Discussion
The present study focussing on the performance of typically developing children between grade one and grade ten (aged 5–15 years) on tasks of verbal fluency is first of its kind in the Indian context. The findings of the study not only provided information on number of words the children could retrieve but also regarding the search strategies employed by them.

This chapter on discussion is divided into eight sections under the following headings: Effect of Age on Verbal Fluency performance; Effect of Gender on verbal Fluency performance; Effect of Task on Verbal Fluency performance; Error Response analysis on Verbal Fluency; Cross Linguistic comparisons of Verbal Fluency performance; Developmental perspective on Verbal Fluency; Strength and Limitations and Recommendations for Future Research.

5.1 Effect of Age on Verbal Fluency performance

One of the primary outcome measures of analysis considered in the present study was the influence of age on verbal fluency. The effect of age is discussed in terms of the differences observed in productivity, as well as on the qualitative measures of clustering and switching.

5.1.1 Age related differences in productivity:

In the present study, the productivity on verbal fluency task was analysed using the quantitative measurement of total number of correct words produced during each task. In consonance with previous studies (Grube & Hasselhorn, 1996; Halperin et al., 1989; Koren et al., 2005; Lucariello et al., 1992; Tallberg et al., 2011), the findings of the present study indicated statistically significant positive influence of age on productivity. With respect to pattern of performance with age, a linear increase in performance was noted with no specific age band showing any dramatic increase in performance, contrary to previous studies (Brocki & Bohlin, 2004; Riva et al., 2000; Sauzeon et al., 2004).

In the present study, on Initial Letter Fluency task, while children in Group I produced 2-4 words, Group V children produced approximately 10-11 words. Similarly, for Semantic Category Fluency task, while children in Group I produced 7 words, it increased to 14-15 words for Group V children. A similar increase in scores with age has been reported by
Halperin et al. (1989) among English speaking children. They reported that, by 6 years of age, children retrieved 4 items for phonological category of ‘sh’ and 10 items for semantic categories of animals and food. By 12 years, there was an increase in productivity with 6 items in phonological category and 18 items in semantic categories.

This increase in productivity with age in the present study can be attributed to the advancement in spoken word production and executive function. As the schooling and environmental exposure increase, the ability to retrieve more numbers of words from the mental lexicon also shows a steady increase. This tendency of increase in productivity was described earlier by Nelson (1974) and later by Sauzeon et al. (2004) as the expansion of hierarchical organization of the category knowledge and access with increase in age. They reported that, with increase in age, there is an increase in semantic network activation which promotes faster exploration, better organization and quicker retrieval of words from the semantic store. This is endorsed in the present study.

Although it has been argued that executive functions such as verbal fluency reach maturity by around 12 years (Anderson et al., 2001; Anderson, 2002; Regard et al., 1982), the findings of the present study indicated that verbal fluency tasks don’t reach adult levels by fifteen years of age. In comparison to S. John et al. (2011) study on Malayalam speaking younger adults (18 to 25 years), children in grade IX and X of the present study, provided significantly lower number of words. In the comparative study, the participants were able to generate approximately 19-20 words (mean score) for the Semantic Category Fluency task of animal and approximately 15 words (mean score) for the Initial Letter Fluency task of /p/. This outcome indicates that the maturation of brain functions for verbal fluency continue to develop throughout adolescence (Chan & Poon, 1999; Jurado & Rosselli, 2007).

5.1.2 Age related differences on clustering and switching:

Along with quantitative analysis of productivity, qualitative measures of clustering and switching were also of interest in the present study. Clustering and switching are the two semantic organizational strategies adopted by the participants during the process of verbal fluency retrieval that involve both semantic memory and executive functioning. Semantic memory is required for the selection of words from subcategories based on semantic or
phonemic cue while the *executive component* is required for ensuring the correct switching to next subcategory for producing correct words without errors (Mayr & Kliegl, 2000; Tallberg et al., 2011).

A trend favouring older children in the current study indicating increasing efficiency in using successful search and retrieval strategies was an interesting observation. A gradual increase in scores with increase in age on the number of clusters and the number of switches (except for group III and IV during the Semantic Category Fluency task) but not on mean cluster size evolved. The strength of association as indicated by Cohen’s $d$ effect size also illustrated the linear trend with greater association between farther groups (moderate to large effect size) than nearer groups on all measures except mean cluster size. These findings are in agreement with studies of Koren et al. (2005), Kave et al. (2008) and Tallberg et al. (2011).

The increase in the **number of clusters** with increase in age reflected the increase in the number of subcategory items and acquisition of new word meanings in children with increasing efficiency in retrieval mechanism. As Snyder and Munakata (2010) proposed, successful performance on verbal fluency is dependent on the selection of correct subcategory representations from the pool of competing items. For example, the retrieval of items within the subcategory of *food* is facilitated by selection of subcategories such as *fruits / breakfast foods / desserts / meats*. Children need to plan this selection in order to facilitate maximum word retrieval without being told how to do. The presence of clusters during word retrieval can also be partly accounted for by the various semantic memory models including the context and exemplar based models (Collins & Loftus, 1975; Mandler, 1979; Smith et al., 1974), which explains in detail the organization process involved during the word retrieval task.

In the present study, **mean cluster size** (MCS) did not show positive influence of age. This observation is in consonance with findings of Koren et al. (2005) and Tallberg et al. (2011). Though Kave et al. (2008) reported positive age effects on MCS, detailed inspection of the scores revealed that this difference was small. This indicates that there is a possibility for reduced or lack of change on MCS measure and that it may not be a critical measure to be considered during clustering analysis in typically developing children.
The presence of increase in **switching** with age was indicative of the enhancement in the strategic retrieval process and development of endogenous flexibility (Snyder & Munakata, 2010) with age. Contrary to this, Sauzeon et al. (2004) reported a decrease in the number of switches with age. This discrepancy in findings could be attributed to the difference in scoring employed. While Sauzeon et al. explained their results based on the ratio scores, the present study focused on the obtained raw score. Consideration of raw scores in the current study supported by research (Kave et al., 2008; Troyer, 2000), which documented that raw scores provided greater information about the number of times a participant can generate a new cluster of response.

