Method
The present study aimed at investigating the developmental changes in verbal fluency of Malayalam speaking children by the method as described below:

3.1 Study Design
A cross sectional study design was carried out in accordance with cluster sampling criteria.

3.2 Study Data
3.2.1 Study Language
The language spoken by all participants of the present study is Malayalam, one of the four prominent Dravidian languages, belonging to Central Travancore dialect.

3.2.2 Study Site
The participants were selected from eleven primary and secondary schools (government and private schools) having Malayalam medium syllabus (Appendix A).

The schools from the municipalities of Pathanamthitta district of Kerala state, India were taken for the study. This district which formed the study site, as per Census 2001, had 193,174 children between five to fourteen years of age group. According to the Census of India (2011), the population within its municipal city limits (population density of 453 persons per square kilometre) was 1,195,537. The overall literacy rate of the district as per the census was 96.93 % with female: male ratio of 1129 girls per 1000 boys.

3.2.3 Study Participants
For the current study, school going children between the ages of five and fifteen years, belonging to lower primary (Classes I - IV), upper primary (Classes V - VII) and secondary school (Classes VIII - X) sections were considered. The classes included were homogenous with respect to curriculum and training. The participants were classified into five groups, based on the class or grades they belonged to, rather than on the age due to the variation in the age level representation in each grade.

Group I: Children belonging to classes I and II
Group II: Children belonging to classes III and IV
Group III: Children belonging to classes V and VI
Group IV: Children belonging to classes VII and VIII
Group V: Children belonging to classes IX and X

In the current study, the lower age limit of five years was considered, justified by the documentation in literature that by around four years of age, children would be able to identify category relationships and produce category exemplars for a superordinate label (Lucariello et al., 1992; Nelson & Nelson, 1990). It was further considered owing to the practical difficulties in employing Initial Letter Fluency among pre-schoolers with literature evidence of low reliability among 3-4 year-old children (Strauss et al., 2006). In order to obtain a developmental perspective of the influence of age on verbal fluency task, this cross sectional study investigated the verbal fluency performance in children till 15 years of age.

3.2.4 Sample Size

Based on the pilot study on twelve participants in each of the group (6 males & 6 females), the sample size was calculated using the following formulae:

\[
 n = \frac{2 \left( \frac{Z_\alpha}{2T} + Z_\beta \right)^2 \sigma^2}{\varepsilon^2}
\]

where \(Z_\alpha/2T = 2.39\), \(Z_\beta =0.84\) at 80% power, anticipated standard deviation (\(\sigma\)) is 8.22 and clinical difference (\(\varepsilon\)) for total number of correct words is 4. A total of 1015 school going children was enrolled in the study.

3.3 Selection Criteria

3.3.1 Inclusion Criteria

The participants were included in the study based on teachers’ / parents’ reports / school records. The following criteria were considered to ensure that a representative sample of Malayalam speaking children, early adolescents and mid-adolescents, were recruited.

- Children between the ages of 5 year 0 months to 15 years 12 months
- Currently attending primary (lower/upper) or secondary school
• Having Malayalam as their first language and primary language of communication in school and ability to speak, read and write Malayalam

• Born, brought up and currently residing and educated in Kerala from kindergarten itself, in order to ensure uniform system of education

• Belonging to middle socio economic status in consonance with Kuppuswamy’s socioeconomic status scale (Mishra & Singh, 2003)

### 3.3.2 Exclusion Criteria

The exclusion was done based on direct observation, teachers’ reports, school records and parental information obtained through telephonic interview. These exclusionary criteria were set on the premise that the childhood period is critical for later cognitive development and that, it is during this period that teaching at school awakens knowledge of the various components of language, viz., phonological, grammatical, semantic, and pragmatic (Bernstein, 1989; Riva et al., 2000).

