Inflectional versus derivational abilities of children with specific language impairment- A panorama from sequential cognition

Kuppuraj Sengottuvel and Prema K S Rao

Department of Speech Language Sciences, All India Institute of Speech and Hearing, Mysore - 570006

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Corresponding Author:

Kuppuraj Sengottuvel
Tel : +91-8259803230
E-mail : kuppu_k7@yahoo.co.in

ABSTRACT

Background: Specific Language Impairment (SLI) is a neurodevelopmental disorder affecting language acquisition in the absence of frank neurological damage, hearing deficits, severe environmental deprivation, or mental retardation. Children with SLI have significant difficulties in syntax domain of language compared to semantics, while their acquisition of pragmatics is relatively spared.
Purpose: The purpose of the present study is to examine the judgment and revision of inflectional and derivational morphemes of children with specific language impairment (SLI).
Methods: 31 children with SLI and 33 typically developing (TD) children participated in the study (age range 8–13 years). The stimuli consisted of 18 sentences with inflectional morphemes and 18 sentences with derivational morphemes for grammatical judgment and revision tasks. Inflectional and derivational performance of SLI group was compared with TD group on judgment and revision scores.
Results: Children with SLI were significantly poorer compared to TD children on inflectional operations (invariably on judging & revising) but performed like TD children on derivational morphemes. Within SLI, inflectional performance was significantly poorer than derivational performance. In contrast, TD children performed better on inflections than derivations. Findings supported the predictions and discussed using possible sequencing problems in children with SLI.
Conclusion: The study describes the findings using sequential difficulties reported by procedural deficit hypothesis (PDH) in SLI.

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Introduction

Language is innate and almost every child learns it effortlessly. Children who find language learning difficult despite their adequate non-verbal abilities are referred to as specifically language impaired. Specific Language Impairment (SLI) is a neurodevelopmental disorder affecting language acquisition in the absence of frank neurological damage, hearing deficits, severe environmental deprivation, or mental retardation.[1] Children with SLI have significant difficulties in syntax domain of language compared to semantics, while their acquisition of pragmatics is relatively spared.[1] Procedural deficit hypothesis (PDH)[2] which addresses the language problems in SLI from a cognitive neuroscience perspective, states that individuals with SLI would also demonstrate affiliated motor sequencing (sequential cognition) problems because both grammar and sequence learning are governed by a common memory system (i.e., procedural).[3] PDH originated from the declarative/procedural (DP) model[4] for language representation which claims that declarative memory system (operates on hippocampal & other medial temporal lobe structures) mediates mental lexicon[4,5] while procedural memory system mediates rule-governed aspects of phonology, morphology and syntax.[2,4] Studies examined motor sequence learning in children with SLI are in favor of PDH.[3,6–9] Across modalities, children with SLI are shown to have poor sequence learning.[10] The following section describes the possible relation inflectional and derivational morphemes shares at the level of sequential cognition.

Inflectional operations add a bound morpheme to a verb in relation to previously occurred auxiliary or subject in that sentence. For example, in the sentence *'she is always playing'*, the inflecting element *'ing'* depends on *'is'* which occurred much earlier in the sentence. That is, the two dependent elements placed further in a sentence share an intricate relation. The inflectional operations resemble sequence learning in following way. Triggering the "n + a^{th}" (where "a" is 1, 2, or 3 & so on) word or segment (e.g., morpheme) in a sentence sequence could be based on the "n^{th}" word. For instance, in natural language such as the one in Example 1, *-nu* predicts *–ne* and *na:le* predicts *-tha* in a non-adjacent sequence, where on both the prediction events there are number of intervening materials. Such probability-based predictions rely on procedural memory.[11] Hence, the present study claims that on inflectional judgment task children with poor sequencing abilities (i.e., SLI) would perform poorly compared to typical children. Unlike inflectional morphemes, derivational morphemes (e.g., *'happier'* derived from *'happy'*) are relatively independent of other words in a sentence (at least less compared to inflectional morphemes). Derivational morphemes are more like lexicons and could be derived from declarative memory like any other words.[12] In natural language such as in Example 2, neither the first word *(avanu)* nor the last word *(jagida:ne)* modifies the derivational morpheme of interest (the middle word, *dzeyasha:li*). Because, it is operated from declarative system which is reported to be intact in SLI, the present study claims that derivational morphemes judgment in SLI would be in par with typical children.

Example 1 Inflectional				
avanu	*na:le*	*o:rinda*	*barutha:ne*	*/nu/* agree with */ne/* (gender agreement)
he	tomorrow	from his place	will come	*/na:le/* agree with */tha:/* (tense agreement)
Example 2 Derivational				
avanu	***dzeyasha:li***	*jagida:ne*	*/dzeyasha:li/* derived from */dzeya/* and operation are not related to other words	
he	victorious	has been		

Identical hypotheses apply for the retrieving tasks, where the target item has to be retrieved from memory system to fill the slot. The study claims that revision of derivational morpheme could just be retrieved like any other word and transferred to the sentence. The target slot location of derivational morpheme would aid easier retrieval as they are independent from other words in the sentence. On the other hand, the link between words of a sentence to morpheme of interest would be necessary for retrieving an inflectional morpheme. Therefore, inflectional revision would be difficult compared to derivational revision for children who have sequencing problems (i.e., SLI).

