

# PITCH PATTERNS IN VOCAL EXPRESSION OF “HAPPINESS” AND “SADNESS” IN THE READING ALoud OF PROSE ON THE BASIS OF SELECTED AUDIOBOOKS

*ŁUKASZ STOLARSKI*

Uniwersytet Jana Kochanowskiego  
lstolarski@wp.pl

## **Abstract**

The primary focus of this paper is to examine the way the emotional categories of “happiness” and “sadness” are expressed vocally in the reading aloud of prose. In particular, the two semantic categories were analysed in terms of the pitch level and the pitch variability on a corpus based on 28 works written by Charles Dickens. Passages with the intended emotional colouring were selected and the fragments found in the corresponding audiobooks. They were then analysed acoustically in terms of the mean F0 and the standard deviation of F0. The results for individual emotional passages were compared with a particular reader’s mean pitch and standard deviation of pitch. The differences obtained in this way supported the initial assumptions that the pitch level and its standard deviation would raise in “happy” extracts but lower in “sad” ones. Nevertheless, not all of these tendencies could be statistically validated and additional examples taken from a selection of random novels by other nineteenth century writers were added. The statistical analysis of the larger samples confirmed the assumed tendencies but also indicated that the two semantic domains may utilise the acoustic parameters under discussion to varying degrees. While “happiness” tends to be signalled primarily by raising F0, “sadness” is communicated mostly by lowering the variability of F0. Changes in the variability of F0 seem to be of less importance in the former case, and shifts in the F0 level less significant in the latter.

**Key words:** Pitch patterns, emotional speech, natural speech

## **1. Background**

One of the central issues discussed in this publication is the notion of “emotion”. Plutchik (2001) suggests that over the course of the 20<sup>th</sup> century more than 90 different definitions of the concept were proposed. There is no consensus on the meaning of the term. Authors of publications dealing with the way feelings are expressed in language usually adopt one of these definitions (or a mixture of them) but stress that other interpretations are also possible (cf. Mozziconacci, 1998; Gobl & Ni Chisade, 2003). In the present paper, understanding this notion is important mostly for methodological purposes. Following Gobl and Ni Chisade (2003), the emotional speech which will be

studied in this project will be treated as a part of a continuum from strong emotions, such as anger and fear (which themselves involve gradability), to milder moods (e.g. relaxed, stressed) and general states of being (e.g. interested, friendly).

Because of the differences in the theories of emotion, numerous dissimilar typologies of the notion have been proposed (cf. Izard, 1977; Plutchik, 1980; Ekman, 1982; Frijda, 1986; etc.). Again, there is no agreement on one classification system (cf. Scherer, 1986; Mason, 2012). A large proportion of the typologies rely on the notion of “basic emotions”, which were first suggested by Darwin (1872). He assumed that distinct emotions were inherent in various species and genetically determined. These emotions evolved gradually as a result of the adaptation of the individual and the species over generations in the face of recurrent challenges (Tooby & Cosmides, 1990). The typologies based on this assumption of a set of “basic emotions” usually involve a limited number of categories, typically involving fear, anger, sadness, happiness, and love (Nesse, 1990; Ortony & Turner, 1990). The “basic emotions” approach has also received criticism (Ortony & Turner, 1990; Nesse & Ellsworth, 2009; Barrett, 2006) and alternative models, in which more emphasis is put on the importance of social origins, have also been proposed (Averill, 2009; Ekman, 1999).

The way emotions are expressed in spoken language has been the subject of intensive study for more than 50 years. In numerous publications, various acoustic parameters have been investigated in relation to selected emotion labels. Among the most frequently used acoustic cues one could mention tempo (Fairbanks & Hoaglin, 1941; Eldred & Price, 1958; Davitz, 1964; Markel, Bern, & Phillis, 1973; Kotlyar & Morozov, 1976; Coleman & Williams, 1979; Scherer & Oshinsky, 1977; Bergmann, Goldbeck, & Scherer, 1988; Breitenstein, van Lancker, & Daum, 2001), intensity (Eldred & Price, 1958; Kaiser, 1962; Davitz, 1964; Huttar, 1968), pausing structure (Siegman, 1978; Scherer, 1979; Cahn, 1990a; Cahn, 1990b) and voice quality (Boves, 1984; Bezooijen, 1984; Ladd, Silverman, Tolkmitt, Bergmann, & Scherer, 1985; Scherer, Wallbott, Tolkmitt, & Bergmann, 1985; Murray & Arnott, 1993; Cummings & Clements, 1995; Laukkanen, Vilkanen, Alku, & Oksanen, 1996; Johnstone and Scherer, 1999; Alter et al., 1999; Gob & Ní Chisade, 2003).

A large body of research has also examined various aspects of fundamental frequency in relation to emotions (Fairbanks & Pronovost, 1939; Lieberman & Michaels, 1962; Davitz, 1964; Williams & Stevens, 1969; Williams & Stevens, 1972; Utsuki & Okamura, 1976; Scherer & Oshinsky, 1977; Fonagy, 1978; Coleman & Williams, 1979; Havrdova & Moravek, 1979; Cosmides, 1983; House, 1990; Carlson, Granström, & Nord, 1992; McRoberts, Studdert-Kennedy, & Shankweiler, 1995; etc.). Together with tempo, it is probably the most thoroughly examined acoustic parameter in the study area under discussion. Scherer (1986) and Gob and Ní Chisade (2003) suggest that the reason for such a large number of publications on these basic acoustic aspects of speech may be the result of the relative ease with which they may be measured. What is more, Breitenstein (2001), citing Banse and Scherer (1996), Murray and Arnott (1993), (1995), Pell (1999), Protopapas and Lieberman (1997), Scherer (1982), (1995) and Scherer and Oshinsky (1977), claims that speech rate and fundamental frequency, in comparison to many other acoustic parameters, have the largest influence on the way in which emotions are recognised in speech.

A detailed summary of the way the relationship between various emotional states and different aspects of F0 is dealt with in the literature is beyond the scope of this article. Nevertheless, it is necessary to provide a description of the way the two emotion labels chosen for the experiment summarised in Section 4 are assumed to correlate with mean F0 and F0 variability. The results of studies dealing with the semantic category of “joy” consistently demonstrate an increase in mean F0 (Skinner, 1935; Davitz, 1964; Fonagy, 1978; Coleman & Williams, 1979; Havrdova & Moravek, 1979), as well as in F0 variability (Skinner, 1935; Havrdova & Moravek, 1979). Conversely, in expressions involving “sadness” the average F0 tends to be lower (Fairbanks & Pronovost, 1939; Kaiser, 1962; Davitz, 1964; Fonagy, 1978; Coleman & Williams, 1979) and also the variability of F0 is decreased (Fairbanks & Pronovost, 1939; Kaiser, 1962). The design of the experiment, the results of which are presented in Section 4, is based on these findings.

## 2. Aims of the study

It has been noted that the primary application of the research described above is speech synthesis (Gobl & Ní Chisade, 2003; Sherer, 1986). To date, much improvement has been made and contemporary speech synthesizers sound more natural than they did several years ago. Nevertheless, the expression of emotions is still an issue which needs to be addressed. For instance, it has become common to use software which reads the content of web pages, but the quality of the speech synthesized in this way is usually adequate only for informational texts. Attempts to use computer programs to read prose typically result in monotonous voice quality devoid of emotive characteristics common in the audiobooks read by human beings. For these reasons, one of the major aims of the present paper is to provide supplemental data on expressing emotions in language which may be used in improving speech synthesizing software.

Another aspect which this study addresses is the fact that the overwhelming majority of publications on affective communication deal with speech which is not elicited in a natural way. Most typically, they involve short expressions which are read by professional actors who are instructed to imitate a given emotion or a set of emotions. Only a few studies are based on spontaneous speech (Hargreaves, Starkweather, & Blacker, 1965; Williams & Stevens, 1969; Kuroda, Fujiwara, Okamura, & Utsuki, 1976; Roessler & Lester, 1976). Since one of the major applications of the research on the expression of human emotions in spoken language is the development of text-to-speech software, the analysis of natural speech should receive more attention. Indeed, if computer programs are intended to imitate a natural way of reading, detailed descriptions of the way texts are read by real humans are essential.