- Children with history of neurological disorders (traumatic brain injury, seizure disorder, prenatal or birth complications) / developmental disorders / psychiatric illness or disorders / substance abuse / scholastic / language difficulties / motor limitations or uncorrected visual or hearing deficits / recurrent middle ear infections / upper respiratory tract infections

- Children requiring special educational placement and/or children who had stayed down in any class at school.

### 3.4 Tasks

Two tasks of verbal fluency were considered, that is, Initial Letter Fluency and Semantic Category Fluency. The subtasks considered for the study were:

**Initial Letter Fluency tasks**

/p/ fluency  
/n/ fluency  
/k/ fluency

**Semantic Category Fluency tasks**

animal fluency  
food fluency  
vehicle fluency
In **Initial Letter Fluency**, the participants were assessed with the letters /p/ ( pj), /n/ ( nd) and /k/ ( k) which are equivalent to English letters ‘P’, ‘N’ and ‘K’. Though ranking of relative frequency of words beginning with a particular letter in Malayalam was not available, two Linguists and two Professors in Malayalam language were consulted for selection of these final three letters. The letters were selected based on the ratio of words in the Malayalam language starting with these letters relative to the total number of words in a Malayalam dictionary (Pillai & Nair, 2008) and as they were commonly used in neuropsychological evaluations in Malayalam (Mathuranath et al., 2003; Mathuranath et al., 2007). The commonly used F-A-S letters were not used in the present study as vocabulary differed across culture, language and ethnicity (Ruff et al., 1997; Tombaugh et al., 1999). It was therefore not justifiable to adapt the verbal fluency scores from one country/ language for investigating fluency performance.

In **Semantic Category Fluency**, the participants were given categories of animal, food and vehicle fluency. These specific categories were chosen as they were concrete, rational, familiar and known to the children in the Indian context. Most of the studies have also reported of category fluency being dependent on regional, environmental and cultural differences (Brucki & Rocha, 2004; Kempler et al., 1998).

### 3.5 Procedure

The procedure carried out in the present study is depicted in Figure 3.1

![Flow chart depicting Study Procedure](image-url)

*Figure 3.1. Flow chart depicting Study Procedure*
3.5.1 Ethical Clearance

Prior to the study, the protocol of the proposed work was submitted to the Institution and University research committees and consequently ethical approval was obtained from Institutional Ethical Committee (IEC) (Appendix B). Either written or oral informed consent was obtained from students / parents / teachers / local guardians (Appendix C). Children were aware that their participation in the study was voluntary and that they could quit at any point, if they chose to.

3.5.2 Selection of schools and participants

Initially, a list of all the Malayalam medium schools within the district of Pathanamthitta was prepared. From the pool of schools, a total of eleven schools was randomly selected for the study. Prior to the initiation of the study, permission was obtained from the District Education Officer and concerned authorities of the selected schools for testing the children (Appendix D).

Children were recruited as per the above mentioned inclusion criteria after taking the informed consent. Each child was tested individually at the school in an isolated quiet room without interruption. A pre-examination semi-structured interview was conducted to collect demographic data (general information regarding age, gender, education level, medical history, communication, psychiatric history, scholastic performance, socio economic status and handedness using Edinburgh Handedness Inventory, Oldfield, 1971) as illustrated in Appendix E. The obtained information was corroborated with teachers / school records / through parental phone interview.

3.5.3 Instructions

For providing the instruction, an adaptation of the standard version of the verbal fluency from Lezak (1995) was used. The participants were given the following verbatim instructions for Initial Letter Fluency task:

“I am going to say a particular letter to you, and I want you to tell as many words as you can think of that begin with the letter in one minute. None of the words can be proper names of people or places. For instance, if I give you the letter B, you could say, book, bank,
basket etc., but not say Binitha, since it’s a person’s name, nor could you say Bombay, since that is the proper name of a place. Do not give the same word with different endings such as bus, buses”.