Studies consistently show that children with SLI show problems in inflectional morphemic usage.[3,13–16] Considering the close relation between sequential cognition and inflectional operations conceived by the present proposal, it is convincing. However, literature on derivational morphemic usage in SLI is yet to reach an agreement. Some studies show intact declarative performance,[12,17,18] while others show affected performance in SLI.[19,20] The present study claims that since derivational morphemes are more like words stored in declarative system, which is largely intact in SLI,[7] they would show preserved derivational performance. To examine the claims made based on sequential deficits for inflectional and derivational morphemes in the present study, it is necessary to compare the performances (judgment & revision) of inflectional and derivational tasks between SLI and typical children. Studies in the past have not made predictions for both these morpheme operations, especially from the views of PDH, which promises to explain the morphemic usage differences in SLI. The wealthy of inflectional operations in Kannada a Dravidian agglutinating language makes it an appropriate candidate language to evaluate the varying vulnerability children with SLI might show on the performances of inflectional versus derivational morphemes.[3]

Methods

Participants

Thirty-three (17 males & 16 females) typically developing (TD) children in the age range of 8–13 years and 31 (22 males & 10 females) SLI children in the same age range participated in the study. All the participants were native speakers of Kannada language and were from middle to upper socio economic status. All the participants were introduced English as their second language at school at approximately at the age of 3–4 years. However, all the participants used Kannada for their everyday communication. TD children were from sub urban areas and language-impaired children were from urban or sub urban areas of Mysore district, India. TD children in the age range of 8–10 years were labeled as TD1 (n = 17) and SLI children in the age range of 8–10 years were labeled as SLI1 (n = 18). Similarly, TD children in age range of 11–13 years were labeled as TD2 (n = 16) and SLI children in the age range of 11–13 years as SLI2 (n = 13). Before commencement of actual experiment, a written consent was obtained from all the participants stating the non-beneficial and scientific nature of the experiment. Children in the SLI group were initially diagnosed as language impaired by speech language pathologist at the Department of clinical services of All India Institute of Speech and Hearing, Mysore (31 SLI children for the present study were selected from 44 such language impaired children). For details on demographic, family history and language acquisition delay of SLI participants, see Appendix i.

At first, participants with difficulties on general learning of language and reading were selected in gross. On parental report, they were reported to have had normal performance, yet showed difficulty in learning to speak or read. After selecting children with learning disability in gross, all the children were administered a language test and non-verbal IQ test to diagnose them as SLI based on Leonard's exclusionary criteria.[1] Thirty-one children were found adequate to fulfill Leonard's SLI criteria and were included in the study. Children with SLI were also agreed upon on other objectives of Leonard's exclusionary criteria such as no history of otitis media, neurological deficits, and oro-motor dysfunction. All the participants (SLI and TD) were administered Gessell's drawing test[21] as a test of non-verbal IQ and the scores are included in Table 1. Participants in SLI group who scored below 85 in IQ measure were excluded from study. Scores for language was obtained using linguistic profile test (LPT).[22] LPT is a judgment (receptive) language test in Kan-

Table 1: Mean and SD of TD and SLI children on various age measures and IQ

Various ages (in years)	Groups							
	TD1 (n = 17)		TD2 (16)		SLI1 (18)		SLI2 (13)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Chronological age	8.94	0.82	11.93	0.85	8.88	0.83	11.84	0.80
Phonological age	9.05	1.29	11.75	1.12	8.44	0.98	11.53	1.26
Semantic age	8.05	0.96	11.37	1.14	7.05	0.93	9.69	1.25
Syntax age	7.64	1.53	10.87	1.62	5.66	0.90	8.00	0.91
Total language age	8.05	1.24	11.06	1.43	6.66	1.08	9.07	1.11
Non verbal IQ	94	7.86	93	6.19	86.13	3.21	89.64	5.52

nada. Language scores obtained in this test are indicative of receptive language ability in domains of phonology, semantics and syntax. Participants were included into SLI group, if their grand language total (combination of phonology, semantics & syntax scores) was at least 1.25 SD lower than the standard language score for that chronological age. The receptive language age details of TD and SLI groups on language domains such as phonology, semantics and syntax are given in Table 1.

Each of the SLI groups had comparable non-verbal IQ and chronological age to their TD counterparts; however, showed significantly poorer language abilities than the paired TD groups in terms of total language age (average of phonology, semantics, and syntax) (i.e., TD2>TD1, $p = 0.00$; TD1>SLI1, $p = 0.01$; TD2 >SLI2, $p = 0.00$, SLI>SLI2, $p = 0.00$).