The present study concentrates on the manner in which two emotions (“happiness” and “sadness”) are expressed vocally in selected audiobooks read by a sample of native speakers of English. The two basic acoustic parameters taken into consideration are mean F0 and F0 variability. As mentioned in Section 1, the fundamental frequency is one of the most relevant acoustic features in signalling emotions and the results obtained in this preliminary study may provide useful insights for further research on the expression of emotion in reading prose aloud.

### 3. Methodology

As mentioned earlier, the semantic categories examined in the present study are “happy” and “sad”. The reason for this choice is that the two labels are used in nearly every typology of emotions. They are treated as belonging to “basic emotions” in theories which predict the existence of such a hierarchical structure and they are also commonly mentioned in other typologies which are based on other assumptions. Further research on acoustic aspects of reading of texts aloud in terms of vocal expression of emotion should include other emotion categories, but their choice necessarily depends on the theory that has been accepted. Since in this study none of the proposed models has been fully accepted, the analysis of the two semantic categories which are present in virtually all of them is the most appropriate.

The choice of the two acoustic parameters examined in this paper – the mean F0 and the standard deviation of F0 – was based on the consideration that they have potentially the largest impact on the way emotions are audibly conveyed to listeners. As explained in Section 1, low mean F0 has been observed to be associated with “sadness”, and high mean F0 with “happiness”. As far as the standard deviation of F0 is concerned, it is a correlate of the F0 variability. The larger the standard deviation of F0 measured for a given extract, the more varied is the pitch involved in a particular reader's voice. Studies examining this acoustic feature have demonstrated that the “happy” semantic category tends to be correlated with high F0 variability and, conversely, “sadness” is frequently associated with low F0 variability.

In order to analyse the connection between the two semantic parameters and the two acoustic features in the reading of prose, a reasonably large corpus of texts from novels had to be created. The initial choice was a collection of books written by Charles Dickens. He is the author of over 40 works, many of which are large novels. Their electronic versions are accessible for free from the official web page of Project Gutenberg ([www.gutenberg.org](http://www.gutenberg.org)). Another step was to look for the corresponding audiobooks, which were found for as many as 28 of Dickens's works. They were downloaded from “[www.librevox.com](http://www.librevox.com)”, which is a site with free audiobooks recoded by volunteers. In some cases only one version of an audiobook for one e-book was found, but in others more versions were available (see Table 1).

The corpus composed of 28 of Dickens's works contains over 4.5 million tokens and 40 thousand types and at first it was assumed to be large enough for the current purposes; nevertheless, the results obtained were inconclusive and one of the possible reasons for this was the relatively small number of examples which could be chosen from Dickens's works. Because of the strict limitations described below, no more than 20 suitable extracts were selected for each of the two semantic categories under discussion. Consequently, later in the research additional materials were added. A random selection of novels written by various nineteenth century writers was from which additional 10 extracts were chosen for each of the two semantic domains. The extracts come from novels written by Louisa May Alcott, Levis Carroll, James Fenimore Cooper, Dinah Craik, Henry Rider Haggard, Thomas Hardy, William Makepeace Thackeray, Wilkie Collins, Anthony Trollope, Jane Barlow and Mary Elizabeth Braddon. Moreover, the additional sample also includes English translations of novels written by Jules Verne (see Appendix B).

The search for expressions involving one of the two emotions studied in this paper began with the choice of appropriate lexical cues. These could have been phrases containing adjectives, as in “cried a cheerful voice” (Charles Dickens, *A Christmas Carol*, Stave 1), or nouns, as in “cried Biddy, in a burst of happiness” (Charles Dickens, *Great Expectations*, Chapter 58). Nevertheless, the most suitable examples involved the adverbs “sadly” and “happily” or their close synonyms because they frequently modify verbs, including reporting verbs such as “say” or “repeat”. A summary of all the adverbs used in this research is provided below:

1. HAPPINESS: happily, joyfully, joyously, amusingly, cheerily, cheerfully, gleefully, gaily, merrily, buoyantly, ebulliently, avidly, jovially, blithely, radiantly.
2. SADNESS: sadly, unhappily, gloomily, cheerlessly, sorrowfully, despondently, dejectedly, dismally, dolefully, joylessly, morosely.

A search was performed using AntConc (Anthony, 2014) in order to identify all instances in which these adverbs were used in the works chosen for analysis. Most of the examples which were selected follow the pattern “first part of a character’s utterance” + expression involving one of the emotional adverbs + “second part of the same character’s utterance” (see Appendix A and B). The adverbs, therefore, were indicators of the way in which a given character in a novel was speaking. It should be emphasized that only those extracts were used in which the intention to express a given emotion was clear and unambiguous from the immediate textual context. Cases such as “he added more cheerfully” (Charles Dickens, *The Life and Adventures of Nicholas Nickleby*, Chapter 55) or “said Mr. Lorry, joyfully relieved after reading this note aloud” (Charles Dickens, *A Tale of Two Cities*, Book 3, Chapter 3), in which the emotion is meant either to apply only up to a point or is mixed with some other mood, were excluded. Additionally, an attempt was made to include those examples in which the reporting verb was either neutral, such as “said” or “replied”, or implied the emotion consistent with the adverb, as in “he muttered gloomily” (Charles Dickens, *The Haunted Man and the Ghost’s Bargain*, Chapter 2). Finally, it must be emphasized that the acoustic analysis was performed only on the second part of a character’s utterance (these fragments are underlined in Appendix A and B). Although the person reading a given extract may know the emotion with which the whole character’s utterance was meant to be expressed from broader context of the situation in which a conversation took place, a direct lexical cue in the middle of the utterance makes the interpretation even more accurate. In this case, the reader is explicitly informed of the manner in which the character is speaking. This makes such fragments of dialogues particularly suitable for the purposes of the present study, as the reader is fully aware of the intended emotional colouring even if the broader situational context is not clearly indicative of it.

The fact that the audiobooks were read by different readers posed the problem of speaker normalization. One of the most effective solutions was to apply the paired t-test or one of its non-parametric counterparts, e.g. the sign test for the mean difference with matched-pairs data or the Wilcoxon signed rank test for paired data. However, using any of these statistical methods automatically imposes a crucial restriction on the way examples should be selected. Namely, for each of the two semantic categories it was crucial to find extracts read by different readers. This means that a given fragment could be analysed more than once, but it needed to be read by someone else. Conversely, all of the different extracts read by the same person could not be taken into consideration and

only one of them could be chosen. This important condition seriously limited the choice of examples. As can be seen in Table 1, many of the audiobooks used in the present study are read by the same readers. Still, the problem of speaker normalization needed to be dealt with and applying any of the tests for paired data was essential.

All the fragments which were suitable for the current purposes were found in the appropriate versions of audiobooks and analysed acoustically in *Praat* (Boersma & Weenink, 2014). The parameters which were measured include mean F0 and standard deviation of F0 in the extracts. The resulting values were calculated automatically by the software on the basis of the pitch contour extracted from each excerpt. Additionally, mean F0 and standard deviation of F0 for each reader were established on the basis of the whole chapter from which a given extract was taken using the same technique of extracting the visible pitch contour. Next, the mean F0 for a given extract was subtracted from the mean F0 for the reader measured in the whole chapter. The same was done in the case of the standard deviation for each extract – its value was subtracted from the value of the standard deviation measured in the entire chapter. This made it possible to observe any changes from what was typical for a given reader to what was measured in the extracts. The data sets which were eventually used in Section 4 contain only the differences between the values under discussion.

In this study all of the statistical tests were performed using *Minitab 16.2.3* (2012).

#### 4. Results and discussion

As mentioned in Section 3, the initial attempt at answering the questions posed by this study involved an analysis based on a corpus of 28 works by Charles Dickens. The titles of the novels and the corresponding versions of audiobooks are summarized in Table 1.

Charles Dickens's works used in the present study	Number of corresponding versions of audiobooks and the readers' initials	Charles Dickens's works used in the present study	Number of corresponding versions of audiobooks and the readers' initials
1. American Notes for General Circulation	1 (collab)	15. Oliver Twist	3 (T.H., A.P., A.V., collab)
2. A Child's History of England	1 (collab)	16. Our Mutual Friend	3 (M.N, D.J., collab)
3. A Christmas Carol	7 (B.F., G.H., K.M., M.B. C.O., L.B., collab)	17. The Battle of Life	1 (M.S.)
4. A House to Let	1 (R.G.)	18. The Chimes	1 (R.G.)
5. A Tale of Two Cities	3 (P.A., B.F., collab)	19. The Cricket on the Hearth	2 (R.G., collab)
6. Barnaby Rudge	2 (M.N., D.L.)	20. The Haunted Man and the Ghost's Bargain	2 (R.G., R.F.)

