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The long-term average spectrum in forensic phonetics: From collation to discrimination of speakers

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Abstract

The present work aims to provide more data regarding the comparison and discrimination of speech samples in the field of forensic phonetics. The methodology used was an acoustic method called long-term average spectrum (LTAS), by calculating its spectral decline. The informants were grouped into a total of four female speakers of the same age by close geographical origins. The extracted data were presented qualitatively and quantitatively. In view of the results, the identification of speakers was not successful in all cases. After discussing the results, implications for judicial phonetics and recommendations for future studies were collected.

Keywords

forensic phonetics; identification; long-term average spectrum; alpha ratio; L_1–L_0 ratio

L'espectre mitjà a llarg termini en fonètica judicial: De l'acarament a la discriminació de locutors

RESUM

Aquest treball té per objectiu proporcionar més dades sobre la comparació i la discriminació de mostres de veu en el camp de la fonètica forense. La metodologia utilitzada consisteix en un mètode acústic anomenat espectre mitjà a llarg termini (LTAS), que parteix del càlcul de la seua declinació espectral. Els informants són quatre parlants femenines de la mateixa edat i amb origen geogràfic similars. Les dades extretes es presenten de manera qualitativa i quantitativa. A la vista dels resultats, les parlants no s'identificaren amb èxit en tots els casos. Després de discutir els resultats, es recopilen diverses implicacions per a la fonètica judicial i diferents recomanacions per a estudis futurs.

MOTS CLAU

fonètica forense; identificació; espectre mitjà a llarg termini; proporció alfa; proporció L_1–L_0

1. Introduction

The most recent studies in applied linguistics have tended to focus on offering a panorama of the role of language, in particular phonetics, in legal tasks and varied legal processes. In this sense, one of the endeavours of linguists has focused on trying to decipher the enigma of recognition, identification, or discrimination of speakers and their respective voice samples. It is for this reason that, although it is commonly held that a speaker can be recognised by their voice, even without being seen, it would imply that "each speaker's voice is personal, unique; as specific to each individual as their fingerprints or the structure of their iris" (Marrero, 2017, p. 11).

With such popular assertions, there is a tendency to assume a very risky concept: that of voice 'individuality'. Admittedly, to affirm this would necessarily imply a belief that the voice contains "some parameters which differentiate us from all other human beings; features which our ear perceives and stores as unique to each person we meet" (*Ibid.*). Consequently, those who maintain that there exists a vocal print which characterises each speaker tend to disregard the fact that the voice is much more inconsistent than is believed. One thing which is certain is that, regardless of this, it is possible to discern who the voice belongs to:

> However, the identification of these parameters is still a mystery to many researchers. Experimental phonetics shows, time and again, that two similar recordings are acoustically distinct, at times more so than those produced by a different speaker. However, the identification of the speaker continues… (Marrero, 2017, p. 12, our translation).

As a result, many authors have ventured to postulate more or less accurate voice identification methods from a single part of the phonic face or course, be it articulatory, perceptive, or acoustic. It goes without saying that this is not the claim of this study, rather the intention is to contribute to the investigative field as meaningfully as possible by using empirical, measurable data. It should be kept in mind that any data which can be submitted as "identifying" material before a jury must be interpreted as a whole and with caution, that is, by way of small contributions which permit, all together, the contribution of somewhat solid data regarding speaker recognition.

1.1. Background

Be that as it may, one problem which hinders the course of legal investigations arises too regularly: the clarity and purity of the evidence is usually poor. Additionally, in the majority of cases, the speaker under police instruction may not (and tends not to) produce "enough idiosyncratic features" (Hollien, 1990, p. 220). The dilemma faced by any forensic expert who works with the human voice is inter- and intraspeaker variation. As a legal ideal, the probabilities of finding inconsistent data (that is, variability) must necessarily be greater among different speakers (interspeaker) than for the same speaker in different instances (intraspeaker); however, this is often not the case. The reason for this is that there do not yet appear to be forensic "universals". On this topic, Hollien (1990, p. 190) comments:

> Chief among them [the problems], of course, is the fact that we simply do not know, as yet, if intraspeaker variability is always less than interspeaker variability—in all situations and under all conditions. Simply put, we are not at all sure that you will always produce speech that is more like your own than it is like anyone else's, no matter how you talk, no matter how you feel, no matter what the speaking conditions. I recognize that this dilemma constitutes a functional nightmare for anyone attempting speaker recognition. However, even if the speech of a particular person is not totally unique under all conditions, there may be ways of identifying differences among talkers anyway.

