IS NONWORD REPETITION A TRUE CLINICAL MARKER OF SLI?

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Abstract

Background: Specific Language Impairment (SLI) is a developmental condition where despite typical general intellectual abilities language learning is effortful for a child. Children with SLI show substantial difficulty repeating nonsense words such as "frescovent" compared to children with Normal Language (CNL) skills. Poor Non Word Repetition (NWR) has been reported as a significant clinical marker of SLI. However, few studies have reported contradictory results.

Aims and Method: The present study aimed at establishing norms as well as identifying the feature among NWR performance that could serve as a clinical marker of SLI. 100 Children ages ranging from 7-13 years were taken and divided into two groups, each group comprising of 50 children for statistical convenience (7-10 yrs and 10-13yrs). Norms were developed for NWR performance at these age range and performance of SLI children (6 children in 7-13 years age range). CNL and SLI were analyzed for percentage on syllables repeated correctly, percentage of vowels and consonants correct, regularizations, reversals, additions, repetitions, substitutions, omission errors and quality of errors.
Results and Discussion: Mean and SD scores for the NWR task for the age group 7-10 and 11-13 yrs were computed. There was a reduction in percentage correct phonemes as an effect of nonword length increment. The results are discussed with reference to decrement in scores for NWR with increase in syllable length that was noted in typically developing children. Discussion extended to cognitive linguistic nature of NWR as clinical marker of SLI.

Key words*: Non word, Specific Language Impairment*

Specific Language Impairment (SLI) is a developmental condition in which a child fails to develop language like a typical child despite normal general intellectual abilities, adequate exposure to language, and in the absence of hearing impairment (Leonard, 1998). Children with SLI manifest linguistic deficits such as phonological, morphological and syntactic errors along with processing deficits (Vasanthi & Prema, 2001). Labeling children with SLI is seldom by strict diagnostic test rather by identifying linguistic or processing markers those are typical of them. Processing markers, particularly using tasks such as the Non-word repetition (NWR) appear to have the potential for indicating SLI risk as NWR task taps both processing as well as expressive dimension because the child has to perceive, store and retrieve (processing domain) the non-word before repeating it (expressive domain) (Prema, Prasitha, Savitha, Purushothaman, Chitra, & Balaji, 2010). Further study that correlated NWR accuracy with receptive and expressive language by Edwards and Lahey (1998) found strong correlation between non-word repetition accuracy and expressive language concluded that the problem lay with the nature of phonological representations in working memory and not with the ability to hold information in phonological working memory. Recent evidences have genotyped PSTM to chromosome 16q which is a quantitative trait locus for NWR (SLI Consortium, 2004).

Poor Non Word Repetition (NWR) has been reported as a significant clinical marker of SLI. Children with SLI perform poorly on repeating non words such as "frescovent" compared to typically developing children (Bishop, North, & Donlan1996; Edwards & Lahey, 1998; Ellis Weismer, Tombli, Zhang, Buckwalter, Chynoweth, & Jones 2000; Gathercole & Baddeley, 1990; Montgomery, 1995b). A nonword consists of a stimulus within the structural rules of a natural language, i.e., it can be read, written and repeated but has no conceptual meaning or semantic value in the current lexicon of that language (Santos & Bueno, 2003). Therefore, NWR task is argued to be a relatively pure measure of phonological short-term memory (PSTM) (Gathercole and Baddeley 1989). PSTM aids in storing verbal input temporarily, allows other cognitive tasks such as verbal comprehension, transfers phonological information such as word form representations to long-term memory (Montgomery, 2003). Dollaghan and Campbell (1998) stated as result of their study that NWR task differentiates children with SLI and typically developing children (NL) with high degree of

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accuracy. Ellis Weismer, Tomblin, Zhang, Buckwalter, Chynoweth, & Jones (2000) reported that children with language impairment as well as children who underwent language intervention performed poorly on NWR task. Authors of the study also considered NWR task as culturally unbiased task of language processing which provides useful index to indicate language disorder. Predictive ability of SLI using NWR was evaluated by Conti-Ramsden and Hesketh, (2003) using Children's Test of Nonword Repetition (CNRep by Gathercole & Baddeley, 1996) and it was found to be 81.3%, second only to past tense marker. The study identified that children who were at risk of SLI fell in lower quarter of normal distribution in NWR (performance lower than 25th centile).