The present study also explored the **type of categorization** employed by the participants during verbal fluency tasks. The categorization process during Semantic Category Fluency tasks was based on taxonomic (words sharing similar properties) and contextual (words sharing same context / schema / theme) relationships. For Initial Letter Fluency task, the categorization was based on the phonological representations in Malayalam language.

In **animal fluency** task, children produced conventional categories (e.g., *reptiles, insects, birds*), contextual categories (e.g., animals belonging to the same habitat, animals having similar human use, animals used for carrying heavy loads etc.) and associative clusters (such as fable associations) specific to the child’s environment and culture. The most common exemplars of the *animal* category were retrieved from subcategories of ‘pet animals’ and ‘farm animals’.

In the present study, with increase in age, varying patterns of cluster production on **animal fluency** were noted. Children belonging to younger groups (Groups 1 & 2) restricted their word generation to habitat / environmental contexts in which the animals are found (wild/home/aquatic) but children in older groups (Groups 4 and 5) tended to retrieve more words belonging to human use (beasts of burden - *camel, horse, elephant*; milk giving animals - *cow, goat, buffalo*; animals used for fur or skin - *rabbit, lamb, tiger*; animals used as vehicles - *camel, horse, buffalo*). Though the presence of clusters based on habitat and zoological categories (*birds / insects*) was common for all the groups, clusters relating to *insectivorous, herbivorous* animals and *poisonous* insects in zoological categories were noted.
only in the higher grade groups. Children were also found to generate words belonging to family members (e.g., *cow–calf, goat–kid, cow–ox, cock–hen*); interestingly, children by Grade VIII (Group 4) were generating clusters such as names of variants of snakes and locally seen fish. These observations indicated the developmental changes in the organization with spreading out of the semantic organization to related semantic categories with increase in age (Koren et al., 2005; Kave et al., 2008; Sauzeon et al., 2004).

Another interesting observation was that, children from the very young age of five years were seen to produce animal names based on the association they had learnt from stories, picture books and their environment (e.g., *cat–mouse, wolf–lamb, mouse–lion, elephant–ant, tortoise – hare*). Though no direct relation between rabbit and the tortoise is noted in terms of habitat or zoological categories, based on the fable stories they have learnt, children were seen retrieving similar words. The exemplars such as “*cat–mouse*” were possibly related to the Tom and Jerry cartoon series and “*lamb–wolf*” related to well-known fable stories. From grade V, children also categorized animals based on their relationships as prey/enemies (e.g., *mongoose–snake; snake–cat; hen–fox; wolf–lamb; snake–frog; fox–rabbit; rabbit–snake; cat–lizard*).

Similar findings of cluster production have been reported in literature, mostly among pre-schoolers and children belonging to the early childhood period. Nash and Snowling (2008), Nelson (1974) and Crowe and Prescott (2003) reported hierarchical semantic organization on similar lines in terms of older children producing the names of non-mammals (species of birds, reptiles), invertebrates, and members of mammalian subclasses (breeds of dogs). They reported that the most frequent exemplars were wild animals for younger children (5-year-olds) while it was domestic animals followed by wild animals for older children (8-year-olds). Lucariello et al. (1992) studied the conceptual structure of animal category and reported on the continued use of schematic and taxonomic relations with age. They noted that the clusters were restricted to zoo animals in a group of 4-year-old children, whereas by 7 years, they tend to retrieve clusters of domestic, zoo, forest animals, and aquatic animals with clusters of primates not included in children’s verbal productions. Presence of retrieval based on environmental context in both older and younger children has also been reported by Crowe and Prescott (2003) and Storm (1980) and is relevant to the findings of this study.
In terms of **food category**, children of all the age groups in the present study generated words which could be categorized based on the contextual as well as conventional taxonomic associations. Subcategories such as fruits, vegetables, dairy products and non-vegetarian foods formed the taxonomic relationships while production of words categorized according to the context it occurs (foods that are eaten together - breakfast food items such as *idli, dosa, puttu*) formed the contextual categories. The most common exemplars of the retrieved food category were ‘fruit’ subcategory and contextual subcategory of ‘breakfast food items’. It was further noted that the number of items as well as the number of clusters based on conventional subcategories were greater with increase in age in older children.

The word generation on **food fluency** in the present study was also dependent on the family environment and occupation. The food items routinely used in the household (e.g., *idli-sambar, tapioca-fish curry, rice porridge-greengram*) were also observed as clusters in most of the children. Children of parents owning ‘bakery shop’ tended to elicit more items on a snack / dessert subcategory as compared to other semantic subcategories. Some of the children kept the location of schema in mind (e.g., bakery / fruit & vegetable shop / restaurants / farms) while generating words belonging to a particular category. The inclusion of other categories of non-Indian food items and food based on colour similarity (naming green colour vegetables, red colour fruits) especially among children above seventh grade was also noted. This ability to generate words grouped according to conventional as well contextual classification among younger children for **food category** as noted in the current study has been reported by Luciarelllo et al. (1992), Nash and Snowling (2008) and Nguyen and Murphy (2003).