In any case, it seems that in recent years a new technique for phonetic analysis has become popular, one which provides higher levels of resistance to all

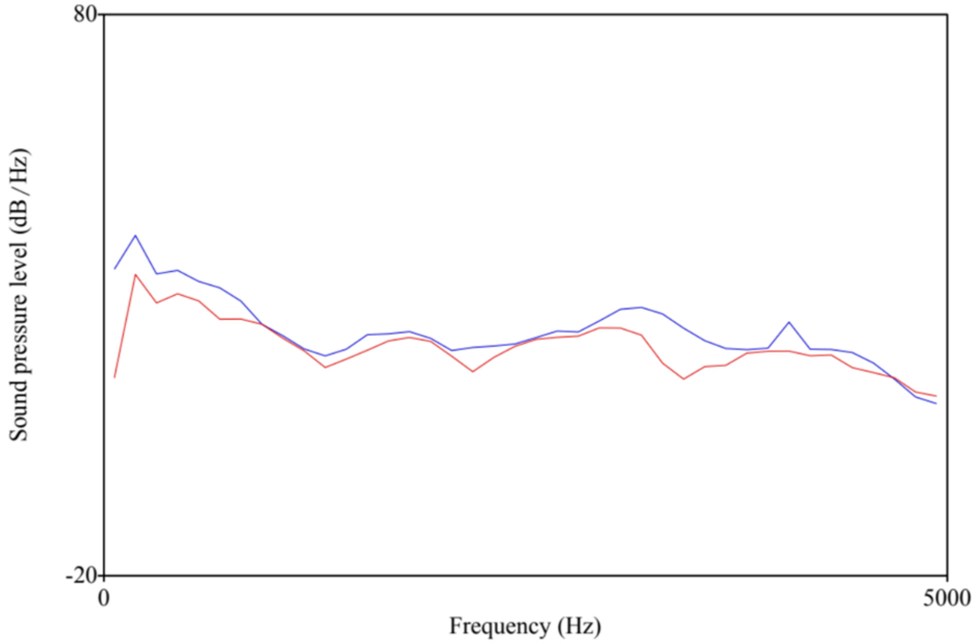

Figure 1. An example of the LTAS of two different speakers, taken from Gil & San Segundo (2014, p. 11).

types of disturbance in the sound signal: the *long-term average spectrum* (LTAS). This method consists of a representation of the "spectral distribution of the speech signal over a period of time" (Löfqvist, 1986, p. 471), a period of time longer than is permitted by common spectra, for obvious reasons. The LTAS is calculated by taking into account the frequency, in hertz (abscissa axis), and the intensity, in decibels (ordinate axis), which is the result of the functionality of the sound source (the vocal folds) and its modification in the supra-glottal resonators. One advantage, aside from that of tolerating higher levels of background noise, is that it allows spontaneous speech to be studied just as well as a controlled reading or sustained vowels produced in a laboratory. See Figure 1.

In this vein, while a visual comparison of the LTAS does not seem to be altogether effective, another series of measurements exists. These are more objective to make comparisons as they are relative to different calculations of the spectral decline, that is, the progressive loss of energy in the face of high frequencies. One of these is the "alpha ratio", which determines the difference in spectral energy concentrated in low and high frequencies (below and above one thousand hertz, respectively), related to the glottal pulse rate.

