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ANALYSIS OF VERBAL FLUENCY OUTPUT ON SEMANTIC CATEGORIES OF 'FOOD' AND 'VEHICLE' IN TYPICALLY DEVELOPING MALAYALAM SPEAKING CHILDREN

In the wake of limited knowledge on verbal fluency performance in typically developing children, the present study aims at investigating the semantic fluency performance of Malayalam speaking children across age, gender and tasks. Using a cross-sectional study design, semantic fluency performance (on *food* and *vehicle* fluency tasks) was investigated in 1015 Malayalam speaking typically developing children aged 5 to 15 years. The findings revealed the positive influence of age and task with no substantial difference between gender groups, with good inter-rater and intra-rater reliability. The study outcomes depicted a distinct pattern of continuous and linear developmental trend in organizational strategies, with no specific age band showing any dramatic increase in performance. Semantic fluency as a task has great potential within the developmental context for understanding the highly language, culture, and task based word retrieval mechanism.

Key words:semantic fluency; typically developing children; Malayalam language; vehicle fluency; food fluency

Introduction

The ability to generate words with speed and accuracy is one of the crucial elements of spoken word production. Successful generation of words involves accessing one's own vocabulary repertoire or mental lexicon and retrieving the words specific to the target from stored word knowledge. Verbal fluency (also known as word generation task / word list generation task / word fluency test / controlled oral word association / controlled verbal fluency test / controlled

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word association test / fluency in controlled association / oral naming test) has gained popularity as one of the empirical procedures that tap the organization of categorical knowledge. The data stemming from this procedure has been used to understand lexical ability in both healthy and disordered adults and children (Koren, Kofman, & Berger, 2005; Lezak, 1995; Mitrushina, Boone, Razani, & D'Elia, 2005; Spreen & Risser, 2002; Troyer, Moscovitch, & Winocur, 1997).

One version of verbal fluency frequently used in neuropsychological testing is semantic fluency, which requires retrieval of words belonging to the provided category. For example, if the specified semantic category is '*animals*', the examinee needs to generate the members belonging to the semantic category of animals, such as *tiger*, *lion*, *cat*, *dog*, etc., within the time frame provided.

Semantic categories reported in the literature include *animals, types of transportation and cars, parts of car, items in a supermarket, things in kitchen, fruits, vegetables, foods, drinks, groceries, birds, first names of people, girls' names, boys' names, plants, tools, clothing, professions, colors, parts of human body, things that make people happy / sad, toys, countries, musical instruments, sports, cities, flowers, trees, U.S. states and inanimate objects* (Lezak, 1995; Mitrushina et al., 2005; Spreen & Strauss, 1998; Strauss, Sherman, & Spreen, 2006). Across categories, comparison of performance on *animals, fruits, vegetables and clothing* (Rosselli et al., 2009), an easy category of *animals* and hard category of *fluids* (Mayr & Kliegl, 2000), categories of *birds, clothes, body parts* and *colors* versus categories of *insects, fabrics, fluids* and *writing utensils* (McDowd et al., 2011), *tools* versus *fruits* (Capitani, Laiacona, & Barbarotto, 1999), and living categories of *animals* and *plants* versus non-living set of *vehicles* and *tools* (Antonucci, Beeson, Labiner, & Rapcsak, 2008) have also been reported in the literature.

The literature is replete with different methods of reporting the findings on semantic fluency. Huff, Corkin, and Growdon (1986), for instance, reported the average of the total number of words produced on the categories of '*vehicles*', '*vegetables*', '*tool*' and '*clothing*', whereas Bayles et al. (1989) reported the total number of words on '*animals*', '*fruits*' and '*vegetables*' categories. Similarly, in child research, Sauzeon, Lestage, Raboutet, N' Kaoua, and Claverie (2004), Kave, Kigel, and Kochva (2008) and Tallberg, Carlsson, and Lieberman (2011) reported an average score for all the semantic categories together rather than an individual category score. While some authors provided '*fruits*' and '*vegetables*' as a single entity (Bayles et al., 1989; Kave, 2005), others considered them as separate categories (Rosselli, Tappen, Williams, Salvatierra, & Zoller, 2009). Authors have also used the general category label of '*supermarket goods*' (Martin & Fedio, 1983; Troster, Salmon, McCullough, & Butters, 1989) or provided category names of '*objects that can be bought in a supermarket beginning with the letter M*' (Lipowska, Bogdanowicz, & Bulinski, 2008).

The task of generating items related to a category (e.g., *animals/fruits*) involves the concept of categorization. Nelson and Nelson (1990) reported that verbal fluency helps in understanding the development of categorization and semantic knowledge in children. In the development of semantic categorization, children exhibit different types of categorization. One such categorization is based on taxonomic relationships, wherein there exists a relation between words based on the similarity among the category members. Categories such as *dog-animal* and *apple-fruits* are some examples of taxonomic categories. Another form of organization is thematic categorization, wherein words belonging to distinct taxonomic categories share a functional (e.g., *coat-hanger*) or situational relation (e.g., *table-stove*). For example, *dog-bone* and *apple-tree* are examples of pairs. Another categorization are script categories / slot-filler categories, which involves items playing the same role in a script. For example, *apple* and *orange* belong to the script category of fruits.

