

Chapter 3

Review of Literature

3. Introduction

This chapter constitutes a meticulous survey of seminal research papers within the area of Speech Language Pathology (SLP), specifically addressing stammering—its nuances, manifestations, and therapeutic prospects. The selection and categorization of these papers align with a trifold taxonomy, encompassing the linguistic facet, computational paradigms, and social aspect intrinsic to the multifaceted discourse surrounding stammering. This chapter aspires to distill the cumulative knowledge emanating from these three convergent domains: Linguistics, Computational techniques, and Social Context. Through a meticulous scrutiny of the literature through this multifaceted prism, this review establishes the groundwork for a nuanced exploration of stammering. By amalgamating theoretical frameworks with empirical findings, this review sets the stage for subsequent chapters, wherein we proffer our own empirical contributions to the understanding and intervention of stammering within the Hindi-speaking demographic.

3.1 Linguistic Aspect

Stammering analysis demands a rigorous examination within the linguistic domain. The chosen research articles in this review are discerningly curated for their substantive contributions to the elucidation of linguistic intricacies tied to stammering. These encompass a spectrum of linguistic

constituents, ranging from phonetic and phonological aspects to syntactic and semantic dimensions. The discernment of these linguistic intricacies not only facilitates a profound comprehension of the linguistic substrates of stammering but also furnishes a sophisticated lens to scrutinize the idiosyncrasies of stammering in the Hindi linguistic milieu.

- According to the covert repair hypothesis (Postma & Kolk, 1993), speech production is hindered by disfluencies which result from internal mistake detection and correction mechanisms. Disfluencies are explained by certain characteristics including interrupting, backtracking, and note adjustments. It is believed that people who stammer find it difficult to produce error-free speech, demanding many corrections and producing elevated levels of disfluency.
- The phonological and prosodic features of stammering, especially in the context of content words (Howell et al., 2000) and function words (Au-Yeung et al., 1998) have been studied. Researchers investigated how time, rhythm, and word and syllable stress patterns affect stuttered speech. Howell's work has influenced the creation of speech treatment methods that concentrate on these facets of speech production. Utilizing Selkirk's phonological word framework, the analysis revealed a heightened stammering rate when function words were in early phonological word positions. Notably, stammering frequency was influenced by the relationship between function words and the single allowed content word within phonological words. The study suggests that stammering on function words in young speakers may function as a deliberate delaying tactic when the subsequent content word is not adequately prepared for articulation.
- Kleinow and Smith's study (Kleinow & Smith, 2000) has looked at how syntax and stammering interact. People who stutter can have trouble creating and fixing intricate

syntactic structures as they speak. Their research has influenced therapies meant to enhance the planning and repair processes for syntactic structures.

- Watson et al. (2011) investigated how phonetic complexity affected those who stuttered in her study. She investigated how various forms of phonetic complexity, including vowel length or consonant clusters, might impact fluency in those who stutter. She also focused on grammatical corrections and syntactic complexity of the data. The goal of the study was to identify the linguistic elements that cause stammering and to provide guidance for treatment strategies that specifically address these aspects.
- Another area of research in the linguistic study of stammering has focused on the relationship between stammering and language proficiency (Reardon, 2000; Ryan, 1992; Watkins et al., 1999). Some studies have found that individuals who stammer often have lower levels of language proficiency and vocabulary, as well as difficulties with sentence structure and syntax and found to have moderate inverse correlation between stammering and language proficiency. However, other studies have shown that stammering can occur in individuals who have high levels of language proficiency and vocabulary.
- Researchers (Kelman & Wheeler, 2015) investigated the cognitive and linguistic aspects of stammering and explored the application of Cognitive Behavior Therapy (CBT), highlighting the value of assisting kids in recognizing and comprehending their thoughts and feelings, challenging their assumptions, and creating coping mechanisms. To provide focused assistance for emotional consequences and increase the evidence foundation for employing CBT with children who stutter.
- Researchers showed (De Nil & Brutten, 1991) that compared to their counterparts who did not stammer, youngsters who did demonstrated much more unfavorable attitudes regarding

speech. Starting at age 7, this disparity was seen across all age groups. Additionally, it was discovered that there was an interaction effect between group (stuttering vs. non-stuttering) and age, indicating that the non-stammering children's attitudes toward speech changed less negatively as they grew older after the age of nine. These results imply that it is crucial for children who stammer to address their attitudes toward communication as negative attitudes are an indicator of unsuccessful intervention.