Charles Dickens's works used in the present study	Number of corresponding versions of audiobooks and the readers' initials	Charles Dickens's works used in the present study	Number of corresponding versions of audiobooks and the readers' initials
7. Bleak House	2 (M.N., C.L.)	21. The Life and Adventures of Nicholas Nickleby	2 (M.N., collab)
8. David Copperfield	2 (T.H., collab)	22. The Mystery of Edwin Drood	1 (A.C.)
9. Dombey and Son	2 (M.N., C.L.)	23. The Old Curiosity Shop	2 (M.N., E.)
10. Great Expectations	2 (M.S., P.K.)	24. The Pickwick Papers	2 (D.L., collab)
11. Hard Times	2 (collab, collab)	25. The Seven Poor Travellers	1 (R.G.)
12. Life and Adventures of Martin Chuzzlewit	2 (D.L., P.K.)	26. The Uncommercial Traveller	1 (collab)
13. Little Dorrit	2 (E.C., M.N.)	27. The Wreck of Golden Mary	1 (J.C.)
14. No Thoroughfare	1 (A.C.)	28. Three Ghost Stories	1 (collab)

**Table 1.** Charles Dickens's works and the number of corresponding audiobooks used in the present study.

Because of the restrictions imposed on the way that examples were selected, no more than 20 appropriate extracts for each of the two emotions under analysis were found (see Appendix 1). The examples were analysed with non-parametric methods because tests for normality indicated that at least in one case a sample may not come from a normal distribution. Namely, the result for the distribution of the 20 numbers summarising mean F0 in extracts involving the emotion of “happiness” indicated a high Anderson-Darling goodness-of-fit score (0.821) and small p-value (0.028). Therefore, the null hypothesis that this particular data set follows normal distribution could be rejected and it was safer to apply non-parametric statistical methods.

The results of the sing test for the initial samples based on Charles Dickens's works are summarized in Table 2. The comparison of the readers' median F0 (146.96 Hz) and the median F0 in extracts involving the emotional category of “happiness” (169.87 Hz) reveals a difference which is statistically relevant ( $p = 0.0026$ ). Such a result confirms the assumption that readers would raise the pitch of their voice when they read fragments which are meant to sound happy. A similar tendency to increase the standard deviation of the pitch has also been confirmed, but this time the corresponding p-value of 0.0414 is only slightly below the  $\alpha$  level of 0.05 and interpretation of this result should be made cautiously. Additionally, the results of the sing test for the median readers' F0 versus the median F0 in extracts involving “sadness” are even more inconclusive. The predicted

tendency to lower the pitch of one's voice seems to be weak (median = 4.63 Hz) and cannot be treated as statistically relevant ( $p = 0.1153$ ).

Because of such problems, the Wilcoxon signed rank test was additionally performed (cf. Table 3). It is considered to be more powerful than the sign test at detecting real differences in the median because it takes into account the magnitude of the observed differences in each pair. The results of the Wilcoxon signed rank test are, however, even more difficult to interpret than in the previous case. While the  $p$ -values for the difference between the median readers' F0 and F0 in extracts involving the semantic category of "happiness" (0.002) and also the difference between the median readers' standard deviation of F0 and the standard deviation of F0 in extracts which are meant to sound "sad" (0.004) are convincingly below the  $\alpha$  level of 0.05, in the other two cases the differences cannot be treated as statistically significant. Indeed, this time the probability of the differences to be coincidental is even higher than in the two corresponding results for the signed test.

It is worth adding that if parametric methods were used instead, the results for the problematic cases of the mean readers' standard deviation of F0 versus the mean standard deviation of F0 in extracts involving "happiness" and the mean readers' F0 versus the mean F0 in extracts involving "sadness" would still be insignificant ( $p = 0.161$  and  $p = 0.517$ , respectively).

Sing test for median readers' F0 versus median F0 in extracts involving "happiness"					
Sample Size	Below	Equal	Above	Median	P-value
20	17	0	3	-23.38	0.0026
Sing test for median readers' standard deviation of F0 versus median standard deviation of F0 in extracts involving "happiness"					
Sample Size	Below	Equal	Above	Median	P-value
20	15	0	5	-6.19	0.0414
Sing test for median readers' F0 versus median F0 in extracts involving "sadness"					
Sample Size	Below	Equal	Above	Median	P-value
20	6	0	14	4.63	0.1153
Sing test for median readers' standard deviation of F0 versus median standard deviation of F0 in extracts involving "sadness"					
Sample Size	Below	Equal	Above	Median	P-value
20	3	0	17	7.755	0.0026

**Table 2.** Sing test performed on the initial data based on audiobooks of Charles Dickens's works.



Wilcoxon signed rank test for median readers' F0 versus median F0 in extracts involving "happiness"			
Sample Size	Wilcoxon Statistic	Estimated Median	P-value
20	21	-27.53	0.002
Wilcoxon signed rank test for median readers' standard deviation of F0 versus median standard deviation of F0 in extracts involving "happiness"			
Sample Size	Wilcoxon Statistic	Estimated Median	P-value
20	61	-6.18	0.104
Wilcoxon signed rank test for median readers' F0 versus median F0 in extracts involving "sadness"			
Sample Size	Wilcoxon Statistic	Estimated Median	P-value
20	141	6.258	0.185
Wilcoxon signed rank test for median readers' standard deviation of F0 versus median standard deviation of F0 in extracts involving "sadness"			
Sample Size	Wilcoxon Statistic	Estimated Median	P-value
20	182	10.44	0.004

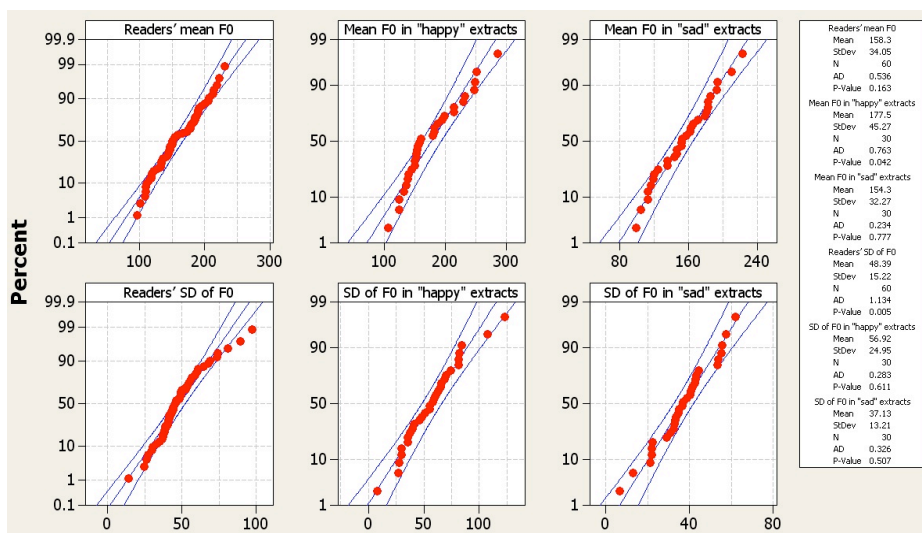
**Table 3.** Wilcoxon signed rank test performed on the initial data based on audiobooks of Charles Dickens's works.

One of the most obvious solutions to the problem was to increase the sample sizes. As described in Section 3, this was done with a selection of random novels by various nineteenth century writers. Ultimately, for each of the two semantic categories under analysis an additional ten examples were found. The acoustic measurements obtained on the basis of these new examples are summarised in Appendix B.

All in all, the final samples included 30 extracts for each of the two emotion categories under study. The examples involving the emotion of happiness are read by 18 men and 12 women. 17 of the readers are native speakers of American English, 12 are native speakers of British English and 1 is a speaker of Irish English. Similarly, the examples involving the semantic category of “sadness” are read by 17 men and 13 women, out of whom 17 use American English, 12 British English and 1 Irish English.