Studies have suggested that by two years of age, children exhibit identification of these categorizations (Fenson, Vella, & Kennedy, 1989); by preschool, they start using these relationships in communication (Blaye & Bonthoux, 2001), and by first grade are able to verbally justify the relationships (Smiley & Brown, 1979). Some researchers have found that young children tend to categorize words based on thematic relations (Smiley & Brown, 1979) or script categories (Lucariello, Kyratzis, & Nelson, 1992). Development of taxonomic category relationships is reported by 7-8 years of age, attributed to the rapid development of vocabulary and world knowledge (Lucariello et al., 1992). Although all the relationships are available from an early age, there is a lack of consensus among researchers on the shift from thematic to taxonomic or from slot-filler to taxonomic categories with development (Nguyen & Murphy, 2003). Raboutet et al. (2010) considered switching, clustering and hierarchical exploration as the three mechanisms of word retrieval during the semantic fluency task. The intercategorical process or switching accounts for search and retrieval of different semantic categories. Switching involves shifting from one subcategory to another. For example, if a child produces the following animal names on semantic fluency task: <u>lion, tiger,</u> <u>snake, lizard,</u> <u>cat, dog</u>; the number of switches is two as the child produced the categories of *feline*, *reptile* and *home* animals. Along with the switching process, the semantic fluency task requires an intracategorical process or clustering, which involves the production of many exemplars belonging to the same category. In the previous example, feline, reptiles and home animal categories are the three clusters retrieved during the animal fluency task. During retrieval children also involve themselves in the third process, which is a hierarchical exploration of retrieving both common and specific examples from within a category. For example, production of category exemplars such as *milk, cheese, yogurt* etc. under the category label of *fruits* for a task of naming items found in supermarkets.

Regardless of the wide implications of verbal fluency among the adult population, there is a dearth of knowledge on how children organize semantic information and retrieve words on different tasks of verbal fluency. The currently available normative data relate to French, Italian, Swedish, Hebrew, Dutch and Spanish (Charchat-Fichman, Oliveira, & da Silva, 2011; Filippetti & Allegri, 2011; Hurks et al., 2010; Kave et al., 2008; Koren et al., 2005; Sauzeon et al., 2004; Tallberg et al., 2011) samples, which are inappropriate for evaluating Indian children. With respect to the Indian context of Malayalam (the language spoken in South India), the focus has predominantly been on the adult and geriatric population (de Jager et al., 2008; Mathuranath et al., 2003), with no published studies on *food* and *vehicle* semantic fluency tasks. Recently, an investigation of fluency performance on ‘animal’ category was conducted by the authors (John & Rajashekhar, 2014) in Malayalam speaking children. Their study provided a detailed coding protocol for animal fluency analysis and further indicated the positive influence of age and task on animal fluency performance.

The current study hence aims to add on to the existing literature, regarding the pattern of semantic fluency development across early to late childhood with emphasis on factors influencing its development and the search strategies employed during the ‘food’ and ‘vehicle’ fluency task. It is presumed that this developmental data, specific to the Malayalam language across the childhood period, will further enhance its usefulness in clinical and research settings in the Indian context by serving as a baseline while evaluating developmental disorders. The present study has attempted to investigate the developmental changes in semantic fluency of Malayalam speaking children by exploring the effects of age, gender and task on semantic fluency measures and organizational strategies.

Material and Methods

Using a cross-sectional study design, 1015 school going children (males – 512; female - 503) 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 enrolled for the study. They were selected from eleven primary and secondary schools (government and private schools) from the municipalities of Pathanamthitta district of Kerala state, India. The children selected for this study were the participants of a previous verbal fluency study in Malayalam (John & Rajashekhar, 2014).

The participants were classified into five groups as indicated in Table 1, based on the class they belonged to, rather than on the age due to the difference in the age level representation in each class. The lower age limit of five years was considered, justified by the documentation in the literature that by around four years of age, children can identify category relationships and produce category exemplars for a superordinate label (Lucariello et al., 1992; Nelson & Nelson, 1990). In order to obtain a developmental perspective of the influence of age on the semantic fluency task, this cross-sectional study investigated the semantic fluency performance in children till 15 years of age.

