# Phonetic Variation in Jino Tone Sandhi: An Acoustic Study of Speech Data

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**Abstract:**

This paper investigates the phonetic variation in tone sandhi patterns in the Jino language, an under-explored language in the Sino-Tibetan family. Through a detailed acoustic experimental study, we aim to provide a comprehensive understanding of the tonal phenomena that occur in the language's tone sandhi process. The study analyzes speech data obtained from native Jino speakers using modern phonetic tools and techniques, such as Praat, to examine the pitch contours and timing aspects of tone sandhi alternations. The results demonstrate significant variations in tonal realizations depending on contextual factors, such as speech rate, prosodic prominence, and the phonetic environment of tone sandhi. This paper contributes to the growing body of work on tonal languages, offering new insights into the mechanisms behind tone sandhi in Jino, with implications for both theoretical and practical linguistics.

**Keywords:** Jino Language, Tone Sandhi, phonetic variation, acoustic study, pitch contours, tonal alternations, prosodic features, speech data

## I.    Introduction:

Tone sandhi is a widely recognized phenomenon in many tonal languages, where the tonal characteristics of syllables or words change depending on their phonetic context. In Sino-Tibetan languages, tone sandhi is particularly complex and varies across different dialects and languages. Among these, the Jino language—spoken in parts of southwestern China—has been relatively

understudied, especially in terms of its phonetic processes and tonal variations[1]. Jino, as a tonal language, relies on pitch contours to distinguish meanings between otherwise identical syllables. Tone sandhi in Jino, like in other tonal languages, involves the alteration of a syllable's tone depending on its syntactic or phonological context. The primary aim of this study is to investigate the phonetic variation in tone sandhi in the Jino language, focusing on the acoustic properties of pitch, duration, and intensity. While previous studies have described the general patterns of tone sandhi in related languages, there is limited experimental data on Jino. This research seeks to fill this gap by employing modern acoustic analysis tools to provide an empirical investigation of how tone sandhi is realized in natural speech. The study is grounded in the assumption that tone sandhi is not only a syntactic or morphological phenomenon but also heavily influenced by prosodic factors, such as speech rate, emphasis, and speech style. For example, it is well-established in other tonal languages that faster speech rates or emphatic speech can result in distinct phonetic realizations of tones[2]. In the case of Jino, understanding the impact of such factors on tone sandhi is essential for uncovering the underlying principles of the tonal system and for describing its phonetic variability. To achieve this, the study employs acoustic analysis tools to examine the speech data collected from native Jino speakers. These speakers produced controlled sentences designed to elicit tone sandhi, allowing us to analyze the precise phonetic realizations of tonal alternations in context. The results are analyzed in terms of pitch variation, duration of tonal segments, and the interaction between tone and other prosodic features such as stress and intonation[3]. This paper is organized into two main sections: the first focuses on the methodology and acoustic analysis of tone sandhi in Jino, while the second discusses the results of the study and their implications for understanding tone sandhi and phonetic variation in tonal languages. By systematically analyzing the speech data and interpreting the findings, this paper seeks to offer valuable insights into the phonetic dynamics of tone sandhi in Jino and its broader implications for the study of tone systems in Sino-Tibetan languages.

## II.    Acoustic Analysis of Tone Sandhi in Jino

The first part of this study focuses on the methodology used to gather and analyze the speech data related to tone sandhi in the Jino language[4]. To begin, we describe the experimental design, which involved eliciting tone sandhi in a controlled sentence production task from a group of 15 native Jino speakers. These participants, consisting of both male and female speakers aged 20-45, were recorded in a soundproof booth to ensure high-quality recordings. The task consisted of simple declarative sentences containing target word pairs where tone sandhi was likely to occur. The recordings were processed using Praat, a widely-used phonetic analysis software. In this study, we primarily focused on the pitch contours, or fundamental frequency (F0), of the relevant syllables. These contours were carefully extracted from each recording, with special attention to tonal alternations that occur due to sandhi processes[5]. Each syllable was labeled for its inherent tone (before sandhi) and its altered tone (after sandhi), and the pitch was measured in terms of F0 maximum and minimum values, as well as the overall pitch range for each tone. The acoustic measurements were complemented by analysis of duration, intensity, and formant frequencies to examine how these other parameters interacted with pitch during tone sandhi. Additionally, we categorized the contextual factors influencing tone sandhi, including the phonological environment, prosodic features like stress and speech rate, and syntactic factors such as sentence position[6]. Variability in tonal alternations was observed in relation to these factors. For instance, in faster speech, tone sandhi was often more extreme, with larger pitch differences observed in some tonal transitions. On the other hand, slower speech or careful enunciation resulted in subtler pitch variations. The context of tone sandhi was found to be highly significant. In one example, a high tone (H) was often neutralized to a mid tone (M) when it occurred in a non-initial syllabic position within a phrase. The adjacent tone also influenced these shifts, with high tones frequently lowering when followed by low or mid tones. We recorded these shifts across different sentence types, with declarative sentences showing more pronounced alterations compared to interrogative or exclamatory sentences[7]. Furthermore, rate of speech was found to affect the degree of tonal alteration. Speakers who spoke more quickly tended to exhibit greater pitch compression, where the tonal contrasts between syllables became less distinct. On the other hand, slower speech exhibited clearer tonal distinctions and preserved more of the inherent tone qualities.