- Studies (Constantino et al., 2022; Erickson & Block, 2013) have been done to explore how linguistic and social variables affect a person's stammering. This research was focused on how social and linguistic variables, including peer relationships and communication attitudes, affect the fluency of a person who stutters. The research sought to advance our comprehension of the intricate interactions of linguistic, social, and emotional elements that contribute to stammering.
- Research works (Shaheen et al., 2012; Weiss, 2004) on the connection between pragmatics and stammering. These studies were concentrated on the social communication strategies employed by people who stutter as well as the effects of pragmatic elements like turn-taking, subject management, and conversational repair on fluency. The objective was to educate treatments targeted at promoting successful social communication and offer insights into the practical difficulties experienced by those who stutter.
- Zhadlenko (2020) discusses the functional intricacies of motor-speech development in a specific demographic group affected by stammering. It brings to the forefront the intricate connection between the morpho functional foundations of motor skills and speech. This connection encompasses the activation of the cerebral cortex, enhancement of brain blood supply, and the restoration of motor and articulatory innervation. Employing a

comprehensive multidisciplinary approach, this research explores philosophical, psychophysiological, neurobiological, psychological, and linguistic dimensions, effectively corroborating the hypothesis of delayed rhythm development in children grappling with stammering. Notably, the study (Zhadlenko, 2020) reveals the profound interdependence that exists between motor processes and linguistic rhythms, thus reshaping our understanding of stammering from a mere speech disorder to a multifaceted interplay of motor and linguistic domains. Consequently, these multifaceted insights advocate for holistic interventions, particularly the employment of logo rhythmic exercises, as a promising avenue for addressing the challenges faced by children in the senior preschool age group dealing with stammering, offering a more comprehensive approach to enhance their speech development and overall well-being.

- A recent study (Imtiaz et al., 2022) provides valuable insights into speech therapy and the treatment of stammering in school-going children and adolescents. The research's focus on non-pharmacological interventions, specifically the "Easy Onset" and "Pantomiming" techniques, is particularly significant in the context of speech pathology. The finding that both techniques demonstrated equal effectiveness in alleviating blocking in stammering is noteworthy, as it underscores the importance of offering therapists flexibility in selecting treatment methods. This not only acknowledges the individuality of each patient but also encourages a patient-centered approach to therapy, where the preferences and specific needs of the patient can guide the choice of intervention. Furthermore, the study highlights the potential of non-pharmacological interventions in speech therapy, mirroring a broader trend in healthcare where holistic and patient-centric approaches are gaining prominence. The fact that both the "Easy Onset" and "Pantomiming" techniques yielded equally positive

outcomes suggests that speech therapists should consider a range of therapeutic options in their practice. Such a nuanced approach ensures that stammering treatment is not a one-size-fits-all endeavor but rather a tailored and individualized process.

- Smith & Weber (2017) discuss a comprehensive and updated theoretical framework to elucidate the intricate developmental trajectory of stammering. This research endeavors to offer a more nuanced understanding of the etiology and progression of stammering by considering a multitude of contributing factors. It systematically reviews and integrates genetic/epigenetic influences, motor aspects, linguistic complexities, emotional facets, and insights from neuroimaging studies to construct a holistic perspective on the disorder's development. The crux lies in its emphasis on the dynamic and evolving nature of stammering, particularly during the crucial preschool years. Rather than viewing stammering as a static condition, it posits that it arises within a continuously changing developmental context. The multifactorial dynamic pathways theory posits that stammering initially stems from deficits in speech sensorimotor processes. However, what sets it apart is the recognition that its progression over time is profoundly shaped by linguistic and emotional factors. This insight implies that stammering cannot be reduced to a single-dimensional problem; instead, it is a multidimensional phenomenon that necessitates a more comprehensive and holistic approach to treatment. By acknowledging the intricate web of influences on stammering development, professionals can tailor treatments that address not only the motor aspects but also the linguistic and emotional dimensions, offering more effective and holistic support to individuals who stutter.