It has been agreed that a greater decline is associated with a flat voice (whose energy concentration above one thousand hertz is rather low) and a lesser decline with brighter voices (with a greater quantity of energy above one thousand hertz). It seems that a greater spectral decline would be associated with a woman's voice, whereas a lower number in this decline would be identified as a man's voice. This all seems to suggest that these and other data could help not only with differences in sex and age, for example, but also to further specify a speaker's vocal characteristics, something which this experiment intended to demonstrate.

The above measurement is usually associated with the calculation of spectral energy concentrated in the regions corresponding to the fundamental frequency and the F_1. These areas become much more crucial when dealing with idiosyncratic features, but less so when it comes to variables (emotional, due to bandwidth reduction, etc.) in most languages, but particularly in Spanish, not only in LTAS, but also in terms of spectrographic clarity, among other aspects. For this reason, high frequencies relative to the third and fourth formants (among others) offer little information. This measurement, which is related to phonation mode (vocal hypofunction or breathy vs. vocal hyperfunction or articulatory tension), is known as the “L_1–L_0 ratio”.

2. Literature review.

Describing the state-of-the-art on the topic of LTAS as a research mechanism for judicial phonetics can be an arduous task, not so much due to the complexity or quantity of previous studies, but rather to the apparent lack of connections made between them in this context. The starting point will be two books which are essential for a first encounter with judicial phonetic sciences: these are *Introducción a la fonética judicial* [*Introduction to Judicial Phonetics*] by Victoria Marrero (2017) for its exceedingly applied nature, and the crucial volume *The Acoustics of Crime* by Harry Hollien (1990), for its theoretical ambition. In addition to these fundamental works, the VILE project, whose conclusions on the matter are collected and reviewed in Battaner et al. (2003) stands out.

Other authors have studied voice quality more generally, with references which are mostly specific to LTAS, although not their main focus. These include Atal (1992), Eskenazi et al. (1990), Kuwabara and Tagaki (1991), and Kuwabara and Sagisak (1995), who have previously studied acoustic correlates of voice individuality. Conversely, others have focused more on the relevance of LTAS, such as the dialectal study of Mexican Spanish carried out by Boullosa (1984), or Sundberg and Nordenberg’s (2006) study whose objective was to assess variation in vocal strength. Another, rather more argumentative study is that of Löfqvist (1986), who makes a case for LTAS.

Meanwhile, beyond the classics and the more sporadic works which focus on, according to the authors, masking (Hollien & Majewski, 1977) or distortion (Doherty & Hollien, 1978) of speech, it will not be possible to further specify until the emergence of more current research dedicated to demonstrating the acoustic parametres interrelated between speech and different emotions, such as that of Sundberg et al. (2011). Furthermore, there are those who, also in an attempt to define vocal quality, but using LTAS, limited their study to university participants, as is the case for Leino (2009).

In any case, the studies of most interest are those focused on demonstrating differences in gender[1] (Mendoza et al., 1996), age (Silva et al., 2011), or both aspects, tied to the voices of professional singers, and non-professionals in regular speech, as well as pathological voices with dysphonia (Master et al., 2006). Roseano et al. (2015) looked for differences in the LTAS between the two native languages of a single bilingual speaker. Similarly, Pittam (1987) found more uses for the LTAS, outside of the judicial use, which will be briefly addressed below.

Here, the works of Delgado Hernández et al. (2017), Master et al. (2006), Mendoza (2017), and Silva et al. (2011) are reviewed, although their contributions come from different perspectives: the use of LTAS in pathological, clinical, and speech therapy specialisations. These studies have been considered here as they contribute to the field of judicial phonetics by providing sociolinguistic information (including biological, sociocultural, and linguistic) which are relied upon for profiling.

3. Hypotheses and objectives

The hypotheses this study aimed to scientifically validate were that a sufficiently precise and accurate approximation between two different speech samples from the same speaker could be made, based on the spectral contour and decline of each speaker. In order to do so, the hypothesis was broken down into two sub-hypotheses according to the two methodologies: on one hand, the calculation of the LTAS alpha and L_1–L_0 ratios (H_1) and, on the other, a series of comparative measurements (H_2), which were proposed so as to show that the difference in spectral decline, in both controlled and spontaneous speech, of a single

[1] The concept of gender should be understood as it is by the authors. White (2001), in his work, set out to detect the differences between gender and sex in children using this technique.

speaker is smaller than it could be between the two modes (and even the same mode) between different speakers.