Again, the distribution of all of the data sets with the additional examples was examined for normality. Figure 1 contains a set of probability plots for each data set: the readers' mean F0, the mean F0 in extracts involving “happiness”, the mean F0 in extracts involving “sadness”, the readers' standard deviation of F0, the standard deviation of F0 in extracts involving “happiness” and the standard deviation of F0 in extracts involving “sadness”. A quick look at the graphs reveals that in most cases the sample data follow normal distribution quite well. Most of the plotted points form a fairly straight line and they are close to the fitted distribution line. Still, in the case of the readers' standard deviation of F0 (the graph in the lower left-hand corner of Figure 1) it is visible that the

normality condition is not satisfied. This observation is also confirmed in the quantitative summary provided to the right of the graphs. The summary contains information on the mean, the standard deviation and the size of each data set. Moreover, it shows the Anderson-Darling goodness-of-fit statistics and associated p-values. The p-value for the readers' standard deviation of F0 is substantially below the  $\alpha$  level of 0.05 and, consequently, the null hypothesis that the data follow normal distribution may be rejected. Another problematic case is the data set which includes the results for the mean F0 in extracts involving the emotion of "happiness". This time the p-value is not as small as in the previous case, but it is still below the commonly accepted  $\alpha$  level of 0.05 ( $p = 0.042$ ).



**Figure 1.** Probability plots for the samples containing the additional examples.

The results above indicate that non-parametric methods are also preferable in the samples containing the additional examples. Accordingly, the first step was to use the sing test (cf. Table 3). As in the formerly analysed samples of 20 pairs, the results consistently indicate that the difference of -11.37 Hz for the median readers' F0 versus the median F0 in extracts involving the emotion of "happiness" and also the difference of 7.585 Hz for the median readers' standard deviation of F0 versus the median standard deviation of F0 in extracts involving "sadness" are statistically significant ( $p = 0.0052$  in both cases). What is more, the result of the test is also statistically meaningful as regards the difference between the median readers' standard deviation of F0 versus the median standard deviation of F0 in extracts involving "happiness" ( $p = 0.0161$ ). Expanding the size of the samples helped to substantiate the assumption that the readers tend to increase the variability of pitch in fragments which are meant to sound happy.

The results of the sing test are still inconclusive as to the predicted decrease in pitch level in extracts involving the emotion of "sadness". The observed difference between

the F0 in such fragments and the median speakers' F0 is statistically insignificant ( $p = 0.0987$ ). Under these circumstances, the Wilcoxon signed rank test, which is a more accurate statistical method, was used again. The results of the test are summarised in Table 4. This time all the expected differences have been statistically validated. The p-value for the troubling case of the median readers' F0 versus the median F0 in extracts involving the emotion of “sadness” equals 0.048, which is just below the accepted  $\alpha$  level.

## 5. Final conclusion

The experiment described in this paper has confirmed all the predicted changes of F0 and the standard deviation of F0 in the contexts of the two basic emotions. The readers tend to signal the notions of “happiness” and “sadness” in a way which is in agreement with many earlier studies on the vocal expression of emotions and it is particularly consistent in the case of “happiness”. The readers are likely to raise F0 while reading passages which are meant to sound “happy” and this observation was statistically significant even in the first sing test conducted on the sample of only 20 pairs. The other hypothesis tendency that F0 variability should be increased in fragments which are supposed to sound “happy” was evident as well. The results were only not statistically relevant in the case of the Wilcoxon signed rank test conducted on the smaller sample discussed in the first part of Section 4. In all other instances the tendency was statistically confirmed.

The results for the emotional category of “sadness”, however, indicate that the two acoustic parameters under analysis may be utilised in reading prose to varying degrees. On the one hand, the prediction that the variability in F0 would be reduced in passages expressing “sadness” has been amply confirmed. The difference between the readers' median standard deviation of F0 and the median standard deviation of F0 in extracts which are “sad” amounts to over 7.5 Hz, which constitutes over 17% in comparison to the reader's median of 42.8 Hz (for the second sample which includes 30 pairs) or 44.42 Hz (for the first sample which includes 20 pairs). In all the tests conducted in the present study this difference is statistically significant. On the other hand, however, the assumption that the readers would lower the pitch of their voice while reading “sad” fragments was much more difficult to prove. The initial sample based on audiobooks of Charles Dickens's works was too small in this case. The p-values in both the sing test (see Table 2) and the Wilcoxon signed rank test (see Table 3) were clearly above the  $\alpha$  level of 0.05. A similar result was obtained in the sing test performed on the second sample with the additional 10 pairs (see Table 4). The tendency was confirmed only in the last test summarised in Table 5. This time the p-value was slightly lower than the accepted  $\alpha$  level (0.048) and the result may be treated as marginally significant. Still, it should be underlined that the very difference between the median readers' F0 and the median F0 in extracts involving “sadness” is, relatively speaking, much smaller than the difference between the median readers' standard deviation of F0 and the standard deviation of F0 in extracts involving “sadness”. In percentage terms, in the former case the shift amounts to about 3%, while in the latter to over 17%. This leads to the

conclusion that in audiobooks “sadness” is signally primarily by a decrease in F0 variability and the lowering of F0 is only an additional aspect.

Sing test for median readers' F0 versus median F0 in extracts involving "happiness"					
Sample Size	Below	Equal	Above	Median	P-value
30	23	0	7	-11.37	0.0052
Sing test for median readers' standard deviation of F0 versus median standard deviation of F0 in extracts involving "happiness"					
Sample Size	Below	Equal	Above	Median	P-value
30	22	0	8	-6.19	0.0161
Sing test for median readers' F0 versus median F0 in extracts involving "sadness"					
Sample Size	Below	Equal	Above	Median	P-value
30	10	0	20	4.63	0.0987
Sing test for median readers' standard deviation of F0 versus median standard deviation of F0 in extracts involving "sadness"					
Sample Size	Below	Equal	Above	Median	P-value
30	7	0	23	7.585	0.0052

**Table 4.** Sing test performed on the data with additional ten examples for each of the two semantic categories.

Wilcoxon signed rank test for median readers' F0 versus median F0 in extracts involving "happiness"			
Sample Size	Wilcoxon Statistic	Estimated Median	P-value
30	65	-18.63	0.001
Wilcoxon signed rank test for median readers' standard deviation of F0 versus median standard deviation of F0 in extracts involving "happiness"			
Sample Size	Wilcoxon Statistic	Estimated Median	P-value
30	127	-6.17	0.031
Wilcoxon signed rank test for median readers' F0 versus median F0 in extracts involving "sadness"			
Sample Size	Wilcoxon Statistic	Estimated Median	P-value
30	329	7.675	0.048
Wilcoxon signed rank test for median readers' standard deviation of F0 versus median standard deviation of F0 in extracts involving "sadness"			
Sample Size	Wilcoxon Statistic	Estimated Median	P-value
30	378	8.48	0.003

**Table 5.** Wilcoxon signed rank test performed on the data with additional ten examples for each of the two semantic categories.

A possible future research project could focus on the ways in which other acoustic features, such as tempo, intensity, pausing structure or voice quality, are related to the expression of the two basic emotions of “happiness” and “sadness” in reading aloud. Moreover, it would be interesting to investigate additional contextual aspects which may influence the way in which the emotions are signalled. For example, it is not clear whether the immediate lexical context, which constitutes the basis of the experiment described in the current paper, is really more consequential than the general situational context in which a given dialogue takes place. The relative level of influence of these two factors on the way in which the reader signals emotions by acoustic cues could be tested empirically. For instance, many of the examples summarised in Appendix A and B include fragments of a given character’s dialogue which precede the adverbs directly signalling one of the two emotions. These “preceding fragments” of the dialogues could be measured in the same way as the extracts which follow the adverbs. The new measurements could be compared to the results obtained from the fragments following the adverbs and the relative influence of the two contexts on the reader’s interpretation of emotional content could be compared directly.

It would also be useful to determine whether there is a possible interaction between the way in which emotions such as “happiness” and “sadness” are signalled acoustically in audiobooks and the manner in which the reader adjusts his/her voice to a given character’s gender. It is easily predictable that whenever a dialogue involves a man, his part may be read with a relatively lower F0 and smaller F0 variability than in the case of a part uttered by a woman. This important factor should not affect the results of the

current study because in both of the analysed contexts, that is in “happy” and “sad” excerpts, the number of male and female characters (27 male and 3 female) is identical. Nevertheless, investigating this aspect in future projects is crucial since it undoubtedly plays a significant role in the reader’s voice pitch modulation and its interaction with the vocal expression of emotions is hard to predict.