Materials

The stimuli for the present study were in Kannada. Kannada is an agglutinating language. Word order is non-significant; however, several morphemes (up to four) suffixed to the root are significant aspects. Derivational morpheme operations are relatively independent of other words in a sentence. On the other hand, inflectional morpheme operations require relation between words; those are distantly placed in a sentence. Stimuli for the present study consisted of 36 Kannada sentences. Eighteen of them (50%) were sentences with derivational morphemes and 18 of them (50%) were sentences with inflectional morphemes. 6 out of 18 (1:3) derivational morphemes were incorrect, which needed revision from the participant. Similarly, 6 out of 18 (1:3) inflectional morphemes required revision. Stimuli needing judgment were grammatically incorrect sentences embedded randomly in the test material. In derivational morphemic stimuli, stimuli numbers 3, 6, 8, 11, 14, and 18 were incorrect (where a morpheme is used incorrectly) (see Table 2, sl. no, 1 & 2 for example). In inflectional morphemic stimuli, stimuli numbers 2, 5, 7, 10, 12, and 13 were incorrect (see Table 2, sl. no, 3 & 4 for example). (See Appendix ii for complete stimuli used)

Table 2: Examples of stimuli used in the study

S. No	Stimuli[1] (target morpheme is italicized)	Choice stimuli in two choice judgment frame	Scoring			
1	Avanu (he) mo:s*aga:ra* (is a cheat)		1		0	
2	Avanu (he) tumba (very) shakti*ga:ra* ***(vanta)*** (powerful)	Avanu thumba shakti*vanta*	4	3	2	1
3	Idu (this) mara (is tree) (picture of one single tree)		1		0	
4	Idu (this) avan*ige* (is his) mane ***(a)*** (home)	Idu avan*a* mane	4	3	2	1

Note: sl. No.s 1 & 2 are derivational, sl. No. s 3 & 4 are inflectional.

Procedure

The examiner presented all the stimuli in same order as in Appendix ii, with the order of inflectional versus derivational morphemes counterbalanced within and across groups. The examiner was proficient in Kannada language usage. Participant's responses were audio recorded for scoring and analysis. After presenting the entire stimuli, stimuli those required revision were presented again randomly (but all the stimuli required revision were re-presented), if the participant had not judged and corrected them during initial presentation (i.e., if the participant had not obtained score of "4" at first). During re-presentation, a new paradigm called two choice judgment frame (TCJF)[2] was introduced during administration of stimuli needing revision (i.e., TCJF was used if a participant either failed to judge or revise the stimuli that needed judgment and revision). In TCJF two sentences were given among which one had the target morpheme used correctly and other had the target morpheme used incorrectly. TCJF was required to present the target morpheme in both correct and incorrect sentence frame. It gave an opportunity to check if the participant had the representation of that target morpheme. The participants' task was to judge the most appropriate usage of the morpheme by selecting the correct sentence among two. The random re-presentation was done to rule out any presentation bias. (There was a chance of he/she guessing the correct one if a stimuli was repeated twice instantly after his/her initial response).

Scoring

For the stimuli needing judgment only, the examiner presented the stimulus orally, as many times as the participant demanded. The number of repetitions was irrelevant to scoring. In case of stimulus requiring judgment alone, the examiner moved on to the next stimulus when the participant provided a response (irrespective of accuracy of response). A score of "1" for correct response and score "0" was given if the stimuli was judged incorrectly (see Table 3). In case of a stimulus needing revision (i.e., the incorrect sentences) the presentation was similar to the judgment only condition, where the examiner presented the stimulus orally and repeated ("n" repetitions), on participants' demand. The number of repetitions was irrelevant for scoring. The participant gets the score of "4" if he judges and revises correctly. After completing the presentation once, the examiner re-presented the stimuli that required revision (see procedural and scoring section). Participant who managed to judge (on their own) and revise with clue in each group obtained score of "3". Participants who managed to judge the stimulus but failed to revise after clue obtained score of "2". Participants who failed to judge the stimulus but managed to revise after clue obtained score of "1". Participants who neither revised nor judged even after the clue in each group obtained score of "0" (see Table 3).

Ten percent of the data was re-analyzed by two more examiners who were speech language pathologists to rule out examiner bias in analysis of responses. The Chronbach's alpha scores

[1] Note: Underlined is target morphemic position. An approximate English translation is given in bracket (small font) after each unit. Bolded ones are the correct morpheme, and underlines and italicized are the target positions. Where ever there are two choices judgment frame it means that sentence is incorrect.

[2] Two choice judgment frame could be paralleled to clue condition in psycholinguistics

Table 3: Example of task administration and scoring

Presentation of stimulus	Participant's response	Scoring
Stimuli needing judgment only		
maguvannu shalege karadukonDu hogu ("annu" is used correctly)	Correct judgment	1
	Incorrect judgment	0
Stimuli needing judgment & revision		
Avanu mane*jaNu* hogutida:ne 'aNu' is incorrectly used	Judges and revises correctly	4
Two choice judgment frame (Which one is more appropriate) Avanu mane*jaNu* hogutida:ne *(or)* Avanu mane*ige* hogutida:ne	Judges the stimuli correctly but no attempt to revise or incorrect revision & *correct judgment in two choice judgment frame*	3
	Judges the stimuli correctly & *incorrect judgment in two choice judgment frame*	2
	Judges incorrectly & *correct judgment in two choice judgment frame*	1
	Judges incorrectly & *judges incorrectly in two choice judgment frame also*	0

showed that the judges correlated 96.3% among their analysis. See Appendix iii for sample score sheets (by examiner 1)

