Jurnal Ilmiah Lingua Idea Vol 17, No 1 (2026): 37-48.
DOI: https://doi.org/10.20884/1.jli.2026.17.1.20221
ISSN 25 80-1066 (online); 2086-1877 (printed)

Realization of the F0 Parameter of German Spontaneous Speech: A Case Study of Two Male Speakers of Different Ages

Alexandra Nimas Devianne Inaz Christie [1*], Agus Ridwan[2]

[1,2]German Literature Study Program, Faculty of Languages and Arts, Universitas Negeri Surabaya, Indonesia
alexandra.22074@mhs.unesa.ac.id*; agusridwan@unesa.ac.id

*Correspondence author

Abstract: This study investigates age-related differences in fundamental frequency (F0) realization and intonation patterns in semi-spontaneous German speech produced by two male speakers aged 12 and 24 years. Previous studies on German acoustic phonetics have predominantly examined F0 patterns in controlled or read speech, or in adult speakers, while studies combining F0 analysis with semi-spontaneous speech and speakers from different age groups remain limited. This study addresses this gap by examining how age influences F0 realization and intonational organization in naturally occurring spoken responses. The data consist of five semi-spontaneous utterances produced by both speakers in the German To Go series on the Coffee Break Languages YouTube channel. The utterances are categorized as semi-spontaneous because they are produced as spoken responses within predetermined topics and communicative contexts rather than from scripted reading tasks. Acoustic analysis was conducted quantitatively using Praat to extract F0 values, while prosodic segmentation employed the Intonational Phrase (IP) framework to identify intonation contours and pitch reset phenomena. The results show that the 12-year-old speaker consistently produces higher average F0 values and a wider pitch range than the 24-year-old speaker. In contrast, the adult speaker demonstrates smoother F0 contours and more stable intonation development across utterances. The younger speaker exhibits more frequent pitch fluctuations and more dynamic F0 movements, indicating age-related differences in prosodic realization. These findings contribute to the study of German acoustic phonetics by demonstrating how age affects F0 realization and IP-based intonation patterns in semi-spontaneous speech. The study is limited by the small number of speakers and utterances analyzed; therefore, future research should include larger speaker populations and additional prosodic parameters to obtain a more comprehensive understanding of age-related prosodic variation in German speech.

Keywords: fundamental frequency (F0); German acoustic phonetics; semi-spontaneous speech; intonational phrase; age-related prosody

Submitted: 17 April 2026; Received in revised form: 22 Juni 2026; Accepted: 25 Juni 2026; Published regularly: 30 Juni 2026

To cite this article (APA Style):
Christie, A. N. D. I., Ridwan, A. (2026). Realization of the F0 Parameter of German Spontaneous Speech: A Case Study of Two Male Speakers of Different Ages, *17*(1), 37-48. https://doi.org/10.20884/1.jli.2026.17.1.20221

Introduction

Age is one of the biological factors that influence prosodic realization and can be observed in variations in fundamental frequency (F0) across speech (Ladd, 2008; Xu, 2011). In German intonation research, recent corpus-based studies have demonstrated that F0 distribution and pitch variation systematically change across age groups and are closely related to physiological development, particularly the length and mass of the vocal folds (Weirich et al., 2024; Titze, 1994). Since intonation is primarily realized through changes in F0, the analysis of F0 contours provides important insights into how speakers organize prosodic information during speech production (Arvaniti et al., 2026).

Prosodic studies on intonation have advanced substantially through interdisciplinary approaches that integrate acoustic phonetics, intonation phonology, and psycholinguistics. F0 is considered one of the primary acoustic correlates of prosody because it reflects intonational movement, stress patterns, and prosodic boundaries (Wagner & Watson, 2010; Ladd, 2008; Gussenhoven, 2004). Previous studies have shown that variations in F0 contours affect listeners' perception of intonation and contribute to the interpretation of spoken utterances (Pitt et al., 2011). In German, studies on intonation have mainly focused on dialectal differences, pitch accent realization, and phrase-final intonation patterns (Kügler & Gollrad, 2015; Zahner-Ritter et al., 2022; Kaland & Grice, 2024).

However, previous studies have predominantly investigated F0 patterns in controlled speech, read speech, or large-scale corpora, emphasizing dialectal and phonological variation. Research specifically examining F0 realization in semi-spontaneous German speech, particularly through a direct comparison between speakers of different age groups, remains limited. Existing studies have explored age-related prosodic development in children (Wells et al., 2004) and acoustic characteristics of adult speech, but few studies have investigated how age-related differences are reflected in F0 contours and intonational organization within the same communicative context. This gap is important because spontaneous or semi-spontaneous speech provides a more natural representation of prosodic behavior than read speech, allowing researchers to observe how speakers organize intonation in actual communication.

