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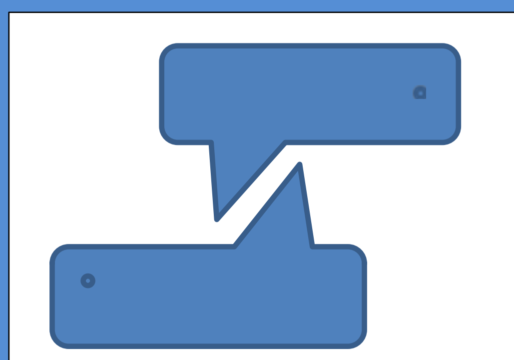

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Table of Contents

Articles

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Enigmatic Nature of Pragmatic Language Impairment: Case study

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Abstract

The present case study addresses language behaviors of a13-year-old girl 'N' who during her development manifested diverse characteristics within the developmental language spectrum disorder. N showed adequate performance on initial language and auditory processing tests. Detailed conversational analysis focusing on semantic and pragmatic aspects of N showed that N engaged in conversations with a lot of information redundancy, failed to provide significant information to listener, exhibited inappropriate cohesion, and demonstrated minimal structural deficits (such as irregular verbs in English). The report intends on highlighting how an exclusionary diagnostic strategy backed by conversational analysis, auditory processing, procedural sequence learning, and language assessment potentially narrowed down on the diagnosis of N. The treatment options are touched upon.

Keywords: semantics, pragmatics, conversational analysis, developmental language disorder, procedural sequence learning.

1. Introduction

Acquisition of language in children has been an interesting area of study that cuts across many disciplines including speech language pathology and linguistics. Challenges posed by children with deficits in language learning are multifaceted in nature. Further, language is a window to understand the dynamics of brain behavior in relation to socio-cultural dimension and therefore, case studies on language acquisition and language disorders open the door to knowledge in this direction. Vance & Clegg (2012) emphasized that single case reports are essential in communication disorders considering the heterogeneity of a developmental condition.

The label of 'developmental language disorder' subsumes disorders, which, although uniquely defined, have significant overlap with each other in terms of characteristics (e.g., Rapin & Allen, 1983). A developmental language disorder could be the result of idiopathic interference in any one or more of the language modules such as phonology, morpho-syntax (structure), semantics (content) and socio-pragmatics (context dependent usage) without any obvious non-verbal intelligence problems. Geetha & Prema (2007) noted that the overlapping symptomatology of developmental language disorders make it difficult to establish a diagnostic label, especially in the Indian context where several other socio-linguistic and cultural factors also come into play. As language disorders in children do not always fall under a homogenous group, there is a need for detailed case studies profiling developmental language disorders, which will provide the practicing Speech-Language Pathologists (SLP's) with best guidelines for intervention. In the present case study, we present the general language and detailed conversational characteristics

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of a child with developmental language disorder with a focus on the role of linguistic analysis in the diagnosis of the child's (identified as N in this report) communication disorder).

The case study addresses the linguistic behaviors of a 13-year-old girl N, who was labeled with different diagnostic labels from her first through several subsequent evaluations carried out during her developmental period. The report includes the analysis of her general language, auditory processing, structural (with particular information on her procedural memory), and semantic-pragmatic aspects of her language. The aim is to highlight the importance of shifting to non-conventional multifaceted approach in narrowing down on the most suited label for some who otherwise seem to have features diffusing across disorders' modules.

1.1. Background information of "N"

N's first visit at the age of 2; 9 (years; months) to the All India Institute of Speech and Hearing (Mysore, India) was with her parents, who brought her on account of her not speaking at sentence level and a delay in answering simple verbal commands. N's father is a native speaker of Malayalam language and mother is a native speaker of Kannada language but both are comfortable in either of the languages for communication. N lives with grandparents who use Malayalam for family communication. All the members of the family are versatile in using English and Kannada and therefore, had opted to use Kannada and English with the child. N's exposure to English was further strengthened when she was enrolled in play home at the age of 2; 4. Her parents reported that N had a history of normal development in all areas other than in expressive language. She had no significant health problems and no record of hearing problems. She had been attending play school 5 months prior to her first visit and her parents reported some social issues such as initial reluctance to mingle with peers. However, eventually she began to socialize easily, albeit at her own pace. She enjoyed music a lot especially rhymes and was observed to keep reciting rhymes even when unsolicited. When N was moody, she was observed to produce echolalic utterances.

1.2. Screening protocol on "N"

N underwent clinical psychological evaluation and was reported to have adequate developmental age (3 years). In order to assess N's receptive and expressive language skills, Receptive-Expressive Emergent Language Scale, 3rd Edition (REELS-3) (Bzoch, League, & Brown, 2003) and 3-Dimensional Language Acquisition Test (3D-LAT) (Herlekar, 1986) was administered. These tests indicate the age range in which the child falls in particular language/cognitive domain. For instance, REELS-3 informs about receptive and expressive language domains of children, whereas 3D-LAT informs, in addition to the above, the cognitive domain related to language of children. Assessment results revealed a delay in N's expressive language [N's expressive language age (ELA) was 24-26 months] with age-appropriate receptive language age (RLA) and cognitive language age (CLA) both of which were 30-32 months. M-CHAT (Robins, Fein, & Barton, 1999) was administered and the results ruled out the possibility of autism spectrum disorder in N. All the assessments were scored based on parental interview and the child was not involved. Hence, she was diagnosed as having expressive language delay and was referred for speech and language therapy. N's parents were guided on methods of stimulating the child for speech-language development on a weekly basis for two months following which she was enrolled into preschool (in a group of approximately 30 children). As per the speech-language pathologist's advice, N's mother worked on improving N's attention, concentration and expressive language skills. N's communication skills began to improve and when she was re-evaluated using REELS-3 on her second visit, at the age of 3; 8, she was reported to have age-adequate speech and language skills (Receptive & Expressive age was 42-48 months). She was able to express herself in 4-5 word phrases and was able to narrate daily life incidents and short stories. N's echolalic utterances had reduced and she was able to form correct grammatical sentences.

Table 1
Language scores of "N"

Domain	Visit 1	Visit 2
Language		
Expressive	27-30 m	42-48 m
Receptive	33-36 m	42-48 m
Cognition	30-32 m	-

Note: N's age was 33 months during visit 1 and 44 months during visit 2. Receptive and expressive scores extracted from REELS, Cognition scores extracted from 3D-LAT, m-months

Re-evaluating N's language on her third visit, after a gap of almost 5 years, at the chronological age of 8; 4, it was observed that while N's expressive syntax and phonology was well developed and age-appropriate, there was something atypical and deviant about her usage of language in social interactions. Her parents were concerned about N's difficulties in understanding and responding to verbal instructions at school, which her peers had no difficulty in responding appropriately to. Her responses to verbal instructions were delayed and often required repetition of instructions. She was reported to have a short attention span of listening and was easily distracted by any background interference, although providing visual cues helped in improving her listening performance. Her parents also reported that N sometimes had trouble in recalling what had been heard in the correct order.

Owing to her listening difficulties, a screening checklist for central auditory processing (SCAP - Yathiraj & Mascarenhas, 2002) was administered and N was found to be at risk for possible auditory processing difficulties. However, detailed central auditory processing tests did not reveal any difficulties in processing such as auditory closure, binaural integration, temporal resolution, and binaural interaction tests (Table 2). Results of tests eliminated the question of central auditory processing difficulties in N.

Table 2
Auditory Processing Scores of "N" during visit 3

Tests	Process	N's Raw Scores
SPIN	Auditory closure	R:60%
		L:60%
DCV	Binaural integration	R:16
		L:14
GDT	Temporal resolution	R:2.6
		L:2.8
MLD	Binaural interaction	SμN0-s0Nμ/ SμN0-SμN0
	500 Hz	12/8
	7000 Hz	6/4

Note: SPIN-speech in noise; N's speech perception in quiet was 100%, DCV-dichotic CV test; N's dichotic correct scores was 8, GDT-gap detection test (scores in milliseconds), MLD-masking level difference (in dBHL).

1.3. Linguistic analysis of communicative behavior of "N"

Linguistic analysis of spoken language samples is a method of assessing language performance, used by speech language pathologists and researchers interested in identifying, documenting, or

focusing intervention for different language disorders. It involves first recording and transcribing the productive language sample and then evaluating it at all levels of performance including phonology, syntax, semantics, pragmatics and vocabulary (Leadholm & Miller, 1995). Language sample analysis is used to investigate and to understand aspects of linguistic vulnerability that are not revealed by performance on standardized language tests. It helps in identifying and diagnosing language disorders in children who may perform well on tests of specific language performance but are nonetheless unable to use language for effectual verbal communication. Language production problems identified by standardized tests also can be validated and investigated further through linguistic analysis of spoken language samples. Performance of N on standardized tests for language and auditory processing (Table 1), although indicated age-appropriate skills, N's overall communication deficits could not be accounted solely by her performance on conventional language tests. Therefore, a more comprehensive evaluation of N's conversation behaviors based on linguistic principles was called for in order to examine the underlying deficits, which were manifested in communication. As suggested by Adams (2001), since conversational analysis yields clearer picture on the status of language domains in school-aged children, a detailed analysis was undertaken and described in the following section.
Procedure for linguistic analysis: Video recordings (video sessions were approximately 20 minutes each) of N's conversations, in English and in Kannada, with different communicative partners (clinician, grandmother, stranger) were collected and transcribed. These transcripts were then analyzed for measures of language structure as well as language performance. In what follows, we provide a linguistic description of N's language behavior in domains such as syntax (sentence structure), semantics (language meaning) and pragmatics (use of language for social interaction) in an attempt to approximate towards a label for N.