Error type analysis of NWR responses of SLI children yielded prototype findings those differentiate children with SLI from children with NL. Edwards and Lahey, (1998), Marton and Schwartz, (2003), and Montgomery, (1995) reported on types of errors in NWR task among school aged SLI and control children. Phoneme substitution was more frequent than phoneme omissions for both groups, and addition of phoneme was infrequent feature. The SLI groups produced significantly more phoneme omission than the controls. The error analysis results showed that even though the frequencies of errors between the SLI and non-SLI groups differed, the error pattern was similar across two groups. Typically developing children and children with SLI did not show difference in number of syllables in repetition on studies that examined prosodic contours of non-words repetitions (Dollaghan, Biber, & Campbell, 1995, Edwards & Lahey, 1998, Roy & Chiat, 2004, Sahlén, Reuterskiöld-Wagner, Nettelbladt & Radeborg, 1999).

Santos, Bueno, and Gathercole, (2006) used The Brazilian Children's Test of Pseudoword Repetition (BCPR), a Portuguese language version of the CNRep (Gathercole & Baddeley, 1996) since word patterns in Portuguese differ from those in the English language in terms of stress and the number of syllables. Authors of the study found substitution as a dominant error type and substitutions observed more at the end of the stimuli, after the stress. They also reported of more errors in lengthy words compared to short words. In other words, the BCPR error analysis reveals that although school learning increases the efficiency of phonological loop system, its capacity is relatively constant during development.

Length of the nonword is a major factor that can influence the responses of children with NL and SLI in a NWR task. Scheer-Cohen and Evans, (in press) conducted an extensive study which included 77 children with SLI and 130 children with NL age ranging from 5-15 years to compare the error types of SLI with NL. Study used varying syllable lengths from 1-4 and revealed that children with SLI produced significantly more frequency of phoneme, consonant and vowel errors compared to children with NL at all ages with except of children below 7 years. Archibald & Gathercole, (2006b) conducted a study including children with SLI and controls from age range of 7-11 yrs, and reported that the children with SLI repeated the lengthier nonwords containing consonant clusters significantly less accurately than the control groups. They concluded the study by attributing the less accurate performance to compromised ability in verbal short-term memory, lexical knowledge, and output processes of children with SLI.

Differentiation of characteristics of children with SLI with NL group is not the sole purpose served by NWR tasks. Literature also demonstrates that detail error analysis of NWR performance expands its dicriminability between developmental disorders, such as those manifested as a result of similar cognitive underperformance. Bree, Rispens, and Gerrits, (2007) investigated whether poor NWR underlies SLI and children at risk for dyslexia. The results showed that children with SLI and the (at-risk of) dyslexia groups performed more poorly than the control group children. Preschool SLI children scored significantly below the mean of the preschool control group, indicating that poor non-word repetition performance is a clinical marker of SLI. The study also showed that almost half of the at-risk group was poor performers, which was expected on the basis of the familial risk factor of the at-risk group. The results showed that a NWR deficit early in life proven substantially for both dyslexia and SLI.

Evidence from error analysis of children with SLI revealed that children with SLI tend to retain the number of syllables in the nonword repetition task. However, they are prone to interchange the syllables or distort them, which are explained using the theory of "segment -to-frame association" (Biran & Friedmann, 2004; Levelt, 1992). The metrical frame includes the number of syllables and stress pattern of the word, and the segment portion consists of information on phonemes (consonants, vowels and clusters). Marton & Schwartz, (2003) found from their study of NWR performance of SLI that 80%

errors produced by children with SLI are segmental errors such as consonant and vowel substitution with no word structure change. According to this theory of phonological encoding in word retrieval, the segments and the structural frame of a word are processed separately. Study by Levelt, Roelofs, and Meyer, (1999) also supports that the segmental and metrical information are represented separately and accessed in parallel, thus leading to segmental errors predominantly.

