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PHONEMIC FLUENCY IN TYPICALLY DEVELOPING CHILDREN: THE SOCIOECONOMIC PERSPECTIVE

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Abstract

This study investigates phonemic fluency among students from different socioeconomic backgrounds. This task serves to gauge one's lexicon comprehension and their ability to recall words from memory. Sixty Punjabi-speaking students aged 8-9, split into high (HSES) and low (LSES) socioeconomic groups, participated. Each group had 30 students who were asked to generate as many words as possible within 60 seconds for the letters /p/, /n/, and /k/. Results showed that students from higher socioeconomic backgrounds performed better, with the highest scores for the letter /k/, followed by /p/ and then /n/. No significant gender differences were found. The study concludes that these reference values can be useful for language and neuropsychological assessments of typically developing children.

Keywords*: Phonemic fluency, Letter verbal fluency, High socioeconomic status, Low socioeconomic status, Verbal fluency*

Introduction

Phonemic fluency, also known as letter verbal fluency, lexical fluency, initial letter fluency, or form-based fluency, is a commonly used measure of verbal fluency and word retrieval (Estevas et al., 2015). In this task, individuals are required to generate as many words as possible that begin with a specific letter within a limited time frame of 60 seconds (Cavaco et al., 2013). The phonemic task assesses various cognitive and linguistic functions, including spontaneous or rapid word naming, vocabulary knowledge, self-control, attention, processing

speed, planning, working memory, organizational skills, and cognitive flexibility (Diamond et al., 2013; Peterson et al., 2000; Biesbroek et al., 2015). This assessment is applicable to individuals aged four years and older, as it necessitates a fundamental understanding of alphabets, letters, and their relationship in creating new words (Reis & Castro- Caldas, 1997; da Silva et al., 2004).

Impairments in phonemic fluency are associated with frontal lobe lesions (Baldo et al., 2006), with a predominant involvement of the left hemisphere (Billingsley et al., 2004) and subcortical brain structures such as the basal ganglia (Thamas et al., 2012) in this task. Conditions like Huntington's disease (Larsson et al., 2008), aphasia (Shah et al., 2018), and multiple sclerosis (Friend et al, 1999)) often result in reduced phonemic fluency. While numerous studies have explored the impact of socioeconomic status on memory (Leonard et al., 2015) and cognitive function (Ducan & Katherine, 2013), its specific influence on phonemic fluency remains uncertain. This study aims to investigate how socioeconomic background affects letter verbal fluency in typically developing Punjabi-speaking children, considering gender and various letters as factors.

Materials and method

The study involved two distinct groups: one with a High Socio-economic status (HSES) and the other with a Low Socio-economic Status (LSES), comprising a total of 60 typically developing children. Each group consisted of 30 children within the age range of 8 to 9 years. All participants were native Punjabi speakers, and their socioeconomic status was determined using the National Institute for the Mentally Handicapped (N.I.M.H) SES scale. Those participants who reported cognitive or neurological issues, persistent middle ear problems, visual impairments, speech and language difficulties, learning challenges, or any other related problems were excluded from the study. Inclusion and exclusion criteria were assessed through interviews with participants and teachers, observations, and a review of various school documents.

During the study, participants were instructed to verbally produce as many words as possible within a 60-second timeframe using the letters /p/, /n/, and /k/. Prior to collecting actual data, a trial session was conducted. Each correctly articulated word was scored as one point, while words that were nonsensical, mispronounced, or repeated were given a score of zero.

Statistical analysis was conducted using STATA/SE version 14.2 (StataCorp LP, College Station, TX, USA). Categorical variables were characterized by indicating their frequency

and percentage, while continuous variables were represented by their mean (standard deviation) and median (range). To compare phonemic abilities between the two groups, t-test was employed. In all statistical analyses, a p-value less than 0.05 was considered statistically significant.

Results

Children from both categories, namely the HSES students (with a sample size of 30) and the LSES students (also with a sample size of 30), participated in a verbal fluency task. An analysis of this task was conducted with respect to gender and different phonemes. Table 1 displays the mean (standard deviation) scores for both groups. When comparing between categories, it was observed that scores for the phoneme /k/ were higher than those for /n/, followed by /p/, for both groups.

