PHONETIC INFLUENCES ON ORAL READING IN KANNADA-SPEAKING CHILDREN WHO STUTTER

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JUNE - 2026

CERTIFICATE

This is to certify that this dissertation entitled **"Phonetic Influences on Oral Reading in Kannada-Speaking Children Who Stutter"** is a bonafide work submitted as part of fulfilment of the degree of Master of Science (Speech-Language Pathology) of the student with Registration Number: P01II24S123039. This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any other university for the award of any other Diploma or Degree.

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CERTIFICATE

This is to certify that this dissertation entitled "**Phonetic Influences on Oral Reading in Kannada-Speaking Children Who Stutter**" has been prepared under my supervision and guidance. It is also being certified that this dissertation has not been submitted earlier to any other university for the award of any other Diploma or Degree.

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DECLARTION

This is to certify that the dissertation entitled **"Phonetic Influences on Oral Reading in Kannada-Speaking Children Who Stutter"** is the result of my own study under the guidance of Dr. Sangeetha Mahesh, Associate Professor and Head, Tele-Centre for Person with Communication Disorder (TCPD), All India Institute of Speech & Hearing, Mysuru. It has not been submitted earlier to any other University for another Diploma or Degree award.

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CHAPTER I

INTRODUCTION

According to Bloodstein (2006) stuttering is typically defined as a speech disorder associated with motor control deficits rather than a language deficit. For instance, (Olander et al.2010) clarified that the speech motor system finds it difficult to instruct muscles appropriately during disfluency, which hinders flow and continuous speaking. Furthermore, developmental stuttering is a result of a breakdown in syllable beginning, in which the speech planning system is unable to proceed (Packman et al., 2007). As children begin to form multisyllabic words and complex speech patterns—which need more intricate coordination of sounds and stress patterns—this difficulty becomes especially noticeable. Packman et al (2007) found that children do not stutter when babbling or while producing their first words due to the absence of additional speech motor demands.

According to Wingate (1988) stuttering is not solely a result of poor motor coordination or execution, but rather of a general weakness in the language production system. According to this viewpoint, stuttering includes more fundamental aspects of the brain's structure and language production. The diversity of stuttering adds to its complexity. Depending on the speaking context, the words spoken, and other language-related elements, fluency can change significantly. For decades, scientists have been interested in this fluctuation.

Numerous linguistic characteristics, such as phonology (speech sounds), syntax (sentence structures), lexicon (word choice), and pragmatics (language use), have been investigated in relation to stuttering. As a result of these connections, studies have consistently found that disfluencies frequently occur at the beginning of words or sentences, in less familiar words, and in complex linguistic structures.

Several psycholinguistic models have tried to explain the phenomenon, such as the Covert Repair Hypothesis (Postma & Kolk, 1993), which links stuttering to errors in internal speech monitoring; the Demands-Capacity Model (Starkweather, 1987) which postulates stuttering as a mismatch between what speech requires and what the child can handle; and the Trade-off Hypothesis (Bernstein Ratner, 1997) which highlights the role of competing cognitive tasks. According to these patterns, phonological, lexical, syntactic, or prosodic (supra-segmental) encoding issues could occur. However, because these processes are interrelated, it is challenging to identify a single cause.

According to some researchers, stuttering results from a lack of coordination between the respiratory, articulatory, and vocal systems (Robb & Blomgren, 1996). Stuttering is a reflection of problems with the speech muscles themselves (MacKay, 1969a). Emotional and cognitive factors also seem to be involved include tension, uncertainty, or delayed motor planning. In support of this, Postma & Kolk (1993) discovered that children who stutter (CWS) frequently talk more slowly, which could be a sign of delays in motor planning or central processing.

1.1 Phonetic aspects of stuttering - Global context

Research into the phonetic determinants of stuttering has a long history dating back to the 1930s. Disfluencies are more likely to occur at a word's initial position, according to one of the first observations, indicating that placement within the speech sequence is crucial. Building on this, more research revealed that consonants are more frequently linked to stuttering than vowels, with some sounds—like /h/, /t/, /w/, /s/, /g/, /d/, /b/, /l/, and /m/— emerging as being especially susceptible. Vowels, on the other hand, seemed to be far less susceptible, however some data suggested that they might not be completely immune. The importance of word position was highlighted by later studies that found stuttering tended to cluster around word beginnings.Interestingly, vowel-initial words also appeared to be challenging; in certain instances, most disfluencies were on these words, especially when they began with sounds like /h/, /w/, /l/, /r/, and /θ/ (Johnson &Brown, 1935; Hahn, 1942; Mann, 1955; Dahlberg, 1966; Williamson al., 1969)

Huinck et al. (2004) emphasized the importance of phonetic and motor complexity in speech production by indicating that articulatory gesture timing and sequencing requirements have a significant impact on stuttering.

In addition, a study done by Dworzynski and Howell (2004) discovered that words ending with consonants were more difficult than those ending in vowels, and that PWS exhibited more disfluencies on words that started with later-acquired consonants than on early ones. The study on Phonetic Complexity and Stuttering in Spanish examined whether increased phonetic complexity influenced stuttering in Spanish-speaking children. The researchers compared children who stutter with their fluent peers using the Index of Phonetic Complexity (IPC). Due to Spanish's simpler phonotactic structure, phonetic complexity did not significantly predict stuttering, in contrast to studies in English. Rather, elements like word length and grammatical function were more important. (Howell & Au-Yeung, 2007).

In order to determine the significance of phonetic complexity, Howell et al (2006) studied English speakers using Index of Phonetic Complexity (IPC). Teenagers and adults exhibited greater rates of stuttering on content words that had late-emerging consonants (/r, l, s, z, ʤ, v, ʧ, h, θ, ð, ʃ, ʒ/) and consonant clusters, particularly in starting positions, while younger children showed no correlation between IPC and stuttering, according to the findings.

The manifestations of stuttering in Afrikaans in a case study on a 43-year-old male multilingual who had severe developmental stuttering.The study found that stuttering occurred most frequently in German, the participant's least proficient language, and was more common on consonants than vowels. The dysfluency majorly observed in voiceless plosives ([k]), voiceless fricatives ([f]), and consonant clusters ([kl]), with prolongations being the most prominent core behavior (Morrish et al., 2016)

Given that consonants—especially those in word-initial positions—are more susceptible to stuttering, research from around the world shows that vowels and linguistic complexity also have a significant impact. The findings exhibit how individual differences in stuttering are shaped by the interplay between phonetic, positional, and linguistic constraints.

To summarize, global research on the phonetic elements of stuttering indicates that stuttering is heavily influenced by phonetic and linguistic factors. Studies have consistently proven that vowels are less susceptible to dysfluency than consonants, especially those that occur in word-initial positions. Phonemes with increased articulatory and motor complexity, late-acquired consonants, and consonant clusters have been linked to an increase in stuttering frequency, particularly among older children and adults. However, the findings suggest that vowels and language-specific phonotactic structures might influence stuttering patterns, emphasizing cross-linguistic differences. Overall, literature shows that stuttering is caused by a complex combination of articulatory demands, word position, linguistic structure, and individual variability.

1.2 Phonetic aspects of stuttering - Indian context

Similar research has been done in India on the phonetic determinants of stuttering, particularly among Kannada speakers. Geetha (1979) studied Persons who stutter between the ages of 5 and 20 by incorporating different tasks such as Conversation, topic narration, story narration, picture description tasks, she discovered that consonants were stuttered more often than vowels. Nasals, voiceless fricatives, and voiced plosives were the consonants most susceptible to disfluency including /t/, /k/, /m/, /h/, /n/, and /l/. Similarly, Jayaram (1983) investigated more closely at the effects of phonetics on stuttering in monolingual and bilingual Kannada adults in spontaneous speech and oral reading. Multilingual PWS had greater disfluency on nasal sounds at word-initial positions, while voiceless fricatives and stops caused the most stuttering. It's interesting to note that bilinguals showed less overall disfluencies than monolinguals, which may indicate that bilingualism offers some protective flexibility when it comes to stuttering management.

In addition, Seth and Maruthy (2019) demonstrated that words starting with consonants were stuttered more frequently than those starting with vowels, and that stuttering was substantially more common on word-initial positions than medial ones. On the other hand, stuttering frequency was not substantially impacted by word length, word class (content vs. function), or inflectional morphology in preschool children.

Overall, Indian studies highlights how phonetic context, vowel complexity, and bilingualism has an affect on dysfluent patterns, indicating that language-specific characteristics are important for comprehending stuttering in multilingual societies.

Need for the study

The phonetic influences of stuttering have been the subject of extensive research for decades. But the literature on the effects of phonetic determinant on stuttering has shown inconsistent findings highlighting individual and contextual variability. The majority of the work has been conducted on children using spontaneous speech rather than utilizing oral reading. The oral reading passages are well-developed and structured, every phoneme has an chance of occurring in the oral reading. Therefore, a more thorough investigation on stuttering in relation to oral reading is required. According to the literature, there is compelling evidence that CWS as a group are more likely to stutter on particular phonemes than on other phonemes. The majority of research indicates that CWS are more likely to stutter when speaking consonants as opposed to vowels.

Although there is clarity on how to evaluate the phonological context, the outcomes are extremely inconsistent.It is important to address the precise question, "Are CWS, more likely to have disfluencies on specific phonemes in oral reading?" is essential when discussing the connection between phonology and stuttering. Cross-linguistic studies involving other populations are required to validate the results.

The nature of this fascinating speech disorder may be better understood by looking at the phonetic loci of disfluencies in children who stutter. Studies involving children who stutter in the Indian environment are limited using oral reading. Hence the present study was planned to determine the phonetic influences of dysfluencies by including all the phonemes in Kannada occurring in a oral reading passage.

Aim of the study

The primary aim of the study is to use a standardized reading passage to examine the phonetic influences of stuttering in Kannada-speaking children from grades three through seven.

Objectives of the study

1. To analyze and compare the loci of dysfluencies based on place of articulation in Kannada speaking children who stutter

2. To analyze and compare the loci of dysfluencies based on manner of articulation in Kannada speaking children who stutter

3. To analyze and compare the loci of dysfluencies based on voicing in Kannada speaking children who stutter

CHAPTER II

REVIEW OF LITERATURE

According to Van Riper (1971), "stuttering" is essentially a puzzle whose pieces are dispersed across the tables of speech pathology, psychiatry, neurophysiology, genetics, and many other disciplines. Stuttering occurs when the forward flow of speech is interrupted abnormally by repetitions of a sound, syllable or articulatory posture or by avoidance and struggle behaviors (Van Riper, 1978). A deficiency in the language production system, a defect that goes beyond motor execution and affects more essential language production system functions rather than just motor control or coordination (Wingate, 1988).

Models and theories related to stuttering

Stuttering is a complex disorder which consist of multiple levels or factors. The exact etiology of stuttering is still unknown.Theories and models emphasize on the internal and external elements that affect a person's capacity for fluent speech production (Andrews et al., 1983; Andrews & Neilson, 1981). Bloodstein & Bernstein Ratner (2008) categorize theories primarily into two categories: etiology theories and moments of stuttering.However, there is substantial overlap between many of the theoretical perspectives. Few theories explains about the onset of stuttering, whereas the other theories focuses on the development of the problem.To have a general overview of the state of knowledge regarding the nature of stuttering, a few theories and models are briefly explored below.

Stuttering as a defect in phonetic and syllabic contextual programming

MacKay (1970) provided a model for different levels of speech production at the phonetic level. At first, the buffer holds abstract words and develops programs that modify the phonemes based on context. Then the buffer feeds into the individual phoneme level when a target word's phoneme is partially primed. However, the activation is not in a sequential order. The buffer system alters phonemes based on contextual constraints.Later, the information from these levels is transmitted into motor units, which code contextually variable phonemes.The unit has a scanner that scans the motor variations at a predetermined rate.When the scanner passes a partially active motor variation, it receives an additional surge of excitation, meeting the threshold for sending motor orders to the musculature.The author concludes that lowering the motor unit threshold leads to increased hyper excitability and pre-priming time in individuals with stuttering.

Psycholinguistic theory

For decades, researchers have investigated the impact of language and linguistic aspects of stuttering. It can be associated by various linguistic factors, including: reduction in syntactic complexity, appearance of transient normal disfluencies during the development of language,delay in speech and language, pragmatic deficits and phonological deficits.Various psycholinguistic theories have been put forward to explain stuttering, as summarized here.