Studies that address NWR as a clinical marker of SLI predominantly come from English. Though, studies conducted in Spanish and Swedish yielded support to poor NWR as clinical marker, the question of difficulties with prosodic structures which could underpin problems with NWR was raised. The Cantonese yielded contradictory results compared to English. Stokes, Wong, Fletcher, & Leonard (2006) as their result of study in Cantonese language reported that children with SLI did not score poorer that children with NL on NWR tasks. They found that although NWR is a sensitive test in Cantonese with older children scoring higher than the younger children, there is no significant difference in performance between children with SLI and their typically developing age-matched (TDAM) peers.

Prema, Prasitha, Savitha, Purushothaman, Chitra, & Balaji (2010) studied the relevance of NWR for screening children with SLI who are native speakers of Kannada language (Dravidian language spoken in Karnataka, India). Comparative design was employed for the study and the participants were matched pairs of SLI and NL children. A 14 year old Kannada speaking adolescent diagnosed as SLI who was matched for age, gender, language and socio economic status with normal child was selected. He was given fifteen non-words from a set of non-words (Prema, 1998) and performance was transcribed verbatim. The authors analyzed the transcribed samples for accuracy of response and the nature of incorrect responses. The results suggested that there was 93.3% accuracy in the repetition of non words by typically developing child compared to 46.6% for the participant with SLI. The error analysis included the analysis of the phonological processes and an examination of the productive error patterns in the children's responses. Error patterns such as additions, devoicing, omission, and liquid gliding were observed consistently in the non-word repetition of the SLI participant. One significant observation reported by the author was that, all the non-words that had liquids were incorrectly produced. Moreover backing a phonological process that is generally not observed in normal children was also predominant.

Shylaja (2010) compared 3-7 year old children with SLI and typically developing children on NWR task and found that children with SLI performed significantly poorer than NL group. Her study also revealed no relation between NWR performance and vocabulary knowledge. Substitution errors were predominant in error analysis of NWR utterances followed by deletion and addition errors. Studies from Kannada reveal that children with SLI produced significantly more errors that children with NL. They have also highlighted of unusual phonological processing in children with SLI. Shylaja, Amulya and Swapna, (In press) studied 8-12 year old children on 2-5 syllable nonword performance. They compared NWR performance of 15 children specific learning disability (SLD) with children with NL. They reported that SLD children found 4 and 5 syllable length to be difficult, where as children with NL found only 5 syllables difficult to repeat. It was found that the children with SLD had significantly higher percentage of vowel and consonant errors specifically syllable substitution and omissions compared to the children with NL. To summarize, types of errors in NWR performance of children with SLI in Kannada were closer to those described for children who are native speakers of English with substitution errors dominating deletion and addition errors.

Need and specific aims of the study

Studies from both English and Kannada show the significance of having NWR task as a tool in diagnostic battery of SLI syndrome. All the studies enunciating the significance of NWR as clinical marker of SLI used syllable lengths not exceeding 5. The need exist to enquire the significance of lengthier nonwords (until 8 syllable non-words) as clinical marker of SLI. The importance of having a standardized NWR tool in diagnosing SLI adolescents has been overlooked. So the present study aims to standardize the 2-8 syllable nonwords in Kannada. Swapna and Shylaja, (In press) standardized a 2-5 syllable length nonwords for 3-7 years population. Moreover, the significance of NWR as a clinical marker of children with SLI in adolescents is yet to be studied. A qualitative analysis of errors is needed to comment on specific types of error pattern exhibited by children with SLI. So the present study aims to

1. *Develop* mean scores for NWR task of 2-8 syllable length from age 7-13 yrs and report the performance as function of error types.

2. Investigate whether the frequency or type of errors that differentiate children with SLI from typically developing children (NL).
3. Qualitatively analysis of features of children with SLI on NWR task.

