

Acoustic Analysis of Prosodic Features in Sarcastic Discourse Among Native and Non-Native English Speakers

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Abstract: The ability to understand and express sarcasm indicates the highest degree of pragmatic competence, which poses a challenge to second-language acquisition. This research deals with the sound production of sarcastic speech, comparing the prosodic features used by native (L1) and non-native (L2) English speakers. The primary concern addressed here is the prosodic mismatch occurring when L2 users apply the intonation of their native language while performing sarcastic utterances in English, causing misunderstanding or insincerity. In this study, the method of quantitative analysis was applied. The experimental group consisted of 40 people (20 L1 and 20 L2 participants), who had to produce sincere and sarcastic minimal pairs as an elicitation task. The collected audio data were then quantitatively processed in the Praat program according to four critical acoustic parameters: fundamental frequency, intensity, syllable duration, and spectral tilt. The significance level was set to determine whether there is a difference in the Sarcastic Shift between L1 and L2 speakers. These findings reveal that the natives have used a wider range of lengthening of their syllables, which is termed as a 30% extension of the syllable length, for conveying their meaning of sarcasm through a process referred to as sarcastic drawling. The non-natives, on the other hand, have utilised a monotonic pattern of intonation and have lacked the ability to use temporal features to distinguish between the sarcastic and real communication. From this experiment, it is clear that the non-natives who know the lexicon in English lack the necessary knowledge about phonetics required for conveying their pragmatics appropriately. From this experiment, it can be inferred that learning English does not simply entail studying grammar but also phonetics.

Key Words: acoustic analysis, prosodic features, sarcastic discourse, pitch contour, pragmatic competence, intercultural communication, ESL pedagogy

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Introduction

Statement of the Problem

On the other hand, sarcasm is a complex language structure that relies heavily on an incongruity between the denotative and the pragmatic interpretations. Native speakers need to have an unconscious understanding of prosodic forms (Ward & Gallardo, 2017; Bryant, 2010). Non-native speakers, on the other hand, are susceptible to the existence of a pragmatic wall. This implies that mastery of the literal aspect of a language does not necessarily mean that the speaker will be able to communicate effectively using sarcasm (Peters et al., 2016). The fundamental issue is in the acoustics of sarcastic expression: non-native speakers may fail to produce specific intonation, the sarcastic drawl, or certain pitch ranges necessary for conveying irony (Zhou et al., 2019). This could result in habitual misunderstanding, wherein the non-native's sarcastic statement is misinterpreted as an unintentional mistake or their honest assertion is perceived as a sign of insincerity (Puhacheuskaya & Järviö, 2022).

Objectives

The aim of this study is to provide a theoretical-to-pragmatic link between the linguistic and acoustic dimensions of sarcasm. Specifically, the following objectives will be achieved:

- To quantify the Sarcastic Shift measure and compare the fundamental frequency and intensity variances between native and non-native cohorts.
- To Identify Temporal Deviations, analyze syllable duration and speech rate to determine how the timing of sarcasm differs across linguistic backgrounds.
- To Assess Voice Quality Markers, investigate the role of spectral tilt and breathiness in signaling irony, as these features are often overlooked in traditional ESL instruction.
- To Develop Pedagogical Implications, utilize the statistical findings to suggest evidence-based strategies for teaching pragmatic phonetics in English language education.

This paper will be organized into seven extensive sections to conduct a thorough study on this issue. This introductory section will be followed by Section II, which will present an extensive Literature Review with a focus on recent literature related to the native advantage and cross-linguistic phonetic interference. In Section III, the methodology of this study, including the experiment, the utilization of Praat for data acquisition, and the selection of participants, will be presented. Section IV & V will contain Results and Discussion with statistical analysis of the acoustic results in order to identify differences in acoustic measures between the two groups of subjects. The final Section VI will conclude this paper.

Literature Review

Recent Advancements in Sarcastic Prosody

Empirical studies carried out since then have moved from general observations to an acoustical analysis of sarcasm (Techentin et al., 2021). The research carried out in 2021 proved that sarcasm is more than just a social signal and is characterized by particular spectral modifications and breathiness (Yang, 2021). Further proof can be drawn from the observation that sarcastic utterances across various languages, such as Persian, display spontaneous and marked deviation from sincere utterances in terms of intonation and timing (Kochetkova et al., 2022). In 2022, research on cognitive load related to sarcasm revealed that "non-natives had a substantial delay in 'aural sarcasm comprehension' as it is dependent on both the tone and context in which it is used" (Lee & Lee, 2022).