Helix Variability/V- Model

The model demonstrates the fact stuttering decreases when the variability of typical syllabic stress production also reduces. This implies that, stuttering can be caused by varying stress in unstable motor systems that are prone to fluctuation.Thus, in this model Packman, Onslow, Richard, and Van Doorn (1996) identified stuttering as a failure in the speaker's ability to store suprasegmental variability (transitions between targets with different stress values).

Neuro psycho-linguistic models

These models of stuttering are based on psycholinguistic models of normal speech and language production processes and provide a conceptual understanding of the underlying deficit in stuttering.(e.g., Levelt's model, 1989). Among the more popular are the Covert Repair Hypothesis (CRH) (Postma & Kolk, 1993) and the Temporal Dyssynchrony Model (Perkins, Kent & Curlee, 1991). CRH follows Levelt's model of speech production, which includes a pre-articulatory monitoring stage. The CRH states that people who stutter have a temporal deficit in phonological encoding (Byrd, Conture, & Ohde, 2007; Melnick, Conture, & Ohde, 2003).Stuttering occurs when the phonological plan is disrupted, causing covert repairs, restarts, and postponements to compensate for the deficit.Thus, stuttering is seen as a by-product or side-effect of self-repairs. However, it remains unclear at what stage phonological encoding or monitoring is disrupted. Dell & O'Seaghdha's(1992) Connectionist models of speech production and comprehension suggest that mis-selections or poorly timed phonetic plans can be attributed to the activation and spreading of representations.The CRH suggests that disruptions may exist at different points in the hierarchy of linguistic system.It consists a pre-articulatory monitoring that allows the speaker to repair the error before its produced stage. Repair events arise from disturbances in the linguistic system. Disruptions are detected through two routes: external (overt speech repairs) and internal (error corrected before the error is output) loops. Speakers may make errors in phonological encoding due to spreading-activation mechanism.The internal speech monitors detect errors in the phonetic plan.Speakers can recognize faults and interrupt speech to correct them, resulting in disfluencies. Individuals who stutter produce greater disfluencies due totemporal impairment in phonological encoding system (phonologic development and phonologic encoding are slower) that results in frequent phonetic plan errors that must be repaired leading speech disfluencies. Stuttering itself is not the loci of repair. This theory explains how stuttering, including repetitions and restarts, is a method for repairing and reducing phonological mistakes.Error detection interrupts speech, resulting in disfluency within the word.Error detection can occur at many stages: early (silent pauses, tense pauses, and blocking), intermediate (sound repetition, prolongations), or late (part word repetitions, prolongation of non initial sound, broken words). To maximize the likelihood of selecting the intended unit, a postponement method is used to delay the articulation of a part of a word and restart from the beginning.This model states that when individual intends to generate a target word, a phonologically-related competitive word is also activated.Initially, both the intended word and competitive words have similar activation routes.At asymptote, the intended target word will have high activation levels, resulting in the formation of the target unit as output. Due to time constraints, speakers must quickly articulate the target word when it has comparable activation paths as the competing word.The authors indicated that faulty word selection frequently happens with content words. In this context,disfluencies like prolongations, repetitions and interruptions can indicate covert repair activity (Howell, Kadi-Hanifi & Young, 1991).Thus the Covert Repair Hypothesis posits that function words frequently exhibit disfluency due to their placement preceding content words, where the root of the speech planning error is believed to arise.

Temporal dyssynchrony model

According to Perkins, Kent and Curlee's (1991) model suggests that stuttering occurs when sound fail to be properly inserted into syllables in a timely fashion during speech production i.e., when the articulatory pace exceeds the simultaneous integration of segments into syllable frames. Thus, the impulse to speak quickly and normally rapid speech, even though all the components that are necessary for speech are not ready, results in the dysfluencies that are perceived as stuttering. Two interacting neural networks control the insertion process: a signal system that generates syllable frames, which are especially vulnerable to cognitive interference, and a symbolic system that is engaged in linguistic processing.The speech breakdown that results from the two neural systems' lack of synchronization is caused by delays in the accessibility of syllable frames, which offer the structural slots for insertion of speech segments. According to Perkins et al (1991), there are a number of potential causes for this lack of synchronization, such as competition for processing capacity, inefficient cerebral resources brought on by hereditary limitations, brain injury, or self-expressive ambiguity, which is the need to speak up but a sense that one is not privileged to do so.The authors define linguistic stuttering as stuttering that results from delayed linguistic processing.

In addition, this theory explains a number of stuttering phenomena: Stuttering resulting from signal system dysfluency only occurs on syllables or phones within the syllable. The onset of stuttering occurs after a period of normal speech development because social dominance conflicts occur years after learning to speak fluently in connected discourse, and genetically driven brain processing inefficiencies appear with the development of connected speech. Since dominance conflict is more prevalent in men, it is more prevalent in men. Dominance conflict is the cause of individual variability. Very brief covert disruptions in fluency are linked to low time pressure. Easy repetitions give way to faster repetitions under increasing time constraint, which are then followed by hesitations and prolongations.

EXPLAN theory of stuttering

EXPLAN theory proposes that fluency failures occur as a result of variations in the time required to plan and execute these segments (Howell & Au-Yeung, 2002).A plan (PLAN) is created by the linguistic formulator process and executed by motor processes (EX). This model's fundamental premise is that PLAN and EX operate independently of one another in parallel. A central monitor receives the feedback from the EX output and uses it to make modifications and relaunch a PLAN.Independence also makes it possible to prepare for the future and carry out the current plan at the same time. Planning may be subject to time constraints when the planned section is being executed quickly. Even though the planning process typically produces a plan before it is executed (Sternberg, Monsell, Knoll & Wright 1978), it may worse under the situations mentioned above. Only the left-most portion of the plan is prepared for execution in this case.As a result, the speaker may either stall (pause speech until the other part of the plan comes) or proceed to speak using just the unfinished plan (progress).This results in particular kinds of disfluencies that are frequently displayed. The differences in disfluencies between children and adult depend on the various strategies that they employ to cope with the underlying problem.

Multifactorial/Dynamic models

The multifactorial approach emphasizes the complexity and numerous factors that affect an individual's ability for fluent speech production.It assists one to comprehend the complexity of stuttering. Multi-factorial models include the demands and capacities model (DCM), multi-factorial dynamic model, neurophysiological model, and stuttering as a neuromuscular disorder. This is because these theories take into account a number of elements that appear to affect both fluent and nonfluent speech in stuttering individuals.

Neuro-physiological model

De Nil (1999) proposes that neuro-physiological and psychological processes are not separate entities.Three levels of behavior are emphasized: (a) processing (central neuro-physiological), (b) output (motor, cognitive, linguistic, social, and emotional), and (c) contextual (environmental impacts).All levels experience bi-directional dynamic feedback, which continuously affects output. Neuro-physiological mechanisms filter the external stimuli and behavioral outcomes, varying over time within and between individuals.

The Demands and Capacity model (DCM)

This framework proposes a discrepancy between the child's capacity and the demands exerted on the child for fluent speech production (Starkweather, 1987; Starkweather & Gottwald, 1990). In four domains, the model differentiates between normal and deficient capacities: (1) motoric capacity, which is the capacity to perform rapid, quick, and effectively coordinated articulatory movements; (2) linguistic capacity, which is the ability to construct and organize sentences; (3) socio-emotional capacity, which includes the ability to communicate and cope with emotional stress; and (4) cognitive capacity, which is associated with metalinguistic awareness and advanced language processing abilities.The demands, which may be self-imposed or external (environmental), may be minimal or excessive in relation to capacities.Stuttering occurs if a child's abilities in the motoric, linguistic, cognitive, and social-emotional domains for fluency do not match the demands of their environment. All of these abilities and demands are dynamic and change over time.Fluency breakdowns are caused and sustained by a combination of contextual factors, including both internal and external demands, and genetically based vulnerabilities in the systems that underlie fluency, such as linguistic, motor, affective, and cognitive mechanisms.Disfluencies may arise if the linguistic demands exceed the person's functional abilities.

Multi-factorial dynamic model

This model's ultimate objective is to investigate the variables that affect speech motor function and "to comprehend the dynamic interactions of these factors as the developing brain seeks the stable, adaptive models of interaction within the neural networks that generate fluent speech (Smith, 1999; Smith & Kelly, 1997). They suggest that examining stuttering through the tabulation of dysfluency form-types' static units only yields a surface event record.This approach's flaw is that stuttering is a dynamic condition with numerous underlying processes.Focusing on the disorder's outward manifestations keeps making it difficult to comprehend its multifactorial nature.The authors explain that early volcanologists focused on surface events using an analogy that works well with stuttering.Volcanoes were counted and categorized according to the type of eruptive materials and the landform's shape.After using this method for decades, scientists realized that categorizing volcanoes according to their surface characteristics was insufficient to account for the phenomenon's dynamic nature.When the theory of plate tectonics was brought to the issue, real comprehension of volcano activity finally started.According to Smith and Kelly, the belief in the "reality of the units of stuttering" is a significant barrier to the development of a universal theory of stuttering.These surface units don't reveal the actual dynamic nature of the phenomenon and are comparable to volcanic smoke.Focusing on the disorder's surface manifestations continually makes it difficult to comprehend its multifactorial nature.

Neuro-physiological model

De Nil (1999), asserts that neuro-physiological and psychological processes are not separate entities.They highlight the dynamic interaction between three behavioral levels:(a) processing (central neuro-physiological), (b) output (motor, cognitive, language, social and emotional), and (c) contextual (environmental influences).All levels experience bi-directional dynamic feedback, which continuously affects output. Neuro-physiological mechanisms filter environmental stimuli and behavioral consequences, which change over time within and across individuals.

Phonetic determinants of stuttering

Research into the phonetic determinants of stuttering has a long history dating back to the 1930s. Disfluencies are more likely to occur at a word's initial position, according to one of the first observations, indicating that placement within the speech sequence is crucial. Few studies have concluded that the grammatical form can be a predicting factor for stuttering (Watson, Byrd, & Carlo, 2011).Building on this, more research revealed that consonants are more frequently linked to stuttering than vowels, with some sounds—like /h/, /t/, /w/, /s/, /g/, /d/, /b/, /l/, and /m/—emerging as being especially susceptible.

Huinck et al. (2004) investigated how adults who stutter produce consonant clusters in comparison to fluent speakers. According to the results, PWS made more errors and dysfluencies, especially when it came to homorganic clusters across syllable boundaries, and their reaction times were noticeably longer. The results emphasize the importance of phonetic and motor complexity in speech production by indicating that articulatory gesture timing and sequencing requirements have a significant impact on stuttering. In addition, a study by Dworzynski and Howell (2004) discovered that words ending with consonants were more difficult than those ending in vowels, and that PWS exhibited more disfluencies on words that started with later-acquired consonants than on early ones. A study by Coalson and Byrd (2016) investigated the role of phonetic complexity in English preschool children who stutter by analyzing words that appeared immediately utterance-initial productions. The study found that phonetic complexity, as judged by the Word Complexity Measure (WCM), did not significantly predict stuttering in young infants. Instead, characteristics including utterance length and grammatical complexity were discovered to have a stronger impact on speech disfluencies. Similarly the study on Phonetic Complexity and Stuttering in Spanish examined whether increased phonetic complexity influenced stuttering in Spanish-speaking children. The researchers compared children who stutter with their fluent peers using the Index of Phonetic Complexity (IPC). Due to Spanish's simpler phonotactic structure, phonetic complexity did not significantly predict stuttering. Rather, elements like word length and grammatical function were more important. (Howell & Au-Yeung, 2007).

Venkatagiri et al (2017) studied how Kannada morphophonemic attributes affect stuttering in adolescents and adult stutterers. The study discovered that lengthier words had a considerable increase in stuttering frequency, but morphophonemic complexity characteristics such as sandhi, consonant clusters, geminates, and number of morphemes had only a minor impact. The findings revealed that in Kannada, word length was a better predictor of stuttering than morphophonemic complexity.

In order to determine the significance of phonetic complexity, Howell et al (2006) studied English speakers in three age groups: above 18 years, 11–18 years, and 6–11 years. They used the Index of Phonetic Complexity (IPC) on phonetically transcribed samples of informal conversational speech. Teenagers and adults exhibited greater rates of stuttering on content words that had late-emerging consonants (/r, l, s, z, ʤ, v, ʧ, h, θ, ð, ʃ, ʒ/) and consonant clusters, particularly in starting positions, while younger children showed no correlation between IPC and stuttering, according to the findings. Morrish et al. (2016) investigated the manifestations of stuttering in Afrikaans, English, and German by conducting a case study on a 43-year-old male multilingual who had severe developmental stuttering.The study found that stuttering occurred most frequently in German, the participant’s least proficient language, and was more common on consonants than vowels.The dysfluency majorly observed in voiceless plosives ([k]), voiceless fricatives ([f]), and consonant clusters ([kl]), with prolongations being the most prominant core behavior.