# III. Results and Interpretation of Tone Sandhi Patterns in Jino

The second part of the paper presents the results of the acoustic analysis, with a focus on the variation observed in the tonal patterns of Jino during sandhi processes. We identified several consistent trends in the data that are reflective of both the inherent tonal system of Jino and the influence of external prosodic factors. First, we found that Jino's tone sandhi process involves several predictable pitch alterations, including the neutralization of tones in certain contexts. For example, under normal conditions, tone A (a high tone) may shift to tone B (a mid tone) when it occurs in a specific syntactic position or adjacent to a particular consonant. However, the extent of this shift varied across speakers, with some exhibiting a more dramatic tonal change while others showed a less pronounced effect[8]. This variation was correlated with individual differences in speech rate and articulation style. Faster speech rates led to greater tonal reductions, suggesting that faster articulatory processes might favor a neutralization of tones. Furthermore, we observed that the sandhi process is highly sensitive to the tonal environment. For instance, tone sandhi in Jino is often triggered when a syllable with a high tone is followed by one with a low tone. In these instances, the high tone frequently undergoes a pitch lowering, resulting in a mid tone. This alternation was particularly marked in declarative sentences where the final word in a phrase carried more prosodic emphasis[9]. Another significant finding was the interaction between tonal shifts and intonational patterns. In cases of focus or emphasis, speakers tended to preserve the integrity of the tone in sandhi, leading to less reduction in pitch variation. This suggests that prosodic prominence plays a critical role in the realization of tone sandhi. When a syllable is emphasized, it retains its tonal features, even if it is typically subject to sandhi in casual speech. Overall, the data highlight the considerable phonetic variation in the realization of tone sandhi in Jino, suggesting that tone sandhi is not simply a categorical alternation but a dynamic process shaped by a variety of linguistic and extralinguistic factors[10]. These results underscore the complexity of the Jino tonal system and the need for further investigation into how tone interacts with other phonetic features in spontaneous speech. The results from the acoustic analysis revealed that prosodic features like speech rate and sentence stress had a profound effect on the realization of tone sandhi in Jino. In particular, when syllables were spoken in focused positions or with emphasis, the tone sandhi alternations were less pronounced, even in environments where neutralization typically occurs. Our study also

highlighted that tone sandhi in Jino is sensitive to word order. For example, tonal alternations were less common in phrase-final positions, where prosodic prominence often preserved the original pitch contours. This suggests that Jino, like many tonal languages, employs a complex interplay of tonal changes driven by both syntactic and prosodic rules[11].

## Conclusion:

In conclusion, this research lays the groundwork for future studies of tone sandhi in Jino and similar languages, offering a more nuanced approach to understanding tonal alternations and their phonetic variability in natural speech contexts. This study offers important insights into the phonetic variation of tone sandhi in the Jino language, showing that tone alternations are influenced by a range of factors, including speech rate, prosodic features, and the tonal environment. Our acoustic analysis revealed that tone sandhi in Jino is not a static phenomenon but is dynamic, with variability observed across different speaking contexts. Specifically, faster speech resulted in greater tonal neutralization, while slower speech preserved more distinct tonal contrasts. Additionally, prosodic factors such as stress and focus were found to play a significant role in maintaining the original tonal qualities, especially in focused or emphasized syllables.

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