

# “A little more ironic” – Voice quality and segmental reduction differences between sarcastic and neutral utterances

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## Abstract

The presented production experiment analyzes the phonetic differences between neutral (i.e. sincere) and sarcastically ironic utterances in German. Results show in line with previous studies that sarcastic irony is expressed by longer utterance durations, lower and flatter F0 contours, and a lower intensity level. Moreover, extending previous findings, sarcastic irony is also characterized by a more variable (in tendency breathier) voice quality and a higher degree of segmental reduction, probably reflecting the speakers' dissociation from the wording of their utterances.

**Index Terms:** irony, sarcasm, intonation, emphasis, reduction

## 1. Introduction

Ironic statements convey the opposite of what the speaker has put into words. Even in this admittedly oversimplified common sense definition (e.g., [1,2]), irony is anything else but a marginal aspect of speech communication. For example, estimated on the basis of spontaneous dialogue corpora [8,23], one hour of speech contains about 10-15 instances of ironic expressions. They represent a type of emphasis at the utterance level. Such utterance-level types of emphasis can be distinguished from other word-level types of emphasis [3,4,5]. While lexical means like extreme exaggerations or question tags are optional irony signals, prosodic signals seem to be a constant companion of ironic utterances. Typically, and particularly in lexically unmarked ironic utterances, prosodic meanings are selected such that they clash with the verbal meanings. In this way, they can indicate irony and express at the same time what the speaker actually wants to say (in combination with the communicative and visual contexts).

Since there is an infinite number of different ironic utterances, and since the prosodic meanings have to be adjusted to clash with each of their verbal meanings, it is obvious that *the* prosody of irony cannot be determined. Therefore, phonetic studies trying to pinpoint specific prosodic exponents of irony have either failed or – implicitly or explicitly – investigated a particular subtype of irony. The most frequently investigated subtype of irony concerns the clash between positive verbal and negative prosodic meanings. It is often referred to as sarcasm, although sarcasm is actually just an attitudinal concept of a provocatively negative kind, which can in principle also be directly expressed in speech without being exploited for an ironic meaning clash [1].

The general aim of the present paper is to continue the line of phonetic research on this sarcastic subtype of irony. However, for the sake of simplicity and because irony is the determining concept, the more accurate term ‘sarcastic irony’ will be used interchangeably with ‘irony’ in the following. Detailed experimental-phonetic analyses of sarcastic irony have begun only about a decade ago, which makes sarcastic irony a relatively young field of research. The phonetic picture that has emerged so far from analyses of English, Italian,

French, German, and Cantonese can be condensed as follows: Compared with neutral utterances, utterances with sarcastic irony are produced longer (i.e. at lower speaking rates) and with clear changes in the levels and ranges of F0 and intensity [6,7,8]. F0 patterns seem to be lowered and narrowed in Western Germanic languages like English and German [9, 10,11,12], but raised and/or widened in Cantonese and Roman languages like Italian or French [13,14,15]. Findings on intensity changes were a bit less consistent, but typically went in the direction of a lower, flatter intensity contour [13,16] (cf. [9,12] for exceptions).

The summarized findings call for an extension in two directions. (1) What about voice quality whose relevance as “the fourth prosodic dimension” as recently been stressed and promoted by [17]? (2) Since modern phonetic research also stresses the strong linkages of segments and prosodies (e.g. [18]), what about the segmental characteristics of sarcastic irony? The present study addresses these two questions on the basis of Standard Northern German.

As regards question (1), there are impressionistic indications from [19] that sarcastic irony is produced with a softer, i.e. breathier voice quality. With respect to question (2), one may expect a higher degree of speech reduction in ironic utterances for the following reason. It has recently been argued in [20,21] that the degree of speech reduction in an utterance is not just the result of an articulatory balance between the competing demands of economy and comprehensibility in a given communicative situation, cf. [27]. Rather, the articulatory effort invested by the speaker also signals his/her attitudes towards the dialogue partner or the content of the message. For example, utterances like “good morning”, “I do not know” (cf. also [22]), “I am sorry”, or “thank you” are less reduced when they not just function as routine statements, but sincerely serve to initiate a conversation, or express compassion, cooperativeness, remorse, or gratitude, cf. also [29]. Since irony requires that speakers distance themselves from the semantic content of their utterances, it is reasonable to assume that they mark this distance by a higher degree of segmental reduction.