By keeping word frequency, accent, length, place, and grammatical function consistent, Soderberg (1962) conducted a methodically controlled investigation.The author came to the conclusion that there was no evidence of variations in the frequency of speech sound disfluencies.These results demonstrate the important interaction of multiple factors related to linguistic characteristics. In contrast to Soderberg's findings, Taylor (1966) found that consonants were more disfluent, with the exception of sounds like /t/, /h/, /w/, and /d/.Although there was variation across the individuals with the consonantal contexts, the author interpreted the results as more disfluencies on plosives than continuants.

Browman and Goldstein's Gestural Phonology Model (1990c) suggests that producing two consonants with the same place of articulation across a syllable requires more initiation time and programming effort compared to producing the same two consonants (cluster) inside a syllable. For example, The consonant cluster /st/ in the word "stop" occurs within a single syllable and is formed with coordinated articulatory movements. However, in a phrase like "missed train," the consonants /s/ and /t/ cross syllable or word borders, necessitating separate start and increased temporal coordination, which may make speech preparation more challenging for stutterers.In a subsequent study, Huinck et al. (2004) further studied on articulatory timing and programming demands in speech production and found similar results, implying that increased demands on timing and motor programming are particularly apparent in stutterers.

Sasisekaran and Byrd (2013) found a difference in phoneme and rhyme monitoring response times between CWS and fluent peers aged 7-13 years, contradicting previous research findings. Their study's findings did not reveal any variations indicating that "processing and/or representation of holistic and segmental units in speech production are intact in CWS."

Global research reveals that vowels and language complexity play an important influence in stuttering, even though consonants—particularly in word-initial positions—are more vulnerable. The results highlight how phonetic, positional, and linguistic demands interact to shape stuttering, with individual differences.

Phonetic determinants of stuttering in Indian context

Similar research has been done in India on the phonetic determinants of stuttering, particularly among Kannada speakers. Geetha (1979) studied Persons who stutter between the ages of 5 and 20 by incorporating different tasks such as Conversation, topic narration, story narration, picture description tasks, she discovered that consonants were stuttered more often than vowels. Nasals, voiceless fricatives, and voiced plosives were the consonants most susceptible to disfluency; specific phonemes included were /t/, /k/, /m/, /h/, /n/, and /l/.Similarly, Jayaram (1983) investigated more closely at the effects of phonetics on stuttering in monolingual and bilingual Kannada adults. Results suggested that multilingual PWS exhibited greater disfluency on nasal sounds at word-initial positions, while voiceless fricatives and stops caused the most stuttering. It's interesting to note that bilinguals showed less overall disfluencies than monolinguals, which may indicate that bilingualism offers some protective flexibility when it comes to stuttering management.

Similarly, the phonetic influences on bilingual children were studied by Soumya and Sangeetha (2011).The results provided a ranking of disfluencies for the Kannada language as /tʃ/, /b/, /k/, /s/, /g/, /ʃ/, /r/, /m/, /j/, /n/, /ʈ/, /p/, /ɖ/, /h/, /v/, /ð/ and /l/. Additionally Geetha and Sangeetha (2015), investigated dysfluencies in short and long vowels which revealed the rank order of disfluency is /e/, /a/, /o/, /i/, /u/, and /a:/, /ai/, /o:/, /au/, and /i/, respectively. Similar to this, Shishira (2019), examined the phonetic influences in Kannada-speaking adults who stutter and found that the rank order of dysfluent consonants was /r/, /p/, /g/, /c/, /t/, /v/, /k/, /s/, /j/, /l/, /d/, /h/, /n/, /b/, /m/, /y/, indicating more difficulty with retroflex and plosive sounds than other phonemes.

In addition, Seth & Maruthy (2019) studied twenty Kannada-speaking preschool children (ages 3–6) using spontaneous conversational speech tasks. The analysis examined phonological (word position, phoneme type, word length) and morphological (word class, inflectional endings) factors.The findings demonstrated that words starting with consonants were stuttered more frequently than those starting with vowels, and that stuttering was substantially more common on word-initial positions than medial ones. On the other hand, stuttering frequency was not substantially impacted by word length, word class (content vs. function), or inflectional morphology.

Phonetic context of disfluencies

According to Bluemel (1930) and Wingate (1945), the repetitions or blocks on the consonants are simply the result of real difficulty pronouncing the following sound, which is nearly always a vowel (or diphthong).Accordingly, he views stuttering as an attempt to produce a stressed vowel.He believes that the shaping motions that set one vowel apart from another may be a factor in stuttering.

Fletcher (1928) made reference to the inability to articulate speech by linking the sound being made with the subsequent one.According to Kenyon (1944), stutterers don't have any issues with consonants, but their vowels cause them to stutter.Forrester (1947) defined stuttering as the ability to move quickly and adequately from one syllable to another.

Hunt (1967) believed that stuttering could affect all sounds, including vowels, rather than just consonants.He further classified the stuttering as vowel stuttering and consonant stuttering. The vowel u (as in ‘rude’) and ’o’ seemed to offer greater difficulty than ‘e’ (as in ‘ebb’) or I (as in ‘it’). Dysfluencies were mostly observed in the articulations of mute and explosive consonants and their medials like /p/, /t/, /k/, /b/, /d/, and /m/ in consonantal stuttering.Since the oral canal was not as totally constricted as it was with the explosives, the aspirated and continuous noises like /f/, /w/, and /s/ presented much less difficulty. Since PWS frequently repeated these sounds in a rapid development, this does not infer that it is due to difficulty articulating explosives.He struggles with articulating the accompanying sound, whether it's a vowel or consonant.Therefore, the barrier primarily occurs during the change from one mechanism to another.Stuttering is caused by a disrupted relationship and hostility between the vocal and articulation mechanisms;The glottis's spasmodic state, which occurs during the explosive sound, is the "effect" rather than the root of the strained relationship.

The following information was found when MacKay (1970) examined stuttering in German natural speech:

1) Stuttered phonemes are typically preceded or followed by an identical phoneme known as the included phoneme.

2) Typically, the inducing phoneme came after the stuttering phoneme rather than before it.

3) The stuttering phoneme and the inducing phoneme were closer than would be predicted by chance.

4) Typically, the stuttering and inducing phonemes were located in the same syllable places.

5) Stressed syllables were typically the source of stuttered phonemes.

It appeared that these results may be explained by three primary speculations:

1. Phonemes and syllables are both components of a hierarchy of speech motor determinants.

2. Similar motor programs' opposing elements interact in a reciprocal inhibitory manner at the syllabic and phonemic levels.Additionally, this idea offered a potential explanation for the phenomena of speech sound blocking and prolongation that happen in situations similar to stuttering.

3. Stressed units have a higher sub threshold excitability than unstressed ones.

Sangeetha and Geetha (2013) explored the phonetic context of disfluencies in ten monolingual Kannada-speaking children with stuttering aged 6 to 8 years. The study examined consonants and vowels in spontaneous speech tasks to determine how phonological context affected stuttering. The results demonstrated that children with stuttering had more disfluencies on consonants than vowels, supporting previous studies.Among consonants, plosives and fricatives showed higher frequencies of disfluencies, with the rank order including /T/, /d/, /r/, /v/, /p/, /j/, /g/, /D/, /sh/, /c/, /s/, /y/, /k/, /l/, /n/, /t/, /m/, /b/, and /h/. Long vowels were found to be more disfluent than short vowels, with high back vowels like /oo/ and /uu/ being the most difficult.The study also found significant individual variability among children on the basis of phonetic loci of disfluency, demonstrating that stuttering patterns are dynamic and inconsistent across speakers.The authors concluded that phonetic, linguistic, and physiological aspects of speech production have a significant influence in developmental stuttering.

In summary, previous investigations on stuttering shows that the disorder is multifaceted, involving intricate relationships between linguistic, phonetic, motor, cognitive, neurological, and environmental factors. Several models, including the Covert Repair Hypothesis, Temporal Dyssynchrony Model, EXPLAN theory, and Demands and Capacities Model, highlights the importance of disruptions in speech planning, phonological encoding, motor execution, and timing synchronization in stuttering. Investigations on Phonetic determinants generally shows that disfluencies occur more often on consonants compared to vowels, especially in word-initial locations, but vowels and phonetic complexity also have an impact on fluency breakdown. Global and Indian research has found that stuttering is more with frequent plosives, fricatives, consonant clusters, and complex linguistic structures. Stress patterns, word length, and articulatory timing also play a role. Researches conducted in Kannada language also showed that phonetic influences differ across individuals, with consonants like plosives, fricatives, and retroflex sounds being more prone to disfluencies. Additionally, studies on phonetic context reveal that stuttering often occurs during syllable or sound transitions, suggesting deficiencies in phonological programming and speech motor coordination. Despite similar characteristics, significant individual variability has been identified across individuals who stutter, suggesting that stuttering cannot be well explained by a single factor alone. Overall, the idea that developmental stuttering is a dynamic and complex condition that is closely related to the phonetic, linguistic, and physiological elements that underlie speech production is generally supported by the reviewed literature.

CHAPTER III

METHOD

Participants: The participants for this study consisted of Kannada speaking children who stutter in the age range of 8 to 12 years. All the participants were native Kannada speakers with good reading ability in Kannada.

Research design : Cross-sectional Descriptive design was employed in the current study.

Inclusion criteria

- Age range within 8 to 12 years i.e children studying from grade 3 to 7
- Diagnosed as having developmental stuttering from a qualified speech language pathologist
- The Severity should ranged from moderate and above degree of stuttering
- Native Kannada speaker
- Normal vision and hearing

Exclusion criteria

- History of other speech and language disorder.
- Have not taken any speech therapy since last 6 months.

Table 3.1

Demographic profile of Kannada speaking CWS

Participants	Age	Gender	Grade	SSI-4 Severity
P 1	11.3	M	6	Moderate
P 2	9.8	M	4	Moderate
P 3	10.3	M	5	Severe
P 4	10.4	M	5	Severe
P 5	8.11	M	4	Moderate
P 6	10	M	4	Moderate
P 7	8.2	M	3	Moderate
P 8	10.2	M	5	Moderate
P 9	10.7	M	5	Severe

P 10	10.11	M	5	Severe
P 11	10.2	M	5	Severe
P 12	9.2	M	4	Moderate
P 13	9.4	M	3	Severe
P 14	12	M	7	Severe
P 15	8.2	M	3	Moderate
P 16	12	M	7	Severe
P 17	9.2	M	4	Moderate
P 18	10.3	M	5	Severe
P 19	8.2	M	3	Moderate
P 20	11.8	M	6	Severe
P 21	9.2	M	4	Severe
P 22	12	M	7	Severe
P 23	8.9	M	3	Moderate
P 24	12	M	7	Moderate
P 25	8.2	M	3	Severe
P 26	12	M	7	Moderate
P 27	12	M	7	Severe
P 28	12	F	7	Severe

The study recruited 28 children with stuttering (CWS). The vast majority of the participants (n = 27) were male, with only one female (n = 1). Participants were divided into two groups based on their SSI-4 stuttering severity ratings: moderate and severe. Fourteen subjects showed moderate severity, while the remaining fourteen had severe stuttering severity.

Materials

1.SSI -4 Riley,(2009)

2. Kannada reading passages (Voiced,Unvoiced and Combined) - The present study utilized the reading passages that were developed for the children from grade III to grade VII by Sangeetha and Sabeena, (2019) as a part of ARF project. Additionally every passage consists of all the phonemes present in Kannada language.