## References:

- Alter, K., Rank, E., Kotz, S. A., Pfeifer, E., Besson, M., Friederici, A. D., & Matiassek, J. (1999). On the relations of semantic and acoustic properties of emotions. In Proceedings of the XIVth International Congress of Phonetic Sciences, San Francisco: 2121–2124.
- Anthony, L. (2014). AntConc (version 3.4.3w) [Computer Software]. Tokyo: Waseda University. Retrieved from <http://www.antlab.sci.waseda.ac.jp/>.
- Averill, J. R. (2009). Constructivism (psychological perspectives). In D. Sander & K. R. Scherer (Eds.), *Oxford Companion to Emotion and the Affective Sciences* (pp 98-99). New York, NY: Oxford University Press.
- Banse, R., & Scherer, K. R. (1996). Acoustic profiles in vocal emotion expression. *Journal of Personality and Social Psychology*, 70, 614-636.
- Barrett, L. F. (2006). Are emotions natural kinds? *Perspectives on Psychological Science*, 1, 28–58.
- Bergmann, G., Goldbeck T., & Scherer, K. R. (1988). Emotionale Eindruckswirkung von prosodischen Sprechmerkmalen. *Zeitschrift für Experimentelle und Angewandte Psychologie*, 35, 167-200.
- Bezooijen, R. V. (1984). *The Characteristics and Recognizability of Vocal Expression of Emotion*. Dordrecht, Holland: Foris Publications.
- Boersma, P., & Weenink, D. (2014). *Praat: Doing Phonetics by Computer* (version 5.4.01) [Computer software]. Retrieved from <http://www.praat.org/>.
- Boves, L. (1984). *The Phonetic Basis of Perceptual Ratings of Running Speech*. Dordrecht, Holland: Foris Publications.
- Breitenstein C., van Lancker, D., & Daum, I. (2001). The contribution of speech rate and pitch variation to the perception of vocal emotions in a German and an American sample. *Cognition and Emotion*, 15(1), 57-79.
- Cahn, J. (1990a). The generation of affect in synthesized speech. *Journal of the American Voice I/O Society*, 8, 1-19.
- Cahn, J. (1990b). *Generating expression in synthesized speech. Technical report*. Boston: MIT Media Laboratory Technical Report.
- Carlson, R. B., Granström, B., & Nord, L. (1992). Experiments with emotive speech: acted utterances and synthesized replicas. *Proceedings ICSLP 92*, Banff, Alberta, Canada 1, 671-674.
- Coleman, R. K., & Williams, R. (1979). Identification of emotional states using perceptual and acoustic analyses. In V. Lawrence & B. Weinberg (Eds.), *Transcript of the Eighth Symposium: Care of the Professional Voice (Part I)*. New York: The Voice Foundation.
- Cosmides, L. (1983). Invariances in the acoustic expression of emotion during speech. *Journal of Experimental Psychology: Human Perception and Performance*, 9, 864-881.
- Cummings, K. E., & Clements, M. A. (1995). Analysis of the glottal excitation of emotionally styled and stressed speech. *Journal of the Acoustical Society of America*, 98, 88–98.
- Darwin, C. (1872). *The Expression of Emotions in Man and Animals*. London: John Murray.

- Davitz, J. R. (1964). *The Communication of Emotional Meaning*. New York: McGraw-Hill.
- Ekman, P. (1982). *Emotion in the Human Face*. Cambridge, New York: Cambridge University Press.
- Ekman, P. (1999). Basic emotions. In T. Dalgleish & M. Power (Eds.), *Handbook of Cognition and Emotion* (pp 45–60). Sussex, UK: John Wiley & Sons.
- Eldred, S. H., & Price, D. B. (1958). A linguistic evaluation of feeling states in psychotherapy. *Psychiatry*, 21, 115-121.
- Fairbanks, G., & Hoaglin, L. W. (1941). An experimental study of the pitch characteristics of the voice during the expression of emotion. *Speech Monographs*, 6, 85-90.
- Fairbanks, G., & Provost, W. (1939). An experimental study of the pitch characteristics of the voice during the expression of emotion. *Speech Monographs*, 6, 87-104.
- Frijda, N. H. (1986). *The Emotions*. Cambridge: Cambridge University Press.
- Fonagy, I. (1978). A new method of investigating the perception of prosodic features. *Language and Speech*, 21, 34-49.
- Gobl, C., & Ni Chasaide, A. (2003). The role of voice quality in communicating emotion, mood and attitude. *Speech Communication*, 40, 189-212.
- Hargreaves, W. A., Starkweather J. A., & Blacker, K. H. (1965). Voice quality in depression. *Journal of Abnormal Psychology*, 70, 218-220.
- Havrdova, Z., & Moravek, M. (1979). Changes of the voice expression during suggestively influenced states of experiencing. *Activitas Nervosa Superior*, 21, 33-35.
- Huttar, G. L. (1968). Relations between prosodic variables and emotions in normal American English utterances. *Journal of Speech and Hearing Research*, 11, 481-487.
- House, D. (1990). *Tonal Perception in Speech*. Lund: Lund University Press.
- Izard, C. E. (1977). *Human Emotions*. New York: Plenum Press.
- Johnstone, T., & Scherer, K. R. (1999). The effects of emotions on voice quality. In *Proceedings of the XIVth International Congress of Phonetic Sciences* (pp 2029–2032). San Francisco.
- Kaiser, L. (1962). Communication of affects by single vowels. *Synthese*, 14, 300-319.
- Kotlyar, G. M., & Morozov, V. P. (1976). Acoustical correlates of the emotional content of vocalized speech. *Journal of Acoustics of the Academy of Sciences of the USSR*, 22, 208-211.
- Kuroda, I., Fujiwara, O., Okamura N., & Utsuki, N. (1976). Method for determining pilot stress through analysis of voice communication. *Aviation, Space, and Environmental Medicine*, 47, 528-533.
- Ladd, D. R., Silverman, K., Talkmitt, F., Bergmann, G., & Scherer, K. R. (1985). Evidence for the independent function of intonation contour type, voice quality, and F0 range in signalling speaker affect. *Journal of the Acoustical Society of America*, 78, 435-444.
- Laukkanen, A. M., Vilkmann, E., Alku, P., & Oksanen, H. (1996). Physical variation related to stress and emotionally state: a preliminary study. *Journal of Phonetics*, 24, 313-335.
- Lieberman, P., & Michaels, S. B. (1962). Some aspects of fundamental frequency and envelope amplitude as related to the emotional content of speech. *Journal of the Acoustical Society of America*, 34, 922-927.