In summary, the hypotheses tested in this study are that ironic utterances in Standard Northern German are longer, breathier, more reduced, and have lower and flatter F0 and intensity contours than their neutral counterparts. Design and procedure of the corresponding production experiment will be outlined in the following section.

## 2. Method

### 2.1. Target Sentences

The study was based on 20 target sentences. They were designed to meet three criteria. First, they were plain and syntactically simple constructions of four to eight frequent German words. This allowed the sentences to be produced fluently and with a clear and consistent prosody. Second, in order to facilitate speech reduction processes, each sentence contained at least two so-called phonetically weak forms in the

sense of [24], i.e. function words like pronouns, auxiliary verbs, modal particles, articles, prepositions, or conjunctions, which are by default unstressed. Third, the sentences were formulated such that they can be directed towards an interlocutor. In addition, they made positive statements about this interlocutor or a third party and in this way lay the ground for realizing the sentences not only in a neutral fashion, but also with sarcastic irony by inverting their positive propositions. The 20 target sentences are provided in the Appendix.

## 2.2. Speakers and Recording Procedure

The target sentences were produced by 10 speakers of Standard Northern German, 5 males and 5 females. They were students at Kiel University and 23-29 years old.

The recordings were conducted at the speakers' homes in rooms which were silent and as anechoic as possible (i.e. typically in the speakers' living rooms). It was assumed (and supported by feedback after the recordings) that familiar surroundings would make it easier for the speakers to get into the kind of mood that is needed to express sarcastic irony. For the same reason, the recordings were conducted by a student of phonetics – DT – who was a good friend of all of the speakers.

Each speaker had a few minutes time prior to the recording to familiarize him/herself with the target sentences. Then, the speaker received the oral instruction to produce each target sentence in an informal everyday fashion while addressing his/her friend DT. The target sentences were presented separately on file cards in order to avoid any list effects on speech production. The speakers were free to repeat each sentence until they were satisfied with the result; and in fact most speakers made use of this possibility several times due to unsatisfactory expressions of irony or insufficient informality.

The group of 10 speakers was divided into two subgroups. One subgroup produced the target sentences first in a neutral fashion and then with sarcastic irony. The other, equally large subgroup started with the expression of sarcastic irony and then uttered the target sentences again in a neutral way. The sentence order was re-randomized after each round and for each new speaker. The concept of sarcastic irony was explained to the speakers on request by means of instances in comic strips, i.e. without using auditory examples.

The elicited ironic and neutral target sentences were recorded digitally with a HiFi speech recorder (Zoom H2n). Instead of using the built-in microphone, recordings were made with a head-mounted microphone so that the relative distance between mouth and microphone was constant during the recording. An entire recording session took about 15 minutes.

Pitch accents in the neutral and ironic sentences fell on the same words and were free from additional positive or negative emphatic intensification [3]. Spot checks just revealed a slightly greater number of high-tone (H\* or L+H\*) accents in the neutral set, reflecting the positive sentence semantics.

## 2.3. Filtering out Unclear Cases

Phonetic analyses were preceded by a small perception experiment. It served to cross-check whether the target sentences selected by the speakers to convey sincerity (neutrality) and sarcastic irony would in fact be clearly associated with these functions by independent listeners.

To that end, all target sentences were cut out of the recorded sound files and normalized in amplitude with Adobe

Audition ([www.adobe.com/Audition](http://www.adobe.com/Audition)) to 90% of the possible dynamic range. Then, they were arranged in four differently randomized orders in which the sentences were separated from each other by a pause of five seconds and a beep. The so-assembled stimulus lists were finally handed over as a single sound file to four naïve German listeners together with a corresponding response sheet.