Method

The study had 98 typically developing children along with 6 children with SLI. Children for normal group were selected from 5 different schools across Mysore city. 50 participants age ranged from 7 to 10 years (group I) and 48 participant's age ranged from 11-13 years (group II) were randomly selected for the study. The participants in this group did not show any sensory, motor or cognitive deficits as per reports from class teachers. 6 children (ranging from 7-13 years) who were diagnosed as having specific language impairment using Leonard's exclusion criteria at the All India institute on Speech and Hearing, Mysore were also selected for the study. Material: Non words ranging from 2-8 syllable length were selected as stimulus. Each syllable length consisted of 5 nonwords in it, forming a total of 35 nonwords. Non words were developed and by qualified speech language pathologists who were native speakers of Kannada considering the phonotactic rules of Kannada. Participants were given the stimulus through snug ear plugs using a laptop at around 70dBSPL in a silent environment. Responses were recorded using Olympus digital recorder WS-100 and analyzed.

Analysis of data: Recorded data were analyzed for

1. Percentage of correct responses – percentage of nonwords repeated precisely (number of nonword repeated precisely divided by 5 X 100)
2. Percentage of syllables correct – number of syllables repeated correctly divided by total number of syllables/100 (for e.g. the total number of syllable for 2 syllable nonwords is 10)
3. Percentages of consonants correct- number of consonants produce correctly divided by total number of consonants in a syllable length multiplied by hundred (E.g. Number of consonants produced correctly/25 for 5 syllable nonwords length X 100)
4. Percentage of vowels correct- number of vowels produce correctly divided by total number of vowels in a syllable length multiplied by hundred (E.g. Number of vowels produced correctly/30 for 6 syllable nonwords length X 100)
5. Accuracy of responses (it was rated in 5 point rating scale, 1 being least accurate and 5 being very accurate) .

Results and discussion

I. Objective 1: Standard scores for typically developing children on NWR task

Standard scores were developed for three measures of nonword repetition analysis. The data included percentage of syllable correct (SC %), percentage of accuracy of response (AOR %), percentage of correct responses (CR %), percentage of consonant correct (% CC) and percentage of vowel correct (%VC). Mixed Analysis of Variants (ANOVA) was done to calculate mean and SD scores for % SC, % AOR and % CR for the two groups (Group I: 7-10 years and Group II: 11-13years) across syllable lengths. Repeated measures of ANOVA were done to identify whether the reduction in score as the function of increase in syllable length is significant for each measure.

I. a. Percentage of Syllables correct (% SC)

Table 1. Mean and SD for percentage of syllables correct for two age groups.

7-10 years			11-13 years		
SC (%)	Mean	SD	SC (%)	Mean	SD
2	99.01	3.60	2	98.72	4.48
3	97.70	5.30	3	98.57	3.63
4	92.88	7.96	4	99.25	2.32
5	84.84	12.77	5	95.93	3.46
6	83.58	10.14	6	91.08	9.25
7	68.66	14.21	7	78.29	14.25
8	56.76	17.41	8	69.74	15.35

Table 1, shows the reducing pattern in the value from 2-8 syllables, the mean for 2 syllables are 99 % and for 8 syllables being 56 % for group I. The man value for 2 syllables is 98 and for 8 syllables are 69 for group II. The reducing in mean as the function of increasing syllable length pattern is uniform for both the age groups. The SD values for both the groups are narrowest for 2 syllable nonwords and the broadest for 8 syllable nonwords suggesting the increasing variability in

accuracy as syllable length increase. Both the age groups conformed to this pattern.

Repeated measures of ANOVA were done to see whether the reducing pattern in mean is significant between syllable lengths. The results of repeated measures of ANOVA for 7-10 years age group revealed that there is no significant difference between 2 and 3 syllable nonwords on this percentage of syllable correct. Likewise performance on 5 syllable nonwords was no significantly better than 6 syllable nonwords (See Table 3 for significance values).

The results of repeated measures of ANOVA for 11-13 years age group revealed that there was no significant difference between syllable lengths 2, 3, and 4 on percentage of syllable correct responses. However the rest of syllable nonwords were significantly different from each other, 8 syllable nonwords being the lowest (See Table 3 for significance values).