For the **vehicle category**, in consonance with previous findings (Chan & Poon, 1999), the current study did not find age related differences in the most frequently generated items. In general, children tend to generate words belonging to clusters depending on the context in which they are encountered. The most typical cluster noticed in all the age bands was vehicles seen on land, air and water. The most four common exemplars produced included *bus, car, scooter* and *lorry*. Children produced names of historical vehicles (such as *chariot*) not seen in their day to day environment but learnt in school textbooks, read in story books or seen on television.
In the present study, along with Semantic Category Fluency, the **Initial Letter Fluency** task was also employed. Children from all age groups were seen to generate words on Initial Letter Fluency, by clustering words together that shared similar phonemic properties. The most common strategies employed by children for organizing the word retrieval during Initial Letter Fluency task included generation of words that began with the same initial two letters (e.g., [kuppi-kup] and words having same last letters (e.g., [kaŋmaŋ-kriŋ]). Children from group 2 (from third grade) were observed to generate words beginning with same initial two syllables (e.g., [kazu:kazu] same initial two consonants with differing vowels (e.g., [na:rha:-ni'rha] differing only by a vowel or consonant sound (e.g., [puza-puza]) having same number of syllables (e.g., [piCəla-pappəfm]) and words differing only with last part such as [kappal-kappalandi].

The occurrence of these subcategories indicated that organization was based on phonological representations in Malayalam language. This phonological pattern representation noted in the present study is distinct and unique to Malayalam language and may not be generalized completely to other languages with differing phonological structure. In Nash and Snowling (2008) study among typically developing English speaking children (5-9 years), clusters of words that shared initial consonant and vowel (e.g., tea–teacher), clusters differing only with a vowel (blood–bad, tail–tall, ball–bill), clusters sharing a consonant and a vowel with an intervening consonant (e.g., tea–tree), and clusters that shared a syllable (e.g., tooth–toothpaste, book–bookcase) were commonly produced. Classifications of words which rhyme (Koren et al., 2005) and words with the same pronunciation but different meanings (Tallberg et al., 2011) have also been reported in literature.

Another interesting finding of the present study was the presence of **task discrepant clustering**. During **Initial Letter Fluency task**, less than five percent of the samples in higher grades (VIII-X) attempted to generate words following semantic rules, if they were unable to generate more words based on phonemic characteristics (semantic in phonemic strategy).
Some of the common exemplars noted during analysis included the production of phonemically related words belonging to body parts [kaŋŋa-ka-ːd-kar-ː]-ka-i-ka-ːn] əŋŋə-əŋə-əŋə-əŋə-əŋə for eye, ear, liver, leg, hand, cheek; [neŋ-ŋa:kk-o-né-ŋa] əŋŋə-əŋə-əŋə-əŋə for chest, tongue, forehead and nails. Other examples included clustering of words based on animals (monkey, bear and fox), furniture (bed, chair and door), jewellery (anklet and earring) and associations (ear, earring). On Initial Letter Fluency, one child even produced semantic clusters based on astrological stars ([puːjam-ːuː-ːujam] əŋŋə-ŋə-ŋə-ŋə-ŋə, which is a common practice in traditional Hindu families.

Similarly, during Semantic Category Fluency task (during animal fluency task in three participants) some of the phonemic categories noted included: words with same initial letter [aːna-aːma-aːːd] əŋŋə-əŋə-əŋə, words with same initial syllable [ka-ːŋ-ːa-ːk] əŋŋə-əŋə, words differing only by vowel or consonant [paːti-pānn] əŋŋə-əŋə, [maːjil-muːjol] əŋŋə-əŋə, rhyming words [maːn-miːn] əŋŋə-əŋə, words with same beginning and ending sound [paːti-puː] əŋŋə-əŋə, words with same beginning syllables [oːtːum-oːtːapakʃi] əŋŋə-əŋə-əŋə and words with same ending syllables [puːc-ːuː-iːc-ː] əŋŋə-əŋə, [feːya-mаːya] əŋŋə-əŋə. However, the fewer number of clusters generated and number of participants did not warrant any statistical analysis.

A similar kind of task discrepant clustering has also been reported in literature (Abwender et al., 2001; Schwartz et al., 2003; Tallberg et al., 2011; Troyer et al., 1997). In Troyer et al. study, the use of alphabetic strategy during animal fluency has been reported among two of 26 participants. It was observed that the words were generated based on alphabetic progression (e.g., aardvark-bear-cat-dog-elephant). Studies have also reported of word generation involving combination of phonemic and semantic strategies (Roberts & Le Dorze 1997; Pekkala, 2004) with the exemplars illustrated in French (pomme and poir for apple and pear) and Finnish (kissa and koir for cat and dog).

These findings on task discrepant clustering do indicate that though Initial Letter Fluency and the Semantic Category Fluency tasks involve different cueing strategies and mechanism of retrieval, there is some amount of overlap in the processes involved in both the
tasks. While the lexical or grapho-phonemic processes are predominantly tapped during Initial Letter Fluency task, the retrieval of words based on semantic rules does indicate that even semantic processes are involved during Initial Letter Fluency. However, it's to be noted that this interaction was observed during Initial Letter Fluency task than the Semantic Category Fluency task.

**Overall**, the findings revealed developmentally related differences in semantic organization dependent on the semantic knowledge. An increase in productivity and clustering-switching with age, with higher age groups performing better than the lower age groups. Children possess both hierarchically organized taxonomic as well as life experience based contextual types of categorization relationships to retrieve words during the verbal fluency tasks. The findings of this study emanating from typically developing children are presumed to contribute to research by providing data for future studies on profiling the deviation of verbal fluency output among childhood disorders.

### 5.2 Effect of Gender on Verbal Fluency performance

In the present study, no statistically significant influence of gender was found on both the quantitative measures of productivity and the qualitative measures of clustering and switching in children. However, the mean scores indicated certain differences in performance on total number of correct words, depending on the task employed. For Initial Letter Fluency, females scored slightly higher than males on the total number of correct words for all age groups except in group IV (/p/ and /n/). On Semantic Category Fluency, female superiority for *food* fluency (in group V) and male supremacy for *animal* (group I) and *vehicle* fluency (group III and IV) in terms of total number of correct words produced were evident.