Evidently, this manner of proceeding is not intended as the solution to the problem of voice discrimination, either in combination with other methods, and especially not independently; however, it may facilitate a consistent expert (counter)argumentation. However, the intention was to use these data to try to further refine the complicated legal process of speaker discrimination and identification. The null hypothesis to be falsified (H_0) concerned the impossibility of finding a fruitful identification between the two samples, regardless of the calculation used.

4. Methodology and procedure

4.1. Participants

The corpus of recordings used for this phonetic study was not intended to include a significant number of speakers, but rather it was proposed as a starting point for future research. For this purpose, speech samples were taken from four monolingual Spanish speakers (with non-bilingual knowledge of other languages), all of whom were 20-year-old female speakers. Two participants originated from Castilla-La Mancha (Toledo and Albacete), with the remaining two coming from Castilla y León (Ávila and León). Furthermore, they were non-professional voices; not trained in singing, and therefore, the data obtained was expected to be within the usual ranges as, for example, those more recently reported by Delgado Hernández et al. (2017, p. 118), among many others.

Regarding the clinical condition of the participants' voices, none had been diagnosed with a speech pathology of any type. While none of the participants reported harmful vocal habits on a daily basis, one did claim to be a sporadic smoker (her smoking habit had begun less than two years previously). Although there is evidence that smoking harms mainly women's voices, especially those of young women (see Marsano Cornejo et al., 2019), the participant still met the study's criteria regarding smoking habits as she did not smoke more than one cigarette daily. For this reason, her speech samples were not disregarded; however, it was taken into account where hers did not correspond with the regular values.

4.2. Data collection

The data collection procedure was carried out using a ZOOAOXO v200 model digital recorder, which has two built-in microphones that pick up 360º sound and reduce noise interference. The recording was realised directly in *.wav* format.

The recording process took place one afternoon in the living room of a home, with all windows and doors closed so as to minimise possible interruptions as well as background noise. The recorder was placed on the table and was not moved throughout the interview. The participants were seated in a rigid chair so as not to affect their posture. These measures may not seem necessary, considering it was established that LTAS copes quite successfully with noise (see 1.1), and, above all, considering the poor quality of evidence found in the legal process; however, this recording process more closely resembles reality than those carried out inside silent or anechoic chambers.

Otherwise, the recording method began with a brief interview purely for identification purposes, which was discarded in the subsequent analyses to prevent the effects of nervousness on the results. Next, they were given a text (see 4.3) to read up to three times in order to familiarise themselves with it, and to reach an acceptable recording quality; of these three readings, only the last one was considered useful, with the recording of the same number being chosen for all participants. All attempts were consecutive, with no time for reflection, to prevent participants from adapting to the overall intonational pattern of the text.

Finally, they were asked a "trick question", such as "What is your impression of the text having read it? What in the text peaked your curiosity or caught your attention?[2] with a double purpose: to put them completely at ease, believing that the important part had already been completed and, consequently, to achieve a more natural style in the section dealing with spontaneous speech, for which a more relaxed mode of phonation was sought. As an exception, where the sample obtained was not considered to be sufficiently relevant, the last part was prolonged with a set of semi-directed questions (see appendix, 1). From this final section, the recording that met the following characteristics was chosen:

a) A recording of substantial duration (minimum of 20 seconds);
b) The clearest possible recording quality, without external interference which could create disturbance (knocks, background noise, etc.);
c) And a (part of the) recording which did not contain extralinguistic noises such as laughter, coughing, and, where possible, without filler vowels or false articulations.