1.4. Structural domain of N

The speech sample was segmented into utterances using communication units (or c-units) to examine the structural aspects of N's language. A c-unit is an utterance defined as "each independent clause and its modifiers" (Loban, 1976, p.9). A sample of 100 complete and intelligible utterances were selected and coded at the level of morphemes according to Systematic Analysis of Language Transcripts (SALT; Miller & Chapman, 2003) software conventions. The SALT program was used to calculate several measures of language production to document the form and content of the child's language. Mean length of utterance (MLU) - one of the most commonly used measures of language productivity and syntactic development, was computed. MLU was calculated in terms of morphemes (MLU morphemes), which is the average number of morphemes per utterance, and words (MLU words), which is the average number of words per utterance. MLU is a general index of children's grammatical skills and is related to overall language abilities; as children develop language, their utterances become longer and the structures used also increase (Brown, 1973; Miller, 1991). Aram, Morris, & Hall (1993) identified MLU as one of the best tools to identify children with language impairment. However, MLU may not be a valid measure when children move ahead from simple sentences to complex sentences (Jalilevand & Ebrahimipour, 2014). Therefore, N's samples were also analyzed for type-token ratio (TTR) which is a measure of functional vocabulary skills and a representative score of diversity of words used by the client in the sample (Templin, 1957; Retherford,2000A substandard TTR is a predictor of language impairment(Miller, 1981).N's MLU and TTR scores are given in Table 3.

Table 3 Expressive language measures
MLU & TTR of "N"

Parameters	Expressive language measures					
	English				Kannada	
	N's	Norms			N's	M*
		M	Min	Max		
MLU (words)	5.9	6.5	3.5	9.0	4.7	3.5
MLU (morphemes)	6.4	7.22	3.9	10.1	6.6	5.8
TTR	0.3	0.3	0.2	0.3	0.3	0.3

Note: M-mean, M*-mean of typical age matched Kannada children, MLU-mean length of utterance, TTR-type token ratio

N did not show expressive language disorder as indicated by MLU and TTR scores. . The age adequate language skills based on REELS & 3D-LAT, as well as satisfactory MLU & TTR in both English and Kannada language with fluent and clear articulation, failed to account for the subtle communication deficits manifested by N. Since procedural memory skill is reported to correlate with a child's syntax abilities (Hedenius, Persson, Tremblay, Adi-Japha, Verissimmo, & Dye, 2011; Kuppuraj & Prema, 2012, 2013a; Lum, Conti-Ramsden, Page, & Ullman, 2012; Lum, Gelgec, & Conti-Ramsden, 2010; Tomblin, Mainela-Arnold, & Zhang, 2007) we used an adapted SRT (AD-SRT) task developed by Kuppuraj & Prema (2013b), to examine N's procedural memory. AD-SRT task has picture appearing in any of four squares on the screen. She was asked to trace the visual stimulus appearing in monitor using game pad with spatially corresponding buttons to the four squares on screen. The stimulus appears randomly in any of the four locations for initial trials. Unbeknownst to the participant the stimulus starts to appear in specific predetermined sequence. The reaction time difference between random and sequence trails gives the quantity of sequence learning. Results of AD-SRT task of N showed that she has intact procedural memory. The difference between sequence and random trials was 303 ms for N (as per Kuppuraj & Prema, 2013b, mean of 193 ms & SD 70 ms for 7-10 years age group) Satisfactory expressive grammar was complemented by her good procedural memory measured using implicit motor sequence learning - serial reaction time (SRT) task.. More like a conventional SRT task.

Despite several tests for language and procedural memory, we failed to account for her communication deficiency. We observed semantic deficits in N's language, which surfaced in difficulty in inferring meaning from the context as is illustrated by the following extract from N's conversation with an adult:

Extract 1

1	Adult:	Where is your house?
2	N:	Mysore only :05 bogadi (elaborates with actual address)
3	Adult:	Bogadi, which is where you stay.
4	Adult:	How did you come from there?
5	N:	Because my house is nearby here.

The complex-processing demands and the high level of inferencing required by the verbal instructions at school may explain the verbal comprehension difficulties that N's parents reported.

1.5. Semantic-pragmatic domain of N

The assessment adopted to analyze N's conversational behavior draws heavily from Clinical Discourse Analysis (Damico,1985). Damico (1985) delineates principles of conversational analysis based on the framework provided by Grice's Cooperative Principle (Grice, 1975). According to Grice (1975), participants in a conversation implicitly obey a general 'Cooperative Principle' (CP). The principle is as follows: "Make your conversational contribution what is required, at the stage at which it occurs, by the accepted purpose or direction of the talk exchange in which you are engaged" (Grice, 1975:45). He further identifies four categories- Quantity, Quality, Relation, and Manner- each of which comprise of conversational maxims. The first category, Quantity, has to do with the quantity of information to be presented and within it fall the maxims "Make your contribution as informative as is required (for the current purposes of exchange)" and "Do not make your contribution more informative than is required". The category of Quality comprises of what Grice calls a "supermaxim": "Try to make your contribution one that is true". Two other maxims also fall within this category: "Do not say what you believe to be false" and "Do not say that for which you lack adequate evidence". The next category, Relation, contains the very brief maxim "Be relevant". Within the category of Manner, Grice places the supermaxim "Be perspicuous" and other maxims like "Avoid obscurity of expression", "Avoid ambiguity", "Be brief" and "Be orderly" (Grice, 1975:45-46).

In Clinical Discourse Analysis, Damico (1985) identifies 17 target behaviors, which were grouped into quantity, quality, relation and manner categories based on whether they represented violations of the corresponding Gricean Conversational Maxims. In the present study, N's dynamic interaction with different conversation partners was examined for these target behaviors and for two more discourse errors – inappropriate use of cohesion markers and syntactic and morphological errors (Hux, Sanger, Reid, & Maschka, 1997).Examples from N's English and Kannada samples are provided to illustrate the patterns found in her speech. Analysis of N's conversational behaviors revealed the following clinically significant features, which surface as violations of the Gricean maxims of Quantity, Relation and Manner.

1.5.1. Quantity

1.5.1.1. Informational Redundancy

N was observed to offer more information than would be expected in cooperative talk by continuing to fixate on a proposition even when her conversational partner had acknowledged its reception and tried to proceed. For example:

Extract 2

1	Adult:	What else is there in your album?
2	N:	In my (al*) album no car/s.
3	Adult:	Animals?
4	Adult:	Other animals are there?
5	N:	I don't have an album.
6		I have one school book.
7	Adult:	Okay in your <school book>^
8	N:	<Only about> domestic animals.
9		Just like cow.
10	Adult:	What other domestic <animals>^
11	N:	<I like> cow.
12	Adult:	You like cow <and> ^
13	N:	<I wrote> about cows and bulls.
14		Cows are females and bulls are males.

In lines 8-11, we observe how N continues to fixate on "cows" even when her conversational partner tries to proceed further with the conversation by asking her about the other domestic animals which have been included in N's book.

1.5.1.2. Failure to Provide Significant Information to the Listener

N occasionally omitted to provide significant information to the listener and assumes their prior knowledge. An example of this is given in Extract 3 where N talks about her 'guests' and continues to do so without providing any information to the listener as to who she was referring to:

Extract 3

1	N:	Near my house (my neighbor) my neighbor house is there.
2		In the side of their house there is my friend house.
3	Adult:	Okay so <after>^
4	N:	< (And even)> and even my guest/s are there no?
5		Even (they) they/'re also in Hebbal

1.5.1.3. The Use of Nonspecific Vocabulary

N used deictic terms like pronominals without providing an antecedent or referent in the verbal or non-verbal context. This leaves the listener in the dark with respect to whom or what is being referenced.

Extract 4

1	N:	But I don't have one album.
2		I have only school book/s.
3	Adult:	Only <school boo>^
4	N:	<In that> I will put one
5		and take one animal picture
6		and put it there.
7		Then I/'ll write cow.
8		Or else they/'ll only write it.
9		(then I will write) (then I/'ll write) then I'll write
10		'I love cow'.
11		'It's a holy animal'.
12		'Do not slaughter the innocent animal'.

1.5.1.4. Inappropriate cohesion markers

One of the main strategies which N used to link her utterances to those of her conversational partner was to repeat all or part of her conversational partner's preceding utterances when agreeing or affirming what they said as shown in the Extract 5.

Extract 5

1	N:	(And like) And on the raw mango some (something) something spice was there.
2	Adult:	Something spicy was there?
3	N:	Spicy was there.

This communication behavior could be either residual effect of earlier intervention for echolalia or self-generated compensatory strategy for inadequate comprehension. She was also observed to use the conjunction 'but' inappropriately as a cohesive device- in linking her own utterances as well as in linking her utterances with those of her conversational partner's (e.g. line 7 in both Extract 6 and Extract 7).

Extract 6

1	Adult:	In your book, what other animals do you have other than cow and bull?
2	N:	(I don't) I don't have bull
3		(any) any animals I don't have
4		Only cow.
5	Adult:	Only cow you have?
6	N:	Ya.
7	Adult:	Okay.
8	N:	But I don't have one album.
9		I have only school books.

Extract 7

1	Adult:	Okay fine can you tell me some story in English?
2	N:	Or else I will talk about colouring.
3	Adult:	Okay talk about colouring then.
4		Tell me about colouring.
5	N:	(If) If we like to colour we can colour.
6	Adult:	Hmm.
7	N:	But we have so many colouring books in our home.