Table 1. Demographic Characteristics of Study Population

	Group I	**Group II**	**Group III**	**Group IV**	**Group V**
N	202	200	201	198	214
Mean(SD)					
Age years	6.44(.78)	8.59(.83)	10.28(.80)	12.20(.75)	14.07(.91)
Grade / Class	I-II	III-IV	V-VI	VII-VIII	IX-X
Gender					
Male (%)	103(51)	101(51)	102(51)	99(50)	107(50)
Female (%)	99(49)	99(49)	99(49)	99(50)	107(50)
Handedness					
Right (%)	181(89.6)	188(94)	192(95.5)	192(96.9)	202(94.39)
Left (%)	14(6.93)	09(4.5)	06(2.98)	02(1)	05(2.33)
Ambidextrous (%)	07(3.46)	03(1.5)	03(1.49)	04(2)	07(3.27)
Education					
Lower Primary	202	200	-	-	-
Upper Primary	-	-	201	98	-
High School	-	-	-	100	214

The children enrolled in the study had Malayalam, one of the four prominent Dravidian languages, belonging to the Central Travancore dialect as their first language and primary language of communication in school. Furthermore, they were required to be born, brought up and currently residing and educated in Kerala (one of the states in South India) from kindergarten. All the participants selected for the study were required to be of middle socioeconomic status in consonance with Kuppuswamy's socioeconomic status scale (Mishra & Singh, 2003).

Children with a history of medical problems such as neurological conditions / developmental disorders / psychiatric illness or disorders/substance abuse/ academic/language difficulties / physical or sensory deficits / recurrent middle ear infections / upper respiratory tract infections were excluded from the study. Children requiring special educational assistance and children who had failed in any class at school were also not included in the study. Inclusion and exclusion were done based on direct observation, teacher's reports, school records and parental information obtained through a telephone interview.

Procedure

Prior to the study, ethical approval was obtained from Institutional Ethical Committee and either written or oral informed consent was taken from participants or their parents. The participants were given the following instruction for the semantic fluency task:

> *"We are going to play a word game. I am going to say a particular category name to you, and 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. 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?*".

The actual semantic 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, excluding names and proper nouns. If they had some difficulty, they were given cues by the examiner. The verbal fluency paradigm involved word generation on two tasks of semantic fluency - *food* and *vehicle* fluency. These specific categories were chosen as they were concrete, rational, familiar and known to children in the Indian context. The order of presentation was fixed (*food* category preceding *vehicle* category) for all the participants.

Analysis

Both qualitative and quantitative aspects of participants' verbal production were investigated. The examiner recorded the participants' responses on a digital recorder (Sony IC recorder, ICD-PX820) and wrote simultaneously into the recording form during data collection for offline analysis. 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 were recorded along with the correct words in the same order in which the words were generated in a recording form. In the study, three outcome measures were taken: Total Number of Correct Words (TNCW), clustering measures (Number of Clusters, Mean Cluster Size) and switching measure (Number of Switches).

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 specified),

b) Perseverations (repetitions of any correct words already given as a response) and c) Morphological variants (example: *bus*, *buses*). For the purposes of scoring, the raw score of a total number of correct words obtained was retained, instead of being converted to percentage scores. For example, if the child says "*idli, dosa, appam, grapes, orange, apple, pineapple, banana*", the total number of correct words was considered as eight.

Clustering measures (Number of Clusters; Mean Cluster Size). Two measures of clustering were considered: number of clusters (NC) and mean cluster size (MCS). *Clusters* were defined as successively generated words belonging to a particular group specific to semantic 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 said "*idli, dosa, appam, grapes, orange, apple, pineapple, banana*", the total number of clusters produced was considered as two (breakfast food items and fruits).

The categorization into clusters during semantic fluency was decided based on a coding protocol (Table 2) that was formulated depending on the naturally occurring children's verbal production and taking into consideration the scoring protocols provided earlier by Troyer et al. (1997), Abwender, Swan, Bowerman, and Connolly (2001) and Kosmidis, Vlahou, Panagiotaki, and Kiosseoglou (2004).

Table 2. Coding protocol for semantic fluency tasks

VEHICLE FLUENCY

Land

- Public (e.g., *bus, train, taxi*)
- Mass transportation (e.g., *train, plane*)
- Private (e.g., *car, motorbike, moped*)
- On road vehicles (e.g., *bicycle, bus, car, jeep, moped, motorcycle, police car, ambulance, taxi, tractor, truck, van*)
- Two wheels (e.g., *bicycle, motorcycle, moped*)
- Recreation (e.g., *skates, roller-blades, tricycle*)
- Snow (e.g., *skis, snowboard, sledge*)
- Work-related (e.g., *tractor, truck, bulldozer, tipper, lorry, JCB, crane, tempo, container*)
- Emergency related (e.g., *ambulance, fire engine*)
- Military-related (e.g., *tank, command-car, jeep*)
- Wagons (e.g., *cart, wheelchair*)
- Pulled (e.g., *carriage, coach, rickshaw*)
- Beasts of burden (e.g., *horse, camel, donkey, elephant, bull*)

Water

- Boat, ship, yacht, raft, sailboat, submarine, speed boat, house boat, snake boat etc.

Air

- Plane, helicopter, hot-air balloon, rocket, jet, missile, supersonic etc.