On the same lines of the current study, in literature, Capitani et al. (1999) had reported an advantage of the semantic category of *tools* for boys and an advantage in the category of *fruits* for girls. This gender difference was attributed to differences in exposure and experience rate to the subcategory. Contrary to these aforesaid studies, no effect of gender has also been reported in children (Sauzeon et al., 2004; Tallberg et al., 2011) as well as adults (Chan & Poon, 1999; Kempler et al., 1998; S. John et al., 2011; Tombaugh et al., 1999).
However, it is not possible, from the present study results to support the positive effects of gender on verbal fluency, based on slight increase in scores for certain tasks.

**Overall**, the present study findings add on to the increasing evidence on lack of statistically significant gender influence on strategic retrieval mechanism. It is hypothesized that similar processing strategies on verbal fluency tasks occur for both boys and girls. It could also be hypothesized that the difference between genders will be more prominent in adulthood rather than childhood due to the variation in life experiences obtained with increased environmental exposure.

### 5.3 Effect of Task on Verbal Fluency performance

In agreement with earlier studies (Charchat-Fichman et al., 2011; Matute et al., 2004; Riva et al., 2000; Sauzeon et al., 2004), it was found that Initial Letter Fluency developed at a slower rate than Semantic Category Fluency for all the outcome measures except mean cluster size. This difference between tasks could be attributed to the difference in retrieval strategies and variation in nature of constraints employed during Initial Letter Fluency and Semantic Category Fluency tasks (Azuma, 2004; Ho et al., 2002; Ratcliff et al., 1998; Riva et al., 2000; Wood, Saling, Abbott, & Jackson, 2001).

The task of **Semantic Category Fluency** involves predominant search of naturally defined subcategories involving physical and functional properties of items (such as farm animals / fruits / air borne vehicles). The task is less taxing for the participants, as the search involves the familiar habitual access route to semantic memory relying on the common rules of categorization with automatic activation of related category items (Nelson, 1974; Rosser & Hodges, 1994).

In contrast to Semantic Category Fluency, the **Initial Letter Fluency** task involves non-heuristical searches for items (Azuma, 2004; Leggio et al., 2000) from the semantic stores. The task of Initial Letter Fluency, as Wood et al. (2001) explained, is neither a natural component of language processing nor it follows the familiar access route to the lexicon like Semantic Category Fluency task. It involves the intentional use of strategic search of broader and less defined phonological level of word representation which makes the organization task more
effortful, demanding and difficult. During Initial Letter Fluency task, the participants’ need to avoid search based on semantic criterion involving meaning of words and follow the orthographic route involving the feature of surface structure of the words. Support for differences between tasks also arises from various neuroimaging studies (Birn et al., 2010; Mummery et al., 1996) and studies among clinical population (McDowd et al., 2011; Troyer et al., 1998a).

Although majority of researchers investigating verbal fluency provided combined score for all the tasks employed (Bayles et al., 1989; Croona et al., 1999; Huff et al., 1986; Kave et al., 2008; Tallberg et al., 2011), the present study in deviation, focused on exploring the potential task effects on verbal fluency performance. On Initial Letter Fluency, differences in retrieval of words based on the task were noted to be greatest for /k/ fluency followed by /p/ and /n/ fluency task for all measures except mean cluster size. This discrepancy in performance can be plausibly related to the letter difficulty with the differences reflecting diversity in frequency of words dependent on the chosen letter. The findings of the present study indicated that the number of commonly occurring words starting with letter /p/ and /k/ in Malayalam is relatively more than words starting with the letter /n/. This probably resulted in more vocabulary choices and lesser degree of difficulty in word retrieval for /p/ and /k/ as compared to /n/.

In an earlier study by Prema and Manu (2001) on the phonemic frequency of letters in Malayalam, it was reported that letter K is most frequently occurring (3.49) followed by letter N (3.10) and letter P (2.46). The occurrence probability for letter K in Malayalam is reported to be .083 with .075 and .060 for letters N and P respectively. This needs to be taken with caution as the reported scores were in relation to words in all positions and not just restricted to initial word position, which forms the scope of the present study. Further evidence regarding differences in performance on Initial Letter Fluency tasks comes from the study by Borkowski et al. (1967), which indicated that vocabulary size for each letter differed resulting in varied dictionary frequency for each letter. Findings of the present study are in contrast to the few cited in literature (Charchat-Fichman et al., 2011; Strauss et al., 2006), where no differences in total number of correct words produced on letter tasks with different sets of

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8 https://sites.google.com/site/personaltesting1211/scoring-matrices-for-complete-malayalam-characters
letters of varying difficulty have been reported. More studies are warranted in Malayalam language among children addressing the issue of levels of difficulty and frequency of words beginning with each letter of the language.

Similarly, on Semantic Category Fluency, the task advantage was noted to be higher for animal and food fluency tasks that represented living categories followed by vehicle fluency that represented non-living or manmade category. This is further indicated by the Cohen’s $d$ effect size value wherein, vehicle fluency only showed small to moderate effect size (.2-.5) for all the age groups as compared to other tasks. The differences in performance across tasks could be justified by the occurrence of more potential familiar category items for some semantic categories rather than the presence of any specific cognitive strategy (Baldo & Shimamura, 1998; Chan & Poon, 1999). For the category of food, the number of items that could be retrieved were still higher than other two categories as it consisted of both living (e.g., fruits, vegetables) and manmade items (e.g., snack items, desserts) with greater proportion of perceptual features such as visual (color, shape, texture), flavour and tactile information. The findings are in consonance with Ardila et al. (2006), who reported that the generation of exemplars is easier during animal fluency task as compared to vehicle fluency. Various researchers have also provided evidence for category specific anatomical specialization (Goldberg et al., 2006; Mummery et al., 1996; Vitali et al., 2005) for different tasks of Semantic Category Fluency in the brain.

Overall, from the present study findings on task effects, it is proposed that the living and non-living categories could serve as a useful and familiar task for future studies in children. Due to the fact that different types of tasks impose different demands on the systematic search and retrieval mechanism based on the degree of difficulty, the deficits on verbal fluency need to be addressed as a function of each task separately rather than as an average score for all the tasks together.