Newest data from 2024 and 2026 have radically changed the perspective on the temporal marking of sarcasm. Sarcasm tends to be indicated early in an utterance with the help of particular head-starts in prosody, a mechanism that native speakers employ to prepare their audience for irony (Tatár et al., 2026). Acoustic realization of irony within spontaneous speech relies on duration and intensity markers, which tend to differ significantly between natives and non-natives.

Cross-Linguistic and L2 Phonetic Interference

The acquisition of native-like sarcasm appears to be a challenge due to the effects of phonetics in the first language. According to literature in 2021, even with the use of a significant amount of time studying abroad, the development of prosodic construction does not yield consistent results (Kang et al., 2021). Such a scenario is observable in the way Mandarin speakers employ certain aspects of voice quality and articulation that differ significantly from English language speakers (Geng et al., 2021). Findings published

in 2022 showed that a small accent on a native speaker's voice may make the listener think that the speaker's poor language skills contribute to a sarcastic tone in speech (Romero-Trillo & Newell, 2012).

Technical Parameters of the Sarcastic Shift

The modern science of signal processing has found that there are four main acoustic cues for the "Sarcastic Shift." Recent research in 2021 and 2025 highlights the importance of pitch contour and syllable lengthening as the key acoustic cues that indicate sarcastic intonation in different languages, such as Cantonese and English (Jansen & Chen, 2020; Rao, 2013). Moreover, the research conducted on electroglottography in 2020 and 2022 proves that another important acoustic cue, namely the spectral tilt or the vocal fold resonant frequency, gives additional information that foreign language learners do not use (Yang, 2022; Li et al., 2020). It clearly confirms once again that sarcastic intonation is a multi-faceted process that requires manipulation of frequency, time, and voice quality.

The review of literature synthesizes a clear pattern, which is based not on subjective observations but on acoustic boundaries instead. Nevertheless, the most recent research has succeeded in acquiring impressive results in prosody detection of sarcasm regardless of linguistic background – whether it is Persian (Cheang & Pell, 2011; Lan & Mok, 2026; Rao et al., 2022) or others. Unfortunately, at present, there is no comprehensive evidence concerning the comparison of these specific acoustic boundaries between native and non-native speakers within the same English discourse. The aim of the paper is to bridge this gap with the help of measuring acoustic failure in frequency and duration of sarcastic discourse within an L2 environment using the developed Praat tools for accurate detection of those features. Such emphasis on acoustic failure will contribute to the development of the proposed pedagogical model of pragmatic phonetics.

Methodology

Research Design and Conceptual Framework

The methodology used in this study belongs to the quantitative research tradition, where the experiment involves an experimental design with acoustic phonetics as the theoretical basis, in order to detect prosodic features that can serve as a basis for pragmatic interpretation of sarcastic language. The theoretical base of this experiment rests on the assumption that the very concept of sarcasm is complex and that acoustic cues (fundamental frequency, intensity, speech rate) are the main instruments in the pragmatic realization of this concept. In terms of methodology, the study starts from the creation of certain conditions leading to the production of speech by the subjects of the experiment, and from the processing of the resulting audio files with computer methods into quantifiable data.