3. Audio-Video recorder

Table 3.2

Occurrence of phonemes w.r.t place, manner and voicing features across different grades

	Place		Manner		Voicing features	
	Bilabials	28	Stops	28	Voiced	62
	Alveolars	18	Affricates	9	Voiceless	30
	Velars	13	Nasals	22		
GRADE III	Labiodentals	5	Fricatives	35		
	Interdentals	14	Laterals	1		
	Postalveolars	9	Flaps	3		
	Glottals	21	Fricatious continuents	1		
	Retroflex	3	Aspirated stops	14		
	Palatal	2				

	Place		Manner		Voicing features	
	Bilabials	31	Stops	33	Voiced	82
	Alveolars	33	Affricates	15	Voiceless	50
	Velars	16	Nasals	29		
	Labiodentals	6	Fricatives	41		
	Interdentals	17	Laterals	1		
GRADE IV	Postalveolars	15	Flaps	2		
	Glottals	10	Fricatious continuents	3		

	Place		Manner		Voicing features	
	Retroflex	2	Aspirated stops	17		
	Palatal	11				

	Place		Manner		Voicing features	
	Bilabials	53	Stops	39	Voiced	94
	Alveolars	31	Affricates	4	Voiceless	54
	Velars	18	Nasals	47		
GRADE V	Labiodentals	4	Fricatives	33		
	Interdentals	16	Laterals	1		
	Postalveolars	4	Flaps	4		
	Glottals	12	Fricatious continuents	9		
	Retroflex	4	Aspirated stops	16		
	Palatal	9				

	Place		Manner		Voicing features	
	Bilabials	83	Stops	87	Voiced	154
	Alveolars	50	Affricates	14	Voiceless	100
	Velars	34	Nasals	50		
	Labiodentals	9	Fricatives	73		
GRADE VI	Interdentals	24	Laterals	2		
	Postalveolars	14	Flaps	3		
	Glottals	24	Fricatious	1		

			continuents			
	Retroflex	3	Aspirated stops	24		
	Palatal	13				

	Place		Manner		Voicing features	
	Bilabials	82	Stops	59	Voiced	141
	Alveolars	72	Affricates	8	Voiceless	103
GRADE	Velars	22	Nasals	73		
VII	Labiodentals	4	Fricatives	71		
	Interdentals	20	Laterals	1		
	Postalveolars	8	Flaps	1		
	Glottals	17	Fricatious continuents	11		
	Retroflex	1	Aspirated stops	20		
	Palatal	18				

Procedure

The target population were recruited from AIISH (All India Institute of Speech and Hearing), and only those participants who did not received any form of speech therapy in the last six months were included in the study. Initially, a thorough case history was obtained from each participant, including information regarding age of onset, loci of dysfluency, and the presence of any sound-specific difficulties. The severity of stuttering was evaluated using the SSI-4 (Riley, 2009) by considering the frequency, duration, and physical concomitants of stuttering, following which percentile scores and severity ratings were calculated. The participants were seated in a distraction-free and quite environment, and the clinician initially established rapport to ensure that the participants felt comfortable during the assessment procedure. Further, grade-appropriate Kannada reading passages were given to each participants, developed and standardized by Sangeetha and Sabeena (2019) as part of the ARF project at AIISH. The passages were designed to contain all Kannada phoneme and were printed in black on plain white sheets. The passage was to be read aloud by the participants at a comfortable loudness and pace. The researcher recorded the entire reading task on audio and video, positioning the camera at a suitable distance to capture the participants' speech behaviors. Each participant took approximately 20-30 minutes to read the entire passage. During the reading task, a few participants in grades III and IV needed occasional prompts. In certain cases, the researcher first read the entire passage aloud to make the participant familiarize with its content before providing the passage for reading.

Ethical considerations

The AIISH Ethical Committee's Institutional Review Board (IRB) accepted this study with reference number SH/IRB/M.5/SLP.37/2025-26 for a bio-behavioral research project involving human subjects. (Appendix A).The selection and involvement of participants complied with all ethical requirements. After outlining the aim and methodology of the study, participants or the parents/caregivers of child participants gave their informed consent prior to the testing.

Data analysis

According to Yairi and Ambrose's (1999) proposal, the loci of disfluencies werecategorized as stuttering-like dysfluencies, which includes blocks, broken words, prolongation, syllable repetition, and monosyllable full word repetition.

The study implemented Upadhyaya's (2000) classification of phonemes, which classifies consonants as Place of articulation: Bilabial, Dental, Retroflex, Alveolar, Velar, Palatal, and Glottal. Likewise, based on Manner, the consonants can be categorized as Stops, Nasal, Fricatives, Affricates, Laterals, Flap, and Continuants. Additionally, based on the voicing feature, consonants are classified as voiced and unvoiced, depending on the dysfluent phoneme.

The examiner used broad band verbal transcription to accurately transcribe the audio-video recorded speech samples of CWS. The transcribed sample concentrated on both disfluent and fluent phonemes. Each phoneme's percentage of dysfluencies throughout the reading task was calculated. In addition, consonants were analyzed based on Place of articulation, Manner of articulation and Voicing feature.

$$\text{\% of dysfluency for each consonant} = \frac{\text{Total no. of dysfluencies for specific consonant}}{\text{Total no. of occurrences of specific consonants in passage}} \times 100$$

CHAPTER IV

RESULTS

The study aimed to analyze the phonetic influences in children with stuttering (CWS).Occurrence of dysfluencies in reading was analyzed with regard to consonants based on Place of articulation, Manner of articulation and Voicing Features. Furthermore, the overall frequency of phonemes (fluent and dysfluent) in relation to the specific details stated was examined.The measures were compiled and analyzed using SPSS 26 (Statistical Package for Social Sciences, Version 26).The data was tested for normality and non-parametric statistical measures were used accordingly.

1) Inter-judge and Intra-judge reliability

10% of the transcribed samples were tested for inter- and intra-judge reliability. The inter-judge reliability measure was determined by two judges, including the investigator and one speech-language pathologist. The other judge had two years of clinical and research expertise with stuttering and was a certified speech-language pathologist. The The judge was given instructions about the transcription of the fluent and dysfluent speech sample pertaining to the phonetic determinants . The investigator transcribed 10% of the sample again after a duration of one week from the initial analysis. The reliability index for comparing interjudge and intrajudge reliability was obtained using the Cronbach's alpha test. The inter-judge reliability and intra-judge reliability were 0.96 and 0.94 respectively.

2) Dysfluent consonants

The occurrence of dysfluent consonants in CWS in Kannada was assessed.Furthermore, the mean percentage of dysfluent consonants category was calculated using the formula i.e., ratio of total number of times the specific dysfluent consonants category occurred to the total number of times that specific consonants category occurred in the speech sample, multiplied by 100.The analysis focused on the mean percentage of terms of their initial position, as disfluencies usually appear in initial position majority of the times. The IPA symbols for Kannada used in the study are as suggested by Schiffman (1979).

2.1 Dysfluent consonants based on Place of articulation

While considering the place of articulation the dysfluent consonants was ranked according to difficulty based on median percentage due to high variability. Table 4.1 and Figure 4.1 depicts the rank of order of difficulty in dysfluent consonants considering place of articulation.

Figure 4.1

Distribution of Dysfluent Consonants Across Different Places of Articulation

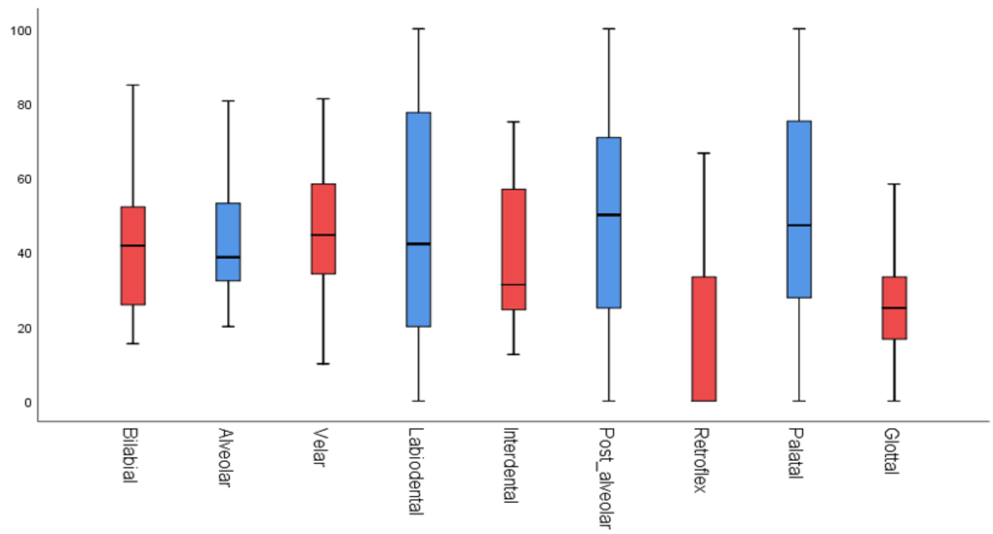

Table 4.1

Rank order of difficulty in dysfluent consonants based on Place of articulation

Dysfluent consonant (Place of articulation)	Mean %	Median %	SD	Rank order difficulty
Bilabial	43.62	41.90	19.79	4
Alveolar	45.09	39.30	20.12	6
Velar	44.80	45.45	19.24	2
Labiodental	49.31	40.00	35.11	5
Interdental	37.63	31.20	18.40	7
Post-alveolar	49.37	50.00	31.89	1
Retroflex	20.67	0.00	34.38	9
Palatal	53.05	44.44	32.08	3
Glottal	27.79	27.79	17.75	8

Friedman test was administered to determine if any significant differences exist across dysfluent consonants and the results suggested a significant difference in CWS [$\chi 2$ (8) = 36.51, $p < 0.05$]. To determine the pair-wise comparisons between the categories in dysfluent consonants, Benjamini-Hochberg correlation was used. The findings revealed significant difference across retroflex in comparison to labiodental ($\chi 2$ = 3.00, Padj <0.05), alveolar ($\chi 2$ = 2.85, Padj <0.05), post-alveolar ($\chi 2$ = 2.85, Padj <0.05), palatal ($\chi 2$ = -3.03, Padj <0.05), velar ($\chi 2$ = 2.70, Padj <0.05), bilabial ($\chi 2$ = 2.64, Padj <0.05), interdental ($\chi 2$ = 1.94, Padj <0.05), findings also revealed significant difference across glottal in comparison to palatal ($\chi 2$ = 2.40, Padj <0.05), labiodental ($\chi 2$ = 2.37, Padj <0.05), alveolar ($\chi 2$ = 2.22, Padj <0.05), post-alveolar (χ2 = 2.22, Padj <0.05). velar (χ2 = 2.07, Padj <0.05), bilabial (χ2 = 2.01, Padj <0.05).

Based on the place of articulation the rank order for dysfluent consonants are as follows; Post alveolar(/tʃ/,/dʒ/) , Velar(/k/,/g/), Palatal(/j/,/ʃ/) , Bilabial(/p/,/b/,/m/), Labiodental(/v/), Alveolar(/t/,/d/,/n/,/s/,/l/), Interdental(/t^h/,/$d^ɦ$/), Glottal(/h/), Retroflex (/r/). In specific post alveolars, velars and palatals was highly dysfluent where as glottal (/h/) and retroflex (/r/) being the least.

In accordance to the median percentage values, post-alveolar consonants had the highest dysfluency frequency (median = 50.0%), followed by velar consonants (median = 45.45%) and palatal consonants (median = 44.44%). The relatively tiny point difference (4.55%) between velar and post-alveolar consonants indicates that these consonant categories showed similar vulnerability to dysfluency in CWS. Similarly, bilabial (median = 41.90%), labiodental (median = 40.00%), and alveolar consonants (median = 39.30%) had only minor point variations, indicating comparable levels of articulatory difficulty and dysfluency occurrence.

The point difference between alveolar and interdental consonants was considerably larger (8.10%), indicating a lower frequency of dysfluency in interdentals. Furthermore, glottal consonants (median = 27.79%) had a significantly lower frequency of dysfluency than post-alveolar consonants, with a 22.21% difference. The most significant point difference was observed between post-alveolar and retroflex consonants (50%), with retroflex consonants having the lowest dysfluency frequency (median = 0.00%). These major point disparities indicate significant variation in dysfluency occurrence across consonant categories based on place of articulation.

Overall, the findings indicate that consonants produced in the post-alveolar, velar, and palatal regions were more prone to dysfluency, while retroflex and glottal consonants had lower dysfluency frequencies. The minor point differences between post-alveolar, velar, palatal, bilabial, labiodental, and alveolar consonants suggest that they have similar articulatory demands and are more susceptible to dysfluency. In contrast, the higher point disparities seen for interdental, glottal, and notably retroflex consonants indicate significant variation in dysfluency incidence across place of articulation.