5.4 Error response analysis on Verbal Fluency

Apart from the quantitative and qualitative analysis of word productivity, the type and frequency of error production during verbal fluency task in typically developing children were also investigated in the present study. The error analysis was taken into consideration to obtain information regarding the pattern of error production in typically developing children
as a function of age. In order to ensure a greater number of word production, the participants needed to refrain themselves from incorrect words by involving themselves in multiple cognitive processes. The higher order cognitive processes involved included monitoring and avoiding of previously retrieved words and ensuring that only words belonging to a specific letter or category were generated thereby avoiding errors such as intrusions (Rosen & Engle, 1997), within the short time span of 60 seconds.

In the present study, it was noted that children were prone to producing errors during verbal fluency. About 11% of the participants on Initial Letter Fluency and 30% on Semantic Category Fluency exhibited errors during verbal fluency tasks. Though some researchers (Charchat-Fichman et al., 2011) have indicated error response analysis in normally developing children as futile, the present study findings endorse the support for employing error analysis as a routine protocol.

The common error types noted in the present study were perseveration, intrusion, non-word and miscues with perseveration being the most common and miscues being the least. In terms of percentage of error production, differences were noted between tasks. In agreement with previous research (Hurks et al., 2006), more number of errors (irrespective of error type) were observed during Semantic Category Fluency task as compared to Initial Letter Fluency task. While perseveration errors were found to be more during Semantic Category Fluency task (around 36% of participants), intrusion error type was noted to be greater during Initial Letter Fluency task (around 18% of participants). In terms of production of non-meaningful words, similar rate of production was noted during both semantic category and Initial Letter Fluency task. Error type of miscue was however restricted to Initial Letter Fluency task alone.

In terms of perseveration, recurrent type (e.g., mouse-rat-squirrel-rat) was predominantly observed with occasional continuous perseveration (e.g., apple-orange-mango-mango) towards end of the time frame when the child was unable to retrieve any more words. These errors occurred due to difficulty in monitoring previously recalled items with sustained attention.
With respect to **intrusion** type of error, children tend to exhibit errors such as retrieving names of places (e.g., *Coimbatore*), proper names (e.g., *kantaswami* as in name of a person), synonyms (e.g., *puvu* and *puʂpəm* two words for *flower*), use of both Malayalam word (L1) and the English word (L2) for the same item (grapes-*[mundıɾi] မန်နိုင်; pineapple-*[kaŋçaCakka] ကောက်ကောက်), or generating semantically related words during Initial Letter Fluency task (for words starting with /k/, patient saying *[kakka-kattil-mesha]* which means *crow-bed-table*). Intrusion errors occur when a child fails to suppress words which are not related to the designated letter or category cue. Children were also noted to attempt themselves in self-correction if they accidently produced intrusion error type. The presence of greater intrusion errors during Initial Letter Fluency task indicated the demand for inhibition of selection of words based on meaning as required during this task. This involves greater demands on executive function for suppression of this habitual behaviour (Henry & Crawford, 2004a; Perret, 1974).

The production of **non-word** errors can be viewed as a mechanism by children to help in word retrieval and as a consequence of lack of ability to retrieve a correct word. While some of the non-words were generated based on the previous words produced (Example, /ka:kka ကကု - *ka:kkatamburatti ကကုကုန်သည်* / with *ka:kka* being the correct word), some of the non-words produced resulted in production of correct category specific word (*ka:kkatambili ကကုကုန်သည် - kambili ကုန်; with kambili being the correct word).

Presence of **miscues** (such as producing *phakshanam* or *phalam* during Initial Letter Fluency task of /p/) in Group I and II could be related to the incorrect knowledge of phonemes typically seen during early school years. Some of the children tended to produce words containing the target letter but not in initial position (e.g., *Cuŋppu ကော်ပျ; with letter P in word final position). Anderson (2002) reported that children tend to retrieve words such as ‘elephant’ while asked to generate words starting with the letter ‘A’. This error was reported by Hurks et al. (2004) as a resultant of inappropriate strategy use (that is, retrieving words based on sound of the letter rather than the phonetic rule of letter).

The present study also focused on **frequency of error production with age**. It was found that the frequency of error production showed a decreasing pattern with increase in age.
for all error types except perseveration error. This decrease in errors can be attributed to the 
general increase in linguistic and cognitive abilities occurring with increase in age. The 
persistence of perseveration errors can be indicative of immature ability to monitor previously 
produced from the growing pool of mental lexicon. On a similar note, Charchat-Fichman et al. 
(2011) and Tallberg et al. (2011) reported lack of age effects on the number of errors in their 
studies among Brazilian and Swedish speaking children.

**Overall**, the presence of these error productions in typically developing children could be 
attributed to the maturation process with less developed semantic and executive system 
required during verbal fluency task. With increase in vocabulary and repeated use of words in 
context, chances for error production faded as children learnt strategies by which unwanted 
memory trace interferences were inhibited. Future studies focusing on error production 
pattern would be of first-order necessity while assessing verbal fluency performance among 
typical and disordered childhood population. It needs to be remembered that children who do 
ot possess efficient categorization skills with inability to use correct search strategies may 
show poor proficiency on verbal fluency task with increased error production.

### 5.5 Cross Linguistic comparison of Verbal Fluency performance

In the present study, a cross linguistic comparison of verbal fluency performance was 
done with the existing literature. The study findings revealed that the performance on verbal 
fluency was sensitive to **culture** with exemplars for the same category, differing across 
studies.