1.5.1.5. Need for Repetition

Occasionally, N was observed to require repetition of questions posed to her owing to inadequate comprehension. For example:

Extract 8

1	Adult:	Where is your house?
2	N:	Mysore only... Bogadi.
3	Adult:	Bogadi, that is where you stay.
4	Adult:	How did you come from there till here?
5	N:	Because my house is nearby here.
6	Adult:	How did you come?
7	Adult:	Did you come by car?
8	N:	I came by a car.

1.6. Relation Category

1.6.1. Poor Topic Maintenance

N was observed to have difficulty in maintaining a topic and she would drift off into talk in some way related to the original subject but irrelevant to the discussion. Extract 9 brings this feature of her conversation into focus:

Extract 9

1	Adult:	What do you like to draw the most?
2	N:	The most I like to draw scenery.
3	Adult:	Scenery?

4	N:	Ya.
5	Adult:	And a house?
6	N:	Ya
7		And I like to draw one temple.
8	Adult:	Temple?
9	N:	Ya in one hill.
10	Adult:	Okay.
11	N:	Chamundi hill/s.
12		I/'ve gone there.
13		(Then I) Then I told my mother "can I have raw mango"?
14		(Then) Then we both went there.
15		Then my father he was walking on the road.
16		Then he saw us both.
17		Then he also came.
18	Adult:	Really?
19	N:	(Then) (Then) Then my mother told "Do you want churmuri"?
20		I said "No".
21		Then I told my mother "I want raw mango".
22		I like raw mangoes
23		Even I like ripen mangoes.
24	Adult:	Hmm.
25	N:	(Then she) (Then) Then one uncle is there no, he give/s no?
26		He took one big piece of raw mango.
27		He cut like this {N shows cutting action with hand}.
28		(Then he)Then he made it like a flower like this {N makes flower shape with both hands}.
29		Then he put it on the cover.
30		And cover like this.
31		Then my mother took it.
32		Then we ate and we enjoyed.

Here, N is observed to gradually drift from the original topic of the conversation which was regarding the things that she was interested in drawing into a full narrative regarding a visit to Chamundi hills.

1.6.2. Failure to ask Relevant Questions

During conversation, N was not observed to request clarification even when it was evident that she had not fully comprehended what the speaker had said. When her conversational partner requested clarification, she usually repeated her utterance and then appended some extra information or she used non-verbal means to repair the conversation.

1.7. Manner

1.7.1. Turn-taking difficulty

In N's conversation with different conversational partners, significant overlap was observed at turn-exchange points with N talking over the other speaker and not allowing the other speaker a turn. Even when her conversational partner's turn was significantly underway, N would wrest the turn from her partner by interrupting the ongoing speaker (see Extract 1). She talked at length within one conversational turn and was observed to dominate the interaction overall by being verbose.

1.7.2. Linguistic non-fluency

N's production was interrupted by repetitions of words or phrases as can be seen by the frequency of mazes in her speech (indicated in parentheses) in extracts 3, 4 and 7.

1.7.3. Delays before responding

N showed awareness of the obligations of conversation and usually contributed immediately following an utterance from her conversational partner although delayed by slight non-fluency (see section 4.2.). However, she was also observed to sometimes fail to respond to a conversational cue from the other speaker thereby passing on the turn and appearing to have not paid attention to or to ignore the other speaker.

1.7.4. Syntactic and morphological errors

N exhibited difficulties with verb tenses, particularly irregular verb tenses as shown in extracts 10 and 11.

Extract 10

1	Adult:	Did you come by car?
2	N:	I came by a car.
3		My driver is there no he only drive.

Extract 11

1	N:	The most I like to eat: 05 beef.
2	Adult:	That is your most favorite thing?
3	N:	But I've never eat that.

1.7.5. Failure to structure discourse

Overall, N's discourse lacked organizational planning (as can be seen in Extract 9). Owing to this her conversational partner was often left confused as to what was being communicated.

2. Discussion

N presented a complex picture of linguistic behavior right from her first visit to speech and hearing center at the age of 2;9 years through several visits till she reached 8;4 years. Clinical linguistic analyses of spoken language corpus of N at every stage of her visit was carried out since the initial information from standard language tests was inadequate to arrive at a diagnostic label for the condition. Initial language tests and auditory processing tests revealed that N had no notable receptive or associated processing deficits. However, N showed a slight delay in expressive language as per test results. Further her parents reported poor sentence comprehension. A search through characteristic features of mixed semantic pragmatic disorder typical of specific language impairment (SLI) as reported by Rapin & Allen (1983) although was a close match to her clinical description, the label could not be confirmed in her succeeding visit as she caught up with typical children in her performance on language tests. Bishop (1989) reported of a boy who showed initial expressive language delay with mild social interaction problems similar to those seen in N. However, Van der Lely (1994) reported that the children with SLI continue to have residual language problems throughout life (Van der Lely, 1994) that probably negates the suspicion of SLI in N.

Specific auditory processing deficits are generally not reported in semantic pragmatic disorder. However, strong research exists on general processing deficits in SLI (Tallal et al., 1985). Kuppuraj & Prema (2013a) reviewed the studies on processing accounts of language impairment and reported that auditory processing deficits contribute only minimally to the language deficits in language-impaired children (see also Given, Wasseman, Chari, Beattie, & Eden, 2008). Therefore, the typical auditory processing scores of N are unlikely to make significant contribution to diagnostic labeling. Nevertheless, the listening difficulties reported in N by parents could be considered from pragmatic perspective rather than auditory perspective as it turns out N's condition could be more of a pragmatic disorder.

During her second visit, N had age-appropriate language on standard language tests. N could talk in longer sentences with adequate grammatical morphemic usage. The typical morpho-syntax usage of N correlates with her adequate procedural memory (e.g., Lum et al., 2012). N had normal ability to implicitly predict and learn the pattern of non-verbal sequences (the process that relies on procedural memory).Ullman &Pierpont(2005) in their hypothesis for grammatical problems in SLI attributes the grammatical morphemic marking difficulties in language impairment to their procedural memory deficits. Kuppuraj & Prema (2014) further found a relation between procedural memory and recursiveness (combining phrases) in language. Therefore, the good procedural memory in N could be matched with observations made on MLU (words & Morphemes) and TTR of N suggesting that N has an adequate structural language system and her deficits are due to factors beyond structural aspects of language.

Detailed conversational analysis focusing on semantic and pragmatic aspects of N showed that N engaged in conversations with a lot of information redundancy. Adams (2001) reported similar findings in her case reports of semantic pragmatic language disorder (SPLD henceforth). In the present report, it is observed that N failed to provide significant information to listener. The lack of significant information provided by N, such as the one shown (see extract two), resembles the story-retelling in children with pragmatic language impairment (PLI) reported by Conti-Ramsden, Crutchley, & Botting (1997). Conti-Ramsden and colleagues reported that children with PLI provide less information in a story-telling task compared to children with SLI. In general, children with SLI produce far less information rich utterances compared to typical children (Merritt & Liles, 1989; Weaver & Dickinson, 1982). In extract 3, as N talks about putting a picture of a cow in her school book she refers to 'they' (line 6) for which there is no antecedent in her conversation. Adams(2001) found such poor referencing in children with semantic-pragmatic language disorder (SPLD).

In the present report, N exhibited inappropriate cohesion. Merritt and Liles (1989) have reported inappropriate cohesion as a conversational behavior in SPLD. Adams (2001) also reported fewer cohesive ties compared to typical children in SPLD. In contrast, however, Adams & Bishop (1989) reported that children with SPLD show no difference compared to typical children in cohesion usage in conversation. Poor topic maintenance has been reported as consistent conversational behavior of SPD (semantic pragmatic disorder) or SPLD (Rapin & Allen, 1983,1987; Adams & Bishop, 1989; Bishop & Adams, 1989). N's failure in asking relevant questions for clarifications and repeating her own utterance when conversational partner asked for clarification has been reported as a feature of SPLD by Bishop & Adams (1989). Leinonen & Letts (1997) also found fewer requests for clarification of information in children with SPLD than typical children. They attributed it to the experience of communication failure these children had throughout development. They proposed such communication failures might have led to reduced confidence in asking for communication clarifications in these children.

N also demonstrates minimal structural deficits such as formation of irregular verbs in English. On the outside it might look like a syntactic error, which contradicts our earlier findings on procedural memory (recursiveness) and good MLU scores. However, as per declarative procedural model (Ullman, 2001) or in general, any dual mechanism model, such irregular word forms are stored in declarative system (lexicon), based on which, in the current report we could consider that as a semantic deficit rather than a syntactic deficit. The fact that the procedural learning is intact further substantiates this premise. We wish to argue that many pragmatic deficits in N would, in fact, be caused by her poor semantic abilities.

Even though, N's condition shows itself to be a perplexing developmental language disorder, diffusing into almost all domains of language and social interaction, practically it is not unusual to see a developmental condition with such diversified impairment of domains. N could well satisfy the hypothetical presentation of SPLD generated by Bishop (1989) for her discussion (the characteristics are the social interaction problem, occasional echolalia, initial receptive and expressive language deficits).

One persistent issue to be addressed in case reports on SPLD (such as the present case) is, whether the core deficit is in the semantic or pragmatic domain. Bishop, Chan, Adams, Hartley, & Weir (2000) indicated that SPLD children do not always have additional semantic problems (or grammatical problems also). Hence, Bishop (2000) proposes a label to this new group of children- pragmatic language impairment (PLI).N was also observed to occasionally fail to respond to questions posed to her, the behavior which is earmarked as one of the pragmatic features noted by Adams (2012) in children with PLI. The overall lack of organizational planning in her discourse is also a feature attested in PLI by Adams (2012). Adams (2001) describes these SPLD children as relatively quiet and show less confident and at times verbose too, because of compensatory strategies employed during conversation to mask the semantic word retrieval struggle. However, in the present report, the analysis does not give confirmatory support on this argument; as a whole, any pragmatic problems in N could be explained using underlying semantic deficits.