Spontaneous speech exhibits greater variability in F0 and more dynamic intonation patterns than read speech (Nakamura et al., 2008). According to Arvaniti (2020), intonation in natural speech is highly dependent on communicative context, making the investigation of spontaneous speech crucial in understanding prosodic organization. In the present study, the data are categorized as semi-spontaneous speech because the utterances are produced as spoken responses to predetermined themes and questions in the German To Go series on the Coffee Break Languages YouTube channel. Although the topics are predetermined, the speakers formulate their responses naturally and without reading from a prepared script. Therefore, the speech data maintains the characteristics of spontaneous speech while remaining within a controlled communicative context.

The analysis of intonation in semi-spontaneous speech can be conducted through Intonational Phrase (IP) segmentation. IP boundaries are not solely determined by syntactic structure but are also identified through acoustic cues such as pauses, pitch reset, and changes in F0 movement (Himmelmann, 2018). Previous studies have demonstrated that prosodic boundaries in German are signaled through acoustic features including pitch movement, duration, and pauses (Petrone et al., 2017; Schubö & Zerbian, 2023; Lialiou et al., 2024). Therefore, IP segmentation provides an effective framework for examining how F0 contours are organized across utterances without relying exclusively on syntactic analysis.

Research on age differences in speech production has primarily focused on language development and children's acquisition of prosodic competence (Wells et al., 2004;

Weissheimer & Mota, 2026). Meanwhile, acoustic phonetic studies have identified F0 and speech duration as important parameters for distinguishing prosodic characteristics among speakers (Pranoto, 2018; Narhan et al., 2023). Nevertheless, studies that explicitly combine acoustic F0 analysis, semi-spontaneous German speech, IP-based prosodic segmentation, and a comparison between adolescent and adult speakers remain scarce.

This study addresses this research gap by conducting an acoustic phonetic case study of two male German speakers aged 12 and 24 years. The study does not aim to generalize findings to the German-speaking population but rather to provide an empirical description of age-related differences in F0 realization and intonation patterns. The speakers were selected based on several criteria: (1) both appear in the same five episodes of the German To Go series, allowing direct comparison under comparable communicative conditions; (2) both are male speakers, minimizing gender-related variation in F0; and (3) they represent two distinct age groups, namely adolescence and adulthood.

The novelty of this study lies in the integration of acoustic F0 analysis, Intonational Phrase segmentation, and semi-spontaneous German speech in a comparative case study of speakers from different age groups. Unlike previous studies that primarily focused on dialectal variation, pitch accents, or general prosodic development, this study specifically examines how age influences F0 realization and intonation contours in naturally produced spoken responses. Thus, this research contributes to German acoustic phonetics by providing empirical evidence regarding age-related prosodic variation and by offering a methodological framework for analyzing semi-spontaneous speech using acoustic measurements and IP segmentation.

Accordingly, this study aims to analyze the realization of mean F0, identify intonation contour patterns based on IP segmentation, and describe prosodic tendencies in semi-spontaneous German speech produced by two speakers of different ages.

Methods

This study is an acoustic phonetic case study employing a quantitative analysis of fundamental frequency (F0) values and intonation contours derived from semi-spontaneous German speech. The study does not adopt a descriptive qualitative approach because the primary data consist of acoustic measurements, namely F0 values expressed in Hertz (Hz) and their corresponding contour patterns. Quantitative acoustic analysis is employed to identify and compare age-related variations in F0 realization and prosodic tendencies between speakers of different age groups.

The study focuses on two male German speakers aged 12 and 24 years who appear in the German To Go series published on the Coffee Break Languages YouTube channel. The speakers are coded as L12 and L24 to facilitate presentation and comparison throughout the analysis. This research is designed as a case study and does not aim to generalize findings to the German-speaking population. Instead, it aims to provide an empirical description of age-related differences in F0 realization and intonation patterns based on acoustic evidence.

The data consist of acoustic measurements extracted from speech recordings obtained from the German To Go learning series. The series contains ten episodes covering introductory communicative topics in German, including greetings, origin, residence, age, birthday, family, occupation, language skills, favorite sports, and hobbies.

The utterances analyzed in this study are categorized as semi-spontaneous speech because they are produced as natural spoken responses to predetermined themes and questions. The

speakers do not read scripted texts; rather, they formulate their answers spontaneously within a controlled communicative setting. Therefore, the speech exhibits characteristics of natural speech while maintaining thematic consistency across episodes.