Results

Comparison of TD and SLI groups on derivational and inflectional judgment tasks

Data on derivational judgment (DJ) tasks of each group (maximum score 12 × 1 = 12) were added together and inflectional judgment (IJ) tasks of each group (maximum score 12 × 1 = 12) were added together for comparison between TD (TD1 & TD2) and SLI (SLI1 & SLI2) groups. Figure 1 shows the comparison of DJ and IJ for all four groups. Figure 2 shows the performance of all the groups (TD1, TD2, SLI1, & SLI2) on DJ and IJ tasks.

DJ and IJ were considered as two with in subject factors and repeated measures of ANOVA was done to see, if DJ and IJ were significantly different (groups as between subject factors). Analysis showed that factors such as DJ and IJ were significantly different, F (1, 60) = 16.47, p = 0.00, η^2 = 0.22. Factors (DJ & IJ) and group interaction was present, F (3, 60) = 14.94, p = 0.00, η^2 = 0.43. Between subject effects showed that groups were significantly different from each other for DJ and IJ, F (3, 60) = 38.46, p = 0.00, η^2 = 0.66. Paired sample *t*-test was done to compare between DJ and IJ of each group. In TD1, IJ was significantly better than DJ, t (16) = –2.75, p = 0.01. In TD2, IJ was better than DJ but the difference was not significant, t (15) = –1.57, p = 0.14. In SLI1, IJ was significantly lower than DJ, t (17) = 3.92, p = .00 and in SLI2, IJ was significantly lower than DJ, t (14) = 3.39, p = 0.00.

Comparison of TD and SLI groups on derivational and inflectional revision tasks

Data on derivational revision (DR) items of each group were added (maximum score 6 × 4 = 24). Similarly, data on inflectional

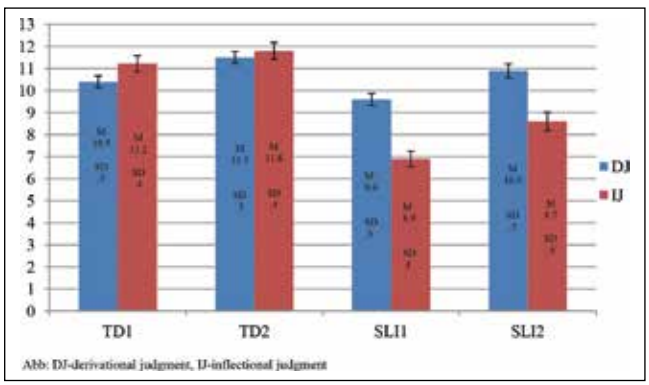

Fig. 1: Comparison between derivational and inflectional judgment scores for all groups.

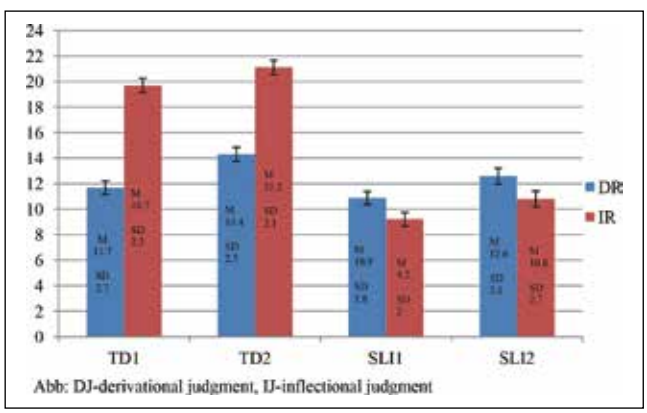

Fig. 2: Comparison between derivational and inflectional revision scores for all groups.

revision (IR) tasks of each group were added (maximum score 6 × 4 = 24). Comparisons between TD (TD1 & TD2) and SLI (SLI1 & SLI2) groups were done. The mean and SD of TD and SLI groups are shown in Figure 2 shows the comparison of DR and IR items of TD and SLI groups.

Derivational revision (DR) and inflectional revision (IR) were considered as two within subject factors and a repeated measures of ANOVA was done to see if DR and IR were significantly different (groups as between subject factors). Analysis showed that factors such as DR and IR were significant, F (1, 60) = 73.93, p = 0.000, η^2 = 0.552. Factors (DR & IR) and group interaction was present F (3, 60) = 65.36, p = 0.000, η^2 = 0.766. Between subject effects showed that groups were significantly different from each other on these factors, F (3, 60) = 62.63, p = 0.000, η^2 = 0.758. Paired sample *t*-test was done to compare between DR and IR of each group. In TD1, IR was significantly better than DR, t (16) = –13.32, p = 0.000. In TD2, IR was significantly better than DR, t (15) = –9.92, p = 0.00. In SLI1, IR was significantly lower than DR, t (12) = 2.40, p = 0.03 and in SLI2, IR was significantly lower than DR, t (17) = 2.70, p = 0.015.