The present report is an attempt to profile the linguistic behaviors of a child with a developmental language disorder who is predominantly an SPLD. The case report also illustrates the need for conversational analysis, which could offer qualitative analysis of the linguistic behavior of these children. The present case report also shows how a test battery including auditory processing tests and procedural memory tests can exclude some suspicions of processing and syntax deficits in developmental disorders. N is expected to perform better on her semantic abilities if a semantic/syntactic bootstrapping strategy is taught to her to interpret the meaning of a word in the context. Though such bootstrapping is implicit in typical children, N might need to be taught to apply bootstrapping explicitly. N was also given pragmatic intervention strategies focused on improving her story-listening comprehension, turn taking /conversational rules, topic management in conversation, listening strategies and narrative organization using meta-pragmatic therapy and her thinking, imagination.

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Speech rhythm in Kannada speaking children aged 7-8 years

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Abstract

Rhythm, a prosodic feature, refers to an event repeated regularly over a period of time. It depends on language and the types of syllables used in a language. While the rhythm of several languages as evident by adult speakers has been classified as syllable-, mora-, and stress-timed, that in children is not much investigated. The present study investigated the type of speech rhythm in typically developing Kannada speaking children in the age range of 7-8 years using fundamental frequency (F0) and intensity (I0) measurements. Thirty children, 15 boys and 15 girls, participated in the study. Picture stimuli depicting simple stories developed by Rajendra Swamy (1991) were used. A five minute speech sample of the participants describing these stories were audio-recorded with a digital voice recorder at a sampling frequency of 44,100 Hz. Using Praat, the utterances were then analyzed to extract maximum F0 and I0 for each vocalic and intervocalic intervals. The Pair wise Variability Index (PVI) for F0 and I0 were calculated. Overall vocalic PVI for F0, ranged from 0.023 to 0.119 with a mean of 0.056 and that for intervocalic intervals ranged from 0.039 to 0.161 with a mean of 0.073. With respect to intensity measures, PVI for vocalic intervals ranged from 0.005 to 0.029 with a mean of 0.012 and that for intervocalic intervals ranged from to 0.013 to 0.068 with a mean of 0.036. Results revealed use of mora-timed rhythm.

Keywords: Rhythm, stress-timed, syllable-timed, mora-timed, Kannada.

1. Introduction

Rhythm, one of the prosodic features, refers to an event repeated regularly over a period of time. Languages are known to differ in their characteristic rhythm (Pike, 1945), and are organized under stress-timed, syllable-timed, and mora-timed (Hoequist, 1983; Low, Grabbe & Nolan, 2000). Rhythm depends on the types of syllables used in a language, where syllable is the smallest unit of speech production and can be thought of as constituting a

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vowel alone or a vowel in combination with one or many consonants (Small, 2012). If a language has simple syllabic structure, for e.g. V, CV or CCV, the durational difference between the simplest and most complicated syllable is not wide and it is possible to say that any syllable is less than 330 ms in duration. Thus, under these circumstances, one can use a fast ***syllable-timed rhythm***. If the syllables are still simpler, for example VC or CV, then the durational difference between syllables is negligible and one can then use a ***mora-timed rhythm***. If a language has complex syllables, for e.g. V and CCCVCC, the difference between syllables can be very wide. For example, the duration of syllable V (a) can be 60 ms and that of CCCVCC (strength - strent) can be 600 ms. In this condition, one has to use a slow ***stress-timed rhythm***. According to the ***rhythm class hypothesis***, (Abercrombie, 1967) each language belongs to one of the prototypical rhythm.

The development of concept on rhythm measurement was started with the concept of isochrony – i.e. each syllable has equal duration. Various measures [syllable duration by Abercrombie (1967); inter-stress interval by Roach (1982); % V and SD of consonant intervals by Ramus, Nespor & Mehler (1999); Pair-wise Variability Index by Low (1998)] were used in the past to measure speech rhythm and classify it. The Pair-wise Variability Index (PVI) is a quantitative measure of acoustic correlates of speech rhythm and it calculates the patterning of successive vocalic and intervocalic intervals. Low, Grabe & Nolan (2000), using PVI indicated the possibility of classifying rhythm as in Table 1.

Table 1. Classification of rhythm based on PVIs.

	Intervocalic Interval (IV)	**Vocalic Interval (V)**
Stress-timed	High	High
Syllable-timed	High	Low
Mora-timed	Low	Low

In the Indian scenario, there have been a number of attempts at examining rhythm manifestations in adults and in young children using PVIs of vocalic and intervocalic interval durations. Hindi has been reported to be a syllable-timed language (high rPVI and low nPVI) and Kannada to be a mora-timed language (low rPVI and nPVI) [Savithri, Jayaram, Kedarnath and Goswami, 2006]; Assamese, Punjabi, Telugu, Marathi and Oriya were reported to be Mora-timed, and Bengali, Kodava, Malayalam, Tamil and Kashmiri to be Syllable-timed, and Rajasthani and Gujarathi unclassified (Savithri, Goswami, Maharani, and Deepa, 2007). Savithri and Sreedevi (2012) reported a developmental trend in speech rhythm in Kannada speaking children in the aged between 3-12 years and indicated that the PVIs increased from 3-4 years to 11-12 years though not linearly.

Literature documenting rhythm research is fraught with inconsistencies. While Ramus et al. (1999) conclude that %V and ΔC are the best metrics to classify rhythm of a language, Grabe and Low (2002) showed that the PVIs offered different classification for the same language. For e.g., PVIs classified Thai as stress timed while %V and ΔC classified it as syllable-timed. While

%V-ΔC classify Japanese distinctly as having mora-timed rhythm, PVI scores show Japanese as being syllable-timed. It has also been shown that durational metrics are vulnerable to method of elicitation of speech samples (for e.g., spontaneous speech, read text and read sentences) and kind of material used (Arvaniti, Ross & Ferjan, 2008). These discrepancies might lead one contemplate the role of intensity (I0) and fundamental frequency (F0) which also contribute to perception of prosodic prominence. Certain languages are known to use these parameters in varying extent to produce lexical stress and sentence accent. Alcoba and Murillo (1998) report that, in Spanish, F0 is used as a primary marker of lexical stress and that duration and intensity are relatively unimportant secondary cues. In varieties of English spoken in British Isles, duration and intensity are considered to be primary cues for lexical stress rather than F0. Ditto applies to Indian languages such as Kannada, a Dravidian language (Rathna, Nataraja & Subramanyiah, 1982). [Kannada is spoken predominantly in the state of Karnataka, India. The language has roughly 40 million native speakers who are called Kannadigas; https://en.wikipedia.org/wiki/Kannada].

In a study on acoustic and perceptual correlates of stress in Kannada language, Savithri (1987) reported lengthened word duration, shortening of stressed word, prolongation of the stressed word, extra effort in production, pause before or after stressed word, raising or falling intonation in stressed word and articulation as perceptual correlates and lenthening of duartion, increase in fundamental frequency and intensity as acoustic correlates. Thus, changes in duration, pitch and loudness were observed to be major cues for perception of stress. In another study, Savithri (1999) investigated relative importance of F0, intensity and duration in the identification of word stress in Kannada language. The results indicated that increments in duration were were a major cue, followed by increments in F0 and intensity. Likewise, Manjula (1997) studied acoustic correlates of stress in WH and Y-N interrogatives in Kannada and found that F0, intensity and duration played an important role in stress perception. A study by Rohini (2006), on stress perception in normals and patients with cerebro-vascular accidents also revealed similar findings although duration seemed to the most important cue. That, the role of markers of prosodic prominences such as F0 and intensity need to be investigated to advance our understanding of rhythm has been emphasized by Kohler (2009), Arvaniti (2009), Cumming (2011) and Fuchs (2014).

Cumming (2011) played pairs of syllables varying in F0 and duration to speakers of Swiss German, Swiss French and French and then asked them to determine the longer syllable of the two. İt was assumed that, speakers of languages where dynamic F0 and increased duration both occur simultaneously to indicate prominence or vowel length, would judge syllables with dynamic F0 to be longer. In French, all stressed syllables are characterised by dynamic F0 but not necessarily increased duration. However, in German, both cues co-occur. İt was seen that, in all language groups, the number of dynamic F0 stimuli was judged as being longer than level F0 stimuli (D>L) and this response was regardless of the native language of the speaker.

In an effort to quantify the influence of differences in mean F0 on perceived duration (as against acoustic duration) Fuchs (2014) converted the influence into a quantitative measure, by modifying the original nPVI-V formula proposed by Grabe and Low (2002) to the new nPVI-V formula (dur * F0) in British English (BrE) and Indian English (InE). Two experiments were conducted in the study. The first experiment was a binary forced choice listening experiment in which syllables of varying duration and F0 were presented. Participants had to decide if the second syllable presented was longer or shorter than the first. Results revealed that, when F0 of the second syllable was increased by 60 Hz, it was perceived 8 ms (4%) longer than the first syllable. Likewise, if second syllable had 60 Hz lower F0 than first; it was perceived as 8 ms or 4% shorter than the first. The second experiment dealt with integrating the influence of F0 on perceived duration into the PVI. The results confirmed that, in comparison with InE, BrE exhibited more variability in perceived duration (considering the influence of F0) than acoustic duration. The difference in variability of perceived duration was found to be 6.6% higher than the difference in acoustic duration.