The selection of speakers was based on several scientific criteria. First, both speakers are male, minimizing gender-related variation in F0 realization. Second, the speakers belong to two different age groups, namely adolescence (12 years old) and adulthood (24 years old), allowing the study to observe age-related prosodic differences. Third, both speakers appear together in the same episodes and respond to similar communicative prompts, making direct comparison possible under comparable speaking conditions. Finally, the recordings provide sufficient audio quality for acoustic analysis.

Although the German To Go series contains ten episodes, this study analyzes five utterances from each speaker, resulting in a total of ten utterances. The five utterances were selected because both speakers appear simultaneously and discuss comparable communicative topics. This selection ensures consistency of communicative context and allows for systematic comparison of F0 realization across age groups.

The analysis focuses on a limited number of utterances because acoustic phonetic case studies emphasize detailed examination of speech characteristics rather than population representation. The selected utterances provide sufficient acoustic data in the form of F0 measurements and intonation contours while minimizing excessive variation caused by differences in discourse context.

The primary data of this study consist of F0 values and F0 contour patterns extracted from audio recordings in WAV format. The video recordings were converted into WAV files and subsequently processed using Praat software, which is widely used in acoustic phonetic research due to its ability to provide accurate measurements of pitch and other acoustic parameters (Jolayemi, 2013).

Before analysis, all audio files were converted into mono format to improve signal stability and reduce interference from multiple sound channels. F0 values were then extracted automatically using Praat and manually inspected to identify possible tracking errors such as octave jumps or irregular pitch estimations. Manual verification was conducted to ensure the validity and reliability of acoustic measurements.

The analysis focuses on several F0 parameters, including mean F0, minimum F0, maximum F0, F0 range, and F0 contour shape. Other acoustic parameters, such as intensity and duration, are not analyzed in detail because the present study specifically investigates age-related differences in F0 realization and intonation patterns.

To analyze intonation patterns systematically, this study applies the Intonational Phrase (IP) segmentation method. IP segmentation is employed to divide speech into prosodic units based on acoustic criteria rather than syntactic structure alone. The segmentation process considers several acoustic cues, including pauses, pitch reset, boundary tones, and substantial changes in F0 movement.

Each IP is analyzed separately to observe how F0 develops throughout the utterance and how pitch reset occurs at prosodic boundaries. This approach allows the comparison of intonation contours between L12 and L24 without being heavily influenced by differences in

sentence complexity. Consequently, the IP framework provides a more consistent basis for examining age-related prosodic variation in semi-spontaneous German speech.

Results

Based on the results of acoustic measurements obtained from Praat, there is a consistent difference in the F0 variation between the two speakers in all five speeches. Acoustic measurements by Praat show the numbers at the mean (*mean*), lowest value (*min*), highest value (*max*), and range of F0 values throughout speech. The mean F0 for L12 speakers ranges from 261,589 Hz to 299,598 Hz, with a min value of F0 between 195,203 Hz and 255,233 Hz, and a max value between 335,904 Hz and 393,121 Hz. L12 speakers have a wide range of F0 values, amounting to 94,218 Hz to 179,602 Hz. Meanwhile, the range of F0 values in L24 speakers reaches 57,809 Hz to 88,948 Hz, with a min value of F0 between 78.927 Hz to 106.576 Hz, and a max value of 160.983 Hz to 176.397 Hz. In general, the results of the acoustic measurements shown in table 1 show that L12 speakers have a higher and wider F0 value compared to L24 speakers.

Table 1.
Data F0

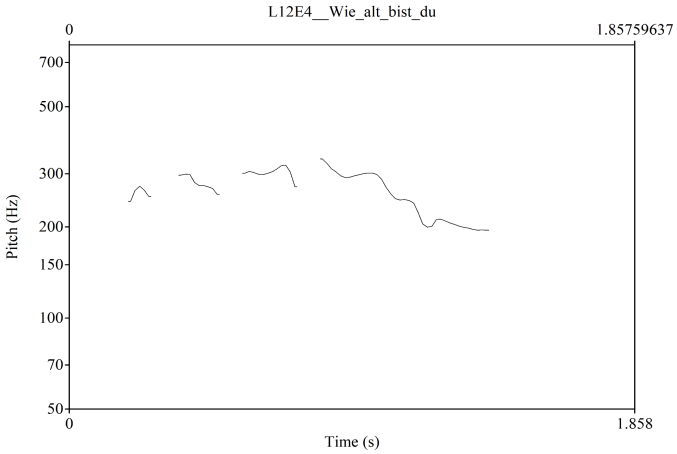
	Episode	Red	Min	Max	Range
L12	E1	293.933	255.233	349.451	94.218
	E4	261.589	195.203	335.904	140.701
	E5	299.598	221.159	363.483	142.324
	E9	289.678	215.286	371.535	156.249
	E10	298.033	213.519	393.121	179.602
L24	E1	128.098	91.078	174.527	83.449
	E4	118.419	84.02	160.983	76.963
	E5	119.537	92.154	176.397	84.243
	E9	130.912	106.576	164.385	57.809
	E10	122.129	78.927	167.875	88.948

