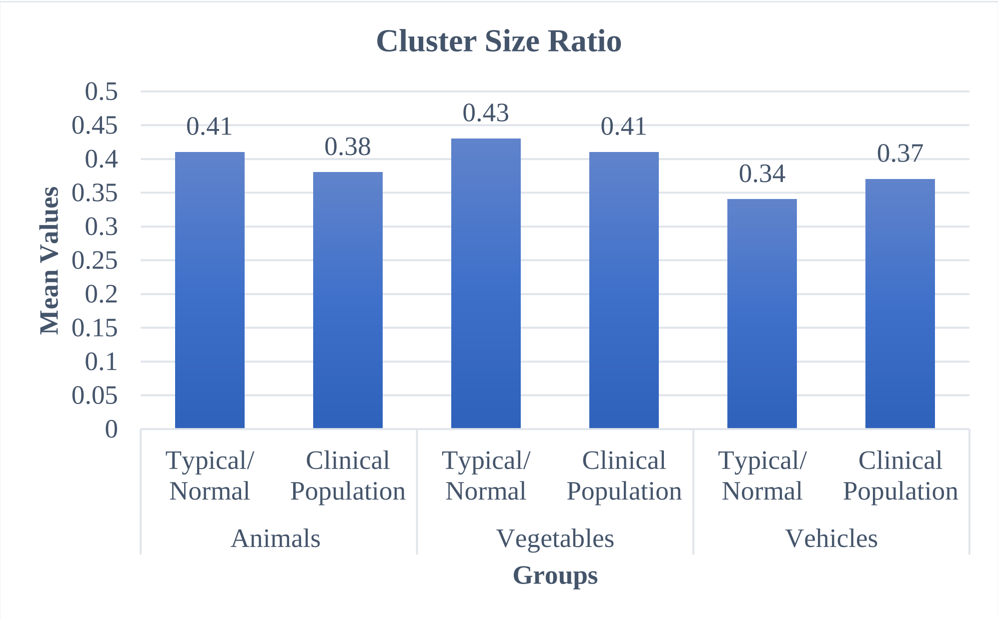

Figure 4.6 : Showing Mean scores of Cluster Ratio for Semantic category tasks in the given groups.

CHAPTER - V

SUMMARY AND CONCLUSION

Verbal fluency has been employed for assessing numerous linguistic and cognitive functions including spontaneous naming, extent of vocabulary, mental organization, search strategies, retrieval mechanisms, endogenous flexibility, lexicon or semantic storage, response speed and ease of verbal production, rule monitoring, inhibition of inappropriate responses, attention and working (Riva, Nichelli and Devoti 2000; Henry and Crawford, 2004). It is a very short, yet highly sensitive test of verbal and cognitive functioning that is widely used in neuropsychological assessment, clinical practice and research.

According to the perspective of Speech language pathologist, Verbal fluency tasks are one means of understanding how concepts or words are organized in brain. Verbal fluency measures have been fairly well researched in typical adult population while research on these measures in Aphasic population is limited. Hence there was a need to explore the verbal fluency output and semantic network exploitation in Aphasic population.

The main focus of this study was to examine the performance and to distinguish the verbal fluency measures between the typical adult and Aphasic adult population. The participants were classified into two groups namely Group I with typical adult population and Group II with Aphasic population. The verbal fluency paradigm involved word generation tasks of three Semantic fluency tasks (Animals, Vegetables and Vehicles). The responses were recorded using *Praat* software and responses were written into the recording form for further offline analysis. For each task employed, the outcome measures of Total number of correct words, Clustering (Number of clusters, Cluster size, Mean cluster size), Cluster Ratio and Cluster Size Ratio were examined across the two groups. The scores were tabulated and statistically analyzed. The findings of the study not only provided information on number of words generated but also the search strategies employed by the subjects. The study indicates the influence of task and difference in performance across the groups and to rule out the affects of brain damage on the semantic fluency of an individual.

The frequency score of 'Animals', 'Vegetables' and 'Vehicles' fluency tasks were better among the typical population than the clinical group. The Cluster 1 among the two groups showed better response in the typical population for Animal and Vegetable categories. For all the three tasks, the Cluster 2 performance of the typical group were higher. The mean cluster size was lesser in the clinical population than the typical group in all the three tasks. The Cluster ratio was lower for all the three tasks in typical population indicating lesser number of clusters per word. The cluster size ratio was higher in the typical population for Animal and Vegetable category showing a greater number of words in a cluster.

To conclude, the findings of this study not only serves as a data for future studies on profiling the deviation of verbal fluency output among the aphasic population, the study also provides an insight into the neuro-cognitive processes such as search, access and retrieval of information stored in the mental lexicon used by the participants. The results also revealed the factors which influenced with their performance such as anxiety, education, language, culture, site of lesion and severity of impairment.

The expressive and receptive, as well as the semantic and syntactic components of language are considered to be inseparable. This view suggests that damage to the language mechanism results in general language impairment in which there is an effect on all aspects of language. (Chapey, 2008). Due to anomia being the characteristic in Non-fluent aphasia their semantic verbal output was limited. The response time was more in aphasic population than the typical groups because of which the frequency of words produced were lesser in the scheduled time.

The performance of the subject reveals the mechanisms involving specific brain areas. That is, performance on semantic memory processes of clustering reflects the role of anterior temporal lobe (Robinson, Shallice, Bozzali and Cipolotti, 2012) processes such as word storage and verbal memory storage. The initiation of word process, cognitive flexibility and mental shifting involves the frontal- subcortical area. The knowledge, of the cognitive processes which underlie word production in verbal fluency tasks, can be useful to understand and manage the word finding problems and their related cognitive process in the clinical population for speech language pathologists.

To summarize, the implications of this research study findings are:

a) Better understanding of the importance of various neurological sites in brain that involves in verbal fluency task performance.
b) For the documentation of both quantitative (total number of correct word production) and less researched domain of qualitative (clustering) performance of Normal and Aphasic individuals.
c) Expanding the clinical and research usefulness of verbal fluency task performance in Aphasic individuals.
d) Empowerment of clinician on typical development of verbal fluency in children during the clinical decision-making process in the disordered population.
e) Verbal fluency task is suggestive of a strategy to circumvent impaired lexical access. The importance of psycholinguistic analysis of verbal fluency responses can inform us about the integrity of the lexical system and the ability to utilize word generation strategies in individuals with Aphasia.
f) Verbal fluency tasks are useful for Speech-Language Pathologists for assessing pre and post therapy outcomes in clinical populations.

Limitations of the study and Future recommendations:

In the present study language, culture, education, gender and age of the participants were not taken into consideration. The sample size was inadequate.

The future study would be more effective if the language, culture, education, gender, age of the subject is taken into consideration. The future research is indicated with increased sample size. The severity and the site of lesions of aphasias and their categorical differences in performance can be considered in further researches.

CHAPTER - V

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