The naïve participants were informed that they would hear a set of isolated sentences from 10 speakers of Standard Northern German. They were furthermore asked to play the sound files in a silent room and judge spontaneously for each sentence whether it was meant sincerely or ironically. Conducting the perception experiment took about 45 minutes.

Based on the retrieved response sheets, target sentences were excluded from further analyses if they were not correctly identified as neutral or ironic in at least 75% of the cases. Although sentences of both types were affected by this filtering, it was primarily the ironic sentences that failed to meet the 75% threshold. Therefore, in order to create equally large samples for the phonetic analyses, additional sentences were randomly excluded from the neutral sample. In summary, the perceptual filtering procedure resulted in 142 target sentences, subdivided into two samples of 71 clearly neutral and 71 clearly ironic tokens.

## 2.4. Phonetic Analyses

The phonetic analyses of the remaining, clear target sentences included acoustic as well as auditory measurements. The acoustic measurements covered all four prosodic dimensions, i.e. F0, intensity, duration, and voice quality. F0 and intensity were represented by four parameters each. In summary, the following ten parameter values (a)-(j) were determined for each target sentence:

- (a) F0 minimum of the sentence, measured in semitones relative to 100/200 Hz for male/female speakers,
- (b) F0 maximum of the sentence, measured in semitones relative to 100/200 Hz for male/female speakers,
- (c) F0 range in semitones, i.e. (b) subtracted by (a),
- (d) average F0 level, calculated in semitones relative to 100/200 Hz for male/female speakers,
- (e) intensity minimum in dB within a non-silent sound section of the target sentence,
- (f) intensity maximum in dB,
- (g) intensity range in dB, i.e. (f) subtracted by (e),
- (h) average intensity level in dB, disregarding silent (sound) sections of the target sentence,
- (i) voice quality in terms of the amplitude difference in dB between the first and the second harmonic (H1-H2), measured in the midpoints of all vowels of a target sentence and then averaged across these vowels,
- (j) tempo, represented by the total sentence duration.

All measurements except for (i) were conducted with PRAAT [28], using the default settings. The F0 measurements (a)-(b) and (d) omitted octave errors and, as far as possible, also microprosodic perturbations. Intensity measurements were not normalized as the use of head-mounted microphones assured a constant speaker-microphone distance. The voice-quality measurements for (i) were made with WaveSurfer ([www.speech.kth.se](http://www.speech.kth.se)) on the basis of narrow-band FFT spectra.

The acoustic-prosodic analysis was complemented by a careful auditory analysis targeted at the degree of segmental reduction in a target sentence. This degree was measured by successively playing short sections of the target sentence and counting the number of assimilations, elisions, and lenitions of sound segments in these sections relative to their canonical full form in Standard German according to [25]. The reduction countings of the individual sections were then summed up for each target sentence. Assimilations could, for example, concern voice and place of articulation. Lenitions included vocalizations of consonants, centralizations of vowels, and changes of obstruents to approximants. The auditory analysis was performed with headphones by DT in a silent room and subsequently cross-checked by a trained phonetician (ON). DT and ON were Standard German listeners. Cases of disagreement were supplemented by visual inspections of spectrograms and/or waveforms and discussed until a final decision was reached.

### 3. Results

The acoustic-prosodic measurements made within the selected 2x71 target sentences were analyzed with a multivariate ANOVA. It was based on the 2-level fixed factor Sentence Type (ironic vs. neutral); and since the sentences of the ironic and neutral sample were not equally distributed across the 10 speakers, possible differences between the two samples were analyzed in terms between-subject effects. The MANOVA resulted in a highly significant main effect of Sentence Type ( $F[10,131] = 69.696$ ;  $p < 0.001$ ;  $\eta_p^2 = 0.842$ ). All dimensions of acoustic-prosodic parameters contributed to this main effect.