Table 1 shows that L12 speakers consistently had a higher F0 mean value than L24 speakers in speech in five episodes. This difference is also evident in the F0 max value, which reaches up to 393,121 Hz in L12 speakers and in L24 speakers, only reaches 176,397 Hz. In addition, the F0 range in L12 speakers tends to be wider than in L24 speakers, with values reaching 179,602 Hz. This pattern shows that F0 variation is higher in L12 speakers, while L24 speakers have a more stable F0 range.

The difference in the F0 variation is not only visible in terms of numbers, but can also be reflected in the pattern *of rising-falling movements* throughout speech. This study will further analyze the contours of F0 to observe the dynamics in detail at the basic frequency, including the pattern of rising, falling, and the presence of F0 pauses that form the prosody unit. Through observation of the contour of F0, it can be identified how the intonation of the two speakers of

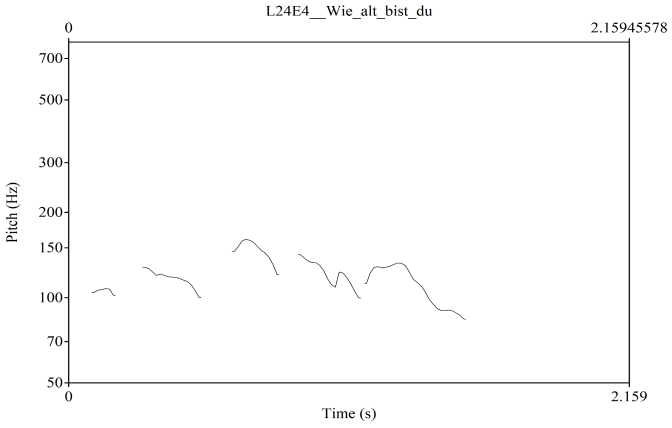
different ages can be identified. This is evident not only from the high or low value of F0, but also from how the pitch changes throughout speech.

Figure 1.
F0 contour of L12 speaker on E4



In L12 speech on E4, the contour of F0 shows a dynamic variation of F0 despite having a relatively short duration. Figure 1 shows that the contour does not move in a straight line (linear), but rather the direction of the contour fluctuates throughout speech. Although the L12 speech on E4 does not have a long F0 pause, so it sounds like a single prosodic unit, the F0 variation shows a different change. Changes such as an ascending pattern at the beginning of speech and a decrease in the end suggest that F0 variation remains dynamically occurring even though there is no clear F0 pause.

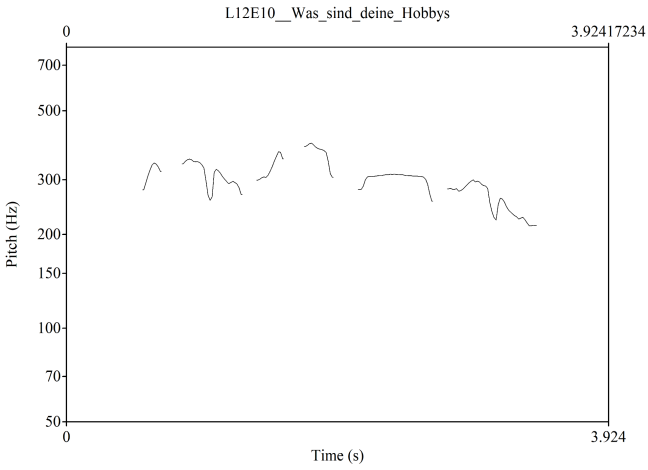
Figure 2.
F0 contour of L24 speaker on E4



Meanwhile, the F0 contour of L24 speech on E4 shows a more stable F0 pattern compared to that of L12 speakers. Figure 2 shows the change of F0 that occurs gradually in a narrower or smaller range. In this speech, there is a pause of F0, but the displacement throughout the speech does not show an extreme spike. The value of F0 tends to rise to the highest point of F0 before