- Walden et al. (2012) introduce a dual diathesis-stressor framework to comprehend the emotional and speech-language factors involved in childhood stammering. It suggests that both linguistic demands and skills, in addition to emotions and their regulation, contribute to stammering. The study encompassed fifty-eight children who stutter and forty controls, with findings highlighting distinctions between children with persistent stammering and those who recover, particularly concerning language proficiency, kinematic variability, and temperament. This research sheds light on the multifaceted nature of childhood stammering, revealing that it is influenced by not only linguistic factors but also emotional components. Recognizing this interplay is pivotal as it implies that therapeutic interventions should encompass both linguistic and emotional aspects to effectively address the condition. Incorporating emotional regulation techniques into stammering treatment plans can potentially lead to more holistic and successful outcomes for children dealing with this speech disorder.
- Ambrose et al. (2015) aims to delineate potential subtypes within persistent and recovered stammering, encompassing epidemiologic, motor, linguistic, and temperament domains. The research cohort comprises fifty-eight children who stutter and forty controls, with findings revealing distinct differences between those with persistent stammering and those who recover, notably in language skills, kinematic variability, and temperament. This research underscores the nuanced nature of stammering, suggesting that it is not a uniform condition but rather comprises various subtypes influenced by multiple domains. This recognition is pivotal as it advocates for a personalized approach to treatment, acknowledging that a one-size-fits-all strategy may not be optimal. Tailored interventions,

guided by the specific subtype characteristics, hold the potential to improve treatment outcomes and better address the diverse needs of individuals dealing with stammering.

- Bleakley et al. (2022) investigate into the user experiences of individuals who stammer when engaging with smart speakers, such as virtual assistants. The study examines aspects of their daily routines, the challenges encountered during interactions, and the strategies employed to overcome these barriers. Notably, participants highlighted various linguistic approaches they use to mitigate interaction difficulties and explored the potential of leveraging smart speakers for speech and language therapy. From a perspective rooted in technological and communication accessibility, it becomes evident that the integration of smart devices into the lives of individuals who stammer presents a dynamic landscape with both challenges and opportunities. On one hand, the study underscores the importance of addressing the unique needs of users with speech disorders to ensure the inclusivity and effectiveness of such technologies. On the other hand, it highlights the potential of smart speakers as tools for speech and language therapy, highlighting the adaptability of these devices in catering to a broader spectrum of user experiences. This research exemplifies the evolving intersection of technology and healthcare, demonstrating how innovative solutions can empower individuals with speech disorders to enhance their communication skills and quality of life.
- Sjøstrand et al.(2021) provides a comprehensive review of non-pharmacological interventions designed to address stammering in young children, with a particular focus on recognizing the adverse effects of stammering on behavioral, social, and emotional

development. The primary objective of this study is to assess the immediate and long-term impacts of these interventions on various facets, including speech outcomes, communication attitudes, quality of life, and potential adverse effects, specifically among children aged six years and younger. It is evident that early intervention is of paramount importance in effectively managing stammering in young children. This research underscores the significance of non-pharmacological interventions, which possess the potential to yield lasting positive effects on a child's overall well-being and developmental trajectory. By addressing stammering comprehensively at an early age, these interventions can help mitigate the negative consequences of stammering on a child's behavioral, social, and emotional dimensions, promoting more positive communication experiences and enhancing their overall quality of life.

- Agarwal et al. (2022) explore the characteristics of individuals with stammering in relation to the age of onset and family history. Among the 136 participants with stammering, 91% were male, and 9% were female. The research establishes connections between the age of onset and the severity of stammering, as well as the duration of stammering and the presence of secondary characteristics. Furthermore, it identifies associations between the severity of stammering and the number of secondary characteristics. Notably, the study does not find any statistically significant relationship between a positive family history of stammering among first-degree relatives and the age of onset, severity, or secondary characteristics of stammering. These findings underscore the importance of early onset age as a potential predictor for the severity of stammering and highlight the need to consider

individual characteristics and family history when conducting assessments and formulating treatment strategies for individuals dealing with stammering.

- El-Ella et al. (2021) discusses stammering as a complex and multifactorial disorder shaped by a range of influences, encompassing genetic predisposition, motor speech skills, linguistic proficiency, as well as cognitive, emotional, and environmental factors. The primary objective of this study was to delve into the diverse risk factors associated with stammering in children, with the aim of shedding light on its intricate nature, etiology, and potential avenues for prevention. Acknowledging the multifaceted nature of stammering is of paramount importance for formulating comprehensive treatment approaches. By gaining insights into the various risk factors at play, clinicians can develop tailored interventions that effectively address the unique needs of each individual, fostering more successful stammering management and prevention strategies.
- Saratikyan (2020) explores the intricate nature of stammering, elucidating its connections with linguistic, motor, sensory, and emotional processes. It emphasizes the necessity of a holistic approach to stammering treatment, advocating for the seamless integration of speech therapy techniques within social contexts. Furthermore, the study provides actionable guidelines for effective implementation, underscoring the importance of tailoring interventions to individual needs. This research underscores the multifaceted challenges of stammering and the significance of a nuanced, personalized therapeutic framework that considers the diverse factors contributing to this condition.