Table 1

Qualitative variables of HSES & LSES children has shown across the task on phonemic fluency task

	/p/		**/n/**		**/k/**		**Total**	
	HSES (n=30)	LSES (n=30)	HSES (n=30)	LSES (n=30)	HSES (n=30)	LSES (n=30)	HSES (n=30)	LSES (n=30)
Mean	5.33	3.7	5.5	3.86	6	4.8	16.8	12.36
SD	1.98	1.87	2.51	1.99	2.75	2.32	6.01	5.27
Median	5	3	5	3	3	4	16.5	12
Min	2	1	1	1	3	1	8	4
Max	10	8	10	10	14	10	33	23

In the Low Socio-economic Status (LSES) group, there were 16 males (53.33%) and 14 females (46.67%) who participated. Table 2 presents the mean (standard deviation) scores for the letters categorized by gender. No significant differences were found between the two genders for any of the three letters (/p/: $p = 0.5651$, /n/: $p = 0.2217$, /k/: $p = 0.5693$) or for the overall phonemic fluency task scores ($p = 0.3714$). It was also observed that the maximum number of words generated in one minute for the /p/ phoneme was 8, while the minimum was 1. For both the /n/ and /k/ phonemes, the maximum word span was 10 and the minimum word span for was 1, as indicated in Table 1.

Table 2

Qualitative measures of LSES group across the gender on phonemic fluency task

Low socio-economic status (LSES) group								
	/p/		/n/		/k/		Total	
	M (n=16) (53.33%)	F (n=14) (46.67%)	M (n=16) (53.33%)	F (n=14) (46.67%)	M (n=16) (53.33%)	F (n=14) (46.67%)	M (n=16) (53.33%)	F (n=14) (46.67%)
Mean	3.93	3.42	4.25	3.42	5	4.57	13.18	11.42
SD	2.71	2.25	1.84	2.13	2.52	2.13	5.44	5.10
Median	5	5	4.5	3	5	4	12.5	10.5
Min	1	2	1	1	1	2	4	5
Max	11	9	8	7	10	10	23	23

In the High Socio-economic Status (HSES) group, there were 19 males (63.33%) and 11 females (36.67%) who participated. The results are presented in Table 3. No significant differences were observed between the two genders for any of the three letters (/p/: $p = 0.6161$, /n/: $p = 0.8454$, /k/: $p = 0.3491$) or for the total score across all three phonemes ($p = 0.8460$). Regarding word span, the highest score achieved for the /p/ phoneme was 10, while the lowest was 2. For the /n/ and /k/ phonemes, the maximum word span was 10 and 14, respectively, with a minimum word span of 1 and 3 respectively, as indicated in Table 1.

Table 3

Qualitative variables of correct words for HSES group across the gender on phonemic fluency task

High socio-economic status (HSES)								
	/p/		/n/		/k/		Total	
	M (n=19) (63.33%)	F (n=11) (36.67%)	M (n=19) (63.33%)	F (n=11) (36.67%)	M (n=19) (63.33%)	F (n=11) (36.67%)	M (n=19) (63.33%)	F (n=11) (36.67%)
Mean	5.10	5.72	5.47	5.54	6.42	5.27	17	16.54
SD	1.52	2.64	2.71	2.25	3.04	2.10	6.69	4.90
Median	5	5	5	5	6	5	16	17
Min	3	2	1	2	3	3	8	9
Max	8	10	11	9	14	9	33	27

Table 1 illustrates the comparison of performance in the letter verbal fluency task between children from High Socio-economic Status (HSES) and Low Socio-economic Status (LSES) backgrounds, considering various letters. As displayed in Table 1, HSES children

outperformed their LSES counterparts (p = 0.0034) across all three verbal fluency tasks. However, significant differences were specifically observed for the /p/ and /n/ phonemes (p = 0.0015 and p = 0.0125, respectively), while there was no significant difference for the /k/ phoneme (p = 0.0925). The overall task scores also exhibited a significant difference (p = 0.0034). The overall mean (standard deviation) scores for the HSES and LSES groups were 16.8 (6.01) and 12.36 (5.27) respectively.

Discussion

The aim of this study was to investigate and compare the performance of typically developing Punjabi-speaking children aged 8-9 years from different socioeconomic backgrounds on a letter verbal fluency task. This task involves retrieving words based on their phonemic characteristics, requiring individuals to maintain focus to avoid errors, generate new words, and refrain from repeating previous responses.