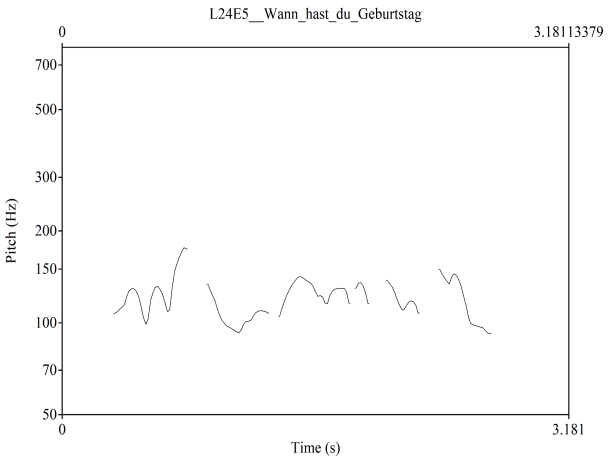
gradually decreasing until the end of speech. This pattern proves that although L24 speakers have more controlled F0 changes.

Figure 3.
Contour F0 of the L12 speaker on E10



In speech with a longer duration, such as in Figure 3, L12 speakers have a significantly varying F0 contour. In this speech, the L12 speaker shows the peak of F0 after the F0 pause, with the max value of F0 throughout speech reaching more than 390 Hz. Each F0 pause is followed by a high F0 reset, thus forming two clear prosody units. In addition, the F0 changes occur rapidly throughout the speech, with sharp up-and-down changes occurring. This pattern shows that long speech has a wide F0 variation in E10 speech by L12 speakers.

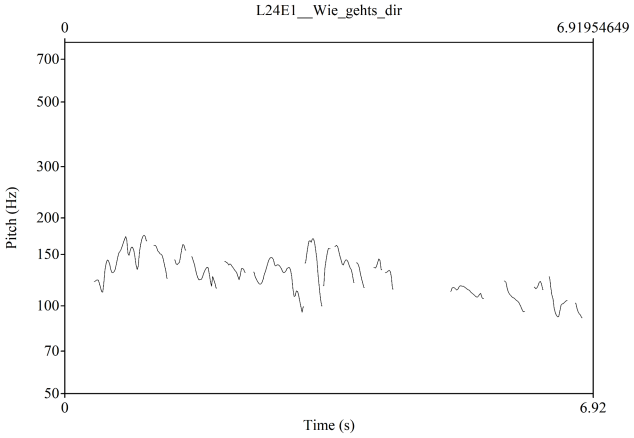
Figure 4.
F0 contour of L24 speaker on E5



The contour of F0 in long-duration speech by L24 speakers shows a more stable F0 pattern than that of L12 speakers. As seen in Figure 4, the value of F0 increases gradually and then decreases subtly. Although there are some F0 pauses in L12 speech on E10, the pitch

changes throughout speech do not experience significant differences. This proves that for L24 speakers, F0 resets occur at a steady speed and do not produce extreme spikes in F0 as in L12 speech.

Figure 5.
Contour F0 of the L24 speaker on E1



In other, more complex long-duration L24 speech, the contour of F0 shows fluctuations in the more pronounced F0 variations. Figure 5 shows that the contour of F0 consists of several prosody units separated by the pause of F0, but the movement of the pitch remains slow and continuous. Some parts show a *declination* pattern, where F0 slowly decreases throughout the speech part. The resulting pitch increase does not reach extreme values, but remains within a narrow range. Patterns like this indicate that L24 speakers, in long-duration and complex speech, consistently maintain F0 stability throughout speech.

Based on the F0 contour analysis, the pattern of tone movement in both speakers can be explained through segmentation of prosody units by the IP (*intonational phrase)* method. In L12 speakers, the break of F0 in the middle of the sentence is usually followed by a clear change in tone, resulting in two or more prosody units with different F0 levels. Each segment in L12 speech has a different F0 max value as well as F0 movement patterns, such as up and down patterns. Meanwhile, L24 speakers show slower pitch changes throughout speech with more frequent F0 breaks due to more complex speech. The pitch change after the F0 pause does not show extreme spikes, which makes the intonation pattern in the L24 speaker feel continuous.

The differences between the two speakers in this case study showed that the F0 variation affected the difference in the realization of prosody in spontaneous speech. The findings in this study show that the realization of the mean F0 and the intonation contour pattern of the two speakers are always different. L12 speakers tend to have a higher F0 mean with a more volatile intonation pattern, while L24 speakers have a lower F0 mean as well as a gradual and stable intonation pattern. Based on these findings, the intonation pattern of L12 speakers was seen to have a more dynamic tendency, while the intonation pattern of L24 speakers appeared to remain stable in the spontaneous speech analyzed.