Similarly, verbatim instructions for Semantic Category Fluency task were:

“Now we are going to do something a little different. This time, I want you to tell me all the names of the items belonging to a particular category that you can think of when I tell you to start. It doesn’t matter what letter they start with. Just tell me all the items you can think of in one minute”.

Subsequently, the participants were asked if they had understood these instructions. Identical instructions were given to all children; however, younger children (below eight years) sometimes required encouragement. During testing, if there was a pause after 30 seconds, the researcher encouraged the participant to attempt producing more words by saying, “What other words can you think of?” or “Can you think anymore?”. After the completion of each individual task, the researcher offered more words of encouragement, in the form of “that was good” or the like. Where encouragement was given, care was taken not to influence the child’s response. No guidelines were given regarding how the participants were to organize their word search and production; this was to ensure that any cognitive strategies they used would be spontaneous.

3.5.4 Administration

During testing, the Initial Letter Fluency tasks were administered prior to the Semantic Category Fluency with 60 seconds allowed per trial. The order of administration of verbal fluency task was constant across participants, both within the Initial Letter Fluency (/p/, /n/ & /k/) and Semantic Category Fluency tasks (animal, food & vehicle).

The actual verbal fluency test was preceded by a practice trial in which the participants were asked to generate as many words as possible belonging to the category of household items (in the Semantic Category Fluency task) and beginning with the letter /s/ (in the Initial Letter Fluency task) excluding names and proper nouns. If they had some difficulty, they were given cues by the examiner.
The children were given the option of stopping and quitting the test at any point of time. The total duration of testing was approximately 15 minutes per child.

### 3.5.5 Data Recording

Each task of verbal fluency was timed using a stopwatch. The examiner recorded the participants’ responses on a digital recorder (Sony IC recorder, ICD-PX820) and wrote simultaneously into the recording form as the examinee spoke for further offline analysis.

### 3.6 Analysis

#### 3.6.1 Outcome Measures

In the present study, both qualitative and quantitative aspects of participants’ verbal production were investigated. Each participant’s responses were numerically coded to ensure confidentiality. All errors including repetitions, non-meaningful words and words not belonging to the specified category / letter were recorded along with the correct words in the same order in which the words were generated. During analysis, any discrepancies in transcription were rectified by recourse to the taped version. The independent variables of the study included **groups** (group I, group II, group III, group IV, group V), **tasks** (Initial Letter Fluency - /p/ fluency, /n/ fluency, /k/ fluency and Semantic Category Fluency– animal fluency, food fluency, vehicle fluency) and **gender** (male, female).

For the study, four outcome measures were taken.

- Total Number of Correct Words (TNCW)
- Clustering measures (Number of Clusters, Mean Cluster Size)
- Switching measure (Number of Switches) and
- Error production analysis (type and frequency of error production)

For the analysis purpose, both correct and incorrect words were taken into consideration for all the measures except for TNCW scores. Detailed description of each of the below listed outcome measures along with exemplars of scoring is provided in Appendix H.

#### I. Total Number of Correct Words (TNCW)

In TNCW, 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 or letter specified),
b) Perseverations (repetitions of any correct words already given as a response) and
c) Morphological variants (example: bus, buses)

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.

II. Clustering measures (Number of Clusters; Mean Cluster Size)

In the present study, two measures of clustering, viz. number of clusters (NC) and mean cluster size (MCS) were considered. Clusters were defined as successively generated words belonging to a particular group specific to semantic / phonemic rules. The number of clusters therefore involved categorization into cluster groups and calculating the total number of clusters produced per trial. For the analysis of clusters, each word was compared with the immediately preceding word (s). For example, if the child says “cat, dog, cow, buffalo, ox, elephant, tiger, fox, lion”, the total number of clusters produced was considered as three (household pet animals, bovines / cow variants and wild animals).

The categorization into clusters during Semantic Category Fluency and Initial Letter Fluency was decided based on the coding protocol formulated (Appendix H) depending on the naturally occurring children’s verbal production and taking into consideration the scoring protocols provided earlier by Troyer et al. (1997), Abwender et al. (2001) and Kosmidis et al. (2004). These guidelines were prepared for consistency sake with flexibility allowed for the coding of associated words that did not fall under the list of predefined clusters.