I. b. Percentage of Accuracy of response (%AOR) and Percentage of correct responses (%CR)

Accuracy of response values in Table II shows that mean value reducing from 2-8 syllables for both the age groups. The SD values are narrow for 2 syllable nonwords and the broadest for 8 syllable nonwords suggesting the increasing variability in accuracy as syllable length increases. Both the age group conformed to this pattern.

Repeated measures of ANOVA revealed no significant difference between 2 -3 and 5-6 syllable lengths on AOR in group I (7-10yrs). 4 syllable nonwords were significantly poorer than 3 and better than 5. Likewise 6, 7, and 8 syllable nonwords showed significantly poor performance compared to smaller length nonwords, 8 syllable being least accurate (See Table 3 for significance values).

Repeated measures of ANOVA in group II (11-13yrs) show that no significant difference between 2, 3, and 4 syllable length nonwords. Likewise 5 and 6 syllable nonwords also do not show significant difference among them. Accuracy of response of 8 syllable length was significantly poorer than 7 syllable nonwords. However the decreasing accuracy value was observed (See Table 3 for significance values).

Table 2: *Mean and Standard Deviation (SD) values for Percentage of accuracy of response (% AOR) and percentage of correct response (% CR) for two age groups.*

7-10 years						11-13 years					
AOR (%)	Mean	SD	CR (%)	Mean	SD	AOR	Mean	SD	CR (%)	Mean	SD
2	99.13	3.60	2	96.4	14.80	2	99.6	1.40	2	99.1	4.08
3	98.50	3.91	3	96.0	8.96	3	98.97	2.56	3	97.0	7.19
4	94.11	7.43	4	82.3	20.25	4	99.31	2.25	4	97.0	9.30
5	85.17	12.21	5	55.6	25.71	5	91.57	8.18	5	70.6	25.31
6	82.49	14.30	6	41.5	30.42	6	90.55	8.35	6	62.5	27.85
7	68.21	12.35	7	16.8	23.45	7	77.95	14.34	7	35.3	26.11
8	55.45	15.15	8	9.80	15.16	8	66.46	12.21	8	18.2	19.03

The mean values for both the groups on percentage of correct response show a consistent reduction pattern as the length of the syllables increase. However, the standard deviation of the correct responses in percentage is very high from syllable length 5 onwards. So, the consideration of number of correct responses for diagnosing should be cautioned. The repeated measures of ANOVA of group I showed that percentage of correct responses for 3 syllable nonwords were not significantly different from 2 syllable nonwords. Similarly 8 syllable nonwords were not significantly different than 7 syllables. However the decreasing pattern was noticed from 2-8 syllable nonwords (See Table 3 for significance values). The repeated measures of ANOVA of group II showed that percentage of correct responses for 4 syllable nonwords were not significantly different from 3 and 2 syllable nonwords. Likewise the performance on 6 syllable nonwords is not significantly poorer than 5 syllable nonwords (See Table 3 for significance values).

Table 3: *Significance values for all three parameters across groups*

%	G I	2>3	3>4	4>5	5>6	6>7	7>8
of		NS	.002	.001	NS	.000	.000
SC	G II	2>3	3>4	4>5	5>6	6>7	7>8
		NS	NS	.000	.001	.000	.000
%	G I	2>3	3>4	4>5	5>6	6>7	7>8
of AOR		NS	.004	.000	NS	.000	.000
	G II	2>3	3>4	4>5	5>6	6>7	7>8
		NS	NS	.000	NS	.000	.000
%	G I	2>3	3>4	4>5	5>6	6>7	7>8
of		NS	.000	.000	.055	.000	NS
CR	G II	2>3	3>4	4>5	5>6	6>7	7>8
		NS	NS	.000	NS	.000	.000

NS – Not significantly different, Values are significant at p= >.05 level of significance