Discussion

The present study demonstrates that age-related differences in prosodic realization are reflected not only in the magnitude of F0 values but also in the organization of intonation contours and prosodic boundaries in semi-spontaneous German speech. The younger speaker (L12) consistently produced higher mean F0 values and a wider F0 range than the adult speaker

(L24). This finding is theoretically consistent with the physiological explanation proposed by Titze (1994), which states that shorter and lighter vocal folds in younger speakers tend to generate higher fundamental frequencies. Beyond physiological factors, the wider F0 range observed in L12 also indicates greater prosodic flexibility and more dynamic pitch movement throughout the utterances. Therefore, the differences identified in this study are not merely numerical variations in F0 values but represent distinct prosodic strategies associated with different stages of vocal and communicative development.

The findings further support the view that F0 is one of the primary acoustic correlates of intonation and prosodic organization (Ladd, 2008; Gussenhoven, 2004). The highly fluctuating contour patterns observed in L12 suggest a more dynamic realization of intonation, characterized by rapid pitch movements and wider pitch excursions. In contrast, L24 exhibits smoother F0 contours with more gradual pitch transitions, reflecting a more stable and controlled prosodic structure. These differences indicate that age influences not only the average F0 values but also the overall organization of intonation in spontaneous speech.

An important contribution of this study lies in the application of the Intonational Phrase (IP) framework to explain these prosodic differences. The analysis demonstrates that IP segmentation helps identify how intonation is organized into prosodic units through pauses, pitch reset, and changes in F0 movement. In L12, pitch reset tends to occur with greater magnitude after prosodic boundaries, producing more salient transitions between IPs and contributing to a more dynamic intonation pattern. Conversely, L24 exhibits smaller pitch resets and smoother transitions across IP boundaries, indicating greater continuity and stability in prosodic organization. These findings suggest that IP segmentation is not merely a technical segmentation procedure but also an effective analytical framework for understanding age-related variation in German intonation.

The present findings also reinforce previous observations that spontaneous or semi-spontaneous speech exhibits more variable and less predictable F0 patterns than read speech (Nakamura et al., 2008; Arvaniti, 2020). The dynamic pitch movements and frequent pitch resets found in L12 illustrate how prosodic realization in natural speech can vary substantially depending on speaker characteristics. Meanwhile, the more stable contour patterns of L24 indicate that prosodic maturity may be associated with greater regularity and continuity in F0 movement. Thus, the study extends previous research on German intonation by showing that age-related prosodic differences can be observed not only through mean F0 values but also through IP organization and pitch reset behavior in semi-spontaneous speech.

This study contributes to German acoustic phonetics by providing empirical evidence on how age influences F0 realization, intonation contours, and IP-based prosodic organization in semi-spontaneous speech. Unlike previous studies that mainly focused on dialectal variation, pitch accents, or read speech, this research integrates acoustic F0 analysis with Intonational Phrase segmentation in a comparative case study of adolescent and adult speakers. Consequently, the study offers both empirical and methodological contributions to the analysis of German prosody, particularly in the context of naturally produced spoken responses.

Nevertheless, several limitations should be acknowledged. This study is based on a case study involving only two speakers and a limited number of utterances; therefore, the findings cannot be generalized to the broader German-speaking population. In addition, the analysis focuses exclusively on F0 parameters and does not examine other acoustic features such as duration, intensity, speech rate, or spectral characteristics that may also contribute to prosodic variation. Future studies are encouraged to include larger speaker populations, broader age groups, and additional prosodic parameters in order to provide a more comprehensive understanding of age-related variation in German intonation.

Conclusion

This study contributes to the field of German acoustic phonetics by providing empirical evidence of age-related differences in F0 realization, intonation contours, and Intonational Phrase (IP)-based prosodic organization in semi-spontaneous German speech. The findings demonstrate that age influences not only the average F0 values but also the organization of intonation patterns, pitch reset behavior, and prosodic variation across utterances. By integrating acoustic F0 analysis with IP segmentation, this study offers a methodological framework for examining prosodic differences in naturally produced speech beyond the context of read or scripted speech.

The study further shows that semi-spontaneous speech provides valuable insights into the dynamic realization of intonation, revealing distinct prosodic tendencies between adolescent and adult speakers. Therefore, the present research extends previous studies on German intonation by highlighting how age-related variation can be observed through both acoustic measurements and prosodic organization.