Combinations

- Buses types (e.g., *tourist bus, private bus, transport bus, school bus, line bus, air bus, tour bus*)
- Train types (e.g., *local train, goods train*)

FOOD FLUENCY

Taxonomic categories

- Fruits (e.g., *grapes, apples, oranges*)
- Vegetables (e.g., *tomato, potato, beetroot, carrot, cabbage, cauliflower*)
- Non-vegetarian foods (e.g., *chicken, pork, fish, mutton*)
- Cereals (e.g., *wheat, rice, oats*)
- Pulses (e.g., *green grams, chickpea, peanut, lentils*)
- Powders (e.g., *semolina, flour, maida*)
- Legumes (e.g., *green peas, beans*)
- Dairy products (e.g., *milk, cheese, butter, cream, buttermilk, sweet buttermilk, curd*)
- Drinks(e.g., *soda, coke, milk, water, juice*)
- Desserts (e.g., *cake, ice cream, pudding*)
- Dry fruits (e.g., *raisin, ground nut, dates*)
- Condiments (e.g., *oil, vinegar, ketchup, sauce*)
- Flavourings / Spices (e.g., *cinnamon, pepper, salt, tamarind, cloves, cardamom*)
- Snacks (e.g., */ulli vada/; /parippuvada/, chips, aval, puffs, samosa*)
- Roots (e.g., *tapioca, yam, colocasia, raddish, potato, beet root*)

Contextual categories

- Daily routine breakfast foods (e.g., *idli, dosa*)
- Typical combinations (e.g., *puttu-pazham; rice porridge-green gram; vada –pazham; chicken-porota, tapioca-fish curry*)
- Sweet food (e.g., *ledu; gilebi, sugar, biscuit, chocolate, cake*)
- Sadhya items (e.g., *pachadi,kichadi, pappadam*)
- Perceptual similarities –color (e.g., *red – tomato, red chilli; green vegetables – cucumber, bitter gourd, snake gourd*)
- Bakery items (e.g., *cake, sweets, puffs, samosa*)
- Chinese items (e.g., *noodles, fried rice*)
- Non-Indian foods (e.g., *Burger, Sharjah shake, Pizza*)
- Habitat (e.g., *coconut-jackfruit, tea-coffee plantations*)
- Gravies/ Curries
- Lunch items; Dinner items

- Family (e.g., *types of banana, mango types*)
- Side dish (e.g., *chutney, pickle, thoran, salad*)

Phonemic categories

differing by vowel [k**a**pp**a**-k**a**:pp*i*]; same ending syllable [t̪e:**ŋa**], [ma:**ŋa**]

In order to calculate the mean cluster size (MCS), the cluster size was first 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 "*grapes, orange, apple, pineapple, banana*", the cluster size is 4. 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 formulae:

Mean Cluster Size = Cluster size divided by Total number of clusters

For example, if the participants said "*idli, dosa, appam, grapes, orange, apple, pineapple, banana*", for the first cluster ("*idli, dosa, appam*") the cluster size was 2 and for the second cluster (*grapes, orange, apple, pineapple, banana*), it was 4. As the child produced two clusters, the mean cluster size was obtained by dividing cluster size (2+4) by total number of clusters (2), thereby obtaining a mean cluster size score of 3.

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 the final word in the first cluster serving as the first word for the second cluster. For example, if the participant said "*idli, dosa, appam, grapes, orange, apple, pineapple, banana*", it was considered as a single switch from a cluster of breakfast food items to fruits subcategory.

Psychometric properties

The psychometric property of semantic fluency in terms of reliability was tested. To investigate the consistency of the semantic fluency scoring criteria, Intraclass correlations (ICC) were 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. ICC scores ranged from 0 to 1 and an ICC score nearer to 1 was considered as higher agreement. During reliability testing, two raters (experienced Speech Language Pathologists) were informed to examine the reliability of both coding protocols as well as the scoring measures. Both intrarater reliability and interrater reliability were high (>. 89) for all the measures that were taken (as indicated in Table 3).

Table 3. Intra-rater reliability and Inter-rater reliability on Verbal Fluency measures in terms of ICC, CI and Maximum Difference

	Intra-rater Reliability			Inter-rater reliability		
Measure	**ICC**	**95% CI**	**Maximum difference**	**ICC**	**95% CI**	**Maximum difference**
TNCW food	.999	.999-.999	2	.999	.998-.999	2
TNCW vehicle	1.000	1.000-1.000	0	.998	.997-.998	2
NC food	.996	.993-.997	1	.976	.967-.983	3
NC vehicle	.993	.989-.995	2	.944	.922-.961	3
CS food	.990	.985-.993	2	.964	.949-.974	2
CS vehicle	.963	.945-.975	2.25	.891	.848-.923	2.7
Switch food	.996	.993-.997	1	.976	.967-.983	3
Switch vehicle	.993	.989-.995	2	.944	.922-.961	3

Note. TNCW - Total number of correct words; NC - Number of clusters; CS - Cluster Size

Statistical Analysis

Repeated measures Analysis of Variance (ANOVA) was performed to examine the effect of age and gender across the semantic fluency tasks. *Mean, standard deviation, maximum* and *minimum* scores were used to summarize the scores on the two semantic fluency tasks. 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 sizes of .2, .5, .8 correspond to small, medium, and large effect sizes, respectively. The data were analysed using the Statistical Package for Social Sciences (version 15.0).