4.3. Corpus

The corpus used for analysis includes a sample of both spontaneous speech and a controlled reading for each speaker. The reason that a phonetically balanced text was chosen was that, when using LTAS "[i]n order to further minimize variations due to phonetic structure, the analysis can be made of the reading of a standard text" (Löfqvist, 1986, p. 471). Therefore, the data obtained from the repeated reading of the text, which is presented below, were kept for two essential reasons: i) one, to allow greater stabilisation of the data as a control group; and ii) two, so as to imitate the usual procedure in police departments.[3]

The chosen text has previously been put to the test in a study by Gil and San Segundo (2013, p. 339), among others, aimed at trying to detect voice disguise and masking by means of hyponasality. Although the results obtained did not prove to be entirely satisfactory, it was chosen for this study for two reasons: firstly, as stated by the authors, "with a view to obtain controlled data, so that all speakers produce the exact same linguistic content" (*Ibid.*); the second being that the objective of the study was not to assess whether this, or similar, texts are useful in speaker identification, but rather to compare the two speech styles; spontaneous speech and controlled reading. Below is the phonetically balanced text:

> El joyero Federico Vanero ha sido condenado por la Audiencia de Santander a ocho meses de arresto mayor y cincuenta mil pesetas de multa por un delito de compra de objetos robados. La vista oral se celebró el miércoles pasado y, durante ella, uno de los fiscales, Carlos Valcárcel, pidió para el joyero tres años de prisión menor y una multa de cincuenta mil pesetas. Gracias a las revelaciones de Vanero de hace dos años y medio se llegó a descubrir la existencia de una sospechosa mafia policial en España, parte de la cual se vio envuelta en el llamado «caso El Nani».
>
> [The jeweler Federico Vanero has been sentenced by the Audiencia of Santander to eight months of major arrest and a fifty thousand pesetas fine for the crime of buying stolen goods. The oral hearing was held last Wednesday and, during it, one of the prosecutors, Carlos Valcárcel, requested three years of minor imprisonment and a fine of fifty thousand pesetas for the jeweler. Thanks to Vanero's revelations two and a half years ago, the existence of a suspicious police mafia in Spain was discovered, part of which was involved in the so-called "El Nani case".]

[2] Yes-no questions were avoided so as not to elicit monosyllabic replies.

[3] In effect, if a suspect is subjected to a police investigation, it is almost exclusively based on cross-checking evidence collected by means of a controlled reading (known voice sample) compared to the recording constituting the crime (questioned voice sample).

4.4. Analysis procedure

Both qualitative and quantitative analyses were carried out. Logically, the first constituted a visual approach to the LTAS, superimposed according to different combinations, as well as a provisional attempt at a general interpretation; on the other hand, the latter accounted for the majority of the analysis, and was given greater importance and relevance due to the fact that it constituted a useful and real (i.e. 'objective, measurable') contribution to the field of judicial phonetics. As the qualitative analysis showed a number of overlaps, the next step was to proceed to the quantitative analysis.

4.4.1. Qualitative analysis

In this section, each of the LTAS which were successfully extracted during the recording process were compared *grosso modo*. To better organise the results of each participant and their respective two takes, each was assigned a colour, to avoid possible data mixing. Table 1 summarises the colour codes with the relevant information (spontaneous speech vs. controlled reading).

Audio	Colour	Type
1a	Red	Spontaneous speech
2a	Green	
3a	Blue	
4b	Purple	
1b	Maroon	Controlled reading
2b	Lime	
3b	Cyan	
4b	Grey	

Table 1. Colour key for the LTAS.

This step focused on a superposition of LTAS pairs; 1a was compared with 1b (red shades), 2a with 2b (green shades), 3a with 3b (blue shades) and 4a with 4b (purple and grey). As is evident, each speaker is identified by a number, and each register is represented by a letter. This part showed a quantitative correlation, which was recorded in the relevant quantitative analysis in the following section via a mathematic formula which allowed for further refinement (see 4.4.2).