The literature demonstrates variability in the phonemic fluency task, especially in the choice of sounds used for the task execution. The most commonly used version involves the sounds /f/, /a/, and /s (Barry et al., 2008; Opasso et al., 2016; Machado et al., 2009), as these sounds are produced at the front of the mouth and are relatively easy to articulate. Later, two additional sets of words were introduced: /c/, /f/, /l/, and /p/, /r/, /w/ (Benton et al., 1994). Barry et al. (2008) discussed Lacy's research and noted that /c/, /f/, /p/, /a/, /s/ are easy letters to produce, while /l/ and /r/ are considered difficult. In our study, the letter fluency task began with /p/, /n/, and /k/. The choice of these sounds was based on their phonetic characteristics: /p/ is a bilabial sound produced at the front of the mouth, /n/ is produced mid-dorsally, and /k/ is a velar sound produced at the back of the mouth. These three sounds cover the mechanisms for most consonant production. Our study concluded that the highest average scores were observed for the /k/ phoneme, followed by /p/ and /n/ for children aged 8-9 years. This observation aligns with the fact that /k/ occurs more frequently than /p/ and /n/ in Malayalam (Prema & Manu, 2001). Additionally, according to Ghatage (1964), the frequency of /p/, /n/, and /k/ in Punjabi language is 14,167, 2,537, and 36,131, respectively, which clearly indicates that /k/ has a higher frequency than /p/ and is followed by /n/ in Punjabi language.

When comparing the outcomes based on gender within the Low Socio-economic Status (LSES) and High Socio-economic Status (HSES) groups, no clinically significant differences were observed. This finding aligns with previous studies that have consistently shown similar results across different age groups in phonemic fluency tasks (Harrison et al., 2000; Leite et

al., 2016; Koren et al., 2005). In the present study, the mean (SD) scores for HSES children for /p/, /n/, and /k/ were 5.10 (1.52), 5.47 (2.71), and 6.42 (3.04) for males and 5.72 (2.64), 5.54 (2.25), and 5.27 (2.10) for females, respectively, as shown in Table 2. For the LSES group, the mean (SD) scores for /p/, /n/, and /k/ were 3.93 (2.08), 4.25 (1.84), and 5 (2.52) for males and 3.42 (1.65), 3.42 (2.13), and 4.57 (2.13) for females, respectively, as shown in Table 3. The literature reveals that in 3rd to 4th grade children, the mean (SD) scores for /p/ and /k/ for males are 6.19 (2.58) and 6.56 (2.75), respectively, while for females, the scores are 6.80 (2.57) and 7.28 (2.68) (John et al., 2016). A study conducted on 5-14years of Malayalam speaking children, among ten groups mean (SD) values for 8-9 years of male and female were 7.60 (1.07) and 9.57(0.82) respectively (Lohithakshan, & Nataraja, 2019). In contrast, in a study on a Portuguese population aged 18-29 years, scores for the /p/ phoneme were 10.7 (4.5) for males and 11.0 (4.5) for females (Cavaco et al., 2013). These results suggest that performance tends to improve with age.

Comparing children from low and high socioeconomic strata, our study found that the mean scores for all three phonemes were higher in the HSES group compared to the LSES group. This is consistent with previous research (Farah et al., 2006; Evans & Schamberg, 2009; sarsour et al., 2011), which has consistently shown that children from LSES backgrounds tend to perform worse on working memory tasks compared to their HSES peers. This difference can be attributed to the educational level of parents, which influences children's vocabulary development. The acquisition of language in children is significantly affected by the language environment and the qualitative differences in parental language input, which vary significantly across different socioeconomic populations (Harrison et al., 2000; Rowe, 2012; Hart & Risley, 1996). However, there have been studies that found no significant differences associated with socioeconomic status in the performance of executive function, working memory, oral and written language (Engel et al., 2008; Weibe et al., 2008). Verbal fluency tasks assess cognitive functions such as attention, mental flexibility, and response inhibition (Reis & Castro- Caldas, 1997; Opasso et al., 2016). Literature suggests that socio-economic environment can adversely affect memory, language, and executive function (Nobel at al., 2006), particularly in young children from LSES backgrounds (Hurks et al., 2006).

Conclusion

This study primarily investigates the influence of socioeconomic status (SES) on phonemic fluency performance. The study's findings indicate that children from High Socio-economic Status (HSES) backgrounds exhibited better recall of units of information for the phonemes /p/ and /n/ when compared to the Low Socio-economic Status (LSES) group. However, no significant difference was observed for the /k/ phoneme. The overall mean (standard deviation) phonemic scores for HSES and LSES were 16.8 (6.01) and 12.36 (5.27), respectively. This suggests that SES should be taken into account when assessing letter fluency tasks. Nonetheless, it is important to acknowledge certain limitations of the study. The sample size was restricted to 30 children in each group, and factors such as syllable length and age were not considered. Additionally, the study did not include a linguistic evaluation in terms of vocabulary, mean length of utterance, and grammatical development. Moreover, there is a need for the development of language-specific tools and learning measures tailored to different socioeconomic strata.

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