Microanalysis of revision performance

Number of participants from each group, whose scores ranged from "4" to "0" was tabulated using cross tabs and a graph was made between TD and SLI children on derivational and inflectional revision tasks. For this tabulation, age groups were merged into single TD and single SLI group. Cross tabulation would display visualization of number of participants from each group who performed with various scores from "0" till "4". Figure 3 shows that individual derivational revision scores of TD and SLI groups were similar. In TD group, more participants performed with score of "3" (~42%) and followed by "1" (~41%). In TD group, approximately 10% of participants performed with score of "4" and 4% performed with score of "2". Similarly, children with SLI also peaked at "1" (~51%) and "3" (~39%) (like TD more participants scored either "1" or "3"). Children with SLI got approximately 4% each on scores "1" and "4" while revision derivational morphemes. Figure 4 shows

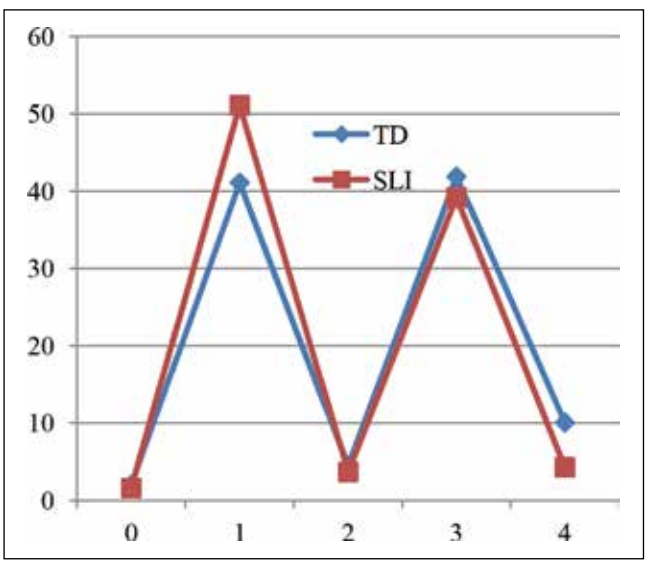

Fig. 3: Cross tab comparison of TD and SLI groups on individual revision of derivational morphemes.

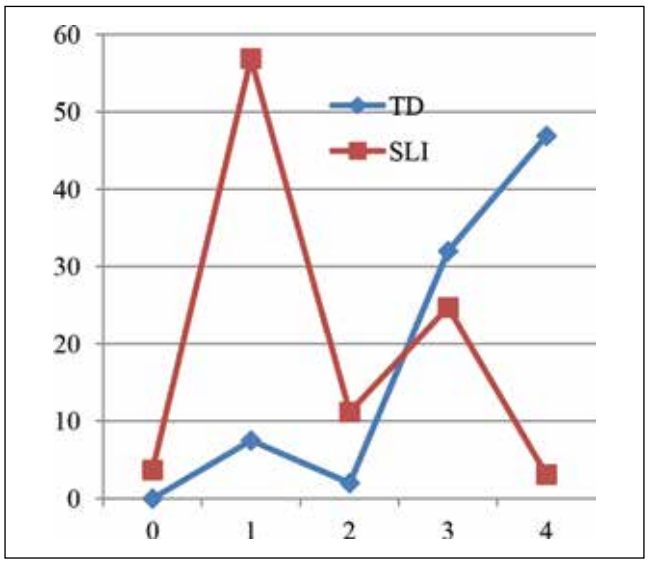

Fig. 4: Cross tab comparison of TD and SLI groups on individual revision of inflectional morphemes.

individual inflectional revision scores of TD and SLI groups. Figure 4 shows that TD children and children with SLI were different in inflectional revision performences. In TD group, more participants performing with score of "4" (~47%) followed by "3" (~32%), 1" (~8) and "2" (~2%). In SLI group, ~57% scored "1", followed by ~25% scoring "3", ~11% scoring "2", ~4% scoring "0", and ~3% scoring "1" (see Figure 4).

Results of correlation analysis

Only the summed judgment results of derivational and inflectional scores were correlated with language measures such as receptive phonology, semantics and syntax. Revision scores of participants were not considered for correlation with language measure as the mode of initial language measure on LPT was judgment (see method). The age groups within TD (TD1 + TD2) and SLI groups (SLI1 + SLI2) were merged for a meaningful interpretation from correlation analysis.

In TD group, derivational judgment positively correlated with phonology, r (33) = 0.408, p = 0.02 (significant at 0.05) and semantics, r (33) = 0.428, p = 0.013 (significant at 0.05) but not on syntax, r (33) = 0.326, p = n.s. Inflectional judgment of TD group correlated positively with scores of phonology, r (33) = 0.535, p = 0.001, (significant at 0.01), semantics [r (33) = 0.503, p = 0.003, significant at 0.01] and syntax, r (33) = 0.554, p = 0.001, (significant at 0.01). In SLI group, derivational judgment positively correlated with phonology, r (31) = 0.378, p = 0.036, (significant at 0.05), semantics, r (31) = 0.403, p = 0.025 (significant at 0.05) and syntax, r (31) = 0.420, p = 0.019, (significant at 0.05). None of the language measures correlated with inflectional judgment scores in SLI group [phonology r (31) = 0.242, p = n.s; semantics r (31) = 0.281, p = n.s; syntax r (31) = 0.332, p = n.s).