Results

Semantic fluency performance across age

In terms of **total number of correct words (TNCW)**, as indicated in Table 4, the univariate analysis revealed an age related increase in scores. The performance was lowest in group I and highest for group V in all

Table 4. Total Number of Correct Words on semantic fluency across Age and Gender

Task	Group I			Group II			Group III			Group IV			Group V		
	M	*F*	**Total**	*M*	*F*	**Total**	*M*	*F*	**Total**	*M*	*F*	**Total**	*M*	*F*	**Total**
food															
Mean	7.10	7.61	**7.35**	9.28	9.54	**9.41**	11.39	10.96	**11.18**	13.21	13.12	**13.17**	13.95	15.66	**14.81**
SD	2.50	2.58	**2.54**	2.66	2.89	**2.77**	3.52	3.41	**3.47**	3.79	3.65	**3.71**	4.33	4.21	**4.35**
Min	3	3	**3**	3	3	**3**	3	4	**3**	6	6	**6**	5	7	**5**
Max	17	15	**17**	16	17	**17**	22	19	**22**	22	23	**23**	23	31	**31**
vehicle															
Mean	7.20	7.10	**7.15**	8.68	8.12	**8.41**	9.62	9.15	**9.39**	10.06	10.08	**10.07**	10.60	10.75	**10.67**
SD	1.76	1.59	**1.68**	2.43	1.87	**2.19**	2.35	2.42	**2.39**	2.61	2.46	**2.53**	3.12	2.92	**3.01**
Min	4	4	**4**	4	4	**4**	5	4	**4**	4	5	**4**	5	5	**5**
Max	14	11	**14**	17	13	**17**	17	16	**17**	18	18	**18**	20	20	**20**

the semantic fluency tasks. Repeated measures ANOVA indicated significant differences on group performance on the semantic fluency task (F (7.84, 1970) = 30.83, $p < 0.001$, partial eta squared = .11). Post-hoc analysis using Tukey's HSD test indicated significant differences between older and younger groups

($p < 0.001$), with the mean difference of scores between groups increasing with increased distance between groups (group V vs. IV:1.28; group V vs. III: 2.54; group V vs. II: 3.85 and group V vs. I: 6.16).

In the *food* fluency tasks, Cohen's d effect size was found to be large for groups I to IV (.93) and groups I to V (1.08); moderate effect size in groups I to III (.64), groups II to IV (.58) and groups II to V (.76). In the vehicle fluency task, the effect size was noted to be moderate only for groups I to III (.55), groups I to IV (.69) and groups I to V (.75), with small effect size between the rest of the groups.

In terms of **number of cluster (NC)** production (Table 5), it was noted that children retrieved more clusters with an increase in age. The least number of clusters was produced by children belonging to group I and the maximum by group V. Statistically significant differences (F (7.861, 1975) = 6.828, $p < 0.001$, partial eta squared = .026) were noted in all the groups except for group III and IV ($p = .122$). In the *food* and *vehicle* fluency task, the effect size was noted to be moderate only for groups I to V (.59 for *food* and .51 for *vehicle*), with the small effect sizes in all the other groups.

As indicated in Table 6, on semantic fluency task, the **mean cluster size** score was fairly constant across the age groups. However, for the food fluency, the scores remained almost the same till group III, after which, a rapid increase was noted. Though the repeated measures ANOVA reflected statistical significance (F (7.15, 1796) = 6.77, $p < 0.001$, partial eta squared = .026), Tukey's HSD test indicated otherwise ($p < 0.001$), only between the farther groups (I to IV, I to V, III to IV, III to V). In consonance with the post hoc findings, Cohen's d effect size was found to be small (<.2) on all the tasks of semantic fluency for all the groups considered in the study.

In terms of **number of switches**, the univariate analysis (Table 7) revealed a rapid increase with grade for all the tasks of semantic fluency (F (7.86, 1975) = 6.57, $p < 0.001$, partial eta squared = .025). A post hoc Tukey's HSD test showed that on semantic fluency tasks, the older groups performed better than the lower groups ($p < 0.001$). However, the mean differences between group III and group IV were not statistically significant. In terms of effect size, only groups I to V showed moderate effect size in *food* (.60) and *vehicle* (.52) fluency. All the other groups in all the tasks showed a small effect size, indicating no strong association between the variables.