Mori, Hori and Erickson (2014), taking a leaf out of observation of Kohler (2009), investigated the role of F0, intensity and vowel quality in differentiating the English Rhythm of Americans from that of Japanese. Maximum F0, maximum intensity and duration of all the vowels in target sentences spoken by the two groups of subjects were measured. In order to examine vowel quality, maximum F_1 values for all vowels were noted. The acoustic measurements were normalised to remove inter-speaker variability. Two types of sentence stress were studied: Non-stress clash situation (where monosyllabic content and function words alternate) and stress clash situation (where stressed syllables occur successively). In non-stress clash situation, for American speakers (AS), the vowels in content words were twice as long as those in function words, resulting in alternating long-short vowels. However, Japanese speakers (JS), did not show such duration-related changes. Instead, their rhythmic pattern was characterised by recursive high-low F0. In stress-clash situation, AS showed recursion of strong-weak syllables by means of F0, intensity and first formant, whereas JS showed inconsistent stress patterns. These results showed that AS and JS employed different strategies for implementing rhythmic alternation.

Results of all these studies emphasize the role of various other phonetic constituents such as F0 and intensity, apart from duration, in speech rhythm and hence necessitate their need to be investigated. However, such studies in Indian languages and more so in Kannada have found to be wanting. Thus, keeping up with the paradigm shift on rhythm research in various languages of the world, the present study investigated the PVIs of fundamental frequency (F0) and intensity (I0) in speech rhythm of typically developing Kannada speaking children in the age range of 7-8 years. The results of the current study were compared with a parallel study on rhythm development in 7-8 year old children that considered duration as the identifying parameter of rhythm (Savithri et. al. 2012). As the latter study reported significant gender difference, and as it is known that girls perform better than boys in almost all aspects of speech and language (Eriksson et. al., 2012; www.sciencedaily.com/releases/2008/03/080303120346.htm),

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the data of the present study were also compared between boys and girls to evaluate for the same. The present findings are a part of a major project funded by the Department of Science & Technology (DST), which investigates the development of speech rhythm (F0, and I0) in Kannada speaking children aged 3-12 years.

2. Methodology

2.1. Participants

Thirty Kannada speaking normal children, 15 boys and 15 girls, in the age range of 7-8 years participated in the study. A screening checklist developed by the Department of Prevention of Communication Disorders at the All India Institute of Speech and Hearing, Mysuru (2010) to identify communication disorders in school children was administered by a Speech-Language Pathologist to ensure that the participants did not have any history of speech, hearing or cognitive impediments.

2.2. Material and Recording

Picture stimuli depicting simple Panchatantra stories developed by Rajendra Swamy (1991) were used. The participants were tested individually and were visually presented with the pictures. They were instructed to see the picture carefully and describe the story depicted by the pictures. Prompting was used when the child did not respond. Five-minute speech sample of each child was elicited and audio-recorded. All speech samples were recorded on to a digital recorder Olympus LS-100 at a sampling frequency of 44,100 Hz.

2.3. Analyses

The speech sample were transferred on to PRAAT (Boersma & Weenik, 2009) software and displayed as a waveform along with fundamental frequency (F0) and intensity (I0) displays. Using Praat, the peak F0 and I0 for each vocalic (V) and intervocalic intervals (IV) were extracted. İntervocalic intervals include both voiced and unvoiced consonants. Peak F0 was measured only for voiced consonants. In Kannada, there are 16 stops, out of which eight are unvoiced [k, kh, ʈ, ʈh, t̪, t̪h, p,ph] and eight voiced [b, bh, g, gh, ɖ, ɖh, d̪, d̪h] (Deepa & Savithri, 2006). There are four affricates out of which – two are voiced [dʒ, dʒh] and two unvoiced [tʃ, tʃh]. Out of the four fricatives, one is partially voiced [h], while the other three are unvoiced [s, ṣ, ʃ]. Measurement procedure was carried out as described by White and Mattys (2007). Vowel-consonant boundary was identified by end of the pitch period before a break in the formant structure and significant reduction in the waveform amplitude. Fricatives could be easily identified by visible frication. Likewise, nasals could be distinguished by their nasal formant structure and reduced amplitude. The consonant vowel boundary could be identified by beginning of pitch period and a definite vocalic formant structure. Separating glides and liquids from vowels was a delicate issue. If the formant structure and amplitude of the two consonant classes were clearly distinguishable from the neighbouring vocalic strutures, they were included under intervocalic/consonantal interval. If not, they were measured under vocalic interval. Figure 1 illustrates extraction of peak F0 and I0 at each of the vocalic (V) and intervocalic (IV) intervals in the sentence [ondu:ralli ondu ka:ge ittu].

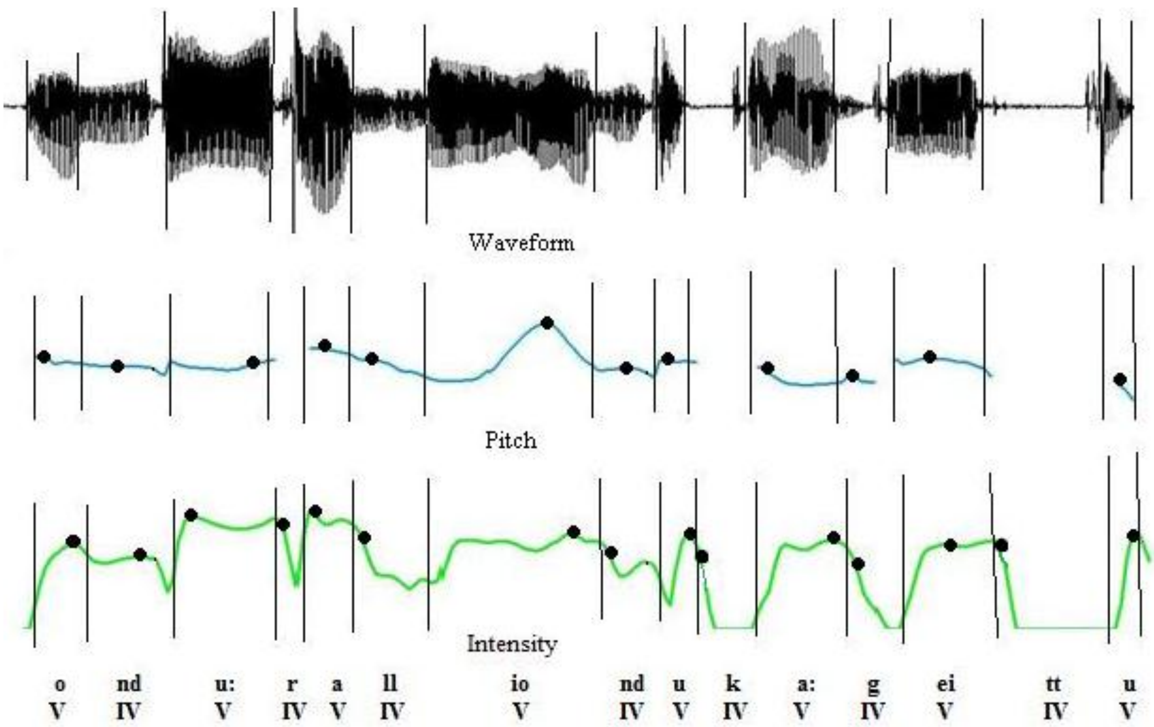

Figure 1. Illustration of extraction of peak F0 and I0 at each of the vocalic and intervocalic intervals.

The F0 and I0 difference between successive vocalic and intervocalic segments were calculated and averaged to get normalized PVI (NPVI). F0 was not measured in case of unvoiced phonemes and hence was left out. Therefore, F0 measurements were considered as successive between the voiced intervocalic intervals only. Pair wise Variability Index (NPVI) developed by Grabe and Low (2002) was used as a measure of rhythm. The NPVI for F0 and I0 were measured using the following formulae-

$$\text{NPVI f0} = \left[\sum_{k=1}^{m-1} \left|\frac{f_k - f_{k+1}}{(f_k + f_{k+1})/2}\right| /(m-1)\right] \quad \text{and} \quad \text{NPVI i0} = \left[\sum_{k=1}^{m-1} \left|\frac{i_k - i_{k+1}}{(i_k + i_{k+1})/2}\right| /(m-1)\right]$$

where 'm' is the number of vocalic/ intervocalic intervals and 'f' and 'i' are fundamental frequency and intensity, respectively at the k^{th} interval. The PVIs were not multiplied by 100 in the present study.

3. Findings

The results indicated that the mean NPVIs for F0 at vocalic (V PVI) and intervocalic intervals (IV PVI) were 0.055 and 0.078, respectively in boys and 0.057 and 0.069 respectively, in girls. The mean NPVIs for I0 at vocalic and intervocalic intervals were 0.009 and 0.049, respectively in boys and 0.014 and 0.022, respectively in girls. The lowest VPVI in boys was 0.02 and the highest was 0.12.; that for IVPVI was 0.04 and the highest was 0.16. In girls, the lowest and highest VPVI was 0.037 and 0.077; also the lowest and the highest IVPVI were 0.04 and 0.09. The Standard Deviation for NPVI on F0 in girls was lower than that in boys.