Discussion

Judgment

The younger TD children performed significantly poorer on derivational compared to inflectional judgment task. The

difference between inflectional and derivational performance was not significant in older TD children. Derivations are usually acquired later than inflections, and it shares relations with literacy[23,24] and vocabulary knowledge[25] during its development. That is, the older age group (TD2) could have developed better derivational skill, on the other hand, the inflectional skills reached plateau earlier. Comparison between groups showed that SLI groups (SLI1 & SLI2) were significantly poorer than TD groups (TD1 & TD2) on inflectional judgment. In contrast, the difference was not significant on derivational judgment. Further, TD participants performed inflectional judgment better than derivational judgment. On contrary, SLI participants performed derivational judgment better than inflectional judgment. Moreover, SLI groups differed contrastingly from TD groups on inflectional judgment but not on derivational judgment. The result of the present study supports the prediction, which stated that inflectional operations would be more difficult for children with SLI. The poor inflectional performance in children with SLI in the present study could be related to findings by studies that showed probability learning deficits in SLI in artificial grammar learning studies.[26–28] Note that inflectional operations in a sequence are probability based. The findings on preserved derivational morphemes of SLI are in favor[12,17,18] as well as in contrary to previous findings.[19,20] Nevertheless, as predicted, the non-dependency nature of derivational morpheme to elements in sentence could have spared them from relying more on sequence learning.

Revision

SLI groups were significantly poorer than TD groups on inflectional revisions. Even though, SLI groups were poorer than TD groups on derivational revisions the difference was not significant. Further analysis showed that TD participants performed inflectional revisions better compared to derivational revisions. Children with SLI showed opposite pattern where they performed derivational revisions better than their inflectional revisions. The study earlier claimed that retrieving a correct derivational morpheme would be easier because it has advantage over inflectional morphemic retrieval. Retrieval of inflectional morphemic element may require obligatory relation between other words in the sentence (see introduction). Unlike inflectional revisions, revision of derivational morphemic elements would be possible like retrieving any other word. The present results showing poor inflectional morpheme retrieval compared to derivational retrieval in children with SLI is in favor of the proposal. In sum, we state that the greater sequential and predictive demands the inflectional retrieval imposes on retrieving the morpheme of interest from associative memory could be a reason why children with SLI revise inflectional morphemes poorer than derivational morphemes. Another perspective of PDH states that children with SLI are generally poor in retrieving words (or morphemes),[2] because brain structures involved in procedural memory operations also underlie some of declarative functions.[7] Though these general word finding problems would not explain the variability in performance between inflectional and derivational morphemes, the findings of the present study showing poor morphemic retrieval (both in derivational or inflectional) in SLI could be in support of studies that reported of poor declarative memory in SLI.[9,29,30]

Correlation

Derivational judgment performance of TD children correlated with language measures of phonology and semantics (lexicon-hence declarative) but not syntax. On the other hand, inflectional judgment of TD children correlated with all the aspects of language including syntax (grammar-hence procedural). The pattern is not obvious when phonology was included. This could be because operationally phonology is less linked to inflectional morphology than syntax during language development.[31] However, excluding the phonology, correlation results showed that derivations correlated with semantics (lexical knowledge) but inflections correlated with syntax (computational skill). The correlation was positive at all the instances. This is in line with studies that related declarative memory scores to lexical while procedural sequencing scores to grammar.[3,6–9,32] The correlation pattern between derivational judgment and language aspects for SLI group was similar to TD. That is, children with SLI performed derivational operations akin to TD peers (in other words intact declarative system). However, the SLI group did not show substantial correlation between general language aspects and inflectional judgment showing that operations such as inflections (syntax) are computed differently in them. Ullman (2004) reported that inflections could be explicitly stored as chunks like any other words in lexicon in children with SLI due to their poor procedural skills. This assumption was however, not strengthened from correlation results of present study because if it was stored in SLI, there should have been a correlation between semantics and inflectional operations in SLI.

Conclusion

The findings, in general, could also be discussed as a poor innate linguistic knowledge[33] and poor productivity,[34] however, difficulty in linguistic knowledge may not explain the difference in inflectional and derivational operations. The present study has limitations such as not having syntactical expressive language measure during subject selection (due to non-availability of expressive language test in Kannada language). Considering revision task as one of the major variable in present study, presence of expressive language impaired group in the SLI group would have been a variable.[35] Overall, the study is an attempt to explain the varying morphemic behavior of children with language impairment from procedural memory perspective. The findings strengthen the claim that these two different morphemic operations are underlined by different memory systems.

Authorship Contribution

Kuppuraj Sengottuvel: Conceived the idea, collected data, analyzed the data, wrote the paper, **Prema K S Rao:** Conceived the idea, designed the stimuli, assisted in writing the paper.