Semantic fluency performance across gender

On TNCW, the repeated measures ANOVA indicated a statistically significant difference for semantic fluency (F (1.96, 1970) = 4.60, $p = .011$, partial eta squared = .005) at an 0.05 significance level. This significance was observed because of the higher mean scores among females in the category of *food* fluency (only in group V). A close inspection of the mean

Table 5. Number of Clusters on semantic fluency across Age and Gender

Task	Group I			Group II			Group III			Group IV			Group V		
	M	***F***	**Total**	***M***	***F***	**Total**	***M***	***F***	**Total**	***M***	***F***	**Total**	***M***	***F***	**Total**
food															
Mean	3.32	3.28	**3.30**	3.98	3.80	**3.89**	4.74	4.25	**4.50**	4.84	4.76	**4.80**	5	5.47	**5.23**
SD	1.31	1.44	**1.37**	1.61	1.63	**1.62**	1.52	1.46	**1.50**	1.75	1.71	**1.73**	1.95	1.85	**1.91**
Min	1	1	**1**	1	1	**1**	2	1	**1**	1	1	**1**	2	2	**2**
Max	7	7	**7**	8	9	**9**	9	8	**9**	10	10	**10**	10	10	**10**
vehicle															
Mean	3.35	3.33	**3.34**	3.75	3.67	**3.71**	4.31	4.15	**4.23**	4.64	4.37	**4.51**	4.78	4.87	**4.82**
SD	1.23	1.27	**1.24**	1.62	1.25	**1.44**	1.39	1.55	**1.47**	1.53	1.43	**1.48**	1.60	1.68	**1.64**
Min	1	1	**1**	1	1	**1**	2	2	**2**	2	2	**2**	2	2	**2**
Max	7	6	**7**	9	7	**9**	8	9	**9**	9	9	**9**	10	11	**11**

scores, however, indicated that these differences between gender groups were not clinically significant for all the other groups and tasks.

No statistically significant difference between males and females was noted for number of clusters (F (1.965, 1975) = .128, p = .876, partial eta squared = .000), mean cluster size (F (1.787, 1796) = 2.55, p = .084, partial eta squared = .003) and number of switches produced (F (1.965, 1975) = .09, p = .912 p > .05, partial eta squared = .000).

Table 6. Mean Cluster Size on semantic fluency across Age and Gender

Task	Group I			Group II			Group III			Group IV			Group V		
	M	***F***	**Total**	***M***	***F***	**Total**	***M***	***F***	**Total**	***M***	***F***	**Total**	***M***	***F***	**Total**
food															
Mean	1.39	1.70	**1.54**	1.70	1.81	**1.76**	1.55	1.80	**1.67**	1.99	1.99	**1.99**	2.04	2.10	**2.07**
SD	1.09	1.30	**1.20**	1.25	1.05	**1.15**	.81	1.01	**.92**	1.03	1.13	**1.07**	1.07	1.00	**1.03**
Min	.17	.17	**.17**	0	.33	**0**	0	.33	**0**	.43	.67	**.43**	.17	.29	**.17**
Max	7	8	**8**	7	6	**7**	4	5.50	**5.50**	8	7	**8**	5.67	5.33	**5.67**
vehicle															
Mean	1.44	1.48	**1.46**	1.67	1.47	**1.57**	1.39	1.42	**1.41**	1.34	1.44	**1.39**	1.34	1.37	**1.36**
SD	.81	.94	**.88**	.98	.74	**.87**	.68	.65	**.66**	.61	.65	**.63**	.58	.57	**.57**
Min	.20	.20	**.20**	.25	.20	**.20**	.38	.20	**.20**	.40	.33	**.33**	.40	.33	**.33**
Max	4	5	**5**	5	4	**5**	3.67	3.33	**3.67**	4	3.50	**4**	3.25	3	**3.25**

Table 7. Number of Switches on semantic fluency across Age and Gender

Task	**Group I**			**Group II**			**Group III**			**Group IV**			**Group V**		
	M	***F***	**Total**	***M***	***F***	**Total**	***M***	***F***	**Total**	***M***	***F***	**Total**	***M***	***F***	**Total**
food															
Mean	2.32	2.24	**2.28**	2.98	2.80	**2.89**	3.74	3.25	**3.50**	3.84	3.78	**3.81**	4.00	4.47	**4.23**
SD	1.31	1.42	**1.36**	1.61	1.63	**1.62**	1.52	1.46	**1.50**	1.75	1.71	**1.72**	1.95	1.85	**1.91**
Min	0	0	**0**	0	0	**0**	1	0	**0**	0	0	**0**	1	1	**1**
Max	6	6	**6**	7	8	**8**	8	7	**8**	9	9	**9**	9	9	**9**
vehicle															
Mean	2.35	2.33	**2.34**	2.75	2.63	**2.69**	3.37	3.15	**3.26**	3.64	3.37	**3.51**	3.79	3.87	**3.83**
SD	1.23	1.27	**1.24**	1.62	1.27	**1.45**	1.41	1.55	**1.48**	1.53	1.43	**1.48**	1.61	1.68	**1.64**
Min	0	0	**0**	0	0	**0**	1	1	**1**	1	1	**1**	1	1	**1**
Max	6	5	**6**	8	6	**8**	7	8	**8**	8	8	**8**	9	10	**10**

Semantic fluency performance across tasks

Across tasks, the scores were higher for the food fluency task as compared to the vehicle fluency task. Repeated measures ANOVA indicated statistical significance for the total number of correct words [(F (1.96, 1970) = 275.47, p < 0.001, partial eta squared = .22)], number of clusters [(F (1.965, 1975) = 250.59, p < 0.001, partial eta squared = .200)], mean cluster size [(F (1.787, 1796) = 134.29, $p < 0.001$, partial eta squared = .118)] and number of switches [(F (1.965, 1975) = 249.69, $p < 0.001$, partial eta squared = .199)]. The pair-wise comparison revealed that these differences were statistically significant ($p < 0.001$).