VPVI for I0 in boys ranged from 0.0099 to 0.01; IVPVI ranged from 0.03 to 0.057. VPVI for I0 in girl ranged from 0.0088 to 0.0295; IVPVI ranged from 0.0131 to 0.0417. The Standard Deviation in girls was higher than that in boys. Tables 2 and 3 show the PVIs in 7-8 year old boys and girls for F0 and I0 respectively. Figures 2 and 3 represent the PVIs of F0 and I0.

Table 2. NPVI for F0 in boys and girls aged 7-8 years.

Sl. No.	**VPVI**		**IV PVI**	
	Boys	**Girls**	**Boys**	**Girls**
1.	0.033	0.0451	0.059	0.0585
2.	0.119	0.0476	0.161	0.0407
3.	0.0418	0.0554	0.0675	0.0850
4.	0.0408	0.0581	0.0631	0.0747
5.	0.0429	0.0497	0.0729	0.0531
6.	0.0592	0.088	0.0924	0.0984
7.	0.0507	0.0373	0.0606	0.0547
8.	0.0233	0.0575	0.0397	0.0460
9.	0.0921	0.0516	0.1415	0.0717
10.	0.039	0.050	0.052	0.0868
11.	0.0333	0.0771	0.0502	0.0916
12.	0.0421	0.0538	0.0769	0.0784
13.	0.0751	0.0663	0.0805	0.0762
14.	0.0553	0.0639	0.0609	0.0740
15.	0.083	0.0610	0.0943	0.0567
Avg.	0.055	0.078	0.057	0.069
SD	0.026	0.013	0.033	.017

Table 3. NPVI for I0 in boys and girls aged 7-8 years.

Sl. No.	**VPVI**		**IV PVI**	
	Boys	**Girls**	**Boys**	**Girls**
1.	0.0078	0.0108	0.0545	0.0177
2.	0.0099	0.0088	0.0488	0.0131
3.	0.0107	0.0092	0.0567	0.0149
4.	0.0124	0.0105	0.0557	0.0190
5.	0.0094	0.0134	0.0427	0.0144
6.	0.008	0.0081	0.0498	0.0145
7.	0.0091	0.008	0.0327	0.0155
8.	0.0062	0.0074	0.0525	0.0158

9.	0.0089	0.0088	0.0437	0.0168
10.	0.0059	0.0091	0.0481	0.0167
11.	0.0099	0.0219	0.0571	0.0417
12.	0.0088	0.0184	0.0449	0.0266
13.	0.0091	0.0295	0.0393	0.0413
14.	0.0111	0.0284	0.0483	0.0409
15.	0.0208	0.0189	0.0681	0.0282
Avg.	0.009	0.014	0.049	0.022
SD	0.003	0.007	0.009	0.011

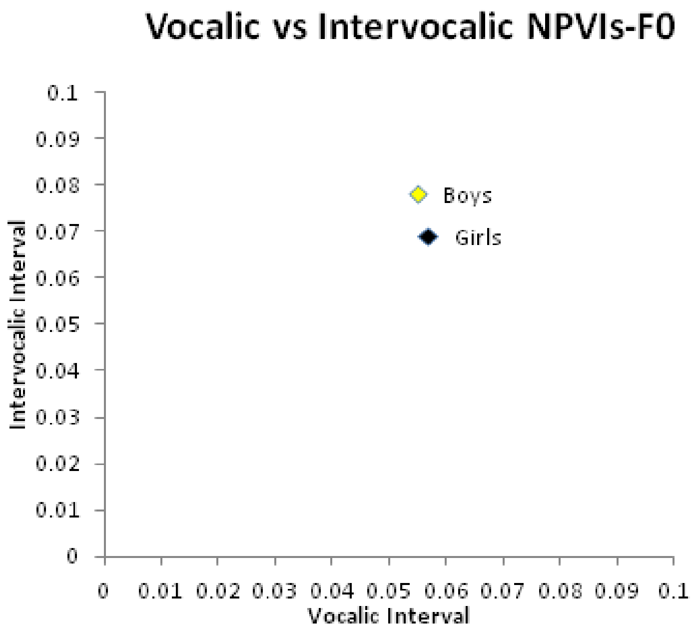

Figure 2. NPVI for F0 in boys and girls.

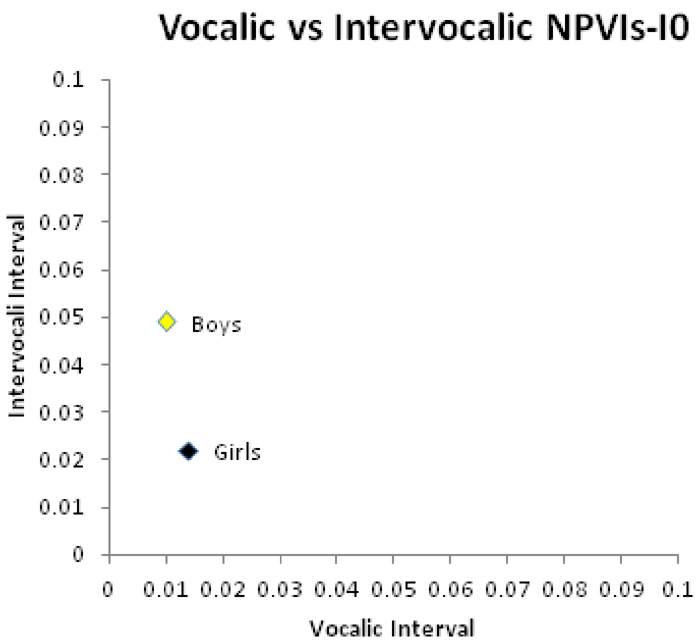

Figure 3. NPVI for I0 in boys and girls.

The PVIs for F0 were scattered widely in boys compared to those in girls. PVIs for I0 were scattered widely in girls compared to those in boys. Figures 4 and 5 represent the scatter-plots of VPVI (vocalic PVI) and IVPVI (intervocalic PVI) for F0 and I0, respectively in 7-8 year old boys and girls.

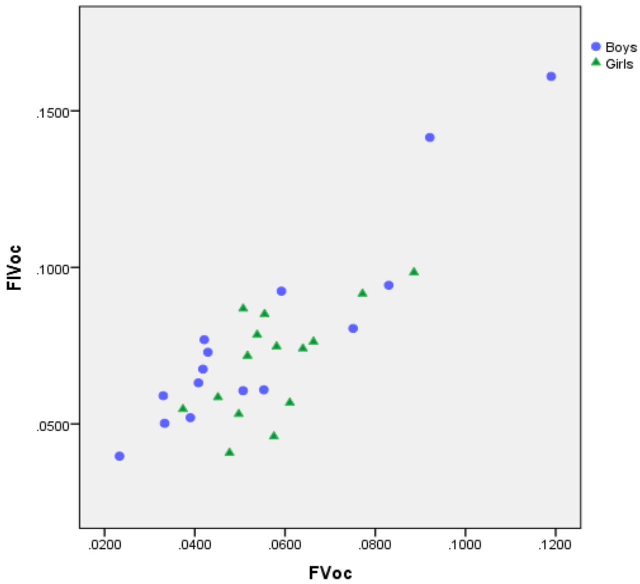

Figure 4. Scatter plot for VPVI (Fvoc on X-axis) and IV PVI (FIVVoc on Y-axis) for F0 in boys and girls.

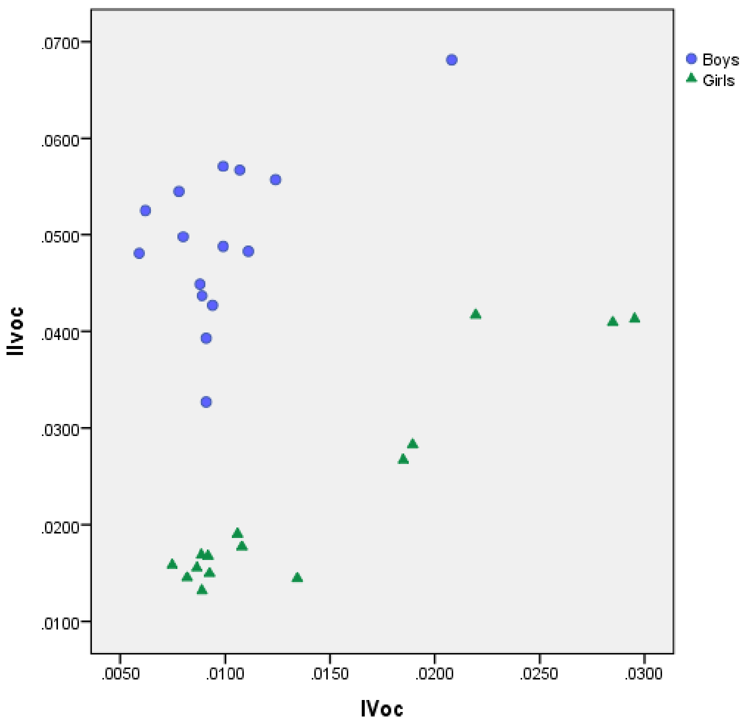

Figure 5. Scatter plot for VPVI (Ivoc on X-axis) and IV PVI (Iıvoc on Y-axis) for I0 in boys and girls.