As regards the F0 parameters (a)-(d), the largest difference between the ironic and neutral sentences and thus the strongest effect in terms of partial eta-squared lies in the height of the F0 maximum ( $F[1,140] = 193.416$ ;  $p < 0.001$ ;  $\eta_p^2 = 0.580$ ). As is illustrated in Figure 1, this maximum was produced considerably (i.e. 3 semitones) lower for the ironic than for the neutral sentences. The same, though less clearly, applied to the F0 minimum ( $F[1,140] = 12.816$ ;  $p < 0.001$ ;  $\eta_p^2 = 0.084$ ), and in accord with the lowering of these two extreme F0 values, the overall F0 level was also about a major third lower for the ironic than for the neutral sentences ( $F[1,140] = 116.366$ ;  $p < 0.001$ ;  $\eta_p^2 = 0.454$ ). In addition, the sentences expressing irony were also characterized by a significantly narrowed F0 range, representing the second strongest F0 effect ( $F[1,140] = 163.532$ ;  $p < 0.001$ ;  $\eta_p^2 = 0.539$ ).

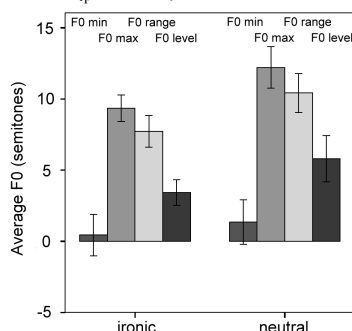


Figure 1: Means and standard deviations of the four F0 parameters (a)-(d), measured in ironic (left) and neutral (right) target utterances;  $n=71$  for each bar.

The biggest intensity contributions to the significant main effect of Sentence Type come from the intensity minima and maxima. Figure 2 shows that both clearly decrease (between

4-9 dB) from the neutral to the ironic sentences (Int-min:  $F[1,140] = 72.334$ ;  $p < 0.001$ ;  $\eta_p^2 = 0.341$ ; Int-max:  $F[1,140] = 71.643$ ;  $p < 0.001$ ;  $\eta_p^2 = 0.339$ ). The intensity range does not differ significantly between the ironic and neutral sentences. However, parallel to the change in F0 level, the intensity level was also significantly lower for the ironic than for the neutral sentences ( $F[1,140] = 37.594$ ;  $p < 0.001$ ;  $\eta_p^2 = 0.212$ ).

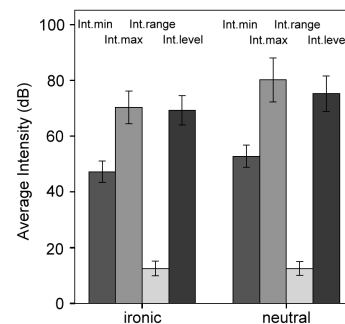


Figure 2: Means and standard deviations of the four intensity parameters (e)-(h), measured in ironic (left) and neutral (right) utterances;  $n=71$  for each bar.

From the remaining two prosodic parameters (i)-(j), i.e. harmonic amplitude difference H1-H2 (voice quality) and sentence duration, only the latter differed significantly between the ironic and neutral sentences ( $F[1,140] = 58.589$ ;  $p < 0.001$ ;  $\eta_p^2 = 0.288$ ), cf. Figure 3. Sentence durations were on average about 25% longer in the ironic than in the neutral productions. Importantly, this effect is not due to the fact that the 20 sentences occurred with different frequencies in the ironic and neutral samples. Even when the sentence durations were normalized and recalculated in terms syllables per second, a separate t test (for unpaired samples and homogeneous variances, based on a prior F test) showed that the duration difference between the ironic and neutral sample persisted, also with regard to its magnitude ( $t[140] = -10.683$ ;  $p < 0.001$ ). The average syllable per second rate in the ironic sentence set was 5.5. This is about 30% slower than the average rate of 7.1 syllables per second in the neutral set.

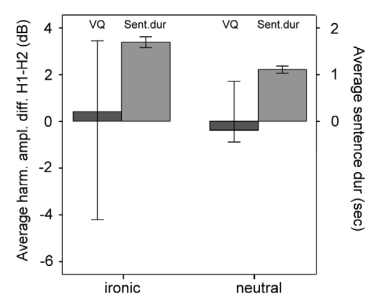


Figure 3: Means and standard deviations of voice quality (dark gray, i) and sentence duration (light gray, j), measured in ironic (left) and neutral (right) target utterances;  $n=71$  for each bar.