Table 4.2

Participant - wise Dysfluency Distribution based on Place of articulation

Participants	Bilabial	Velar	Interdental	Labiodental	Palatal	Alveolar	Post-alveolar	Glottal	Retroflex
P 1	25.30 %	26.47 %	25 %	22.2 %	12.5 %	39.2 %	-	16.6 %	-
P 2	26.6 %	43.75 %	29.5 %	33.3 %	66.6 %	21.4 %	50 %	10 %	-
P 3	36.1 %	33.33 %	12.5 %	-	66.6 %	36.6 %	66.6 %	25 %	25 %
P 4	84.90 %	55.5 %	31.25 %	100 %	100%	86.6 %	100 %	58.3 %	100 %
P 5	32.2 %	81.2 %	58.8 %	-	26.3 %	40.6 %	50 %	-	26.7 %
P 6	51.6 %	11.1 %	18.1 %	16.6 %	50 %	42.8 %	-	20 %	-
P 7	18.5 %	30.7 %	21.4 %	20 %	100 %	31.2 %	12.5 %	33.3 %	33.3 %
P 8	33.8 %	38.8 %	31.2 %	50 %	44.4 %	40 %	-	33.3 %	-
P 9	67.9 %	66.66 %	37.5 %	100 %	77.7 %	80.6 %	100 %	58.3 %	-
P 10	25 %	50 %	33.3 %	100%	44.4 %	27.5 %	100 %	66.6 %	-
P 11	45.2 %	61.1 %	23 %	100 %	33.3 %	36.6 %	33.3 %	16.6 %	-

P 12	41.9 %	14.2 %	29.4 %	16.6 %	-	25 %	25 %	10 %	-
P 13	78.5 %	76.9 %	71.4%	80 %	100 %	56.2 %	50 %	14.2 %	66.6 %
P 14	52.43 %	63.63 %	65 %	100 %	61.11 %	60.56 %	100 %	29.41 %	100 %
P 15	50 %	62.9 %	50 %	40 %	100 %	40 %	62.5 %	-	-
P 16	48.61 %	55 %	65 %	100 %	27.77 %	48.57 %	75 %	41.17 %	100 %
P 17	41.6 %	37.50 %	35.29 %	16.66 %	36.36 %	66.66 %	-	30 %	-
P 18	43.39 %	45.45 %	25 %	-	55.55 %	37.93 %	50 %	33.33 %	50 %
P 19	18.51 %	10 %	14.28 %	40 %	100 %	37.50 %	25 %	28.75 %	-
P 20	79.16 %	50 %	75 %	25 %	44.44 %	95.6 %	62.50 %	17.64 %	100 %
P 21	54.21 %	64.7 %	50 %	44.44 %	25 %	36.73 %	33.33 %	25 %	25 %
P 22	70.96 %	50 %	58.82 %	66.66 %	72.72 %	72.72 %	50 %	60 %	50 %
P 23	20.73 %	20 %	50 %	50 %	27.77 %	22.85 %	50 %	11.76 %	-
P 24	51.85 %	46.15 %	24 %	20 %	-	20 %	25 %	33.33 %	-
P 25	40.24 %	35 %	55 %	75 %	27.77 %	30.98 %	75 %	17.64 %	-

P 26	15.38 %	38.46 %	21.42 %	40 %	100 %	50 %	62.5 %	42.85 %	22.3 %
P 27	23.17 %	35 %	25 %	75 %	22.22 %	33.33 %	75 %	17.64 %	-

2.2 Dysfluent consonants based on Manner of articulation

While considering the manner of articulation the dysfluent consonants was ranked according to difficulty based on median percentage due to high variability. Table 4.2 and Figure 4.2 depicts the rank of order of difficulty in dysfluent consonants considering manner of articulation.

Figure 4.2

Distribution of Dysfluent Consonants Across Different Manner of Articulation

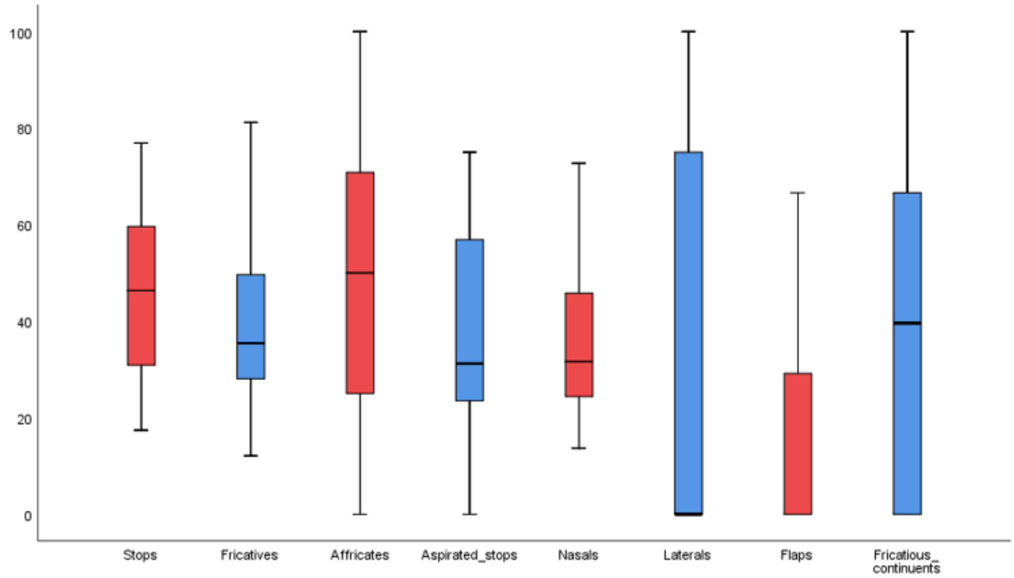

Table 4.3

Rank order of difficulty in dysfluent consonants based on Manner of articulation

Dysfluent consonant (Manner of articulation)	Mean %	Median %	SD	Rank order difficulty
Stops	46.38	48.00	16.60	2
Fricatives	39.45	34.20	16.91	4
Affricates	49.68	50.00	31.43	1

Aspirated Stops	36.70	31.20	19.64	6
Nasals	39.79	31.70	19.98	5
Laterals	30.00	0.00	44.20	7
Flaps	16.97	0.00	30.69	8
Fricatious continuents	41.64	36.36	35.16	3

Friedman test was administered to determine if any significant differences exist across dysfluent consonants and the results suggested a significant difference in CWS [χ2 (7) = 30.10, $p < 0.05$]. To determine the pair-wise comparisons between the categories in dysfluent consonants, Benjamini-Hochberg correlation was used. The findings revealed significant difference across Laterals in comparison to Affricates (χ2 = 1.87, Padj <0.05) and flaps in comparison with fricatives (χ2 = 1.92, Padj <0.05).

Based on the Manner of articulation the rank order for dysfluent consonants are as follows; Affricates (/tʃ/,/dʒ/), Stops (/p/,/t/,/k/,/b/,/d/,/g/), Fricatious Continuents (/j/), Fricatives (/s/,/ʃ/, /h/, /v/), Nasals (/m/,/n/), Aspirated stops (/t^{h}/,/$d^{ɦ}$/), Laterals (/l/), Flaps (/r/). In specific Affricates, stops, Fricatious Continuents and Fricatives were highly dysfluent and laterals and flaps were the least.

In terms of point differences, the smallest difference was found between fricatives and nasals (0.34%), indicating that these two categories had nearly identical levels of speech difficulty. There was a somewhat bigger variance (2.19%) between fricatious continuents and fricatives, indicating relatively moderate variations in dysfluency. The difference between affricates and stops was 3.30%, whereas nasals and aspirated stops differed by 3.09%, indicating moderate articulatory difficulties.

There was a noticeably greater point difference (4.74%) between stops and fricatious continuents, suggesting a more distinct level of difficulty between these categories. An even higher difference (6.70%) was observed between aspirated stops and laterals, indicating that laterals were considerably less challenging. The largest point difference was found between laterals and flaps (13.03%), indicating that flaps were generated with significantly less difficulty than all other consonant types.

Overall, the progression from minor to significant point differences indicates that consonants requiring intricate articulatory coordination and more rigid oral constrictions, such as affricates and stops, were correlated with greater dysfluency, whereas consonants requiring comparatively simpler and more fluid tongue movements, such as laterals and flaps, demonstrated lower levels of articulatory difficulty.

Table 4.4

Participant - wise Dysfluency Distribution based on Manner of articulation

Participants	Stops	Affricates	Fricatives	Nasals	Laterals	Flaps	Fricatious continuents	Aspirated stops
P 1	24. 2 %	8.3 %	24.6 %	22 %	50 %	-	-	-
P 2	35.7 %	50 %	21.2 %	24.13 %	-	-	66.6 %	29.4 %
P 3	44.7 %	66.6 %	24.13 %	31.7 %	10 %	25 %	60.5 %	12.5 %
P 4	61.3 %	100 %	80.6 %	89.3 %	100 %	-	100 %	31.2 %
P 5	63.3 %	50 %	28 %	34.4 %	-	-	66.6 %	58.8 %
P 6	31.8 %	-	39 %	44.8 %	-	-	-	18.1 %
P 7	23 %	12.5 %	34.2 %	22.7 %	-	33.33 %	-	21.4 %
P 8	44.7 %	-	41.9 %	25.5 %	100 %	-	42.8 %	31.2 %
P 9	76.9 %	100 %	81.2 %	59.5 %	100 %	-	71.4 %	37.5 %
P 10	41.3 %	100 %	59.3 %	21.2 %	-	-	28.5 %	33.33 %
P 11	52.6 %	33.3 %	30.33 %	46.8 %	100 %	-	28.5 %	23 %

P 12	30 %	25 %	12.1 %	44.8 %	-	-	-	29.4 %
P 13	59.25 %	50 %	40.6 %	72.72 %	-	66.66 %	-	71.4 %
P 14	52.54 %	100 %	54.9 %	61.64 %	-	100 %	54.54 %	65 %
P 15	61.5 %	62.5 %	50 %	40.9 %	-	-	-	50 %
P 16	60 %	75 %	59.15 %	30.13 %	100 %	100 %	36.36 %	65 %
P 17	41.93 %	-	41.17 %	31.03 %	-	-	100 %	35.39 %
P 18	58.06 %	50 %	41.37 %	29.78 %	-	50 %	57.1 %	25 %
P 19	17.37 %	25 %	29.41 %	27.27 %	-	-	100 %	14.28 %
P 20	73.33 %	62.5 %	49.29 %	78.08 %	-	-	54.54 %	75 %
P 21	61.62 %	33.33 %	31.50 %	42 %	50 %	33.33 %	-	50 %
P 22	54.57 %	50 %	26.09 %	68.96 %	100 %	50 %	66.66 %	58.82 %
P 23	23.63 %	50 %	25.35 %	13.69 %	100 %	-	36.36 %	30 %
P 24	48 %	25%	29.41 %	40.9 %	-	-	-	24 %
P 25	50.87 %	75 %	30.98 %	24.65 %	-	-	36.36 %	55 %

P 26	29.62 %	62.5 %	51.42 %	14.28 %	-	-	100 %	21.42 %
P 27	25.45 %	75 %	28.16 %	31.5 %	-	-	18.18 %	25 %

2.3 Comparing dysfluent voiced and unvoiced consonants

The mean percentage of dysfluent voiced consonants was 43.37 (SD-17.47) and for dysfluent voiceless consonants was 43.88 (SD-17.09). Careful analysis of mean score suggest that the voiceless consonants had slightly high dysfluencies compared to voiced Consonants.

However, Wilcoxon signed rank test suggested no significance differences while comparing the voiced and unvoiced consonants (Z= -0.52, p>0.05).