In the present study, on **animal** fluency task, Malayalam-speaking children generated 
the names of pet animals (“*cat*” and “*dog*”) followed by farm animals (“*cow*”) more 
frequently in all the age groups. In consonance with Typicality model (Rosch, 1975), the most 
typical members of the group were retrieved earlier during the task as compared to less typical 
members. In Nash and Snowling (2008) study, “*cat*”, “*dog*”, “*tiger*” and “*lion*” were the most 
common animals. Kave et al. (2008) based on their study among Israel community, reported 
that children in Israel associated *cats / rats* with pet animals and not as “*garbage*” animals, 
though they were commonly seen on the streets and in garbage cans.
Research findings among adult population have also revealed positive cultural and linguistic influences on verbal fluency. In Troyer (2000) study, for animal fluency task, based on their study participant responses, animals were furthermore categorized as African animals, Australian animals, North American animals, Arctic/Arctic animals, Weasles, etc. Kosmidis et al. (2004) reported additional clusters produced by Greek individuals based on whether they belonged to tropical animals or animals of steppe. Kempler et al. (1998) study showed that the most frequent animals named by African American, White, Chinese, Hispanic, and Vietnamese speakers living in Southern California were the same (i.e., “dog,” “cat,” “horse,” and “elephant”). However, they also found that the frequency of other animal names demonstrated regional and cultural differences among the groups: “ox” and “buffalo” were common for the Vietnamese speakers, “donkey” for the Spanish speakers, “rat” for the Chinese speakers, and “giraffe” for the English speakers.

In general, in order to overcome cultural specific advantages, a commonly followed practice is utilizing animal category and comparing the study results across the population. However, as described, there are differences noted in terms of the type of the responses obtained from the participants from different cultures and environment. The findings of the present study contradicted the widely believed concept of universality on the animal fluency task and indicated that the classification of the number of clusters was specifically based on the environment they belonged to and what they were used to in their habitat.

Cultural variations depending on the geographical location were also observed on food fluency task. Children were seen to retrieve frequently produced words from familiar subcategories in their environment. The category items on food fluency was not just restricted to taxonomy of fruits and vegetables children have learnt in school but also related to food items eaten commonly and specifically in Kerala. For example, the cluster of food items eaten during the yearly Kerala festival - Onam Sadhya was a common cluster noted in food fluency. In the study of Kave et al. (2008), native Hebrew speaking children generated food categories such as food eaten raw (e.g., tomato, cucumber, pepper) / greens (e.g., lettuce, spinach, celery), winter (e.g., apple, kiwi, tangerine) and summer (e.g., watermelon, peach, grapes). However, in Nash and Snowling study (2008), children categorized food as vegetables, fruit,
meat, Italian (e.g., pizza, pasta), fish and chips, sweet (e.g., chocolate, cake), sauce (e.g., gravy, ketchup) and schematic groups (items in a meal).

Along with these cultural differences, linguistic factors also add up to variations in animal fluency performance. Based on the word length, differences have been reported between languages, wherein Spanish speakers generated the least number of words and Vietnamese, the maximum (Kempler et al., 1998). Table 5.1 indicates the performance on the verbal fluency parameters across different languages in typically developing children on animal fluency task. Other studies have been omitted as they included single age group or employed different administration and scoring protocol for analysis.

The present study scores when compared with other languages (English, Hebrew, Dutch, Spanish & Swedish) revealed interesting findings. The lowest number of words was generated by Malayalam speakers and the maximum by Dutch children. Similarly, on the qualitative measures, differences were observed predominantly for number of clusters and number of switches. These differences could be probably related to the inherent linguistic differences in word length that exist among the languages. Depending on the length of the words in a particular language, the speed of retrieval has an impact on total words produced. All the languages listed above belong to a different language family with distinct language characteristics and varying phonetic inventory. While Malayalam language belongs to Southern group of Dravidian language, languages like Dutch, Spanish and Swedish belong to Indo-European language family and Hebrew belongs to Semitic language family.

The decrease in scores in Malayalam can be plausibly attributed to the presence of greater average word length and longer words being used more frequently in daily use. While the average word length has been reported to be around five in English, it has been reported to be near 10.255 (highest among the Indian languages) with the average number of syllables per word in Malayalam being 4.44 (Bharati et al., 2002). Another striking variation between study findings can also be attributed to the retrieval of compound words (word made up of two or more words), which have not been taken into consideration during coding in other language studies. Some of the compound words feature noted during analysis in Malayalam includes words such as [pachakuthira], [kannimaŋga] etc. Another unique feature of Malayalam is that
gender distinction in Malayalam is considered as both grammatical and semantic category. Words such as ‘kuːʈʈukaːɾːn̩’ and ‘kuːʈʈukaːɾ̩’, which are used for representing masculine and feminine form for English word “friend” exists as two different words in Malayalam. While the word length effects on verbal fluency have not been directly investigated in children, there is scope for future studies to investigate the word length effects across languages.

Table 5.1

Cross Language comparison of Verbal Fluency performance in children for animal fluency task