3.1. Comparison for NPVIs across F0, I0 and duration

Results of Mann-Whitney test showed significant difference between genders on IVPVI for I0 [$|Z|$= -4.417, $p<0.01$]. Boys had significantly higher IVPVIs as compared to girls.Results of Wilcoxon Signed Ranks revealed that both boys and girls showed significantly higher NPVIs for F0 as compared to I0 in both genders (for VPVI, [$|Z|$=3.408; $p<0.05$; for IV PVI; [$|Z|$= 3.408, $p<0.05$]. Table 4 show the PVIs in 7-8 year old boys and girls for duration. The data on PVIs of duration from a previous study by Savithri et. al. (2012) was compared with PVIs of F0 and I0 so as to obtain a holistic view of the role of the three parameters in rhythm in 7-8 year old speaking Kannada language. Results of Mann-Whitney test revealed a significantly higher PVIs on F0 [for VPVI, [$|Z|$=4.542; $p<0.05$; for IV PVI; [$|Z|$=4.169, $p<0.05$] and I0 [for VPVI, $|Z|$=4.667; $p<0.05$; for IV PVI; [$|Z|$=4.667, $p<0.05$] in boys. Similar finding was observed for girls for both F0 [for VPVI, [$|Z|$=4.666; $p<0.05$; for IV PVI; [$|Z|$=4.666, $p<0.05$] and I0 [$|Z|$=4.666; $p<0.05$; for IV PVI; [$|Z|$=4.666, $p<0.05$].

Table 4. NPVI (VPVI refers to Vocalic PVI and IVPVI refers to Intervocalic PVI) for duration in boys and girls aged 7-8 years.

Sl. No.	VPVI		IV PVI	
	Boys	**Girls**	**Boys**	**Girls**
1.	0.185	0.194	0.187	0.209
2.	0.192	0.183	0.187	0.216
3.	0.169	0.239	0.18	0.228
4.	0.187	0.286	0.189	0.3
5.	0.171	0.256	0.189	0.245
6.	0.139	0.196	0.139	0.211
7.	0.202	0.227	0.189	0.248
8.	0.153	0.176	0.150	0.194
9.	0.110	0.184	0.108	0.2
10.	0.097	0.273	0.091	0.313
11.	0.149	0.263	0.148	0.264
12.	0.158	0.245	0.164	0.293
13.	0.111	0.186	0.111	0.196
14.	0.211	0.18	0.184	0.195
15.	0.165	0.174	0.165	0.19
Avg.	0.16	0.217	0.159	0.233
SD	0.034	0.04	0.033	0.042

4. Discussion

The results revealed several ineteresting points. First of all, the results indicated ***low vocalic and intervocalic NPVI for F0 in boys and girls*** which suggest a mora-timed rhythm in Kannada speaking children in the age range of 7-8 years. On an NPVI-vocalic/intervocalic plane, data points falling close to 1 were considered to reflect high PVIs, while those falling less than 0.5 were considered to reflect low PVIs. Ergo, from the analsyis of mean

NPVI values from tables 2 and 3, it is safe to assume that the children exhibited mora-timed rhythm. The results are in consonance with those of Savithri et al (2012). Data of Savithri et al (2012) were re-calculated and it was observed that the mean vocalic and intervocalic NPVIs for boys were 0.16 each and that for girls were 0.22 and 0.23, respectively. According to rhythm class hypothesis (Abercrombie, 1967), a language with high PVIs can be classified to have stress-timed rhythm, low PVIs as mora-timed and high intervocalic PVI, low vocalic PVI as syllable-timed. None the less Standard Deviation of PVIs for F0 was higher in boys compared to girls. Higher standard deviations indicate greater variations between PVIs of participants. This may reflect the fact that boys had greater variation in F0 within themselves. Combining the SD with average PVI (higher in boys compared to girls), it may be possible that some boys had better intonation pattern than others. SD of PVIs for I0 was significantly higher in girls compared to boys. Combining the SD with average PVI (higher in girls for VPVI and higher in boys for IVPVI), it may be postulated that some girls had better intensity variations than others. Also girls might have used different intervocalic intervals compared to boys. Intervocalic interval dictates the intensity; for example intensity is higher for fricatives, and laterals compared to stop consonants. Figure 6 illustrates the VPVIs for F0 in boys. It can be observed that participants 2,6,9,13,14 and 15 have higher VPVIs and participants 1, 8, and 11 have lower VPVIs and others have in between VPVIs for F0.

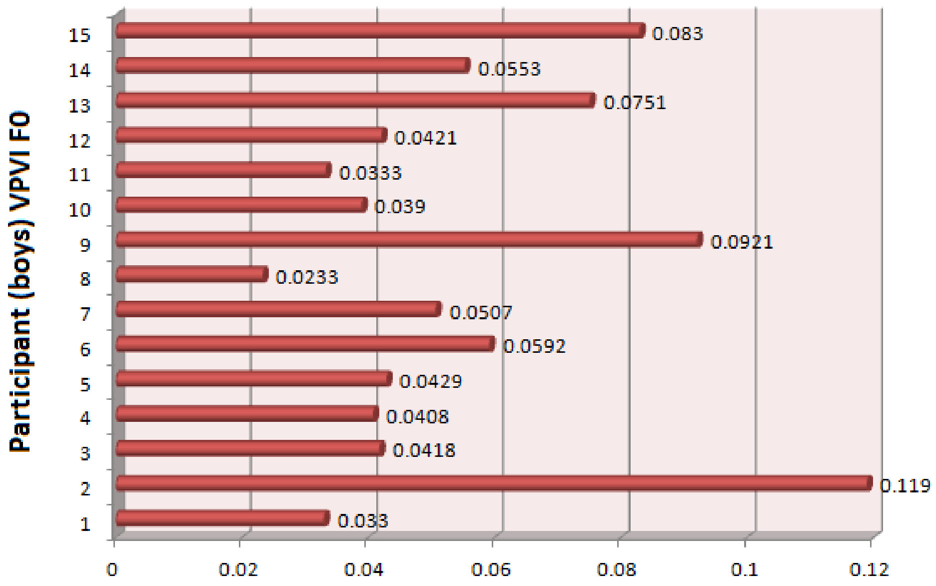

Figure 6. VPVIs for F0 in boys.

On the other hand, in girls, it can be observed that, except participant 6 and 11, most of them have similar VPVIs. Figure 7 illustrates VPVIs in girls.

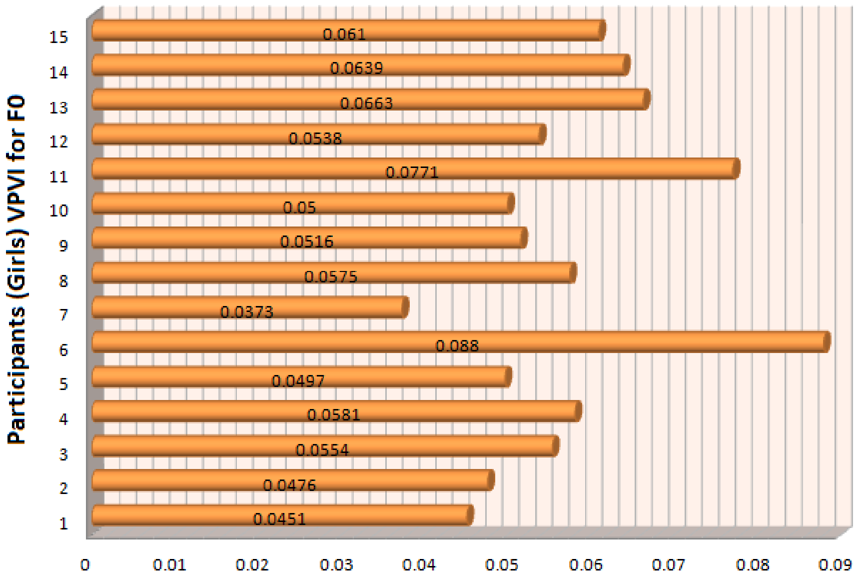

Figure 7. VPVIs for F0 in girls.

Second, ***scattering of PVIs on F0 was wider in boys compared to girls indicating high variations in the usage of F0 within boys***. Results of the study by Willis and Kenny (2007) in boys and girls (average age in boys = 12.11, average age in girls = 13.0) indicated higher SD on F0 in boys (43.8) compared to girls (16.1) in a reading task and counting task (boys = 39.8; girls = 19.6). The finding also draws significant parallels with reports of Lee, Potamianos, and Narayanan (1999) who investigated changes in magnitude and variability of fundamental frequency along with various other acoustic parameters such as duration, formant frequencies etc. in the speech of 436 children, aged 5 to 17 years as a function of age and it was reported that among boys, significant pitch decrease/variations existed during two periods; from age 6- 8 years and from age 12-15 (i.e. during puberty). However, for girls, significant difference within-subject variability existed only between ages 10 – 14 years. Abrupt variations in the fundamental frequency of 8 and 10 year old boys have also been documented by Whiteside and Hodgson (1999). The accelerated F0 changes have been attributed to increased rate of laryngeal growth and use of intonation patterns that were different from girls.

Third, ***boys had significantly higher IVPVI on IO compared to girls***. This may reflect that variations in intensities of intervocalic intervals in boys were noticed more than those in girls. It is possible that boys used all intervocalic intervals that varied in intensities which the girls did not. Analyses of intervocalic intervals used by boys and girls indicate that boys used more percent trills and affricates compared to girls. Table 5 shows the percent use of various phonemes by boys and girls in the corpus.

Table 5. Percent use of various phonemes by boys and girls.

	Stops	Nasals	Trills	Laterals	Affricates	Fricatives
Girls	52.7	24.5	7.5	10	0.37	5.1
Boys	53.0	25.0	8.7	8.0	0.47	4.3

Further, results of t-test showed significant difference (P<0.05) between gender on laterals and affricates; girls used significantly higher percent of laterals and boys used significantly higher percent of affricates in the corpus. Gelfer and Young (1997) examined the variability of their subjects' comfortable speech intensity and reported that the mean SPL range associated with conversation level reading of young adult subjects to be from 61.5 dB (SD=3.1) to 80 dB (SD=3.6) for men and from 60.4 dB (SD=3.1) to 77.2 dB (SD=2.8) for women indicating higher intensities in men compared to women.