Figure 4.3 and Table 4.5 depicts Rank order of difficulty in dysfluent consonants based on Voicing Features

Figure 4.3

Distribution of Dysfluent Consonants based on Voicing features

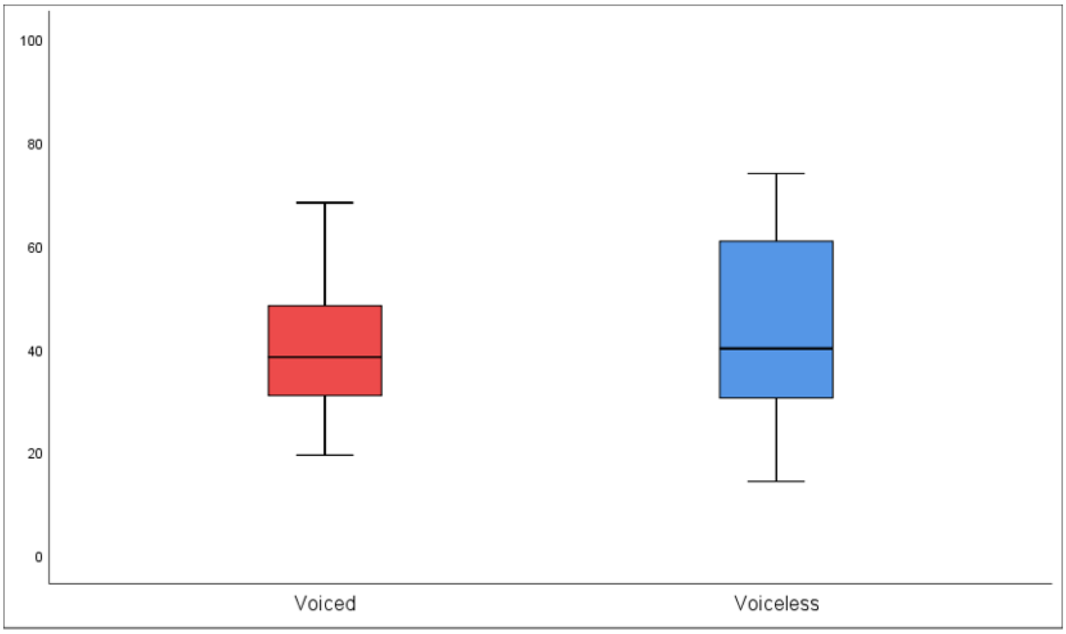

Table 4.5

Rank order of difficulty in dysfluent consonants based on Voicing Features

	Mean %	Median %	SD	Rank of difficulty
Voiced consonants	43.37	40.00	17.47	2
Voiceless consonants	43.88	38.40	17.09	1

The study determined that CWS might present similar difficulties in both consonant groups; specifically, there are no significant changes in stuttering frequency between voiced and voiceless consonants.

Table 4.6

Participant - wise Dysfluency Distribution based on Voicing features

Participants	Voiced	Voiceless
P 1	21.8 %	26.8 %
P 2	23.2 %	38.4 %
P 3	36.4 %	28.8 %
P 4	80.8 %	66 %
P 5	49.0 %	54 %
P 6	36.8 %	36.9 %
P 7	25.3 %	28.5 %
P 8	35.2 %	38.4 %
P 9	66.3 %	72.2 %
P 10	41.4 %	33.3 %
P 11	46.66 %	32.6 %

P 12	31.08 %	20.6 %
P 13	55.69 %	70 %
P 14	46.29 %	63.33 %
P 15	61.93 %	47.58 %
P 16	42.02 %	32.60 %
P 17	36.47 %	47.16 %
P 18	28.37 %	14.28 %
P 19	68.34 %	62.63 %
P 20	47.71 %	43.39 %
P 21	59.75 %	74 %
P 22	19.40 %	27.72 %
P 23	40 %	32.14 %
P 24	32.14 %	43.68 %
P 25	40 %	34.17 %
P 26	35.48 %	46.66 %
P 27	28.68 %	28.86 %

In voiced consonants, the percentage of dysfluencies ranged from 19.40% to 80.80%. Participant 4 had the highest percentage (80.80%), followed by Participant 19 (68.34%) and Participant 9 (66.30%). Participant 22 had the lowest percentage (19.40%), followed by Participant 1 (21.80%) and Participant 2 (23.20%).

Similarly, The range of dysfluencies in voiceless consonants was 14.28% to 74.00%. Participant 21 had the highest percentage (74.00%), followed by Participant 9 (72.20%) and Participant 13 (70.00%). Participant 18 had the lowest percentage (14.28%), followed by Participant 12 (20.60%) and Participant 22 (27.72%).

A participant-wise comparison showed that 15 of 27 participants had a higher percentage of dysfluencies in voiceless consonants than in voiced consonants. The participants were P1, P2, P5, P6, P7, P8, P9, P13, P14, P17, P21, P22, P24, P26, and P27. On the other hand, compared to voiceless consonants, 12 out of 27 participants showed a larger percentage of dysfluencies in voiced consonants. These individuals were P3, P4, P10, P11, P12, P15, P16, P18, P19, P20, P23, and P25.

CHAPTER V

DISCUSSION

The primary objective of this study was to use a standardized oral reading passage to examine the phonetic influences on stuttering in Kannada-speaking Children who stutter. The findings clearly reveal that phonetic context has a major impact on the loci of dysfluencies in children who stutter (CWS), with different hierarchies developing according to the place and manner of articulation, but voicing characteristics did not significantly differ.This demonstrates that speech breakdown is closely linked to the phonetic and motoric complexity of the target sounds rather than occurring at random.

5.1 Phonetic Influence of Place of Articulation on Dysfluencies

Based on the place of articulation the rank order for dysfluent consonants were as follows; Post alveolar, Velar, Palatal, Bilabial, Labiodental, Alveolar, Interdental, Glottal and Retroflex. In specific; Post alveolars, velars and palatals were highly dysfluent (>45%) where as glottals and retroflex being the least.

The probable reason for this could be that extremely dysfluent sounds (post-alveolar, velar, and palatal) need precise, complicated, and intricate spatial coordination of the tongue blade or body against the roof of the mouth in terms of kinematics, a high order articulatory requirement that is directly explained by The EXPLAN theory of stuttering Howell and Au-Yeung (2002) which explains that Speech depends on the simultaneous processes of muscular execution (EX) and cognitive-linguistic planning (PLAN): Bio-mechanically, as already discussed during the production of post-alveolar, velar, and palatal consonants necessitates very detailed, localized tongue gestures against the broad top contours of the oral cavity, imposing a significant computational load on the cognitive-linguistic formulator

(PLAN). This high-order spatial demand and systemic vulnerability directly support Walsh et al.'s (2015) empirical findings, which established that young children who stutter exhibit a distinct developmental lag in speech motor dynamics, as evidenced by significantly greater trial-to-trial instability and variability in their articulatory coordination compared to fluent peers.

When a child encounters a Post-alveolar target (such as /tʃ/ or /dʒ/), the linguistic system must estimates a precise retroflexion or posterior advancement of the tongue blade towards the post-alveolar ridge. Because this demands sophisticated, quick muscle adaptations to shift from total occlusion to fricative release, the time required to construct this specific phonetic plan increases considerably. The inherent acoustic and temporal characteristics of the target sound itself further complicate this planning requirement. For example, compared to a singleton voiceless velar stop like /k/, the voiceless affricate /tʃ/ exhibits a significantly longer total production duration because its mechanical release must transition into a sustained, turbulent frication interval rather than a brief, open-air aspiration lag. Heyde et al. (2016) provide kinematic evidence to support this transitional vulnerability, demonstrating that speakers who stutter have altered motor profile features and considerably lower mean peak velocities specifically during an offset phase—the crucial motoric shift away from a consonant occlusion into the following vowel. Under the rigid, forward-moving time restrictions of an oral reading task, the motor execution system (EX) quickly depletes the plan for the previous syllable and requires the post-alveolar motor program. However, because the consonant's great structural complexity, the formulator only processed the first "left-most portion" of the motion. As a result, the child's speech motor control system experiences an operational deficit; it must either stall by repeating the previous syllable while the tongue architecture is finalized, or proceed into the word with an incomplete plan, resulting in an instantaneous disruption in speech flow manifested as an auditory block or a prolongation at the post-alveolar zone. Similar breakdowns occur while producing velar sounds (/k/ and /g/) and palatal sounds (/j/ and /sh/). According to the EXPLAN model, broad supralaryngeal tongue movement patterns are not pre-programmed overlearned reflexes in developing children; instead they require active, extensive spatial targeting during the phonetic assembly stage (PLAN). When the steady pace of oral reading (EX) outpaces this complicated planning step, the motor system tries to carry out a gesture before its spatial coordinates are fully processed. The child attempts to lift the tongue body to the palate with an unfinished motor command, which Lu et al. (2022) observed to cause the articulatory organs to either freeze in mid-gesture. This particular phenomenon of articulatory freezing is physiologically substantiated by the real-time magnetic resonance imaging (RT-MRI) observations of Lu et al. (2022), who captured actual moments of stuttering on camera and discovered that disfluent consonants exhibit a severe "consonant overshoot"—a massive hyper-constriction in which articulators either freeze in place due to prolonged static posturing or repeat due to rapid gestural oscillations. This unique psycholinguistic-to-motor mechanism may probably explain why post-alveolar, velar, and palatal sounds produced the largest high levels of dysfluencies in the study, serving as empirical evidence that linguistic complexity consistently overpowers and affects motor execution capacity in children who stutter.

In contrast, glottal and retroflex sounds were found to be the least dysfluent categories in the present study of Kannada-speaking children, which can be attributable to a combination of articulatory simplicity, psycholinguistic synchronization, and structural features of the evaluation stimuli. From a physiological aspect, glottal sounds (such as /h/) do not require sophisticated supralaryngeal tongue moves, necessitating only fundamental laryngeal modifications with low biomechanical demands on the speech motor control system. This physiological feature is well supported by the kinematic data of Löfqvist and McGarr (1984), who did significant research on laryngeal articulation utilizing transillumination and fiberoptic tracking. Their findings show that glottal configurations have a highly efficient biomechanical profile, relying solely on simple, well-timed laryngeal adductory and abductory movements. Unlike complicated upper-vocal-tract sounds, glottal gestures do not necessitate intricate inter-articulator coordination or tight mechanical coupling between the tongue musculature and the jaw, placing low neuromotor execution demands on the developing speech motor system. In the context of the EXPLAN framework, because these sounds do not necessitate elaborate, high-order spatial targeting from the tongue musculature, the cognitive-linguistic formulator requires less time assembling their phonetic programs. As a result, the PLAN process easily maintains up with the constant rate of motor execution (EX). This temporal harmony ensures that a fully developed motor plan is regularly transmitted to the articulators before execution begins, allowing the child to move through these phonemes without encountering an operational mismatch or having to use coping techniques such as stalling or progressing. Similarly the retroflex /r/ is also found to be least dysfluent in the present study. Retroflex production is phonetically represented as a fast liquid gesture or flap.

Shishira (2019) analyzed the frequency of dysfluent consonants based on their place of articulation. Their results revealed most frequent to least frequent consonants based on place of articulation are as follows; retroflex, alveolar, palatal, velar, dental, glottal and bilabial. In specific bilabial was least dysfluent than retroflex, palatal and velar and retroflex was highly dysfluent than dental, alveolar, palatal, velar and glottal. It was concluded that the most frequent dysfluent consonants were found to be retroflex and the least dysfluent was bilabial. However the results of the present study is in contrast with Shishira (2019) for most dysfluent (retroflex) consonant. In the present study it was observed that the retroflex being the least dysfluent consonant based on place of articulation. However, the current study found that glottal sounds were the least dysfluent consonants, which is consistent with Shishira (2019) conclusions.

Sangeetha and Geetha (2013) analyzed the frequency of dysfluent consonants based on their place of articulation. Their results revealed most frequent to least frequent dysfluencies as follows: retroflex, alveolars, palatals, velars, labials, dentals and glottal. It can be concluded that retroflex sounds were the most dysfluent category of consonants while the glottal was the least dysfluent in CWS.

The conclusion that glottal sounds are the least dysfluent in the current investigation is consistent with the findings reported by Shishira (2019) and Sangeetha and Geetha (2013). However, the current study found contrastive results for retroflex consonants. While retroflex sounds were shown to be the most dysfluent in the investigations conducted by Shishira (2019) and Sangeetha and Geetha (2016), the current study did not follow this pattern.

Table 5.1

Rank order of difficulty in dysfluent consonants based on Place of articulation across different studies

Dysfluent consonant (Place of articulation)	Mean %	Median %	SD	Rank order Difficulty in current study	Rank of difficulty in Shishira (2019)	Rank of difficulty in Sangeetha and Geetha, (2013)
Bilabial	43.62	41.90	19.79	4	7	5
Alveolar	45.09	39.30	20.12	6	2	2
Velar	44.80	45.45	19.24	2	4	4
Labiodental	49.31	40.00	35.11	5	-	-
Interdental	37.63	31.20	18.40	7	-	6
Post-alveolar	49.37	50.00	31.89	1	-	-
Retroflex	20.67	0.00	34.38	9	1	1
Palatal	53.05	44.44	32.08	3	3	3
Glottal	27.79	27.79	17.75	8	6	7

Across the three investigations, glottal phonemes were consistently identified as among the least dysfluent consonants, with the current study's findings closely matching those of Shishira (2019) and Sangeetha and Geetha, (2013). Within the current corpus, the relative occurrence of the glottal /h/ sound was robustly balanced across all grades, with each grade level giving a dense distribution of 10 to 15 structural units. This low rate of dysfluency across grades is well supported by Löfqvist and McGarr's (1984) kinematic data, which demonstrated that glottal configurations depend on an extremely streamlined biomechanical profile consisting of simple laryngeal adductory and abductory motions that eliminate the need for complex interarticulator coordination.