The voice quality measure only yielded a trend towards higher H1-H2 values in ironic sentences ( $F[1,140] = 2.796$ ;  $p < 0.097$ ;  $\eta_p^2 = 0.020$ ). Next to this trend, however, there is a much more salient and statistically significant difference between the voice-quality measurements of the ironic and neutral samples. As can be seen in Figure 3, this difference concerns the standard deviation of the H1-H2 values, which were much larger

in the ironic than in the neutral sample. It is not surprising in view of this observation that the H1-H2 parameter clearly stood out highly significantly in the Levene tests of the MANOVA ( $F[1,140]=70.073$ ;  $p<0.001$ ). So, while the overall voice quality in the neutral sentences was mainly constant and modal, the ironic sentences were produced with either breathier or tenser voice qualities. This interpretation of the measurements is in accord with an auditory inspection of the data.

The results of the auditory reduction analysis are summarized in Figure 4. It shows firstly that both the neutral and the ironic target sentences were subject to reduction processes such as assimilation, elision, and lenition. Secondly, however, the degree of reduction in terms of the mean frequency of reduction processes looks overall higher in the ironic than in the neutral sentences. This impression was confirmed in a one-way ANOVA. That is, the ironic set showed on average 4.8 reductions per sentence, which is significantly more than the 3.6 reductions that occurred on average in the neutral set of target sentences ( $F[1,38]=10.464$ ;  $p=0.003$ ;  $\eta_p^2=0.216$ ). However, it must also be noted that this overall difference was not equally present for each target sentence. While sentences like 8, 15, 16, and 19 were realized with about twice as many reductions in the ironic condition, other sentence like 1, 3, 7, 12, and 17 were produced with a similar or even slightly higher number of reductions in the neutral condition.

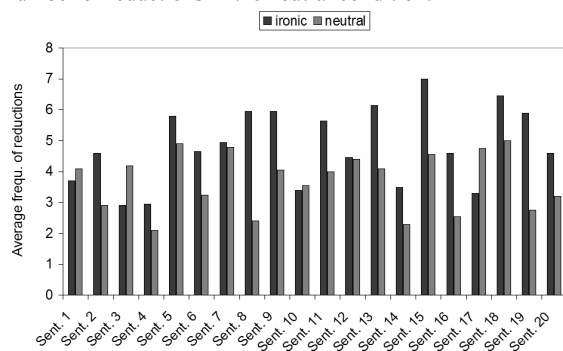


Figure 4: Mean frequency of reductions found across the 10 speakers in the ironic (dark gray) and neutral (light gray) productions of the 20 target sentences.

#### 4. Discussion and Conclusions

The present findings support the conclusion of previous studies that sarcastic irony has a separate phonetic profile in comparison to neutral (i.e. sincere) speech. This profile involves extended utterance durations due to a reduced speaking rate, as well as changes in the F0 and intensity patterns. In accord with previous findings for Western Germanic languages, sarcastic irony was characterized in the present study by a lower and flatter F0. Intensity findings for sarcastic irony have always been less consistent both within and across languages. For example, expressing sarcastic irony in varieties of English was associated with an increase in intensity parameters in [9], but with a decrease in intensity parameters in [13]. Similarly, for Standard German the intensity level was raised in [12], but lowered in the present study of the same language variety. Moreover, in contrast to [13,16] the present findings do not include a narrowed intensity range, as the intensity minima and maxima were both lowered to the same degree. The lack of a narrowed intensity range is also the only deviation of the results from the hypotheses put forward in the introduction. All other hypotheses were confirmed.

One possible explanation for the inconsistencies in intensity is that the direction of intensity changes – unlike those of F0 and speaking rate – does not reflect sarcastic irony itself, but rather the arousal level on which the expression of sarcastic irony is based. That is, similar to cold and hot anger [26], there may be different degrees or subtypes of sarcastic irony (in addition to higher-level types of irony like kind and sarcastic irony, cf. [15]). It fits in with this explanation that [16] introduced on an impressionistic basis the distinction between dry and dripping sarcasm and found that their intensity patterns differed relative to neutral utterances. This attempt of [16] stresses the need for a separate line of research on the sub-structures of the irony concept, which can then complement and guide our growing phonetic understanding of irony.