In the present study the performance of nonword repetition reduced as function of nonword's length. As the length of the nonword increased from 2 till 8 syllables, the performance of all three measures (%SC, % AOR and % CR) reduced suggesting length of nonword as a major factor contributing to the performance. The reduction in scores as function of increase in length is not uncommon. The meta analysis study by Estes, Evans and Else-Quest (2007) considering four types of nonword repetition measures: (a) CNRep (Gathercole et al., 1994); (b) NRT (Dollaghan & Campbell, 1998); (c) lists using three- to four-syllable words (e.g., Edwards & Lahey, 1998; Kamhi & Catts, 1986); and (d) nonword sets designed by Montgomery and colleagues (e.g., Montgomery, 1995b, 2004) revealed that performance of participants degrade as length increases. Nonword repetition task developed by Shylaja (2010) and Standardization of Nonwords for 3-7 years (Swapna and Shylaja, in press) in Kannada also exhibited similar pattern. Results of this study enumerates that the performance deterioration is applicable even at lengthier nonwords (until 8 syllable used in this study).

The measures (% of syllable correct, % of accuracy of response and % of correct response) reveal that % of syllable correct is more reliable than the other two measures. The SD of % of correct response measure is too high as the length of syllable increase. This highly variable measure must be considered with caution when used to analyze nonwords performance for lengthier nonwords (i.e. from 5 and greater length). The application of percentage of accuracy of response too has to be taken with consideration since it is a subjective measure. The finding is consistent with the previous studies by Dollaghan & Campbell (1998) who suggested that the percentage of phonemes correctly repeated in NWR task should be considered instead of NWR accuracy for the validity enhancement of NWR task.

I. c. Correlation analysis

Table 4: *Correlation of % of vowels and consonants correct to % syllables correct (for combined age group)*

Syllable lengths	2	3	4	5	6	7	8
Vowel	0.75**	0.75**	0.66**	0.47**	0.77**	0.87**	0.91**
Consonant	0.75**	0.59*	0.73*	0.45**	0.50*	0.55*	0.71*

**- correlation value significant at <0.01 level of significance,
*-correlation value significant at <0.05 level of significance

A correlation analysis between percentages of syllable correct, percentage of consonant correct and percentage of vowel correct was done to identify the contribution of consonant and vowel errors reduction in percentage of syllable correct response. The analysis provided huge data and it was less conclusive. However, the general observation was that from syllable length 5 onwards vowel scores have contributed better to the % syllable correct score compared to consonant scores, suggesting the domination of consonant errors in lengthier syllables (from 5 to 8 syllable nonwords). The correlation values from syllable lengths 5 to 8 for consonants are negative suggesting that as the length increased the consonants percentage reduced. Thus, the consonants are negatively correlating with syllable lengths at higher syllable lengths. The results of present study is in consonance with study by Santos, Bueno, and Gathercole, (2006) who stated that consonant errors dominate vowel errors as the length of syllables increase and contributing to poor performance of lengthier nonwords.

Table 5: Mean and SD for substitution, deletion and addition error types for 7-13 years age group (combination of two groups).

Syllable length	Substitution		Deletion		Addition	
	Mean	SD	Mean	SD	Mean	SD
2	.61	2.40	0	0	0	0
3	.10	1.01	.10	1.01	.61	2.40
4	1.42	3.37	.60	1.94	.10	.50
5	4.43	4.32	1.27	2.33	.15	.70
6	3.43	5.53	1.20	2.36	.30	.81
7	19.23	7.74	4.39	3.52	4.14	3.07
8	28.18	6.82	9.70	4.24	4.63	5.85

I. d. Error analysis of typically developing children

Table 5, Shows that SD value for deletion and addition error types was too high, and needs to be considered while comparing and concluding data. Over all analysis revealed that substitution errors were significantly higher than deletion and addition errors for all syllable lengths from 2-8. Deletion errors were significantly higher than addition errors for syllable lengths 6, 7, and 8. Deletion errors were higher for syllable lengths 2, 3, 4 and 5 compared to addition errors, but they were not statistically significant. Results from previous studies also conformed to this pattern of substitution error dominating the deletion and addition errors.

Santos, Bueno, and Gathercole, (2006) also reported the same effect and they stated that Substitution errors are highest amongst the error types followed by deletion and addition errors. The frequency of all the error types increases as function of nonword length. Findings from study by Shylaja (2010) also were in consistent with results of the present study. Studies examined performance of school aged typically developing children and children with SLI revealed that the frequency of phoneme substitution was more than phoneme omissions for both the groups, but addition errors were infrequent (Edwards & Lahey, 1998; Marton & Schwartz, 2003; Montgomery, 1995)

II. Objective 2: Frequency and type of errors that differentiates children with SLI from children with NL.

Scores on error analysis for NWR performance of children with NL and SLI were compared to identify error types those differentiate children with SLI from NL.