Fourth, ***PVIs for F0 was significantly higher compared to those for I0***. According to Fant (1960), contrastive to large changes in F0 in connected speech, an increase in voice level at a constant pitch will only cause an increase of 4 dB. Similar changes occur for the shift from a medium to a low voice effort.

The results of the present study were compared with those of the study by Savithri et al. (2012) on PVIs for duration. It was observed that PVIs on duration were significantly higher than those on F0 and I0. Results of study by Nataraja and Savithri (1990) indicate that the F0 range in speech was 304 Hz (adult females) and intensity range was 22 dB. Compared to duration, F0 and intensity do not change much. Pepiot (2014), reported an F0 range of 90 Hz and 41 Hz, respectively in adult female and male American English speakers and an F0 range of 74 Hz in females and 40 Hz in male French speakers. A longitudinal study by Bennet (1983) on children aged between 8-11 years old reported that the 8-, 9- 10- and 11- year olds exhibited an F0 range of 204-270 Hz, 198-264 Hz, 208-259 Hz and 195-259 Hz respectively. Also, while calculating NPVIs in duration, the difference between successive intervals roughly equalled the average of two successive intervals, thereby yielding higher NPVIs, which was unlikely in case of F0 and I0.

Results of Savithri et al. (2006) in adults speaking Kannada revealed higher vocalic PVI compared to intervocalic PVI. However, in the present study the vocalic PVI (for F0 and I0) was lower than that of intervocalic PVI. Figure 8 shows a comparison of the results of the present study with that of Savithri et al. (2006).

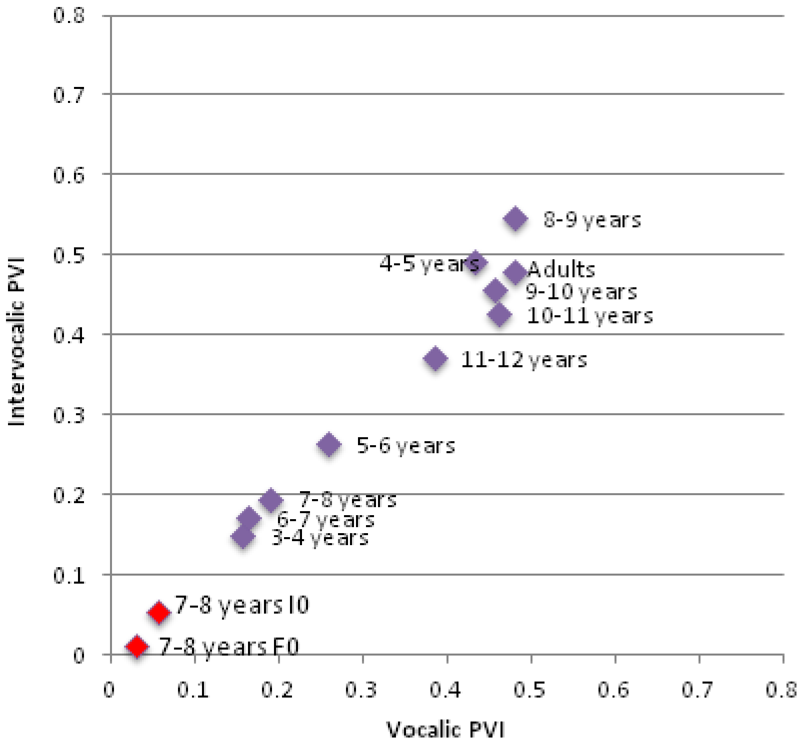

Figure 8. PVIs for duration in children (blue colour) and adults speaking Kannada and PVI for F0 and I0 (red colour).

The study also sought to compare the findings with those of Grabe and Low (2002) in order to study the rhythm of Kannada in relation to other langugaes of the world. Grabe and Low (2002) extracted vocalic and intervocalic PVIs of different languages of the world and reported stress-timed rhythm in British English, German, Dutch and Thai; syllable-timed rhythm in Tamil, Spanish, French, and Singapore English; mora-timed rhythm in Japanese and mixed rhythm in Polish and Catalan. Figure 9 was prepared based on the data given by Grabe and Low (2002) in their article on Durational Variability in Speech and the Rhythm Class Hypothesis and the data of the present study along with that by Savithri et. al. (2012) on duration was inserted on the figure for a comparison. In the present study and in the study by Savithri et. al. (2012) all normalized values varied in the range of 0 to 1. Hence all these normalized values were multiplied by 1000 for the sake of comparison.

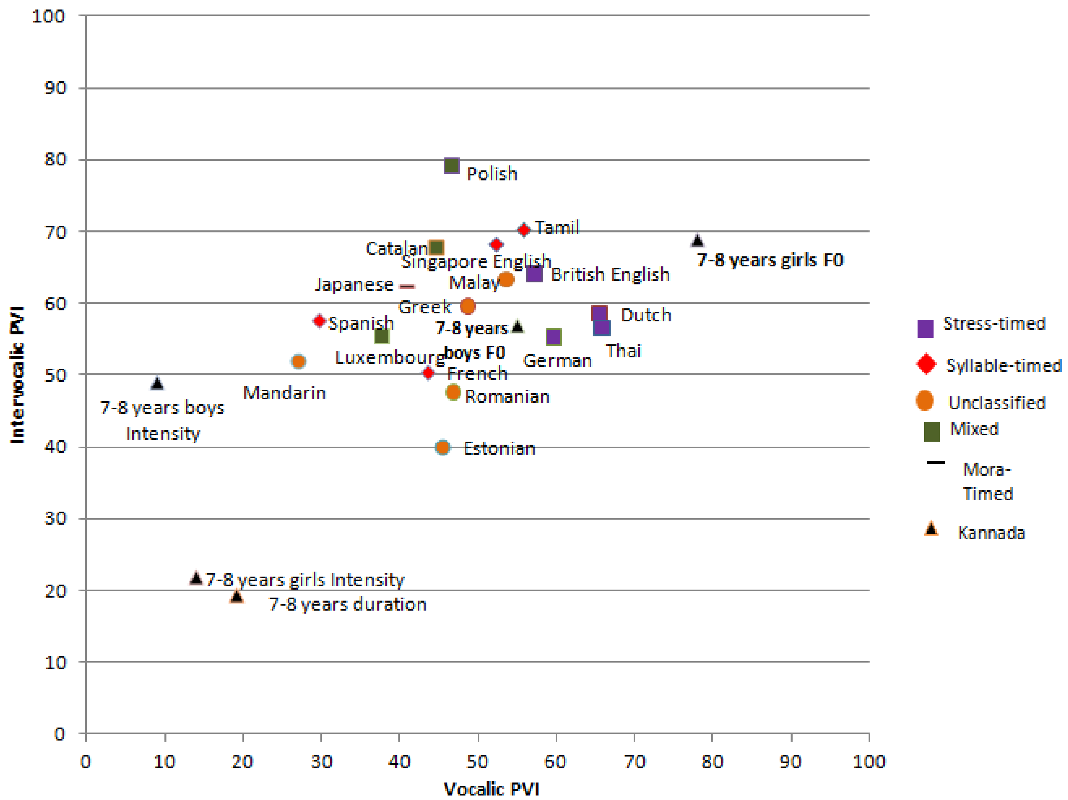

Figure 9. Vocalic and intervocalic PVIs in Kannada (F0, I0) and other languages (duration) of the world.

Comparing the data on F0 PVIs in Kannada with various languages of the world, one can observe that rhythm (F0) in 7-8 year old girls in the present study was closer to Dutch, Thai, British English and German which are all stress-timed languages. Further, rhythm (I0) in 7-8 year old boys in the present study was closer to Mandarin and the remaining had very low PVIs. It may be possible that the basis of the classification of speech rhythm in some of these languages is questionable.

5. Conclusions

The present study investigated speech rhythm in typically developing Kannada speaking children in the age range of 7-8 years using PVIs on F0 and I0. Unlike other researchers in the field, the PVIs for duration, interstress intervals, syllable durations, %V, ΔV, ΔC were not measured. This is the first study where F0 and I0 of vocalic and intervocalic intervals were measured from desriptions of pictures in children which may perhaps be better measurements for speech rhythm. Following this, the acoustic pair-wise variability index (PVI) was calculated which indicates the level of variability in vocalic and intervocalic intervals. The data strongly support a pronounced use of mora-timed rhythm in Kannada speaking children age between 7-8 years, especially in girls. These measures are also helpful in classifying the rhythm types in languages. The findings provide an insight into rhythm manifestations in young children and can be applied to assess persons with aprosody. For example, a speech-langauge pathologist can quickly assess the type of rhythm used in a child with speech/ language disorder and conclude whether it is normal or not. If found abnormal (other than mopa-timed in this case), efforts can be made to teach the child a mora-timed rhythm. Till date therapy on prosodics, especially rhythm, is scanty. A rhythm class can be stabilized only when one knows about the rhythm class used by a typical speaker of a particular language/ dialect/ age/ gender. Therfore, the results have positive implications for a speech-langauge pathologist. Rhythm can be taught to patients with aprosodia. For example, a visual feedback of almost equal F0 and I0 can be taught to a child aged 7-8 years with aprosodia speaking Kannada. Similarly atherapy using almost equal F0 and I0 can be helpful in children with stuttering. Future studies using PVIs in children of other age groups are warranted.

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