Overall, on semantic fluency,

- **Age effects**: 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. The mean cluster size score was constant across the age groups except for an increase in scores by group IV on *food* fluency
- **Gender effects:** 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)
- **Task effects:** 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*.

Discussion

The present study focused on the performance of typically developing children between grade one and grade ten (aged 5–15 years) in tasks of semantic fluency. The findings of the study not only indicated the number of words retrieved by children but the search strategies employed by them for specific tasks. The study findings are discussed with respect to age, gender and task effects on semantic fluency.

Effect of Age on Semantic Fluency performance

One of the primary outcome measures of analysis considered in the present study was the influence of age on semantic 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.

Age related differences in productivity: Productivity in the semantic 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, Healey, Zeitchik, Ludman, & Weinstein, 1989; John & Rajashekhar, 2014; Koren et al., 2005; Lucariello et al., 1992; Tallberg et al., 2011), the current findings indicated a statistically significant positive influence of age on productivity. With respect to the pattern of performance with age, a linear increase in performance was noted with no specific age band showing any dramatic increase in performance and in contrast to previous studies (Brocki & Bohlin, 2004; Riva, Nichelli, & Devoti, 2000; Sauzeon et al., 2004).

In the semantic fluency task, while children in Group I produced seven 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 had reported that by six years of age children retrieved ten items, which increased to 18 items by 12 years for the semantic categories of *animals* and *food*.

This increase in productivity with age, as observed in the current study, can be attributed to advancement in spoken word production and executive function. With an increase in schooling and environmental exposure, the ability to retrieve a greater number of words from the mental lexicon also showed 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 an increase in age. They reported that, with an increase in age, there was an increase in semantic network activation which promoted faster exploration, better organization and quicker retrieval of words from the semantic store. This viewpoint has been endorsed in the present study.

Age related differences on clustering and switching: The current study also focused on exploring the clustering and switching strategies employed by children during semantic fluency. A trend of increased efficiency in using successful search and retrieval strategies favoring older children was an interesting observation. It was observed that a gradual increase in scores with an increase in age on the number of clusters and the number of switches (except for group III and IV during the semantic fluency task) was not so on the mean cluster size evolved. The strength of association as indicated by Cohen's d effect size also illustrated a linear trend with greater association between farther groups (moderate to large effect size) than nearer groups on all measures excepting mean cluster size. These findings are in agreement with the studies of Koren et al. (2005), Kave et al. (2008) and Tallberg et al. (2011).

The increase in the number of clusters with an increase in age reflected the increase in the number of subcategory items and acquisition of new word meanings in children with increasing efficiency in the retrieval mechanism. As proposed by Snyder and Munakata (2010), successful performance on verbal fluency is dependent on the selection of correct sub-category 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 to do so.

In the present study, mean cluster size (MCS) did not show any positive influence of age. This is in consonance with the 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 of their study revealed the difference as being small. This indicates the possibility for reduced or lack of change on MCS measure and not for consideration as a critical measure during clustering analysis in typically developing children.

The presence of an increase in switching with age indicated an enhancement in the strategic retrieval process and development of endogenous flexibility with age, as reported by Snyder and Munakata (2010). In contrast, Sauzeon et al. (2004) reported a decrease in the number of switches with age. This discrepancy in the findings could be attributed to the differences in scoring employed. While Sauzeon et al. related their results on ratio scores, the present study focused on the obtained raw scores. Consideration of raw scores in the current study is supported by research (Kave et al., 2008; Troyer, 2000) documenting that raw scores provided greater information on the number of times a participant can generate a new cluster of response.

Types of categorization: The present study also explored the type of categorization employed by the participants during semantic fluency tasks. The categorization process during semantic fluency tasks was based on taxonomic (words sharing similar properties) and contextual (words sharing same context/schema/theme) relationships. In terms of the *food* category, children of all age groups generated words that 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 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 contextual categories. The most common exemplars of the retrieved food category were the '*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 was greater with an 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 a '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 the 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 color similarity (naming green color vegetables, red color 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 the *food* category as in the current study has been reported in the literature (Luciarello et al., 1992; Nash & Snowling, 2008; Nguyen & Murphy, 2003).

For the *vehicle* category, as in one study (Chan & Poon, 1999), there were no 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 learned in school textbooks, read in storybooks or seen on television.