II. a. Comparison between 7-10 years age group.

Table 6: Comparison of type of errors between NL and SLI group 7-10 yrs group

Length	Substitution		Reversals		Addition		Deletion		Regularization	
	NL	SLI	NL	SLI	NL	SLI	NL	SLI	NL	SLI
2	3	6.6	0	0	0	0	0	0	4	3
3	3.3	13.3	1.3	0	0	0	0	1	0	0
4	7	16.5	1	1.3	0	5	0	0	4	0
5	17	28	2	0	1	1	7.6	13.3	5	0
6	23	21	1	0	1	1	17.3	23.3	3	0
7	27	23.8	2	0	1	0	18	29.5	11	0
8	42	42	4.6	0	1.6	1.6	23	30.8	7.2	6.6

Table 6, show that SLI children from 7-10 years produce 50 % (approx) more substitution errors than children with NL from the same age group. This effect was observed only till 5 syllable length and the effect is negligible for 6, 7, and 8 syllable lengths. Length of syllables exhibits a pattern in deletion of syllables. There is a negligible deletion error until 4 syllable nonwords. The SLI group exhibited greater omission of syllables than children with NL in 5, 6, 7 and 8 syllable nonwords. Children with SLI did not differ from children with NL on reversal, addition and regularization errors.

Table 7, shows the comparison of type of errors between there is no consistent pattern in data of children with SLI and typically developing children in error analysis from age 10-13years. Questioning the validity of NWR task beyond 10 years should be dealt with caution since the study included only three participants in that age range and prevalence of NWR errors in SLI is not hundred percent (See meta-analysis by Estes, Evans and Else-Quest, 2007).

Table 7: Comparison of type of errors between NL and SLI group 11-13 yrs group.

Length	Substitution		Reversals		Addition		Deletion		Regularization	
	NL	SLI	NL	SLI	NL	SLI	NL	SLI	NL	SLI
2	0	0	0	0	0	0	0	0	1	0
3	1	2	1	0	0	0	0	0	0	0
4	1	5	1	0	0	0	1	0	4	3
5	6	6.6	3	2	0	1.3	9	1.3	3	0
6	20	18.6	1	0	0	1.1	14.6	12.2	5	3
7	23.3	26	2	1	1	0	19	15.9	9	8.3
8	37.3	39	2	1	4	8.3	21	23	8	3

To summarize the comparison of errors between children with SLI and NL, it is evident that children with SLI produce same quality of errors as children with NL, however the frequency is high. (Edwards & Lahey, 1998; Marton & Schwartz, 2003; Montgomery, 1995) also reported the similar findings. They also added that Children with SLI produce more substitution errors compared to deletion and addition errors which are in consistent with present study results.

Reversals and lexicalization errors are not significant in children with SLI in the present study. Similar findings were reported in the past where Lexicalization or Regularization errors were reported in normal (Dollaghan, Biber, & Campbell, 1995; Ellis Weismer & Hesketh, 1996) as well as SLI children (Edwards & Lahey 1998; Marshall, Harris & Van der Lely 2003). So we conclude the infrequent lexicalization errors observed in our SLI participants as non-significant marker of SLI.

Table 8: Comparison of SLI group with NL on Substitution, Deletion and Addition type of errors.

Syl length	2			3			4			5			6			7			8		
Error type	S	D	A	S	D	A	S	D	A	S	D	A	S	D	A	S	D	A	S	D	A
Significantly SLI <NL	y	n	n	y	n	n	y	n	n	y	y	y	y	y	y	y	y	y	n	y	y

y- yes, n- no

Table 8, Shows those substitution errors of children with SLI were significantly higher than substitution errors produced by children with NL for syllable lengths 2, 3, and 4. From 5 syllable length onwards children with SLI produced significantly higher errors on all three error types, except that substitution errors at 8 syllable length was not significantly higher than normal group. It should be observed that even for lengthier nonwords SLI children produce significantly more errors compared to typically developing children, suggesting clinical marking ability of NWR even at 8 syllable levels.