Finally, the LTAS of each participant in the spontaneous speech style (x_b) was superimposed with each LTAS produced by the other speakers in the controlled reading style (y_a). The main objective here was to verify that similarities between the LTAS of different speakers were not greater than those between different samples from the same speaker and, therefore, to ensure that the maximum degree of speaker variability was maintained. Otherwise, this would be a strong *a priori* indication that the results obtained in the quantitative analysis would not be relevant and, therefore, the hypotheses should be disregarded.

4.4.2. Quantitative analysis

In this second data processing step, the previously mentioned variables were calculated. Firstly, the mean LTAS values at different frequency points were recorded and the difference between them calculated. It should be said that, had the notable similarities between the LTAS of different individuals not been observed at the qualitative analysis stage, this numerical comparison would not have been carried out, due to the fact that it would result in excessive, presumably inconclusive, results. This process was carried out using a *Praat* script developed by Roseano et al. (2015),[4] whereby the following was calculated:

$$\textit{Given that } LTAS_1 = \{x_1, x_2, x_3, x_4, x_5 \ldots x_{80}\}$$
$$\textit{and } LTAS_2 = \{y_1, y_2, y_3, y_4, y_5 \ldots y_{80}\},$$
$$\Delta_{LTAS} \textit{ was calculated}$$

Secondly, the alpha ratio and the L_1–L_0 ratio were calculated so as to corroborate or discount various doubts which arose throughout the analyses. It is possible to obtain both data using a *Praat* function named *get slope*, which requires the user to specify

[4] Roseano et al. (2015) includes an explanation of the script and the mathematical formula used for calculation (with corrections that were not considered here, since all the recordings for this study were made under equal conditions).

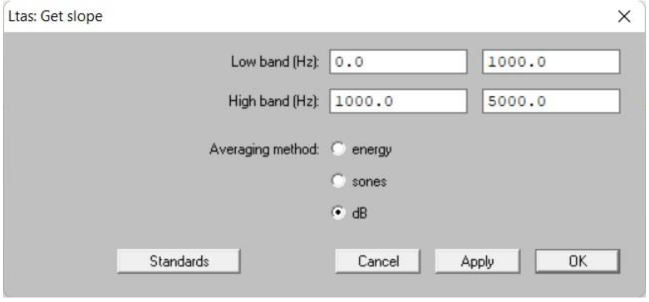

Figure 2. Calculation of alpha ratio.

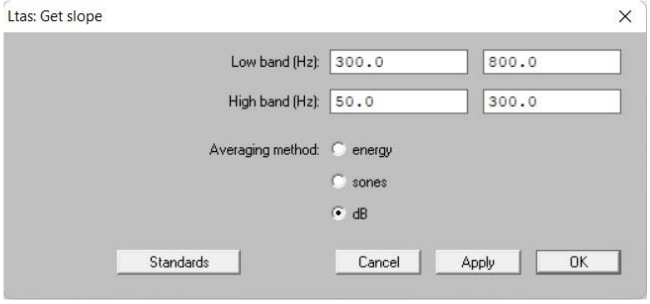

Figure 3. Calculation of L_1–L_0 ratio.

the desired intervals and means of expressing the information. In this case, following the majority of the studies consulted, it was decided that the data would be recorded in dB. The exact details are the following (see Figures 2 and 3).[5]

Subsequently, a brief statistical analysis was carried out using two approaches: the first, and most significant, was the processing of the data using *Excel*; the second, and more illustrative (but no less relevant), was the preparation of data synthesis figures using *RStudio*, following the cluster analysis methodology. Having collected the data in *Excel*, the next step was the basic statistical calculation with the mean variation of LTAS pairs following the formula presented above, as well as the standard deviation (maximum and minimum) so as to observe which of the absolute change data were non-significant. The mean and median of each LTAS was also considered. Finally, a Student's *t*-test was performed on the data resulting from the pairwise association of the LTAS and their respective eighty frequency points for both intra- and interspeaker combinations.