Nevertheless, this study has several limitations. The analysis is based on a case study involving only two speakers and a limited number of utterances; therefore, the findings cannot be generalized to the broader German-speaking population. In addition, the study focuses exclusively on F0 parameters and does not include other acoustic features such as duration, intensity, speech rate, or spectral characteristics that may also contribute to prosodic variation.

Future research is encouraged to include a larger number of speakers representing broader age groups and different communicative settings. Further studies may also integrate additional acoustic and prosodic parameters to provide a more comprehensive understanding of age-related variation and intonation patterns in German spontaneous speech.

Author Contributions Statement

Author 1: Conceptualization and Research Design, Data Curation and Investigation, Methodology, Formal Analysis, Writing - Original Draft, Visualization
Author 2: Supervision, Methodology, Writing - Review & Editing, Validation

REFERENCES

Armis, M. K., Harahap, A. I., & Syarfina, T. (2023). Procedural Analysis of Acoustic Phonetic Studies In Angkola Batak Language. Source: Journal of Indonesian Language and Literature Education, 19(1), 158–165. https://doi.org/10.25134/fon.v19i1.6878

Arvaniti, A. (2020). The Phonetics of Prosody. Oxford Research Encyclopedia of Linguistics. https://doi.org/10.1093/acrefore/9780199384655.013.411

Arvaniti, A., Grice, M., & D'Imperio, M. (2026). Advancements of phonetics in the 21st century: Intonation. Journal of Phonetics, 114. https://doi.org/10.1016/j.wocn.2025.101459

Asu, E. L., Lippus, P., Salveste, N., & Sahkai, H. (2016). F0 declination in spontaneous Estonian: implications for pitch-related preplanning in speech production. Speech Prosody, 1139–1142. https://doi.org/10.21437/SPEECHPROSODY.2016-234

Chen, Y. (2011). How does phonology guide phonetics in segment-f0 interaction? Journal of Phonetics, 39(4), 612–625. https://doi.org/10.1016/j.wocn.2011.04.001

DiCanio, C., Benn, J., & Garcia, R. C. (2020). Disentangling the Effects of Position and Utterance-Level Declination on the Production of Complex Tones in Yoloxóchitl Mixtec. Language and Speech, 64(3), 1–43. https://doi.org/10.1177/0023830920939132

Dünkel, F. (2016). Youth Justice in Germany. In Oxford Handbooks Online: Criminology and Criminal Justice. Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199935383.001.0001

Gussenhoven, Carlos. (2004). The Phonology of Tone and Intonation. Cambridge University Press.

Himmelmann, N. P., Sandler, M., Strunk, J., & Unterladstetter, V. (2018). On the universality of intonational phrases: A cross-linguistic interrater study. Phonology, 35(2), 207–245. https://doi.org/10.1017/S0952675718000039

Jolayemi, D. (2013). Doing Phonetics with Computer: Introducing Praat, and Its Application to Phonology of English. English Language Teaching Today (ELTT), 10(1), 9–19.

Kaland, C., & Grice, M. (2024). Exploring and explaining variation in phrase-final f0 movements in spontaneous Papuan Malay. Phonetics, 81(3), 321–349. https://doi.org/10.1515/phon-2023-0031

Kügler, F., & Gollrad, A. (2015). Production and perception of contrast: The case of the rise-fall contour in German. Frontiers in Psychology, 6(1254), 1–17. https://doi.org/10.3389/fpsyg.2015.01254

Ladd, D. R. (2008). Intonational Phonology (2nd ed.). Cambridge University Press.

Lialiou, M., Grice, M., Röhr, C. T., & Schumacher, P. B. (2024). Auditory Processing of Intonational Rises and Falls in German: Rises Are Special in Attention Orienting. Journal of Cognitive Neuroscience, 36(6), 1099–1122. https://doi.org/10.1162/jocn_a_02129

Mennen, I. (2004). Bi-directional interference in the intonation of Dutch speakers of Greek. Journal of Phonetics, 32(4), 543–563. https://doi.org/10.1016/j.wocn.2004.02.002

Nakamura, M., Iwano, K., & Furui, S. (2008). Differences between acoustic characteristics of spontaneous and read speech and their effects on speech recognition performance. Computer Speech and Language, 22(2), 171–184. https://doi.org/10.1016/j.csl.2007.07.003

Narhan, R., Sholihatun, P., & Syarfina, T. (2023). Analysis of Frequency, Intensity, and Duration in Turkish by Native Speakers and Non-Native Speakers using Praat. LINGUA: Journal of Language, Literature, and Its Teaching, 20(2), 351–372. https://doi.org/10.30957/lingua.v20i2.840