III. Objective 3: Qualitative analysis of errors in children with SLI

Assimilation process is the major error type noticed in two of the SLI participants of the study aged eight and nine years respectively. The second prominent feature observed in overall NWR responses of children with SLI is intactness of word structure. See Table 9, for description of NWR of SLI children.

Table 9, shows the data from two children with SLI aged 8 and 9 years. The assimilation error types and intactness of word frame is noticed. All the assimilation errors are anticipatory (effect of following sound on preceding sound) where the initial sounds are influenced by following sounds.

Table 9*: Describes the errors noticed in 2 of SLI participants*

Response for Stimuli	**Assimilation errors**
p*ikasha* for thi/**p**a:/tcha	1st syllable replaced with 2nd syllable
d*hudhavova* for nu/**d**da/**d**ho/va	1st syllable replaced with 2nd syllable
d*hinnagetche* for gi/nna:/**d**he/tche	1st syllable replaced with 3rd syllable
k*udukutha* for dhu/vu/du/**k**o	1st syllable replaced with 4th syllable
vuga..a..u.thi * for ju/tha/**v**a/dhu/**g**i	1st and 2nd syllables replaced with 3rd and 5th syllables respectively

*dotted utterances were distorted

The assimilation error types and intactness of word frame is noticed. All the assimilation errors are anticipatory (effect of following sound on preceding sound) where the initial sounds are influenced by following sounds. The data show no perseveratory assimilation errors and it was nonexistent in the data from SLI children who participated in the study. Theory of "segment -to-frame association" (Biran & Friedmann, 2004; Levelt, 1992) is adapted to explain findings such as intact word structure and anticipatory

assimilation errors in present SLI qualitative data. The metrical frame includes the number of syllables and stress pattern of the word which are retained in the utterances of children with SLI. The segment portion consists of information on phonemes (consonants, vowels and clusters) and observed to be influenced by poor phonological short term memory. The results of the present study are in agreement with study by Marton & Schwartz, (2003). Morton and Schwartz (2003) claimed from their research that children with SLI produced 80% of segmental errors with no word structure change. According to this theory of phonological encoding in word retrieval, the segments and the structural frame of a word are processed separately, hence expected to be disturbed by different cognitive limitations. Study by Levelt, Roelofs, and Meyer, (1999) also supports that the segmental and metrical information are represented separately and accessed in parallel. The intact word frames in the NWR of the present study is consistent with segment to frame association principles (Biran & Friedmann, 2004; Levelt, 1992; Levelt, Roelofs, & Meyer, 1999; Marton & Schwartz, 2003).

One possible explanation for predominant anticipatory assimilation error type is that the phonological short term memory capacity is overwhelmed whilst retaining all segments of the nonword and placing them in appropriate metrical slots of word structure. The overwhelmed demand erased the sounds from initial part of nonwords and replaced them with later sounds of nonwords similar to recency effect in Serial position task (See Atkinson & Shiffrin, (1968) for explanation on serial position effect and recency effect). Along with recency erect and segment to frame association theory the assimilation errors in the present cases are explained. Children with SLI in the present study performed no different to children with NL on vowel errors. In fact, the relative intactness of vowel production helped SLI children to retain the word frame as children with NL.

Conclusions

The present study developed norm for NWR performance for age range 7-13 years using measures of percentage of syllable correct. Results are consistent with previous studies suggesting decreasing in percentage of syllable correct as function of nonword length. The error type analysis revealed more substitution errors followed by deletion and addition errors. Results of comparison of SLI data with normal data revealed that children with SLI differ from typically developing children predominantly on quantity of errors. However, in depth qualitative analysis revealed assimilation error types also and it was explained using segment to frame association hypothesis. The results of the study support the premise wit which the study was conducted i.e., nonword repetition performance could be treated as a true clinical marker of SLI.

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