The linguistic study of stammering has provided valuable insights into the nature of this speech disorder and has helped to advance our understanding of the underlying mechanisms involved. However, more research is needed to fully understand the complex linguistic and cognitive processes involved. The research gap on the stammering data of Hindi or any other Indian languages also come out of this review of literature. Linguistic data of the Indian stammerers, most of whom are bilinguals, can be a big resource to contribute new findings in the growing body of stammering literature.

3.2 Computational Aspect

In an era dominated by technology, the computational aspect of stammering adds a layer of complexity to our understanding of this speech disorder. The curated research articles in this review discerningly contribute to the computational exploration of stammering, offering insights into the algorithms, models, and technological interventions designed to analyze and address speech disruptions. From signal processing techniques that dissect the acoustic properties of stammered speech to machine learning models deciphering linguistic patterns, this examination scrutinizes the diverse computational approaches. The intersection of stammering with computational methodologies not only enhances our diagnostic capabilities but also opens new avenues for innovative therapeutic interventions. By decoding stammering in the digital realm, this exploration aims to contribute to the evolving field of computational linguistics, offering a technologically informed perspective on understanding and mitigating the challenges posed by stammering in contemporary communication landscapes.

There is a conspicuous absence of any computational research in the domain of Hindi stammering till date. We referred to supportive material and research papers focused on English, Chinese, French, German and Spanish. Every language has its peculiarity, and it is difficult to reuse the data of a language and findings for stammering detection in another language; Hence we feel the need for works in stammering detection exclusively in Hindi.

- (Howell et al., 1997) worked on a two-stage disfluency recognizer that would first segment the speech in different linguistic units and then categorize them into lexical disfluencies and supra-lexical disfluencies. In this experiment the data was taken from twelve different subjects who were asked to read out The Story of Arthur the Rat making it a study for English PWS.
- The study by Pruett et al. presented the use case of digital health records in identification of developmental stammering and its associated issues (Pruett et al., 2021). They worked on a phoneme based stammering risk classifier. In which they deployed text mining algorithms on digital health records and notes taken by doctors. They matched new patterns with existing control phenotypes; gathered textual data was used to train decision tree classifier. The resulting model scored 83% positive prediction.
- Stutter Net by (Sheikh et al., 2021) uses time-delay neural network to detect stammering instances in an audio signal. They use University College London's Archive of Stuttered Speech (UCLASS) dataset for the model training that is specifically for English language. UCLASS dataset was recorded in a controlled setting, and it does not provide the right data for the real time stammering detection.
- Kourkounakis et al. used a deep residual network along with bidirectional LSTM layers to classify stammering. This classification model tries to cover different forms of stammering

(Kourkounakis et al., 2020). They used the leave-one-subject-out (LOSO) method for cross validation of the model. This model was also trained and tested using the UCLASS database. It uses spectrograms instead of language models as used in conventional stammering detection methods.

- In a recent user experience study (Clark et al., 2020) studied how people with peculiar speech patterns are unable to use virtual assistants as these tools lack sophistication to cover peculiar speech characteristics that gives them undesired outcome. They outlined crucial challenges such as less volume of work, works in the scant stage and lack of non-specialized assistants in the development of diverse speech supportive technology.
- Mitra et al. did a quantitative analysis that how disfluencies affect speech recognition accuracy, and how existing speech recognition systems can be improved (Mitra et al., 2021). They obtained data from eighteen adult native English speakers and used word error rate (WER) to measure the errors in the ASR output. They also showed how tuning several decoding parameters resulted in 1.7% better intent classification.
- Barrett et al. in their technical review paper studied fifty-eight papers that discuss machine learning approaches for detecting developmental stammering (Barrett et al., 2022). Exact comparison of all those papers were not possible as the machine learning algorithms, model architecture, input features and data size used were not consistent across all studies. The average accuracy for models that used binary classes was 92%.

Therefore, from the above discussion and review we find a research gap that no research was done to classify stammering data from the non-stammered speech.