- Markel, N. N., Bern M. F., & Phillis, J. A. (1973). The relationship between words and tone-of-voice. *Language and Speech*, 16, 15-21.
- Mason, W. A. (2012). Basic emotions: a reconstruction. *Emotion Review*, 4, 238-244.
- Minitab 16 Statistical Software. (2010). [Computer software]. State College, PA: Minitab, Inc. Available from <http://www.minitab.com/>.
- McRoberts, G. W., Studdert-Kennedy, M., & Shankweiler, D. P. (1995). The role of fundamental frequency in signaling linguistic stress and affect: evidence for a dissociation. *Perception and Psychophysics*, 57, 159-174.
- Mozziconacci, S. (1998). *Speech Variability and Emotion: Production and Perception*. Eindhoven: Technische Universiteit Eindhoven.
- Murray, I. R., & Arnott, J. L. (1993). Towards the simulation of emotion in synthetic speech: a review of the literature on human vocal emotion. *Journal of the Acoustical Society of America*, 93, 1097–1108.
- Murray, I. R., & Arnott, J. L. (1995). Implementation and testing of a system for producing emotion-by-rule in synthetic speech. *Speech Communication*, 16, 369–390.
- Nesse R. M. (1990). Evolutionary explanations of emotions. *Human Nature*, 1, 261-289.
- Nesse, R. M., & Ellsworth, P. C. (2009). Evolution, emotions, and emotional disorders. *American Psychologist*, 6, 129–139.
- Ortony, A., & Turner, T. J. (1990). What’s basic about basic emotions? *Psychological Review*, 97, 315–331.
- Pell, M. (1999). Fundamental frequency encoding of linguistic and emotional prosody by right hemisphere-damaged speakers. *Brain and Language*, 69, 161–192.
- Plutchik, R. (1980). *Emotion: a Psychoevolutionary Synthesis*. New York: Harper & Row.
- Plutchik, R. (2001). The nature of emotions. *American Scientist*, 89, 344-350.
- Protopapas, A., & Lieberman, P. (1997). Fundamental frequency of phonation and perceived emotional stress. *Journal of the Acoustical Society of America*, 101, 2267–2277.
- Roessler, R., & Lester, J. W. (1976). Voice predicts affect during psychotherapy. *Journal of Nervous and Mental Disease*, 163, 166-176.
- Scherer, K. R. (1979). Personality markers in speech. In K. R. Scherer & H. Giles (Eds.), *Social Markers in Speech* (pp. 147-209). Cambridge, UK: Cambridge University Press.
- Scherer, K. R. (1982). Methods of research on vocal communication: paradigms and parameters. In K. R. Scherer & P. Ekman (Eds.), *Handbook of Methods in Nonverbal Behavior Research* (pp. 136– 198). Cambridge, UK: Cambridge University Press.
- Scherer, K. R. (1986). Vocal affect expression: a review and a model for future research. *Psychological Bulletin*, 99, 143-165.
- Scherer, K. R. (1995). Expression of emotion in voice and music. *Journal of Voice*, 9, 235–248.
- Scherer, K. R., & Oshinsky, J. S. (1977). Cue utilization in emotion attribution from auditory stimuli. *Motivation and Emotion*, 4, 331–346.
- Scherer, K. R., Wallbott, H. G., Tolkmitt, F. J., & Bergmann, G. (1985). *Die Stressreaktion: Physiologie und Verhalten*. Gottingen, West Germany: Hogrefe.

- Siegmán, A. W. (1978). The telltale voice: nonverbal messages of verbal communication. In A. W. Siegmán & S. Feldstein (Eds.), *Nonverbal Behavior and Communication* (pp. 183-243). Hillsdale, NJ: Erlbaum.
- Skinner, E. R. (1935). A calibrated recording and analysis of the pitch, force and quality of vocal tones expressing happiness and sadness. *Speech Monographs*, 2, 81-137.
- Tooby, J., & Cosmides, L. (1990). The past explains the present. Emotional adaptations and the structure of ancestral environments. *Ethology and Sociobiology*, 11, 375-424.
- Utsuki, N. & Okamura, N. (1976). Relationship between emotional state and fundamental frequency of speech. *Japanese Air Self Defense Force, Report of the Aeromedical Laboratory*, 16, 179-188.
- Williams, C. E., & Stevens, K. N. (1969). On determining the emotional state of pilots during flight: an exploratory study. *Aerospace Medicine*, 40, 1369-1372.
- Williams, C. E., & Stevens, K. N. (1972). Emotions and speech: some acoustical factors. *Journal of the Acoustical Society of America*, 52, 1238-1250.

## Appendix A

Emotional Word	Source	Context (the part which has been analyzed is underlined>	Reader's Initials	Reader's Gender (1-male, 2-female)	Reader's Dialect (1-AmE, 2-Brit, 3-IrishE)	Reader's mean F0 in Hz	Reader's SD of F0 in Hz	Mean F0 in the extract in Hz	SD of F0 in the extract in Hz	Difference between reader's mean F0 and F0 in the extract in Hz	Difference between reader's SD of F0 and SD of F0 in the extract in Hz
joyfully	<i>David Copperfield</i> , Chapter 35	"Agnes!" I joyfully exclaimed "Oh, my dear Agnes, of all people in the world, what a pleasure to see you!"	T. I.	1	3	133.3	44.24	187.58	62.75	-54.28	-18.51
joyfully	<i>David Copperfield</i> , Chapter 35	"Agnes!" I joyfully exclaimed "Oh, my dear Agnes, of all people in the world, what a pleasure to see you!"	D. L.	2	1	190.47	54.21	251.4	39.8	-60.93	14.41
joyfully	<i>Dombey and Son</i> , Chapter 30	"Mama!" cried Florence, joyfully meeting her. "Come again!"	C. L.	2	1	212.99	61.36	285.67	83.83	-72.68	-22.47
joyfully	<i>Our Mutual Friend</i> , Book 3, Chapter 16	"Mr Wilfer," said John Rokesmith, excitedly and joyfully, "Bella takes me, though I have no fortune, even no present occupation, nothing but what I can get in the life before us... Bella takes me!"	M. N.	2	2	184.43	64.95	157.48	35.02	26.95	29.93
joyfully	<i>Our Mutual Friend</i> , Book 3, Chapter 16	"Mr Wilfer," said John Rokesmith, excitedly and joyfully, "Bella takes me, though I have no fortune, even no present occupation, nothing but what I can get in the life before us... Bella takes me!"	A. C.	1	2	147.11	53.69	138.15	27.1	8.96	26.59
joyfully	<i>Our Mutual Friend</i> , Book 3, Chapter 16	"Mr Wilfer," said John Rokesmith, excitedly and joyfully, "Bella takes me, though I have no fortune, even no present occupation, nothing but what I can get in the life before us... Bella takes me!"	D. J.	1	1	150.09	36.88	150.13	29.91	-0.04	6.97
cheerfully	<i>Great Expectations</i> , Chapter 53	"When it turns at nine o'clock," said Herbert, cheerfully, "look out for us, and stand ready, you over there at Mill Pond Bank!"	M. S.	1	1	110.68	54.91	136.01	65.78	-25.33	-10.87
cheerfully	<i>Life and Adventures of Martin Chuzzlewit</i> , Chapter 5	"When I say nothing," observed Mr Pinch, cheerfully, "I am wrong, and don't say what I mean, because I get a great deal of pleasure from it, and the means of passing some of the happiest hours I know. It led to something else the other day, but you will not care to hear about that I dare say?"	P. K.	1	2	136.09	35.14	140.15	35.33	-4.06	-0.19
cheerfully	<i>Little Dorrit</i> , Chapter 2, Chapter 28	"I still look round, from time to time, sir," said Mr Rugg, cheerfully, "to see whether any lingering Destinies are accumulating at the gate. They have fallen in pretty thick, sir, as thick as we could have expected."	E. C.	1	2	146.15	49.23	152.34	54.9	-6.19	-5.67
cheerfully	<i>The Chimes</i> , Chapter 1	"He'd eat his dinner with an appetite, whoever he was, if it smelt like this," said Meg, cheerfully. "Make haste, for there's a hot potato besides, and half a pint of fresh-drawn beer in a bottle. Where will you dine, father? On the Post, or on the Steps? Dear, dear, how grand we are. Two places to choose from!"	R. G.	2	2	185.09	74.31	248.35	81.02	-63.26	-6.71
cheerfully	<i>The Life and Adventures of Nicholas Nickleby</i> , Chapter 35	"You are a foolish, silly creature," said Nicholas cheerfully. "If that is what you mean, I grant you that. Why, here's a dismal face for ladies' company!—my pretty sister too, whom you have so often asked me about. Is this your Yorkshire gallantry? For shame! for shame!"	A. S.	2	1	205.71	49.51	213.94	54.9	-8.23	-5.39
cheerfully	<i>The Old Curiosity Shop</i> , Chapter 54	"Nell here?" he said cheerfully, as he closed his book. "It does me good to see you in the air and light. I feared you were again in the church, where you so often are."	E. I.	2	2	152.84	46.48	152.73	47.95	0.11	-1.47
cheerfully	<i>The Pickwick Papers</i> , Chapter 54	"She is right on one point at all events," said the old gentleman cheerfully. "Fine for the wage!"	P. B.	2	1	222.72	73.98	247.58	123.13	-24.86	-49.15
cheerfully	<i>The Uncommercial Traveller</i> , Chapter 8	"He is a careful fellow this, you must know," said the Doctor, cheerfully. "I was raining hard when they put him in the open cart to bring him here, and he had the presence of mind to ask to have a sovereign taken out of his pocket that he had there, and a cab engaged. Probably it saved his life."	W. T.	1	1	140.78	49.56	150.4	70.15	-9.62	-20.59
gaily	<i>A Christmas Carol</i> , Stave 1	"Come, then," returned the nephew gaily. "What right have you to be dismal? What reason have you to be morose? You're rich enough."	C. O.	1	1	117.01	32.83	124.2	27.55	-7.19	5.28
gaily	<i>A Christmas Carol</i> , Stave 1	"Come, then," returned the nephew gaily. "What right have you to be dismal? What reason have you to be morose? You're rich enough."	L. B.	2	1	177.51	60.68	229.71	68.23	-52.2	-7.55
gaily	<i>A Christmas Carol</i> , Stave 1	"Come, then," returned the nephew gaily. "What right have you to be dismal? What reason have you to be morose? You're rich enough."	B. F.	1	2	146.8	46.11	195.2	64.71	-48.4	-18.6
gaily	<i>A Christmas Carol</i> , Stave 1	"Come, then," returned the nephew gaily. "What right have you to be dismal? What reason have you to be morose? You're rich enough."	G. H.	1	2	134.75	81.02	182.48	81.44	-47.73	-0.42
gaily	<i>A Christmas Carol</i> , Stave 1	"Come, then," returned the nephew gaily. "What right have you to be dismal? What reason have you to be morose? You're rich enough."	K. M.	1	2	117.33	41.05	182.26	51.03	-64.93	-9.98
gaily	<i>A Christmas Carol</i> , Stave 1	"Come, then," returned the nephew gaily. "What right have you to be dismal? What reason have you to be morose? You're rich enough."	M. B.	1	1	131.86	59.5	153.76	82.19	-21.9	-22.69