In order to calculate the mean cluster size (MCS), first the cluster size was calculated. Cluster size (CS) referred to the number of words in a cluster. CS was counted from the second word of each cluster (e.g. a 3-word cluster was counted as a cluster size of 2), so that a single word has a cluster size of 0. For example, if the child said “cow, buffalo, ox”, the cluster size was 2.
size is 2. The cluster size for the smallest cluster of two words was therefore given the lowest point of one score. Mean cluster size was further calculated by the following formula:

\[
\text{Mean Cluster Size} = \frac{\text{Cluster Size}}{\text{Total number of Clusters}}
\]

For example, if the participants said “cat, dog, cow, goat”, for the first cluster (“cat, dog”) the cluster size is 1 and for the second cluster (cow, goat) it is 1. As two clusters were produced by the child, the mean cluster size was obtained by dividing cluster size (1+1) by total number of clusters (2), thereby obtaining a mean cluster size score of 1.

III. Switching measure (Number of switches)

The switch score was operationally defined as the transition from one cluster to another cluster or non-clustered word / from one non-clustered word to another non-clustered word or cluster / from one cluster to another with final word in first cluster serving as the first word for the second cluster.

For example, if the participant said “cat, dog, cow, goat”, it was considered as a single switch from a cluster of household pet animals (cat, dog) to farm animals (cow, goat).

IV. Error Response analysis

In error response analysis, the error production during verbal fluency production was analysed in terms of type and frequency / rate of error production. The error analysis was taken into consideration in order to obtain information regarding the ongoing strategies employed by the participants during the task of verbal fluency. The responses were checked for four types of error production:

- Perseveration (inappropriate repetition of an earlier response, e.g., cat,dog,cat)
- Intrusion (non-categorical or non-initial letter errors, and names of people or cities, e.g., saying places names like Kerala, Palakkad)
- Non-word (non-meaningful words)
- Miscue (words starting with a non-initial letter that is phonologically comparable to the initial-letter or words containing the initial letter but not starting with it)
These errors were initially coded and based on the number of errors demonstrated by children, classified into either 0, 1, 2 or \( \geq 3 \). The scoring was dependent on the rate of error production, with scoring done separately for each error type. A score of 0 was given for number of children exhibiting no error of any type and score of \( \geq 3 \) for those exhibiting more than three quantities of errors of a particular type.

### 3.6.2 Statistical Analysis

Repeated measures Analysis of Variance (ANOVA) were performed to examine the effect of age and gender across Initial Letter Fluency and Semantic Category Fluency tasks. Mean, standard deviation, maximum and minimum scores were used to summarize the scores of the three Initial Letter Fluency and three Semantic Category Fluency tasks. Norms (percentile scores) stratified for group, gender and tasks were calculated with 25th percentile as the cut off score. The Post hoc analysis was done using Tukey HSD. The level of significance was set at 5%.

Further, effect sizes (Cohen’s \( d \)) were calculated to determine which variables made meaningful contributions to fluency scores. It was computed by dividing the mean difference between groups by the pooled standard deviation. According to Cohen (1988), effect size of .2, .5, .8 correspond to small, medium, and large effect sizes, respectively.

The psychometric properties of verbal fluency in terms of reliability and validity (correlation) were tested. To investigate the consistency of the verbal fluency scoring criteria, Intra class correlations (ICC) was used for intra-rater reliability and inter-rater reliability between the scores of 101 randomly selected samples (10% of all protocols) but covering all five groups. During reliability testing, raters were informed to examine reliability of both coding protocol as well as the scoring measures. The data was analysed using the Statistical Package for Social Sciences (version 15.0).

Based on the aforesaid method, the data was collected, analysed and inferences drawn as described in the following chapters.