On the other hand, retroflex sounds, which were found as the most dysfluent consonants in earlier studies by Shishira (2019) and Sangeetha and Geeth,(2013), showed much lower levels of dysfluency in the current investigation. This deviation from previous findings can be primarily due to stimulus characteristics in the assessment material; across all educational levels, the structural occurrence of the rhotic /r/ sound was significantly lower in each reading passage than in any other consonantal category. Furthermore, whereas palatal and velar sounds showed very significant dysfluency in all three investigations, there was some heterogeneity in the ranking order of other place of articulation.

From a statistical viewpoint, the reduced frequency of occurrence minimizes the structural opportunities for a speech breakdown to occur on these specific sounds throughout the reading activity. For example, in the grade 7 reading passage, bilabial phonemes appeared 82 times, but the retroflex category was represented only once. From a statistical standpoint, such a severe restriction in phoneme occurrence inserts a significant mathematical bias; if this single retroflex phoneme is produced disfluently, the resulting descriptive statisticexhibit to reflect a 100% rate of disfluency, which unintentionally misrepresents the child's actual motor ability. Also, when a sound occurs less frequently, the speech motor system feels less cumulative tiredness and has a lower operational burden connected with that particular articulatory gesture.

As a result, the high fluency found on glottal and retroflex /r/ consonants is best understood as a multifaceted interaction; the intrinsic fluidity of the liquid /r/ gesture and the lack of elaborate supralaryngeal tongue motions in glottals /h/ decrease the cognitive-linguistic planning time (PLAN), keeping it perfectly coordinated with motor execution (EX), while their lower frequency of occurrence in the text reduced the total motoric strain and statistical likelihood of causing a stuttering moment. This supports the idea that stuttering loci are extremely sensitive to both the immediate biomechanical complexity of a speech sound and the macro-structural demands of the linguistic context.

Individual variability based on Place of articulation

The current investigation found significant individual variability in the occurrence of dysfluencies among different place of articulation. Although post-alveolar consonants had the highest median dysfluency percentage at the collective level (50%), participant-wise analysis revealed significant individual variability.

Some participants showed high percentages of dysfluency for post-alveolar consonants, while others showed minimal or no dysfluency for the same category. For example, post-alveolar dysfluency ranged as 0% in participants P2, P6, and P9 to 100% in participants P1, P4, P11, and P14. Similarly, bilabial consonants varied greatly, ranging from 15.38% (P26) to 84.90% (P4), and alveolar consonants ranged from 20.00% (P24) to 95.60% (P20). Velar consonants showed significant variance, with dysfluency rates ranging from 10.00% (P19) to 81.20% (P5). Palatal consonants have one of the broadest distributions, ranging from 12.50% (P1) to 100% (P13, 19, and P26). Retroflex consonants, on the other hand, were lacking in dysfluency production for many participants (0%), whereas a few persons had extraordinarily high dysfluency percentages of 100% (P4 and P16). This diversity is mirrored in the somewhat high standard deviation values obtained for labiodentals (SD = 35.11), retroflexes (SD = 34.38), palatals (SD = 32.08), and post-alveolars (SD = 31.89), showing a wide range of scores across participants.

5.2 Phonetic Influence of Manner of Articulation on Dysfluencies

The Friedman test [$\chi2$ (7) = 30.10, $p < 0.05$] showed that the manner of articulation has a significant impact on the distribution and frequency of dysfluencies in Kannada-speaking children (CWS).Based on the Manner of articulation the rank order for dysfluent consonants were as follows; affricates, stops, fricatious continuents, fricatives, nasals, aspirated stops, laterals, and flaps. The absolute rate of affricates (Rank 1) and stops (Rank 2) at the top of the dysfluency hierarchy indicates a severe systemic vulnerability when children who stutter are expected to accomplish complete structural occlusion within the vocal tract. Biomechanically, stop consonants necessitate a multi-phase motor sequence. A quick, tight closure of the major articulators (the blocking phase), the preservation of this closure to create significant intraoral air pressure, and the sudden, explosive release of that impounded air (the burst phase).This sequence places significant demand on transglottal airflow control and rapid musclar stiffening.

Affricates enhance the motoric and aerodynamic complexity even further. An affricate (e.g., Kannada /tʃ/ or /dʒ/) is a phonetic gesture that begins with a complete stop closure and ends with a controlled, turbulent fricative release rather than an explosive burst. Because of this hybrid nature, the child's speech control system must make an extremely quick, dynamic mid-phonemic transition from absolute structural occlusion to a highly precise, constricted constriction canal without interfering with the syllable's forward movement.

From a psycholinguistic standpoint, this bottleneck can be fully described by combining the EXPLAN theory of stuttering (Howell & Au-Yeung, 2002) and the Temporal Dyssynchrony Model (Perkins, Kent, & Curlee, 1991). The EXPLAN model states that speech production is governed by two independent, parallel processes: cognitive-linguistic formulation of the phonetic plan (PLAN) and physical motor execution of the compiled program (EX). Because an affricate integrates two very different mechanical methods (stop and fricative) into a single structural frame, its linguistic assembly demands an enormous computational effort. Therefore during the PLAN phase, the linguistic formulator takes much longer to combine the dual-stage spatial and aerodynamic instructions.

During an oral reading task, the child is driven by a stable, forward-moving text constraint, causing the motor execution system (EX) to operate at a constant rate. When the child encounters an affricate or a stop, the execution system quickly exhausts the motor commands of the previous syllable and demands an immediate plan for the next complicated target. However, due to the sound's inherent structural complexity, the linguistic formulator has only been able to compile the "left-most portion" of the motor program, which is often the initial stop closure phase. This causes an immediate temporal mismatch, or dyssynchrony.

The Temporal Dyssynchrony Model states that when the rapid pace of syllable framing exceeds the system's ability to seamlessly integrate phonemic segments, a breakdown will occur. Faced with this operational shortcoming, the child's speech control system must initiate an instant coping mechanism. It may try to stall by repeating the previous word or syllable while waiting for the remaining fricative release coordinates to be finalized. Conversely, if the child tries to produce the word with incomplete, fragmented plan, the motor system stalls in mid-gesture. This manifests directly as the tense, silent blocks or audible repetitions observed in this study at the outset of stops and affricates, where the articulators remain physically stuck in the first closure state due to a lack of forthcoming motor commands to release the sound.

Fricatious continuents (Rank 3), fricatives (Rank 4), and nasals (Rank 5) make up the middle tier of the hierarchy. Fricative gestures exhibit moderate rates of dysfluency due to the lack of perfect structural blockage. Unlike stops and affricates, fricatives require the articulators to construct an extremely narrow constriction canal through which a continuous, turbulent stream of air is directed. Because the vocal tract is never totally sealed, the speech motor system is not subjected to the rapid, explosive changes in intraoral air pressure associated with stops. This continuous venting of the air stream reduces the severity of aerodynamic shocks, making the motor system less likely to collapse into a complete block. However, maintaining a consistent, microscopic constriction canal under reading-rate pressure necessitates very accurate, continual muscular posturing, which explains why these sounds are substantially more dysfluent than liquid sounds.

Nasals have a distinct physiological profile that protects them from severe dysfluency. Although nasals provide a complete occlusion of the oral cavity (similar to stops), the velopharyngeal port remains open, allowing air to flow freely through the nasal passages. Because the air is constantly released, intraoral air pressure cannot accumulate behind the oral block. The lack of substantial intraoral pressure minimizes the tactile and kinesthetic feedback burden on the speech motor control system, allowing the PLAN and EX processes to remain relatively synced and resulting in a lesser level of difficulty than oral stops.

The current study found that laterals (Rank 7) and flaps (Rank 8) were the least vulnerable to speech breakdowns, with a statistically significant decline in difficulty when compared to affricates and fricatives. Biomechanically, Laterals and flaps are classified as liquids because the tongue tip moves quickly, fluidly, and ballistically. A flap or lateral gesture necessitates no acute muscular tension, tight structural seals, or high-friction air turbulence. Instead, the tongue tip makes a brief contact with the alveolar ridge before rapidly releasing into the next syllable. According to the EXPLAN model, because these fluid liquid sounds are highly automated, well-mapped, and lack sophisticated multi-phase aerodynamic requirements, their cognitive-linguistic compilation time is minimal. During the production of these sounds the PLAN process is readily ahead of or fully synced with motor execution (EX). There is no operational mismatch, and the linguistic system continuously supplies fully compiled, fluid motor programs long before the articulators are ready to execute them, allowing the child to move through these sounds with ease.

When compared to the larger corpus of stuttering literature, these findings show both universal phonetic vulnerabilities and language-specific differences. The high concentration of dysfluencies on stops and complex consonantal gestures eg: (/tʃ/, /dʒ/) is consistent with global trends, as reported by Morrish, Howell, and Au-Yeung (2016), who found that plosives and complex phonemic clusters are universally vulnerable sites for speech breakdowns due to their high motoric and aerodynamic requirements.

Within the Indian and Dravidian context, results of the current study fit very well with the fundamental work of Jayaram (1983), studied phonetic influences on stuttering in monolingual and bilingual adults. Their analysis concluded that initial nasals, voiceless fricatives, and voiceless plosives were more commonly stuttered than other sounds. The current investigation confirms increased dysfluency in plosives and fricatives but contradicts the result that nasals have higher dysfluency, as they had the intermidiate dysfluency levels.

Another study by Soumya and Sangeetha (2011),studied Kannada speaking individual, and results found that affricate /tʃ/ was ranked as the most dysfluent phonetic consonant. This independent replication emphasizes that the dual-stage, stop-fricative structure of affricates is a key universal source of linguistic and motoric strain in Kannada-speaking children who stutter.

In accordance with Sangeetha's and Geetha (2013) study, dysfluent consonants in CWS are ranked from most frequent to least frequent based on their manner of articulation, are as follows; flap, continuants, affricates, plosives, laterals, fricatives, and nasals. It can be concluded that flap was the most dysfluent category of consonants while the nasals were the least dysfluent. When the current study's findings were compared, no clear consensus emerged about the most dysfluent consonant groups.

A recent study by Shishira (2019), the rank order of dysfluent consonants according to manner of articulation for CWS, from most to least frequent, is as follows; Lateral, Plosives, Fricative, Flap, Continuant, Affricate and Nasal. In specific laterals were being highly disfluent amd nasal consonants being the least.

Table 5.2

Rank order of difficulty in dysfluent consonants based on Manner of articulation across different studies

Dysfluent consonant (Manner of articulation)	Mean %	Median %	SD	Rank order Difficulty in current study	Rank order Difficulty Sangeetha and Geetha, (2013)	Rank order Difficulty Shishira, (2019)
Stops	46.38	48.00	16.60	2	4	2
Fricatives	39.45	34.20	16.91	4	6	3
Affricates	49.68	50.00	31.43	1	3	6
Aspirated Stops	36.70	31.20	19.64	6	-	-
Nasals	39.79	31.70	19.98	5	7	7
Laterals	30.00	0.00	44.20	7	5	1
Flaps	16.97	0.00	30.69	8	1	4
Fricatious continuents	41.64	36.36	35.16	3	2	5

A comparison of the outcomes from the three investigations found similarities and differences in dysfluency dependent on manner of articulation. In the current study, affricates were discovered to be the most dysfluent consonant group, which contradicted the findings of Sangeetha and Geetha (2013), and Shishira (2019). Stops showed relatively high dysfluency throughout the studies, indicating a partial consistency in the results. In contrast, the order of difficulty for laterals and flaps varied significantly among the three investigations.

The observed disparities could be explained with respect to changes in the speech tasks used across research. The current study and Shishira (2019) utilsed oral reading tasks, meanwhile Sangeetha and Geetha (2013) investigated spontaneous speech samples. Spontaneous speech places extra demands on language formulation, lexical retrieval, and information planning, potentially influencing the frequency and distribution of dysfluencies across phoneme categories. Oral reading, on the other hand, reduces linguistic planning demands and allows participants to focus solely on speech output, which may result in various patterns of dysfluency.