The examples which include the emotion of “happiness” taken from Charles Dickens’s works

Emotional Word	Source	Context (the part which has been analyzed is underlined)	Reader's Initials	Reader's Gender (1-male, 2-female)	Reader's Dialect (1-AmE, 2-BritE, 3-IrishE)	Reader's mean F0 in Hz	Reader's SD of F0 in Hz	Mean F0 in the extract in Hz	SD of F0 in the extract in Hz	Difference between reader's mean F0 and SD of F0 in the extract in Hz	Difference between reader's SD of F0 and SD of F0 in the extract in Hz
despondently	<i>Our Mutual Friend</i> , Chapter 7	Having so held and waved the candle as that all these heterogeneous objects seemed to come forward obediently when they were named, and then retire again, Mr Venus despondently repeats, "Oh dear me, dear me!"	D. J.	1	1	142.76	38.92	146.43	36.67	-3.67	2.25
despondently	<i>Our Mutual Friend</i> , Chapter 7	Having so held and waved the candle as that all these heterogeneous objects seemed to come forward obediently when they were named, and then retire again, Mr Venus despondently repeats, "Oh dear me, dear me!"	D. B.	1	2	108.64	40.39	113.08	32.49	-4.44	7.9
gloomily	<i>A Tale of Two Cities</i> , Second Book, Chapter 9	"We have so asserted our station, both in the old time and in the modern time also," said the nephew, gloomily, "that I believe our name to be more detested than any name in France."	P. A.	1	2	158.17	59.19	163.04	21.14	-4.87	38.05
gloomily	<i>A Tale of Two Cities</i> , Second Book, Chapter 9	"We have so asserted our station, both in the old time and in the modern time also," said the nephew, gloomily, "that I believe our name to be more detested than any name in France."	B. F.	1	2	151.06	41.29	171.48	38.94	-20.42	2.35
gloomily	<i>A Tale of Two Cities</i> , Second Book, Chapter 9	"We have so asserted our station, both in the old time and in the modern time also," said the nephew, gloomily, "that I believe our name to be more detested than any name in France."	N.	2	1	196.4	45.94	193.3	43.31	3.1	2.63
gloomily	<i>Bleak House</i> , Chapter 51	He took a few turns up and down and sunk upon the sofa. "I get," he repeated gloomily, "so tired. It is such weary, weary work!"	M. N.	2	2	184.8	49.72	157.56	55.1	27.24	-5.38
gloomily	<i>Bleak House</i> , Chapter 51	He took a few turns up and down and sunk upon the sofa. "I get," he repeated gloomily, "so tired. It is such weary, weary work!"	C. L.	2	1	200.58	55.94	185.56	33.44	15.02	22.5
gloomily	<i>Little Dorrit</i> , Book 2, Chapter 28	"Without giving an unqualified assent to what you say," returned Arthur, gloomily, "I am much obliged to you for your interest in me."	E. C.	1	2	143.79	42.71	143.44	41.32	0.35	1.39
gloomily	<i>The Haunted Man and the Ghost's Bargain</i> , Chapter 2	"It is only since last night," he muttered gloomily, "that I have remained shut up, and yet all things are strange to me. I am strange to myself. I am here, as in a dream. What interest have I in this place, or in any place that I can bring to my remembrance? My mind is gone blind!"	R. G.	2	2	179.4	56.43	165.65	22.37	13.75	34.06
gloomily	<i>The Haunted Man and the Ghost's Bargain</i> , Chapter 2	"It is only since last night," he muttered gloomily, "that I have remained shut up, and yet all things are strange to me. I am strange to myself. I am here, as in a dream. What interest have I in this place, or in any place that I can bring to my remembrance? My mind is gone blind!"	R. F.	1	1	165.64	40.2	152.31	34.66	13.33	5.54
gloomily	<i>The Pickwick Papers</i> , Chapter 48	"I remember," said Mr. Allen gloomily, "Upon which we ate <u>it ourselves, in alternate bites.</u> "	S. E.	1	2	149.65	69.2	146.93	62.14	2.72	7.06
gloomily	<i>The Pickwick Papers</i> , Chapter 48	"I remember," said Mr. Allen gloomily, "Upon which we ate <u>it ourselves, in alternate bites.</u> "	D. L.	2	1	188.34	52.73	183.27	32.89	5.07	19.84
sadly	<i>No Thoroughfare</i> , Act 2	"O, Mr. Vendale," she said sadly, "it would have been kinder to have kept your secret. Have you forgotten the distance between us? - It can never, never be!"	A. C.	1	2	121.55	37.21	183.13	40.34	-61.58	-3.13
sadly	<i>Oliver Twist</i> , Chapter 46	"No, my love," replied Mr. Brownlow, looking sadly back. "She has not moved, and will not till we are gone."	T. H.	1	3	133.41	38.56	112.5	22.07	20.91	16.49
sadly	<i>Oliver Twist</i> , Chapter 46	"No, my love," replied Mr. Brownlow, looking sadly back. "She has not moved, and will not till we are gone."	R. D.	1	2	144.67	48.14	116.65	29.02	28.02	19.12
sadly	<i>Oliver Twist</i> , Chapter 46	"No, my love," replied Mr. Brownlow, looking sadly back. "She has not moved, and will not till we are gone."	A. P.	1	1	174.31	68.27	152.34	53.66	21.97	14.61
sorrowfully	<i>David Copperfield</i> , Chapter	"She is but so-so. And this," said Mr. Micawber, nodding his head sorrowfully, "is the Bench! Where, for the first time in many revolving years, the overwhelming pressure of pecuniary liabilities was not proclaimed, from day to day, by innumerable voices, declining to visit the passage, where there was no knocker on the door for any creditor to appear to, where personal service of process was not required, and detainers were merely lodged at the gate!"	V. B.	2	1	214.47	48.31	210.28	40.7	4.19	7.61
sorrowfully	<i>Life and Adventures of Martin Chuzzlewit</i> , Chapter 43	"A short interview after such an absence!" said Martin, sorrowfully. "But we are well out of the house. We might have placed ourselves in a false position by remaining there, even so long, Mark."	P. K.	1	2	148.5	42.89	124.34	31.11	24.16	11.78
sorrowfully	<i>The Life and Adventures of Nicholas Nickleby</i> , Chapter 22	"I don't know," said Smike, shaking his head sorrowfully. "I think I had once, but it's all gone now - all gone."	C. C.	1	2	101.22	27.23	135.33	55.53	-34.11	-28.3
sorrowfully	<i>The Old Curiosity Shop</i> , Chapter 25	"No," rejoined the schoolmaster shaking his head sorrowfully, "no better. They even say he is worse."	E. 1.	2	2	149.68	41.59	135.78	13.04	13.9	28.55

The examples which include the emotion of "sadness" taken from Charles Dickens's works