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Appendix i: Demographic and language acquisition details of children with SLI

SLI1 P. no	*Demo graphic*		*Familial History**	*Delayed acquisition (in months)*	*SLI2 P. no*	*Demo graphic*		*Familial History**	*Delayed acquisition (in months)*
	Age	*Sex*		*1st Word*		*Age*	*Sex*		
1	8	M	+VE	16	*1*	11	M	+ve	18
2	8	M	+VE	18	*2*	11	F	-ve	14
3	8	M	+ve	18	*3*	11	M	-ve	14
4	8	F	-ve	24	*4*	11	M	+VE	30
5	8	M	-ve	15	*5*	11	F	-ve	24
6	8	M	-ve	20	*6*	12	F	+ve	20
7	8	M	+VE	14	*7*	12	M	+VE	18
8	9	F	-ve	18	*8*	12	F	+VE	18
9	9	M	+VE	18	*9*	12	M	+ve	14
10	9	F	+VE	18	*10*	12	M	-ve	24
11	9	M	-ve	24	*11*	13	F	+VE	24
12	9	M	-ve	20	*12*	13	M	+ve	18
13	9	M	+ve	18	*13*	13	M	-ve	18
14	10	F	+ve	24	➢ On an average SLI1 uttered 1st word at 19.7 months, SD = 3.83 & SLI2 uttered 1st word at19.7 months, SD = 4.77. ➢ SLI1 ~ SLI2 in acquisition of 1st word [t(29)=.118, p=90]				
15	10	M	+VE	20					
16	10	M	+VE	22					
17	10	M	-ve	18					
18	10	M	+VE	30					

P. no = participant number, * +VE- positive family history at first degree relation; +ve – positive family history at second degree relation, M-male, F-female.

Appendix ii. Stimuli

a. Stimuli for derivational morphemes used in the study

Sl. No	*Stimuli (target morpheme is italicized)*	*Choice stimuli in two choice judgment frame*	*Scoring*
1	Avanu (he) mo:sa*ga:ra* (is a cheat)		1 0
2	Idu (this) ha:sya*maya* (comical) kate (story)		1 0
3	Avanu (he) tumba (very) shakti*ga:ra* ***(vanta)*** (powerful)	Avanu thumba shakti*vanta*	4 3 2 1
4	Maguvige (to baby) u:Ta tinn*isu* (feed)		1 0
5	jo:pa:nava*:gi* (careful) duDDu (money) upayo:gisabe:ku (to be used)		1 0
6	Avana (his) naDava*Ne* (activities) sari iLa ***(ige)*** (not acceptable)	avana naDava*lige* sari iLa	4 3 2 1
7	na:vu (we) chakli tinno*:Na* (shall eat?)		1 0
8	Namage (for us) halaya (old) nena*pana* irutade ***(pu)***(memories will be there)	namage halaya nena*pu* irutade	4 3 2 1
9	na:vu (we) padagala (words) jo:d*aNe* maduteve (connect)		1 0
10	krishna ra:jana (raja's) sereyal*u* (prisoner)		1 0
11	a:vadi*ga:ra* (snake charmer) a:vaNu (snake) a:dDisuthane (make it dance)***(iga)***	a:vadi*iga* a:vaNu a:dDisuthane	4 3 2 1
12	Avanu (he) bharat*iya* (is an Indian)		1 0
13	ganesha suLL*a* (liar)		1 0
14	Hechu (too much) thiNuvathu (eating) ha:ni*maya* ***(kara)***(harmful)	hechu thiNuvathu ha:ni*kara*	4 3 2 1
15	va:ni ha:dannu (the song) *ha:Duthahodalu* (singing and moving)		1 0
16	go:liyannu (pebbles) chella*:Du* (disperse and play)		1 0
17	doDa*tana* (wisemanship) namaLi irubeku (should be there in us)		1 0
18	avanu (he) kate*vanta* (laureate) ***(gara)***	avanu kate*gara*	4 3 2 1

Underlined is target morphemic position. An approximate English translation is given in bracket (small font) after each unit. Bolded ones are the correct morpheme, and underlines and italicized are the target positions. Where ever there are two choices judgment frame it means that sentence is incorrect.