3.3 Social and other aspects of Stammering

A comprehensive understanding of stammering transcends linguistic boundaries, delving into the intricate social matrix that shapes the experiences of individuals affected by this speech disorder. This exploration critically evaluates research articles chosen for their substantive contributions to unraveling the social complexities inherent in stammering. The synthesis spans societal perceptions, interpersonal interactions, and the psychological ramifications intertwined with the lived experiences of those grappling with stammering. By navigating diverse social milieus, this examination aims to unveil the distinctive layer of intricacy that stammering introduces to social interactions. The societal attitudes towards stammering play a pivotal role in shaping an individual's self-esteem, social integration, and overall well-being. This inquiry extends beyond immediate linguistic disruptions, delving into the emotional and psychological dimensions that intertwine with the social fabric, contributing to a nuanced comprehension of the social repercussions of stammering.

- The study by (Shevtsova et al., 2021) delve into the psychological characteristics of individuals with stammering, specifically examining the interplay between personal and reactive anxiety. The study reveals that those with stammering often exhibit heightened levels of social anxiety, a pronounced fear of negative evaluation, and a strong fixation on their speech impairment. This research underscores the significance of understanding the profound connection between emotional well-being and speech challenges in stammering individuals. It emphasizes the need for a comprehensive treatment approach that not only addresses the physical aspects of stammering but also integrates psychological aspects, such as anxiety and fear of negative evaluation, to provide a holistic and effective treatment strategy.

- (Rafique et al., 2023) provide a comprehensive assessment of how stammering influences job performance among individuals aged 30 to 40 in diverse workplaces across Lahore. Through interviews, valuable insights were collected, revealing a distinct contrast: individuals managing their own businesses or NGOs and experiencing stammering report job satisfaction, whereas those employed in private companies express dissatisfaction, primarily attributing it to their stammering condition. Notably, stammering adversely impacts job performance, eroding confidence levels, particularly during interactions with strangers, superiors, or supervisors. The additional burden of facing mockery and ridicule exacerbates feelings of anxiety and frustration among those affected. This research underscores the pivotal role of the workplace environment in the well-being of individuals grappling with stammering, emphasizing the crucial need for increased awareness, and understanding in professional settings to foster inclusivity and support for those with speech disorders. Furthermore, it underscores the importance of tailoring strategies to address the unique challenges faced by stammering individuals in different occupational contexts, striving to promote equitable opportunities and enhance overall job satisfaction.
- Additionally, there has been research (Anderson et al., 2020; Bosshardt, 2006; Iverach et al., 2017; Susca, 2006) into the relationship between stammering and cognitive factors, such as attention, memory, and executive function. Some studies have found that individuals who stammer have difficulties with attention allocation, working memory, and other cognitive processes. These findings suggest that the underlying mechanisms of stammering may involve both social and cognitive factors.
- The social elements that affect stammering have been studied (Conture et al., 2013). Researchers have looked at how language demands, listener attitudes, and conversational

circumstances affect the fluency of those who stutter. Her research has advanced knowledge of the intricate relationship between social variables and stammering.

3.4 Conclusion

In this chapter, we navigated the landscape of existing research, delving into pertinent literature across three distinct sections: Linguistic Aspect Papers, Computational Aspect Papers, and Social/Other Aspects of Stammering-Related Research Papers. This literature review serves as a bridge between theoretical insights and practical applications, aligning our research within the broader academic discourse surrounding stammering.

The exploration of linguistic dimensions provided valuable insights from studies focusing on bilingualism, code mixing and switching, as well as language exposure and proficiency in the context of stammering. The intersection of linguistics and stammering has proven to be a rich field, providing a nuanced understanding of how language factors contribute to the manifestation and management of this speech condition. This section has provided us insight to find out the necessary linguistic features present in the data of Hindi language stammerers.

Our journey through computational aspect papers has shed light on the technological advancements and methodologies employed in the study of stammering. From sophisticated algorithms to innovative computational approaches, these studies offer valuable tools for our research, allowing for a more nuanced analysis and interpretation of linguistic data related to stammering. This survey has also helped us to find out the particular research gap in the field of computational linguistic aspect of stammering.

The exploration of social and other aspects of stammering-related research papers has expanded our understanding of the broader impact of stammering on individuals and society. Social dynamics, psychological implications, and societal perceptions have been scrutinized, providing a holistic perspective that extends beyond the linguistic and computational realms. The papers in this section reconfirm the gravity of the problem and establish the need for more research in the field of stammering, especially in the context of India, where even now speaking about it, at least for a certain section, is a social taboo. With this introduction we move to the next chapter on the methodology of our corpus building and annotation schema.