## Appendix B

Emotional Word	Source	Context (the part which has been analyzed is underlined>)	Reader's Initials	Reader's Gender (1= male, 2= female)	Reader's Dialect (1= AmE, 2= BrE, 3= IrishE)	Reader's mean F0 in Hz	Reader's SD of F0 in Hz	Mean F0 in the extract in Hz	SD of F0 in the extract in Hz	Difference between reader's mean F0 and F0 in the extract in Hz	Difference between reader's SD of F0 and SD of F0 in the extract in Hz
joyfully	Jules Verne. <i>Around the World in 80 Days</i> . Chapter 2.	Having scrutinised the house from top to bottom, he rubbed his hands, a broad smile overspread his features, and he said joyfully, " <u>This is just what I wanted! Ah, we shall get on together, Mr. Frog and I! What a domestic and regular gentleman! A real machine, well, I don't mind serving a machine.</u> "	A. F.	1	2	107.86	45.44	105.77	29.69	2.09	15.75
joyfully	Jules Verne. <i>Around the World in 80 Days</i> . Chapter 2.	Having scrutinised the house from top to bottom, he rubbed his hands, a broad smile overspread his features, and he said joyfully, " <u>This is just what I wanted! Ah, we shall get on together, Mr. Frog and I! What a domestic and regular gentleman! A real machine, well, I don't mind serving a machine.</u> "	D. H.	1	1	157.1	52.37	155.04	59.69	2.06	-7.32
joyfully	Jules Verne. <i>Around the World in 80 Days</i> . Chapter 2.	Having scrutinised the house from top to bottom, he rubbed his hands, a broad smile overspread his features, and he said joyfully, " <u>This is just what I wanted! Ah, we shall get on together, Mr. Frog and I! What a domestic and regular gentleman! A real machine, well, I don't mind serving a machine.</u> "	R. S.	1	1	109.1	24.59	124.46	37.2	-15.36	-12.61
joyfully	Jules Verne. <i>Around the World in 80 Days</i> . Chapter 2.	Having scrutinised the house from top to bottom, he rubbed his hands, a broad smile overspread his features, and he said joyfully, " <u>This is just what I wanted! Ah, we shall get on together, Mr. Frog and I! What a domestic and regular gentleman! A real machine, well, I don't mind serving a machine.</u> "	E. 2	2	1	178.36	30.16	213.52	58.05	-35.16	-27.89
cheerfully	James Fenimore Cooper. <i>The Pioneers, or The Sources of the Susquehanna</i> . Chapter 3.	As house, village, and valley burst on his sight, he exclaimed cheerfully to his daughter: " <u>See, Bess, there is thy resting-place for life! And think too, young man, if thou wilt consent to dwell with us.</u> "	G. S.	1	1	144.95	37.11	160.03	74.22	-15.08	-37.11
cheerily	Dinah Maria Mulock Craik. <i>John Halifax, Gentleman</i> . Chapter 3.	He pulled a wry face, though comical withal, and said, cheerily, " <u>Everybody must like what brings them their daily bread. It's a grand thing for me not to have been hungry for nearly three days.</u> "	C. S.	2	2	218.79	44.53	231.91	41.08	-13.12	3.45
cheerily	Jules Verne. <i>A Journey to the Interior of the Earth</i> . Chapter 29.	"Good morning, Axel!" he cried cheerily. " <u>I feel sure you are better.</u> "	K. M.	2	1	190.65	56.76	198.29	60.53	-7.64	-3.77
gaily	Jules Verne. <i>Dick Sand's Boy Captain</i> . Chapter 15.	"It will give me much pleasure," answered Harris, gaily; " <u>I will employ the interval in fetching my horse, who has breakfasted already.</u> "	A. T.	1	1	127.79	13.73	131.75	7.47	-3.96	6.26
gaily	Levs Carroll. <i>Sybil and Bruno</i> . Chapter 14.	"Don't wait too long!" I said gaily. " <u>Faint heart never won fair lady!</u> "	S. D.	1	2	154.34	97.7	144.84	107.28	9.5	-9.58
merrily	Louisa May Alcott. <i>Work: A story of experience</i> . Chapter 12.	She glanced at the title of the new gift, read "Heroes and Hero-worship," and answered merrily: " <u>No, sir, but I'm looking hard!</u> "	L. P.	2	1	188.01	44.34	179.92	45.65	8.09	-1.31

Additional 10 examples which include the emotion of “happiness” taken from various nineteenth century novels

Emotional Word	Source	Context (the part which has been analyzed is underlined)	Reader's Initials	Reader's Gender (1-male, 2-female)	Reader's Dialect (1-AmE, 2-Brit, 3-IrishE)	Reader's mean F0 in Hz	Reader's SD of F0 in Hz	Mean F0 in the extract in Hz	SD of F0 in the extract in Hz	Difference between reader's mean F0 and F0 in the extract in Hz	Difference between reader's SD of F0 and SD of F0 in the extract in Hz
gloomily	Anthony Trollope, <i>He Knew He Was Right</i> , Chapter 29	"It is very sad for me," said Trevelyan, gloomily--"very sad, indeed. My home is destroyed; my life is made solitary. I do not even see my own child. She has her boy with her, and her sister. I have nobody."	A. L.	2	1	230.82	49.09	223.12	44.5	7.7	-4.59
sadly	Henry Rider Haggard, <i>Colonel Quarrich</i> , Chapter 13	"The cant of the impressionist school," he said sadly, "on the contrary, the business of the artist is to paint what he knows, to be there."	E. 2	2	1	172.76	38.4	152.97	22.09	19.79	16.31
sadly	Thomas Hardy, <i>The Trumpet Major</i> , Chapter 9	Loveday imagined her tone that she must have an interest in Derriman, and said sadly, "You blame me for going across to the window and leading you to follow me."	J. F.	1	1	132.63	89.84	104.59	42.53	28.04	47.31
sadly	William Makepeace Thackeray, <i>Vanity Fair</i> , Chapter 54	"It may be so," Rawdon answered sadly, "but this don't look very innocent"	A.	2	1	177.54	43.29	162.45	34.96	15.09	8.33
sadly	Verne, Jules & Michael Verne, In the Year 2889, Chapter	"You decline! All is over then!" murmured the British agent sadly. "The United Kingdom falls to the share of the Americans, the Indies to that of--"	J. K.	1	1	119.33	26.13	119.78	6.5	-0.45	19.63
sadly	Verne, Jules, <i>The Field of Ice. Part II of the Adventures of Captain Hatteras</i> , Chapter 2	That would be little use, said Hatteras, sadly; "my opinion might appear interested; let me hear all yours first."	J. C.	1	1	95.35	38.69	99	53.42	-3.65	-14.73
sadly	William Wilkie Collins, <i>The Dead Alive</i> , Chapter 8	I went upstairs, and, knocking softly at her door, made my inquiries from outside. The clear young voice answered me sadly, "I am trying to bear it. I won't distress you when we meet again."	P. M.	2	1	190.96	41.08	193.85	42.76	-2.89	-1.68
sadly	Louisa May Alcott, <i>Work: A Story of Experience</i> , Chapter 15	David stood beside her silent, till the first irrepressible paroxysm was over; then, while she sat weeping softly, quite bowed down by emotion, he said, sadly now, not sternly: "You could not know, because we hid the truth so carefully. I have no right to resent that belief of yours, for I did wrong my poor, pretty, almost as much as that lover of hers, who, being dead, I do not curse. Let me tell you every thing, Christie, before I ask your respect and confidence again. I never deserved them, but I tried to, for they were very precious to me."	L. P.	2	1	181.1	41.33	179.38	57.42	1.72	-16.09
sadly	Mary Elizabeth Braddon, <i>Lady Audley's Secret</i> , Chapter 2	"I would give ten years of my own life if I could see him alive," answered Robert, sadly. "I am sorry for you, Mr. Mallon--I am sorry for all of us."	E. K.	2	1	207.04	44.32	181.5	36.76	25.54	7.56
sorrowfully	Jane Barlow, <i>Strangers at Lisconnel</i> , Chapter 3	"Deed was I," said Mrs. Kilroye, sorrowfully, "a fine fog. And vexed she'd be, real vexed! she guessed the way it was gone on us, for the dear knows what dirty, odd rascallions'll get the wearn' of it now. Rasc' vexed she'd be."	J. E. C.	1	1	113.9	29.87	119.31	33.04	-5.41	-3.17

Additional 10 examples which include the emotion of "sadness" taken from various nineteenth century novels