b. Stimuli for inflectional morphemes used in the study

Sl. No	*Stimuli (target morpheme is italicized)*	*Choice stimuli in two choice judgment frame*	*Scoring*			
1	Idu (this) mara (is tree) (picture of one single tree)		1		0	
2	Ive (these) na:yi*galu* (pic c) **(yi)** (are dogs)	idu na:*yi*	4	3	2	1
3	barataLi (in India) iruvaru eLru (all citizens are) aNatamandiaru (brothers)		1		0	
4	Avalu (she) kerege (bank) ne:ru (water) taralu (to bring) hoguvalu (went)		1		0	
5	Idu (this) avan*ige* (is his) mane ***(a)*** (home)	Idu avan*a* mane	4	3	2	1
6	naMa (in our) manejaLi (home) TV ide (is there)		1		0	
7	Maguv*alli* (the baby) sh:lege (to school) karidukonDu (take) ho:gu (go) ***(aNu)***	Maguv*(aNu)* sh:lege karidukonDu ho:gu	4	3	2	1
8	Na:vu (we) devaraNu (god) po:jisuteve (do pooja)		1		0	
9	Na:velaru (we all) busina (for bus) samayake (time) thumba (very) ka:yuteve (will be waiting)		1		0	
10	Avanu (he) mane*jaNu* (to home) hogutida:ne ***(ige)*** (is going)	Avanu mane*ige* hogutida:ne	4	3	2	1
11	Adu (that) ra:mana (ra:ma's) ka:ru (car)					
12	naMa (our) shal*ege* (in school) computer ide (is there) *(Li)*	naMa shal*aLi* computer ide	4	3	2	1
13	aPa: (dad) kelasa*Nu* (for job) hoguta:re ***(ike)*** **(go)**	aPa: kelasa*ike* hoguta:re	4	3	2	1
14	Indu (today) male (rain) baruthade (will come)		1		0	
15	Indu (today) male (rain) barabahudu (might come)		1		0	
16	Na:le (tomorrow) na:vu (we) cinemage (to cinema) hoguvevu (will go)		1		0	
17	Avanu (he) o:ta (food) maDida (ate)		1		0	
18	Huduga (the boy) kelege (down) *biddida:ne* (fallen) (picture of boy fallen from tree)		1			0

Underlined is target morphemic position. An approximate English translation is given in bracket (small font) after each unit. Bolded ones are the correct morpheme, and underlines and italicized are the target positions. Where ever there are two choices judgment frame it means that sentence is incorrect.

Appendix iii. Examples of score sheets

a Data analysis sheet of TD 1 participants on derivational task

TD1 P no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1	1	2	1	1	4	0	1	1	1	1	1	1	1	1	1	1	3
2	1	1	3	1	1	1	0	3	1	1	3	1	1	3	1	0	1	3
3	1	1	1	1	0	3	1	1	1	1	1	1	1	4	1	1	1	2
4	1	0	4	1	0	4	1	1	1	1	1	1	1	3	1	0	1	0
5	1	1	1	1	0	3	0	1	1	1	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	3	1	1	3	0	1	3	1	1	1	3
7	1	1	3	1	1	3	1	1	1	1	1	1	1	3	0	1	1	3
8	1	1	1	1	0	1	0	1	1	1	3	1	0	1	1	1	1	1
9	1	1	3	1	0	3	1	1	1	1	1	0	1	3	1	1	0	0
10	1	1	1	1	1	1	1	1	1	0	3	1	1	1	1	0	1	4
11	1	1	3	1	1	4	0	1	1	1	2	1	1	1	1	1	1	1
12	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1	0	1	3
13	1	1	3	1	1	1	1	1	1	1	1	1	1	3	1	1	1	3
14	1	1	1	1	0	3	1	1	1	1	1	1	1	1	1	1	1	3
15	0	1	1	1	0	1	0	1	1	1	1	1	1	3	1	1	1	1
16	1	1	3	1	1	3	1	1	1	1	4	1	1	0	1	1	1	3
17	1	1	4	1	1	4	0	1	1	1	1	1	1	3	1	1	1	1

p. no-Participant number, stimuli 1, 2, 4, 5, 7, 9, 10, 12, 13, 15, 16, & 17 needed judgment alone. The shaded ones (3, 6, 8, 11, 14, & 18) were stimuli needed revision and it is projected in the same order as it was presented in derivational task.

b. Data analysis sheet of SLI2 participants on inflectional task

SLI2 p. no	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	0	3	1	0	3	1	1	1	1	1	1	0	1	1	1	0	0	0
2	1	3	0	0	2	1	3	1	1	1	0	3	3	0	0	0	0	1
3	0	3	1	1	1	0	1	1	1	1	0	1	2	1	1	0	1	1
4	0	1	1	1	1	1	3	1	1	1	1	1	3	1	1	1	1	0
5	1	1	1	1	3	1	1	1	1	0	1	1	1	1	0	1	1	1
6	1	2	0	1	3	1	3	1	1	4	1	2	2	0	0	0	1	0
7	1	1	0	1	1	0	2	1	0	1	0	1	3	1	1	0	0	0
8	0	3	1	0	1	0	2	1	1	1	1	1	1	0	1	1	1	1
9	1	3	1	1	2	1	3	1	1	2	1	1	1	1	1	1	0	1
10	1	3	1	0	2	1	1	0	1	1	1	1	1	1	0	1	0	0
11	1	4	0	1	3	1	1	1	0	3	1	2	1	1	1	0	1	0
12	1	3	1	1	1	1	3	0	0	1	1	3	1	1	1	1	1	1
13	1	1	1	1	3	1	1	1	1	2	1	1	2	0	1	1	0	1

p. no-Participant number, stimuli (1, 3, 4, 6, 8, 9, 11, 14, 15, 16, 17, & 18) needed judgment alone. The shaded ones (2, 5, 7, 10, 12, & 13) were stimuli needed revision and it is projected in the same order as it was presented in inflectional task.

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