<table>
<thead>
<tr>
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<tbody>
<tr>
<td><strong>Total Number of Correct Words</strong> Mean(SD)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Group I</td>
<td>10.74(2.4)</td>
<td>-</td>
<td>12.86 (.57)</td>
<td>-</td>
<td>-</td>
<td>7.38(2.49)</td>
</tr>
<tr>
<td>Group II</td>
<td>12.31(2.7)</td>
<td>11.4(4.6)</td>
<td>16.32 (.61)</td>
<td>12.00(3.26)</td>
<td>13.50(4.00)</td>
<td>9.42(2.85)</td>
</tr>
<tr>
<td>Group III</td>
<td>14.27(3.7)</td>
<td>15.2(4.3)</td>
<td>18.74 (.62)</td>
<td>14.21(3.64)</td>
<td>17.60(4.40)</td>
<td>11.75(3.13)</td>
</tr>
<tr>
<td>Group IV</td>
<td>18.90(6.2)</td>
<td>17.7(4.9)</td>
<td>20.31 (.77)</td>
<td>-</td>
<td>-</td>
<td>13.15(3.38)</td>
</tr>
<tr>
<td>Group V</td>
<td>-</td>
<td>18.8(4.9)</td>
<td>21.84 (.79)</td>
<td>-</td>
<td>18.70(3.90)</td>
<td>14.24(3.46)</td>
</tr>
<tr>
<td><strong>Number of Clusters</strong></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Group I</td>
<td>-</td>
<td>-</td>
<td>0.61 (.13)</td>
<td>-</td>
<td>-</td>
<td>3.88(1.47)</td>
</tr>
<tr>
<td>Group II</td>
<td>-</td>
<td>-</td>
<td>0.93 (.14)</td>
<td>3.19(1.23)</td>
<td>3.7(1.7)</td>
<td>4.88(1.77)</td>
</tr>
<tr>
<td>Group III</td>
<td>-</td>
<td>-</td>
<td>1.20 (.14)</td>
<td>3.73(1.10)</td>
<td>4.4(1.5)</td>
<td>5.87(1.89)</td>
</tr>
<tr>
<td>Group IV</td>
<td>-</td>
<td>-</td>
<td>1.44 (.16)</td>
<td>-</td>
<td>-</td>
<td>6.14(2.19)</td>
</tr>
<tr>
<td>Group V</td>
<td>-</td>
<td>-</td>
<td>1.76 (.18)</td>
<td>-</td>
<td>3.8(1.7)</td>
<td>6.69(2.15)</td>
</tr>
<tr>
<td><strong>Mean Cluster Size</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group I</td>
<td>-</td>
<td>-</td>
<td>1.79 (.23)</td>
<td>-</td>
<td>-</td>
<td>1.09(.58)</td>
</tr>
<tr>
<td>Group II</td>
<td>-</td>
<td>-</td>
<td>2.25 (.25)</td>
<td>2.12(.99)</td>
<td>0.98(.53)</td>
<td>1.11(0.5)</td>
</tr>
<tr>
<td>Group III</td>
<td>-</td>
<td>-</td>
<td>2.77 (.25)</td>
<td>2.05(.79)</td>
<td>1.08(.69)</td>
<td>1.16(0.46)</td>
</tr>
<tr>
<td>Group IV</td>
<td>-</td>
<td>-</td>
<td>2.92 (.31)</td>
<td>-</td>
<td>-</td>
<td>1.39(.70)</td>
</tr>
<tr>
<td>Group V</td>
<td>-</td>
<td>-</td>
<td>2.91 (.32)</td>
<td>-</td>
<td>1.06(.39)</td>
<td>1.36(.62)</td>
</tr>
<tr>
<td><strong>Number of Switches</strong></td>
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</tr>
<tr>
<td>Group I</td>
<td>-</td>
<td>-</td>
<td>11.29 (.47)</td>
<td>-</td>
<td>-</td>
<td>2.88(1.47)</td>
</tr>
<tr>
<td>Group II</td>
<td>-</td>
<td>-</td>
<td>14.14 (.49)</td>
<td>4.72(2.11)</td>
<td>12.83(4.12)</td>
<td>3.88(1.77)</td>
</tr>
<tr>
<td>Group III</td>
<td>-</td>
<td>-</td>
<td>15.69 (.50)</td>
<td>5.94(1.96)</td>
<td>16.81(4.45)</td>
<td>4.88(1.90)</td>
</tr>
<tr>
<td>Group IV</td>
<td>-</td>
<td>-</td>
<td>16.42 (.58)</td>
<td>-</td>
<td>-</td>
<td>5.13(2.18)</td>
</tr>
<tr>
<td>Group V</td>
<td>-</td>
<td>-</td>
<td>17.12 (.65)</td>
<td>-</td>
<td>18.33(4.12)</td>
<td>5.68(2.15)</td>
</tr>
</tbody>
</table>
The dissimilarity between the study findings in childhood population could also be attributed to other factors such as differences in the scoring protocol employed. For the task of animal fluency, in the present study, the scoring protocol permitted inclusion of gender variants, mythological exemplars, extinct animal names during animal fluency, numbers during Initial Letter Fluency and brand names during vehicle fluency during scoring. Contrary to present study, Tallberg et al. (2011) permitted scoring for both general category and category exemplars (bird and sparrow), while scoring for imaginary animals, compounds involving previous words were excluded. The lack of uniformity in scoring protocol is also seen in the study by Kave (2006), wherein they considered animal-offspring as two different words but gender variants as single word.

In the present study, the analysis of responses produced by children indicated the predominant use of words spoken on a daily basis in school (e.g., class, camp, project etc.). Due to increased frequency of exposure, the access to these subcategory items is more readily available. Few of the correct words retrieved were meaningful but based on the child’s knowledge of movie names (e.g., [kɪɾːɪ dams, nattura:dza:vu, nɪ:laːtɛmaɾə] आदित्य, नातुरजोड़ू, नि:ला:ता:मा:रा). Due to distinct living environment with different exposure rate to different types of subcategories, the use of separate language and culture based norms while evaluating children on verbal fluency task is necessitated.

Overall, the differences in performance between studies in children in different languages can be attributed to multiple factors, viz., differences in task employed, variations in administration and scoring utilized, linguistic differences, regional differences and socio-cultural differences. More studies on cross-cultural and cross-language comparisons are therefore essential in this population for a deeper understanding of the influence of language and culture on verbal fluency performance. Considering the aforesaid issues, it is felt that utilizing a universal cluster coding protocol or methodology is not a realistic practice and that it needs to be decided based on the child’s verbal production in each cultural and linguistic environment.
5.6 Developmental perspective on Verbal Fluency

The findings of the present study clearly outline the influence of age and task variations on performance in typically developing children with no prominent effect of gender. The study outcomes depicted a distinct pattern of organizational strategies employed by children for a successful performance on verbal fluency tasks. A cross linguistic comparison revealed that the pattern of word organization was exclusive for Malayalam language, which can be attributed to linguistic and environmental differences.