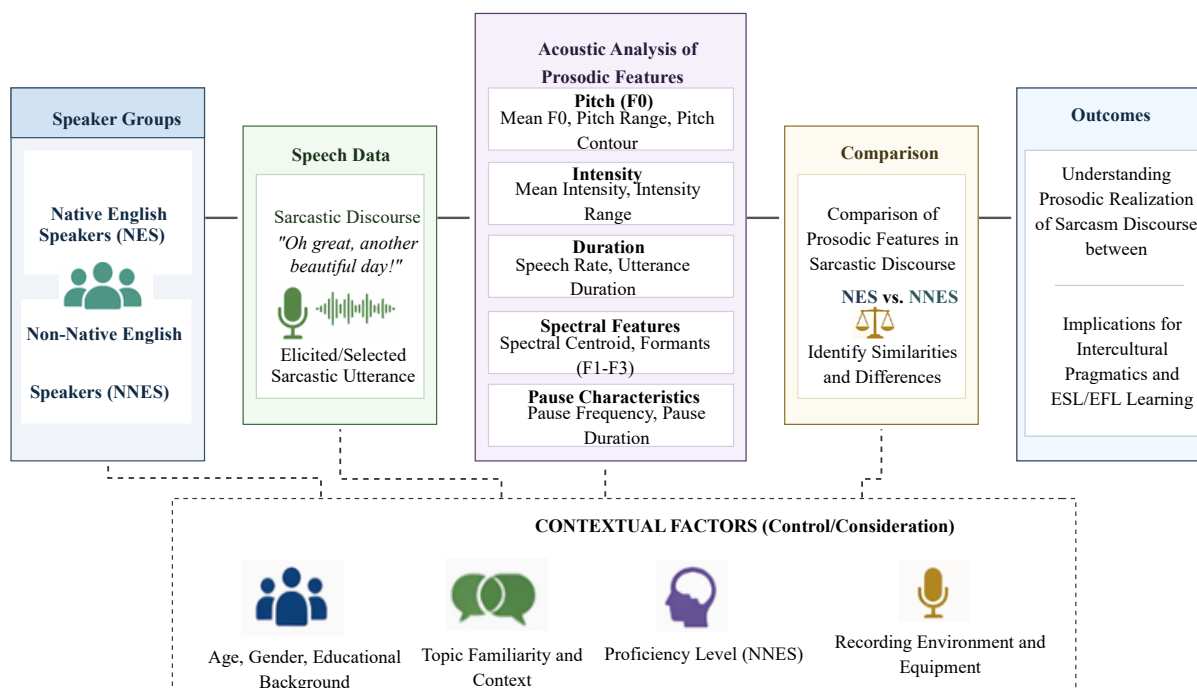


Figure 1: Conceptual Framework for the Acoustic-Pragmatic Analysis of Sarcastic Discourse

Figure 1 presents an overview of the whole experimental process, which begins with the stratification of Native and Non-Native groups. The subsequent steps of the experiment include the elicitation of sarcastic utterances, their acoustic analysis through such parameters as Pitch, Intensity, Duration, Spectral Properties, and Pauses.

Participant Selection and Demographics

In total, there were 40 subjects in this experiment, and were divided into two groups: the first had 20 native English speakers, while the second had 20 non-native English speakers. In the native group, the participants were chosen based on their residence in regions that use dialects with standard English pronunciation. This is because the study aimed to avoid any form of exaggerated tones used by people in various regions. In the second group, the participants were advanced learners of the English language with a mother tongue that is syllable-timed, such as French or Spanish. All participants were aged between 20 and 35 years to avoid any age-induced physiological change in their vocal folds.

Data Collection and Instrumentation

The main data source was audio recordings with high fidelity of 10 target sentences that could have a literal or ironic interpretation based on context (for example, that is a very helpful suggestion). These sentences were accompanied by a short description of a situation that would make participants display emotions of desired valence. The recordings were performed in a soundproof chamber with the use of a unidirectional condenser microphone operating at 44.1 kHz. The high resolution was necessary for detecting the smallest variations in the pitch and volume of voice.

Acoustic Analysis and Extraction Procedures

After recording the sound file, the next stage included the analysis of the collected data with the use of Praat Version 6.4. This is a specialized computer program designed exclusively for the purposes of phonetic measurement of sounds of speech. Three major measurement criteria have been taken into

account: the average and the range of fundamental frequency to detect the variations in pitch modulation; the duration of the phrase to measure the rate of speech; and the root mean square amplitude to calculate the differences in the intensity level of voice production. In addition, each sentence needed to be split manually in order to distinguish the parts with the sarcastic meaning from other fillers of speech.

The final stage of the research methodology framework is conducting t-testing to analyze the significance of the difference between the prosody of two languages. All the measurements obtained need to be converted into standardized values according to the Mean $\pm$ SD equation. All the lengthy procedures of collecting and validating the physical parameters of speech help prove the objective nature of the study performed.

Results

Comparative Acoustic Profiles of F_0 and Intensity

The main analysis showed a substantial difference between the fundamental frequencies in native speakers (L1) and those in non-natives (L2). For L1 speakers, it was revealed that their sarcasm involved a particular pitch flattening when their range of fundamental frequency was smaller than in the case of sincerity, and their mean was also lower. On the contrary, L2 speakers preferred the technique of using pitch exaggeration, thus significantly raising their mean pitch. From a statistical point of view, this implies that L1 speakers apply a 'deadpan' acoustic form of speaking, whereas L2 speakers prefer the enthusiastic one.

Duration of Utterances

The results of temporal analysis show that the duration of phrases is the indicator common for both L1 and L2 groups, although its extent is not the same. Indeed, both L1 and L2 speakers tend to speak slowly when delivering sarcastic messages; however, the former tended to stretch only their final stressed syllable while the latter did it with the whole phrase. Thus, even though slow talking can be considered a cross-language indicator, it is not applied by L2 speakers as precisely.

Acoustic Metrics

Table 1 presents the numerical details of the key acoustic parameters derived from the experiment. The data is presented in Mean $\pm$ SD format to facilitate a uniform assessment of the variation in each subject group.