Overall, the findings of the current study revealed developmentally related differences in semantic organization dependent on the semantic knowledge. An increase in productivity and clustering-switching with age was recorded, 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 semantic fluency tasks. The findings of this study emanating from typically developing children could contribute to providing data for future studies on profiling the deviation of semantic fluency output among childhood disorders.

Effect of Gender on Semantic Fluency performance

In the present study, no clinically significant influence of gender was found in both the quantitative measures of productivity and the qualitative measures of clustering and switching in children. Similar findings have been reported in the literature in children (Sauzeon et al., 2004; Tallberg et al., 2011) as well as adults (Chan & Poon, 1999; Tombaugh, Kozak, & Rees, 1999).

Comparison of individual mean scores indicated that on the task of *food* fluency, females had a higher score in group V. This is substantiated in the literature (Capitani et al., 1999), with a male advantage for the *tools* category and female advantage for the *fruits* category. This gender difference was attributed to differences in exposure and experience rate to the subcategory.

Overall, the findings of the present study have enhanced evidence of the lack of statistically significant gender influences on the strategic retrieval mechanism in children. It is hypothesized that similar processing strategies on the semantic fluency tasks occur for both boys and girls. It could also be hypothesized that the differences between genders would be more prominent in adulthood rather than childhood due to the variation in life experiences obtained with increased environmental exposure.

Effect of Task on Semantic Fluency performance

Although the majority of researchers investigating semantic fluency provided combined scores for all the tasks employed (Bayles et al., 1989; Huff et al., 1986; Kave et al., 2008; Tallberg et al., 2011), in deviation the present study focused on exploring the potential task effects on semantic fluency performance. On semantic fluency, the task advantage was noted to be higher for *food* fluency tasks that represented living categories, followed by *vehicle* fluency that represented the non-living or manmade category. This is further indicated by the Cohen's d effect size value, wherein *vehicle* fluency only showed a small to moderate effect size (. 2-. 5) for all the age groups as compared to other tasks.

The difference 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 was still higher than other category as it consisted of both living (e.g., *fruits, vegetables*) and man made items (e.g., *snack items, desserts*) with a greater proportion of perceptual features such as visual (color, shape, texture), flavour and tactile information. Various researchers have also provided evidence for category specific anatomical specialization (Goldberg, Perfetti, & Schneider, 2006; Mummery, Patterson, Hodges, & Wise, 1996; Vitali et al., 2005) for different tasks of semantic fluency in the brain.

Based on the present study findings on task effects, it is proposed that the living and non-living categories could serve as useful and familiar tasks for future studies in children. Further, owing 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 semantic fluency need to be addressed as a function of each task separately rather than as an average score for all the tasks together.

A developmental perspective on Semantic Fluency

The findings of the present study have clearly outlined 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 successful performance on semantic fluency tasks. In terms of organization, the structure of the word retrieval mechanism showed a continuous and linear developmental trend rather than a rapid or incremental change in children.

The categories generated in children were formed on the basis of thematic - taxonomic relationships. 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). This further indicated that human concepts are represented in a variety of forms in semantic memory. The word retrieval from the vast knowledge concept of the lexicon, therefore, requires meticulous organization and planning skills. With respect to word retrieval strategy employed, greater demand on the semantic structure during semantic fluency was also noted.

The major strength of the present study is in its study group and design. This study on the developmental trend of a large data set of 1015 Malayalam speaking children from five to fifteen years is the first of its kind in the Indian context. The research design employed a simple, brief and easy to administer task of semantic fluency, with a high level of suitability for children with the advantage of task administration being relatively quick (one minute per task) and not requiring any sophisticated equipment (except for a stop watch and pen-paper). In terms of analysis, unlike in the majority of studies in the literature, the research design focused on exploring not only the quantitative aspects of how many words children were able to retrieve for various task variations but also emphasized the role of qualitative analysis of how word retrieval occurred. The stratification based on five groups has made the task a popular test for school and hospital based clinical research studies, thereby increasing the utility of verbal fluency indices and generalization of outcomes. The findings of the study widen the scope of semantic fluency use in clinical and experimental research in terms of understanding the pattern of the word retrieval mechanism in children.

One major limitation of the current study was its non-inclusion of any specific tests such as verbal IQ, working memory capacity, speed or reading abilities to evaluate cognitive mechanism underlying semantic fluency performance. With respect to the task selection employed in the present study, the category selection was made based on existing literature evidence rather than based on an in-depth frequency analysis of difficulty. The study outcome of grade and gender adjusted scores, therefore, needs to be treated with caution while interpreting data using other categories.

To summarize, the present study on verbal fluency using both qualitative and quantitative analyses has indicated that semantic fluency as a task has great potential within the developmental context. In the wake of the limited knowledge of semantic fluency performance in typically developing children, the findings of the present study would be of relevance in understanding the developmental changes occurring in typically developing children and the mechanism of word retrieval during the semantic fluency task which is highly language, culture and task based. In order to increase the usefulness of a semantic fluency index in clinical practice in diagnosis and as a therapeutic tool, further research is warranted for each language, culture, and population across various semantic fluency measures.

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