Methodological differences could also have led to the disparities. In spontaneous speech, the speaker naturally evaluate the occurrence of phonemes, which may not be evenly distributed among phonetic categories. Certain phonemes may appear more frequently than others, influencing reported dysfluency patterns. In contrast, the reading passages used in the current study were createded to incorporate a diverse and wide variety of Kannada phonemes; yet, achieving perfectly balanced representation of all phoneme categories remains difficult. Differences in phoneme frequency between speech samples may thus explain variations in rank order of dysfluency.

Furthermore, participant-related factors could have influenced the results. Some of the younger children in the current study needed more familiarity with the reading material before finishing the task. In such circumstances, the researcher read the passage aloud to the participant before beginning the reading task to acquaint them with the content. This enhanced familiarity could have lowered linguistic uncertainty and shifted the distribution of dysfluencies for specific phoneme categories. Differences in task demands, methodological techniques, phoneme distribution, and participant performance characteristics may all contribute to the reported discrepancies among studies.

Individual variability based on Manner of articulation

Substantial individual variation in dysfluency patterns across various manner of articulation was also noted. Although affricates and stops were identified as the most dysfluent categories on the collective level, participant-wise results revealed significant difference among children. For example, dysfluency on stop consonant ranged as 17.37% (P19) to 76.90% (P9), whereas fricatives ranged as 12.13% (P12) to 81.20% (P9). Nasals had a wide range, from 13.69% (P23) to 89.30% (P4). Affricates demonstrated significant variety, with some individuals having 0% dysfluency (P6, P8, P15, P17, and P24), while on the other hand, others had 100% dysfluency (P4, P10, and P14). Fricatious continuents showed similar diversity, ranging from 0% in multiple persons to 100% in participants P17, P19, and P26. Laterals and flaps exhibited the most diversity. Many people had 0% dysfluency in these categories, but a few had 100% dysfluency in laterals (P4, P8, P15, P23, and P22) and flaps (P16 and P18). This dysfluency pattern explains why laterals (0%) and flaps (0%) have such low median values, despite their comparatively high standard deviation values. The substantial variability across manner categories suggest that although affricates and stops were generally more susceptible to dysfluency, the specific manner classes linked with dysfluency that varied considerably across participants.

These results further support the heterogeneous nature of developmental stuttering, implying that phonetic loci of dysfluency differ across children even when broad group-level trends are evident.

5.3 Comparing dysfluent voiced and unvoiced consonants

To gain an in-depth understanding of the phonetic parameters driving speech breakdown in Kannada-speaking children who stutter (CWS), the study investigated the distribution of dysfluencies across voicing components. The descriptive statistical analysis revealed that the mean percentage of dysfluencies on voiceless consonants was 43.88% (SD = 17.09), putting them at Rank 1 of difficulty, while the mean percentage of dysfluencies on voiced consonants was slightly lower at 43.37 (SD-17.47) putting them in Rank 2.

A careful initial assessment of these mean scores reveals that voiceless consonants exhibited a marginally higher frequency of dysfluencies than their voiced counterparts. However, when these differences were subjected to inferential statistical analysis with the Wilcoxon signed-rank test, no statistically significant difference was found between the two categories ($Z = -0.52$, $p > 0.05$). The results suggested that CWS might present similar type of difficulty in both the consonant groups. There are no significant evidence in stuttering frequency between voiced and voiceless consonants.This significant result shows that, the binary phonological distinction of voicing is not a primary or independent trigger for speech dysfluency during oral reading. The results of the present study are in consensus with other researchers (Sangeetha & Geetha, 2013; Shishira, 2019; Jayaram, 1983) who also reported no such differences.

A participant-wise comparison showed that 15 of 27 participants had a higher percentage of dysfluencies in voiceless consonants than in voiced consonants. The participants were P1, P2, P5, P6, P7, P8, P9, P13, P14, P17, P21, P22, P24, P26, and P27. On the other hand, compared to voiceless consonants, 12 out of 27 participants showed a larger percentage of dysfluencies in voiced consonants. These individuals were P3, P4, P10, P11, P12, P15, P16, P18, P19, P20, P23, and P25.

Qualitative analysis of Female Dysfluent patterns

The study included a total of 28 participants, were 27 participants were male and only 1 participant was female. In order to give descriptive insights into the female participant's dysfluency pattern, the findings are presented qualitatively.

The analysis based on Place of articulation revealed that Labiodental consonants exhibited highest percentage of disfluencies (75%), followed by Interdentals (60%), Palatals (55.5%), Velars (35%), Alveolars (34.78%), Bilabials (26.38 %), Post-alveolars (25%) and Glottals (17.6%). The findings indicated that Labiodentals showed the highest disfluencies and glottals showed the least disfluent moments.

Further, the analysis based on Manner of articulation revealed Aspirated stops showed the highest disfluencies (60%), followed by Fricatious continuents (45.4%), Fricatives (36.6 %), stops (33.33 %), Affricates (25%) and Nasals (23.28%) respectively. The findings indicated that Aspirated stops showed the highest disfluencies and Nasalswere the least disfluent moments.

With respect to voicing characterstics, Voiceless consonants exhibited a higher percentage of dysfluencies (41.75%) compared to voiced (30.82%). These findings suggested that voiceless consonants were relatively more dysfluent to the participant than voiced consonants.

The observed disparities between female and male participants can be explained in light of earlier research indicating sex-related differences in stuttering. Stuttering is persistently more common in men than in women, with male-to-female ratios ranging from roughly 3:1 during childhood to almost 5:1 in adulthood (Yairi & Ambrose, 2013). This rising ratio has been associated to the greater likelihood of spontaneous recovery seen in females. According to Gattie et al. (2025), females are significantly less likely than males to experience chronic stuttering in adulthood, which may indicate protective biological and developmental characteristics in females.

The literature has also reported differences in stuttering traits between males and females. According to Samson (2022), young female who stutterers often experience stuttering differently than young males, exhibiting more avoidance techniques and experiencing a greater psychosocial burden. These results imply that, in contrast to males, females might use various coping strategies and exhibit different stuttering manifestations.

The distinct dysfluency occurrence observed in the current female participant may be influenced by biological factors in addition to psychosocial ones. In a recent study, Mohammadi et al. (2025) examined how adult women who stutter varied in the severity of the stuttering over the menstrual cycle. According to the researchers, stuttering severity declined during menstruation and the luteal phase and increased during the follicular phase. They postulated that changes in sex steroid hormones, especially testosterone and estradiol, could have an impact on the brain circuits linked to speech production and fluency. According to the study, these hormone fluctuations may also affect dopaminergic activity in the basal ganglia, a brain network that has been closely linked to the pathophysiology of stuttering. While decreased dopaminergic activity has been connected to better fluency, higher dopaminergic activity has been linked to more severe stuttering (Mohammadi et al., 2025).

The current findings can also be viewed within the framework of Smith and Weber's (2017) Multifactorial Dynamic Pathways Theory, which proposes that stuttering results from the interaction of speech motor, linguistic, cognitive, affective, and biological elements. According to this theory, individual differences in dysfluency patterns are expected, and each speaker may experience various interactions between phonetic complexity, speech motor demands, and biological variables. As a result, the female participant's increased dysfluencies for labiodental, interdental, and aspirated stop consonants might be the result of a combination of biological and speech motor characteristics specific to that person.

Considering that only one female participant participated in the current study, the findings cannot be extrapolated to the larger group of female stutterers. However, the qualitative observations highlight the need for larger female participants in future research to better understand the impact of biological, hormonal, and speech motor factors on stuttering characteristics and offer preliminary insight into potential sex-related differences in dysfluency patterns.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The loci of stuttering have been reported to be linguistically conditioned. Hence, the present study is an attempt to examine the phonetic influences of stuttering in Kannada speaking children who stutter. The study investigated the reading samples of 28 CWS (1 female and 27 males) age ranging from 8 to 12 years. The speech samples were audio and video recorded and dysfluencies were analysed based on Place of articulation, Manner of articulation and Voicing features. Some of the important results were:

- The rank order of phonetic dysfluencies with respect to place of articulation included Post-alveolar, Velar, Palatal, Bilabials, Labiodental, Alveolar, Interdental, Glottal and Retroflex. The study suggested Post-alveolar sounds were highly dysfluent and Glottal sounds were least dysfluent.
- The rank order of phonetic dysfluencies with respect to manner of articulation included Affricates, Stops, Fricatious continuents, Fricatives, Nasals, Aspirated stops, Laterals and Flaps. The study revealed Affricate sound was highly dysfluent and Flaps sounds were least dysfluent.
- Based on the voicing features, careful analysis revealed voiceless consonants had slight high disfluencies compared to voiced consonants. However the appropriate non parametric test revealed no significant difference between voiced and voiceless consonants.
- The female participant demonstrated a phonetic dysfluency pattern that differed from the overall group results. Greater dysfluency was observed on labiodental and interdental consonants, while post-alveolar consonants were more dysfluent in the entire group. In terms of articulation, aspirated stops were the most

dysfluent, whereas nasals were the least dysfluent. Similar to the overall findings, voiceless consonants were more dysfluent than voiced consonants. These findings emphasize the individual differences associated with stuttering.

Phoneticians are interested in stuttering because phonetics is crucial to understanding stuttering behavior. This is due to the fact that phonetics and stuttering help to clarify, simplify, and comprehend the various aspects of stuttering, encompassing sociocultural, psychological, physiological, and genetic factors (Zmarich, 2017).

The current study's findings revealed a variety of dysfluencies across consonant categories. Specific timing phenomena in stuttering, such as articulatory slowness, irregular scaling in articulatory gesture magnitude, variability in speech output, and inappropriate co-articulation delivery, are explained by variable theories (Van Leishout, 2008).

The study evaluated each phoneme's relative difficulty based on its place and manner of articulation in Kannada-speaking CWS. Our findings may have clinical implications in addition to theoretical ones. Our results lend credibility to the idea that CWS need a thorough evaluation that is both comprehensive and in-depth. The Kannada language-based results presented here could be helpful in offering cross-linguistic proof of phonetic influences on CWS disfluencies.

Implications of the study

- The present study will provide an insight about understanding phonetic influence in Kannada speaking children who stutter.
- The results would advance our theoretical understanding of phonetic influences on stuttering through a systematic reading task.

- It is expected that the study would have clinical significance for the assessment and treatment of Kannada speaking children who stutter.

Limitations of the Study

- The number of Participants were less
- Only 1 female participant was included in the study.
- The language considered was only Kannada.
- Although all Kannada phonemes were included in the oral reading passage, they were not distributed equally across the passage.
- The results with respect to consonants (voicing feature, place of articulation and manner of articulation) had partial disagreement when compared with the literature.

Future directions

- Study on other languages that has various linguistic structure is recommended.
- Similar study can be conducted including more number of participants.
- Similar study can be conducted including more number of female participants.
- Similar study can be conducted across languages, gender and severity.

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APPENDIX A

ETHICAL CLEARENCE

All India Institute of Speech and Hearing
(An autonomous Institute under the
Ministry of Health and Family Welfare, Govt. of India)
Center of Excellence - Assessed & Accredited by NAAC with 'A' Grade
ISO 9001:2015 Implemented Institute
Manasagangothri, Mysuru-570006

ಅಖಿಲ ಭಾರತ ವಾಕ್ ಮತ್ತು ಶ್ರವಣ ಸಂಸ್ಥೆ
ಮಾನಸಗಂಗೋತ್ರಿ, ಮೈಸೂರು–570006

अखिल भारतीय वाक् श्रवण संस्थान
मानसगंगोत्री, मैसूरु - 570 006

INSTITUTE REVIEW BOARD (IRB) APPROVAL FOR BIO-BEHAVIOURAL RESEARCH PROPOSAL INVOLVING HUMAN SUBJECTS AT AIISH

AIISH Institute Review Board (IRB)

Ref: SH/IRB/M.5/SLP.37/2025-26

Date: 11.03.2026

Title of the Dissertation	: Phonetic Influences on Oral Reading in Kannada Speaking Children Who Stutter
Name of the Student	: Ms. Shraddha S Mutalik Desai
Guide	: Dr. Sangeetha Mahesh
Co-Guide (if any)	: Nil
Proposed Duration of the Project	: 06 months
Source of funding	: Non-funded Master's dissertation
Estimated budget	: Nil
Reference Number of the Project	: Nil
Date on which the IRB meeting was held	: 05.03.2026
A clear statement of the decision reached IRB meeting (In the event of the proposal is not APPROVED, a statement of reasons for the same must be indicated)	**: APPROVED**
Advice & suggestions (if any)	: Advised to submit the permission letters from clients where the participants are being recruited for the study.

Signature & Name of the Member Secretary-IRB
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