As for this growing phonetic understanding, the present study showed for the first time that changes away from modal voice quality and a higher degree of segmental reduction can also be a part of sarcastic irony. It is argued here with reference to [20,21,22] that the higher reduction level is supposed to signal that the speaker distances him/herself from the wordings of the sentences; in the same way as “I’m sorry” or “good morning” are more strongly reduced when they are used (insincerely) for routine matters. Looking at Figure 4, it seems that not all ironic target sentences differed in terms of reduction from their neutral counterparts. Target sentences like 1, 7, and 12 showed about the same absolute number of reductions in the two Sentence Type conditions. However, even for these sentences it can be argued that the *relative* degree of reduction was still higher in the ironic condition, since sentences in the ironic condition were produced (consistently) longer, i.e. at a slower speaking rate. So, speakers had basically more time in the ironic sentences to reach the respective articulatory targets, but obviously made no use of this possibility. This fact, in combination with the significant effect of reduction on Sentence Type, challenge an important assumption in the modelling of speech production. It has often been claimed with reference to the H&H theory [27] that slower speech is automatically also less reduced. The present study shows there is no such automatism. The degree of reduction is not just the passive result of time, speaker economy and listener demands. Rather, reduction is also actively varied to convey different kinds of function in speech communication.

The changes in voice quality went in both directions tense voice and breathy voice. It seems that the direction of the change was determined by the sentence semantics. For example, target sentences like 1, 10, and 15 were more often realized with a tense voice, whereas the majority of sentences like 2, 4, 8, 14, and 20 typically showed a breathier voice. Thus, like for intensity, and maybe even shaping the latter, the heterogeneous voice quality findings may reflect different degrees or subtypes of (sarcastic) irony. For example, it is striking that statements in which the irony is used to point to future alternatives were tenser, whereas ironic statements pointing to the lack of alternatives were mostly breathier.

In any case, it can be concluded from the present study that sarcastic irony is a four-dimensional rather than just a three-dimensional prosodic phenomenon, which moreover extends beyond the prosodic layer into the traditionally separated segmental layer of the speech signal. Both of these new insights must be further investigated and put into a cross-linguistic perspective. It seems also worth looking for speaker-specific differences, even though the only differences found here were those between sentences, probably caused by uncontrolled degrees or subtypes of (sarcastic) irony.

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## 6. Appendix

1. Das ist aber mal interessant  
(That's so interesting)
2. Das Wetter gefällt mir heute mal richtig gut  
(I really like the weather today)
3. Das wird bestimmt spannend  
(This will surely be exciting)
4. Das läuft ja super  
(This works out perfectly)
5. Das riecht richtig lecker  
(It smells really delicious)
6. Er sieht aus wie ein richtiger Herr  
(He looks like a real gentleman)
7. Das nenne ich mal eine richtige Freundschaft  
(That's what I call a real friendship)
8. Er ist besonders wichtig  
(He is a very important person)
9. Der schmeckt mir der Senf  
(I like how the mustard tastes)
10. Mach mal ruhig weiter so  
(Just go on like that)
11. Klar, lad ein, wen du willst  
(Sure, invite who you like)
12. Das ist ja lustig hier heute  
(It is indeed funny here today)
13. Danke für den Aufwand  
(Thanks for all your efforts)
14. Das ist ja fantastisch  
(This is indeed fantastic)
15. Komm ruhig später  
(Just come later)
16. Sie kann so gut kochen  
(She can cook so well)
17. Was für eine schöne Jacke  
(What a wonderful jacket)
18. Da bin ich richtig gut drin  
(I'm really good in that)
19. Na klar kannst du das haben  
(Of course, you can have that)
- 20.) Das ist ein schönes Leben  
(This is a beautiful life)