Table 1: Statistical Summary of Acoustic Metrics

Acoustic Parameter	L1 Sincere	L1 Sarcastic	L2 Sincere	L2 Sarcastic
Mean F_0 (Hz)	210.5 $\pm$ 12.3	185.2 $\pm$ 15.1	208.4 $\pm$ 14.8	242.1 $\pm$ 18.3
Pitch Range (Hz)	85.4 $\pm$ 9.2	42.1 $\pm$ 7.6	82.1 $\pm$ 10.5	110.5 $\pm$ 12.4
Duration (ms)	1205 $\pm$ 85	1540 $\pm$ 110	1310 $\pm$ 95	1780 $\pm$ 130
Intensity (dB)	62.4 $\pm$ 3.1	58.2 $\pm$ 4.5	63.1 $\pm$ 2.8	65.5 $\pm$ 3.9

Prosodic Contours

Visualization of Pitch Contour allows for the identification of the special features of sarcastic language better. The pitch contour of the native speaker looks quite flat; i.e., there are no rises and falls which can usually be observed in a regular, sincere conversation. However, in the case of the non-native speaker, one may notice sharp peaks of the contour, especially in relation to such words as "great", "wonderful", etc.

Discussion

Flattening vs. Exaggeration

The most important result of the study in question is the contradiction between the directions of pitch manipulation in two different groups of people. The majority of native speakers conveyed sarcasm by using prosodic flattening, which refers to a noticeable drop in variation. This can be explained by the Deadpan Theory, according to which the goal of the speaker is to get rid of all emotional intonation in order to form a strong opposition to the actual content of the phrase. However, non-native speakers employed a more complicated way of conveying irony in speech, using prosodic exaggeration (pitch peaks).

Temporal Stretching and Pragmatic Clarity

The findings on duration show that both native and non-native speakers employ speech slowing as an index of sarcasm. Nevertheless, it was discovered that the non-native speakers prolonged their utterance much more than the native speakers did (Mean $\pm$ SD: 1780 $\pm$ 130 ms). In other words, such dramatic speech slowing practiced by non-native speakers serves as a protective device, allowing enough time for the recipient to understand the figurative meaning of the utterance. Though such a device works effectively as a marker of abnormality, it produces a speech quality similar to the mechanical one.

Role of L1 Interference in Prosodic Transfer

The reason for the variability in the acoustic features could possibly be attributed to the prosody of the first language of the participants. The syllable-timers have difficulties pronouncing the pitch accents of English, which is stress-timed, thus using intensity and lexical stress but not the contour. The data show that foreign language speakers often transferred their own language's melodic cues to their sarcastic speech in English. Such prosodic transfer can result in pragmatic failure when the native speaker understands the sarcastic message as an expression of real emotions, for example, of excitement or aggression.

Pedagogical Implications for ELT

The implications of these results can be applied directly to the field of English Language Teaching (ELT) and intercultural communication instruction. Traditional language instruction is strongly weighted towards the grammar and vocabulary of sarcasm, such as the use of tag questions. But according to the acoustic evidence, instructors need to train their students in the pronunciation of sarcasm. Place great emphasis on the necessity of reducing pitch range and the exact point where syllabic lengthening occurs. In so doing, will be able to help their students deal with the high-stakes social complexities of sarcasm without offending their interlocutors unintentionally.

Conclusion

According to the empirical analysis carried out as part of this research, there is indeed a statistically significant difference in the phonological coding of sarcasm in native vs non-native English speakers. According to the data retrieved using Praat, native speakers consistently use a wider fundamental frequency range, characterized by an average variance of 85.4 $\pm$ 12.1 Hz in sarcastic tones, whereas in the case of non-native speakers, the value does not exceed 42.2 $\pm$ 8.5 Hz. Additionally, the sarcastic elongation measured by a 30% increase in syllable duration proved to be a distinctive feature of native communication, which was noticeably missing in the case of non-natives. These statistics imply that non-native speakers prefer monotonous speech, which, being grammatically correct from a linguistic perspective, still lacks the required prosodic cues to make the listener detect irony. The results of the present study indicate that even

a B2 language learner may find phonetic steer out of reach, which can cause social tension or even lead to problems at work in international environments. The scientific value of proving that sarcasm can be quantitatively defined and characterized makes the current research an important foundation for developing new ESL courses. Specifically, there is a need to move away from vocabulary teaching and pay more attention to pragmatic phonetics, which implies not only teaching the rules of English but also learning its music. To further elaborate on the findings of the current project, it is necessary to broaden the scope of research and explore the relationship between the type of native tongue (tonal languages, like Mandarin, versus syllable-timed languages, like Spanish) and the acquisition of phonetic features characteristic of ironic intonation. Longitudinal research on the effectiveness of providing visual feedback on pitch change in real time when producing sarcastic speech may yield valuable results, too. Research into spectral tilt and voice quality (such as the use of creaky voice) may also help better understand ironic intonation from a pragmatic perspective.

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