Niebuhr, O. (2017). On the perception of "segmental intonation": F0 context effects on sibilant identification in German. J AUDIO SPEECH MUSIC PROC. 2017(19). https://doi.org/10.1186/s13636-017-0115-3

Ningsih, T. W. R. (2020). Prosodic Analysis on Film Actors' Monologues Using Praat Applications (Studies in the Field of Acoustic Phonetics). NUSA, 15(4). https://doi.org/10.14710/nusa.15.4.419-432

Parasian, N. A., Duke, M. Y., Syarfina, T., & Erwina, E. (2025). Suprasegmental Analysis of Male and Female Speakers in Imperative Sentences of the Toba Batak Language. AKSARA: Journal of Language and Literature, 26(1), 252–264. https://doi.org/10.23960/aksara/v26i1.pp252-264

Petrone, C., Truckenbrodt, H., Wellmann, C., Holzgrefe-Lang, J., Wartenburger, I., & Höhle, B. (2017). Prosodic boundary cues in German: Evidence from the production and perception of bracketed lists. Journal of Phonetics, 61, 71–92. https://doi.org/10.1016/j.wocn.2017.01.002

Pitt, M. A., Dilley, L., & Tat, M. (2011). Exploring the role of exposure frequency in recognizing pronunciation variants. Journal of Phonetics, 39(3), 304–311. https://doi.org/10.1016/j.wocn.2010.07.004

Pranoto, M. S. (2018). Analysis of the Frequency, Duration, and Intensity of Voices of Javanese Men and Women Using Praat Software. LINGUA: Journal of Language, Literature, and Teaching, 16(2). https://doi.org/10.15294/lingua.v14i2.15237

Private, H. (2018). Introduction to Linguistic Research Methodology. Indonesian Center for Humanities Studies.

Rizma, F., & Savitri, A. D. (2025). Intonation of Indonesian Expressions in Javanese Speakers of Surabaya: An Acoustic Phonetic Study. Journal of Spala, 12(02), 23–35. Retrieved from https://ejournal.unesa.ac.id/index.php/jurnal-sapala/article/view/72003

Sanfelici, E., Féry, C., & Schulz, P. (2020). What verb-final and V2 have in common: Evidence from the prosody of German restrictive relative clauses in adults and children. Zeitschrift Für Sprachwissenschaft, 39(2), 201–230. https://doi.org/10.1515/zfs-2020-2011

Schauffler, N. (2023). Alternation preferences affect focus marking in German and English differently. Frontiers in Psychology, 14. https://doi.org/10.3389/fpsyg.2023.1192004

Schubö, F., & Zerbian, S. (2023). Correlation of prosodic boundary cues in German. Proc. The International Congress of Phonetic Sciences (ICPhS), 1245–1249.

Seeliger, H., Lützeler, A., & Kaland, C. (2023). The perception of German wh-phrase-final intonation. Proc. The Second International Conference on Tone and Intonation, 10–14. https://doi.org/10.21437/tai.2023-3

Tavakoli, S., Matteo, B., Pigoli, D., Chodroff, E., Coleman, J., Gubian, M., Renwick, M. E. L., & Sonderegger, M. (2025). Statistics in Phonetics. Annual Review of Statistics and Its Application. 12:133-156. https://doi.org/10.1146/annurev-statistics-112723-034642

Titze, I. R. (1994). Principles of Voice Production (pp. 185–207). Prentice Hall.

Wagner, M., & Watson, D. G. (2010). Experimental and theoretical advances in prosody: A review. Language and cognitive processes, 25(7-9), 905–945. https://doi.org/10.1080/01690961003589492

Weirich, M., Duran, D., & Jannedy, S. (2024). Gender and age based f0-variation in the German Plapper Corpus. Proc. Interspeech 2024, 1565-1569, https://doi.org/10.21437/Interspeech.2024-1592

Weissheimer, J., & Mota, N. (2026). Speech production in child language development. In SciELO Preprints. https://doi.org/10.1590/SciELOPreprints.14998

Wells, B., Peppé, S., & Goulandris, N. (2004). Intonation development from five to thirteen. Journal of Child Language, 31(4), 749–778. https://doi.org/10.1017/S030500090400652X

Xu, Y. (2011). Speech prosody: a methodological review. Journal of Speech Sciences, 1(1), 85-115. https://doi.org/10.20396/joss.v1i1.15014

Zahner-Ritter, K., Einfeldt, M., Wochner, D., James, A., Dehé, N., & Braun, B. (2022). Three Kinds of Rising-Falling Contours in German wh-Questions: Evidence From Form and Function. Frontiers in Communication, 7. https://doi.org/10.3389/fcomm.2022.838955