In terms of organization, the structure of word retrieval mechanism showed a continuous and linear developmental trend rather than depicting a rapid or incremental change in children. The performance on verbal fluency measures did not reach maturity but continued to develop throughout the adolescence with Initial Letter Fluency developing at a slower rate than Semantic Category Fluency. The categories in children were formed on the basis of thematic - taxonomic relationships as well as on the basis of the phonological structure of Malayalam language. The word retrieval was found to be dependent on personal experiences, learning in schools and environmental exposure (e.g., vehicles that go on the road/water/air, food items in shop/home, animals in zoo/farm). This further indicated that human concepts are represented in variety of forms in semantic memory and the word retrieval from the vast knowledge concept of lexicon requires meticulous organization and planning skills.

With respect to word retrieval strategy employed, greater demand on semantic structure during Semantic Category Fluency and on phonological structure during Initial Letter Fluency were noted. The study findings also indicated that Initial Letter Fluency and Semantic Category Fluency tasks were not purely phonemic and semantic in nature (task consistent type). There can be an overlap of phonemic and semantic strategies during both the tasks, wherein children may employ phonemic based strategy to retrieve semantically related words or use semantic based strategies to retrieve phonemically related words (task discrepant type). The presence of both task discrepant and task consistent type of clustering indicated that a successful performance on verbal fluency task required specialized organization of both phonological and semantic representations to retrieve words from mental lexicon.

In literature, numerous efforts have been made to explain the mechanism of verbal fluency. While some researchers attempted to explain the task of verbal fluency based on
models of lexical access (Dell et al., 1997; Caramazza, 1997), semantic memory (modular, context and exemplar based) and lexical store, other researchers focused on the role of executive functions (Baddeley, 2012; Miyake et al., 2000). The findings of the present study indicated that a unitary model alone cannot entirely explain the verbal fluency mechanism; rather the task involved complex interaction of the language processes, semantic memory and executive functioning. The language processes and semantic memory are involved in the selection of as many numbers of correct word production possible based on the phoneme or category. Verbal fluency task also involves specific cognitive abilities of executive functioning in terms of self-initiation of response, self-monitoring of the responses produced and inhibition of inappropriate responses. Though verbal fluency looks simple in terms of administration, it is challenging and complex due to the demands it sets in terms of rule constraints and need for proper utilization of search and retrieval strategies.

5.7 Strengths and Limitations of the study

The major strength of the present study lies in its study group and design. This study on the developmental trend of a large data comprising of 1015 Malayalam speaking children from five to fifteen years is the first of its kind in the Indian context. Most of the studies done till date have focused on either a smaller age band or restricted to younger population of less than 10 years of age.

The research design employed is simple, brief and easy to administer task of verbal fluency with high level of suitability for children. With the advantage of task administration being relatively quick (one minute per task) not requiring any sophisticated equipment (except a stop watch or pen and paper) with no issues related to ceiling effect, the task turned out to be simple and effortless. Children may perform the task by considering it as a play activity rather than as a test. This can therefore make it a popular test for children in school and hospital based research studies.

This study also provided well described sample composition information, detailed overview of administration procedure with percentile scores and scoring protocol in a manual format for future researchers’ ease of appropriate interpretation and comparison. Unlike many studies where children were grouped into a single cluster and analysed, the stratification based
on five grade groups with adequate sample size employed in the present study, increased the utility of verbal fluency index and generalization of outcomes.

Unlike majority of studies documented till date in the literature, this study focused on exploring not only the quantitative aspect of how many words children were able to retrieve for various task variations but emphasized the role of qualitative analysis of composition of responses, which gives information on how the retrieval occurs. The study findings further provided evidence regarding the type of search strategies children employed in order to enhance word retrieval during verbal fluency task. In addition, presence of good psychometric property in terms of inter-rater and intra-rater reliability supports the utility of these measures in future studies.

There are a few limitations in the present study that need to be addressed in future endeavors in the same domain. One major limitation of the current study is that it did not include any specific tests (Verbal IQ, working memory capacity, speed or reading abilities) for grouping children or to evaluate cognitive mechanism underlying verbal fluency performance. The researcher excluded these tests keeping in mind the practical difficulties related to the time consumed for multiple test administration and difficulty in gaining child’s attention and interest throughout the testing process. It was considered essential to ensure that the testing procedure should be less taxing and time consuming for all age groups including children as young as five years.

With respect to task selection employed in the present study, the letter and category selection were done based on frequency of occurrence and existing literature evidences. An in depth frequency analysis of the relative difficulty of letters or categories was not made, prior to the initiation of the study. The study outcome of age/gender adjusted scores therefore needs to be used with caution while interpreting data using other letters or categories. Moreover, the data was collected from a monolingual Malayalam speaking population, whose bilingual proficiency was untested. This could limit the usefulness for clinical interpretation among bilingual population in Kerala.
With respect to scoring measures, though the study focused on clustering-switching measures, the extent of involvement of semantic and executive component during the task was not well demarcated by the current research design or the study outcomes. Another limitation is related to the predominant focus on task congruent clustering alone during scoring and analysis without detailed exemplar frequency analysis. The presence of scarce data on task discrepant clustering, prevented the researcher from attempting a statistical analysis on this correlate.

In terms of analysis of psychometric properties of the test, the present study lacked information on test-retest reliability which could have been helpful in tracking change and delineating the stability of the test performance scores.

5.8 Recommendations for future research

Based upon the insight gained from conducting this research and the review of existing literature, several recommendations are appropriate for future researchers to embark upon:

- Establishing demographically corrected norms for each Indian language, taking into consideration age, task effects and linguistic differences
- Investigating the verbal fluency performance for other indices of performance (as a function of time, employing other methods of qualitative analysis across other semantic categories and different letter sets) in children
- Extension of usefulness of the task to childhood disorders in Indian context for enhancing the diagnostic sensitivity and specificity
- Exploring the role of verbal fluency as a therapeutic tool for developing oral or computer games to facilitate better organizational strategies for the clinical population