Regarding the calculation of the two ratios, the absolute change was recorded, for both same-speaker pairs and different-speaker pairs, as well as those previously mentioned (median and standard deviation). In order to present the data in a more visual manner, a scatter plot of the ratio data was prepared, as well as various dendrograms of both spectral decline and spectral contour. Furthermore, the absolute change was calculated for each ratio, in same-speaker and different-speaker pairs, after which the remainder was calculated, so as to determine extent to which the variation differed from one case to the next. This was done by firstly subtracting the ratios from each other; after which the result of each underwent the same procedure between the results of the alpha ratio on one hand, and the L_1–L_0 ratio on the other hand.

5. Results

5.1. Qualitative analysis

The four LTAS corresponding to the two samples produced by each speaker are presented in Figures 4 to 7. The results of the superposition were, or at least appeared to be, overall satisfactory, with no discordances observed in the curve of the spectral decline, beyond the mismatches in the first frequencies, and some frequency points in the middle and high regions.

[5] There is another small variation in data collection when it comes to the alpha ratio, which entails taking the first reference value of the *low band* from 0.5 Hz instead of the one chosen here, with no reason (or seemingly no reason) for doing so. Leino (2009) is an example of this, but, as in these cases it is necessary to choose one method or another, here the chosen method was that used by Silva et al. (2011).

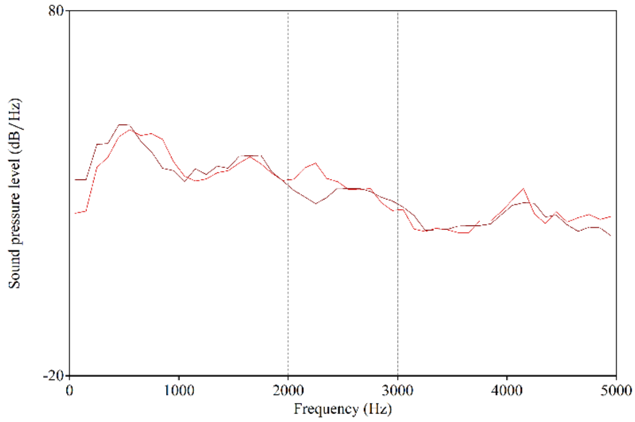

Figure 4. 1a & 1b.

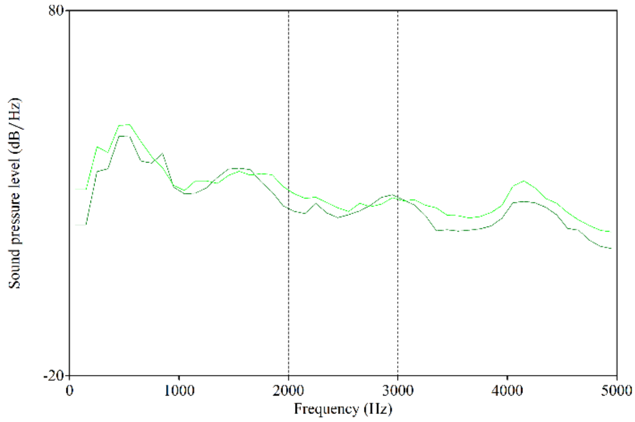

Figure 5. 2a & 2b.

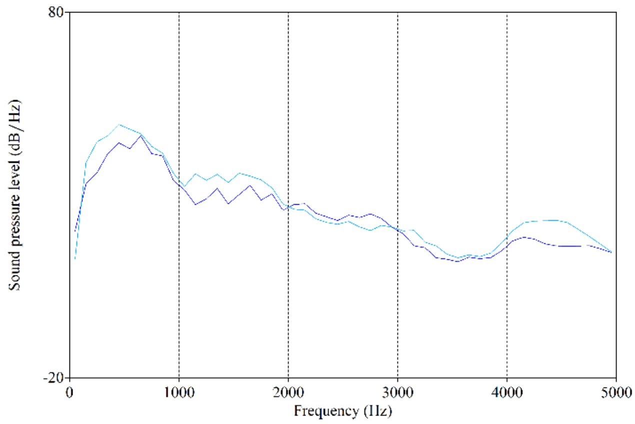

Figure 6. 3a & 3b.

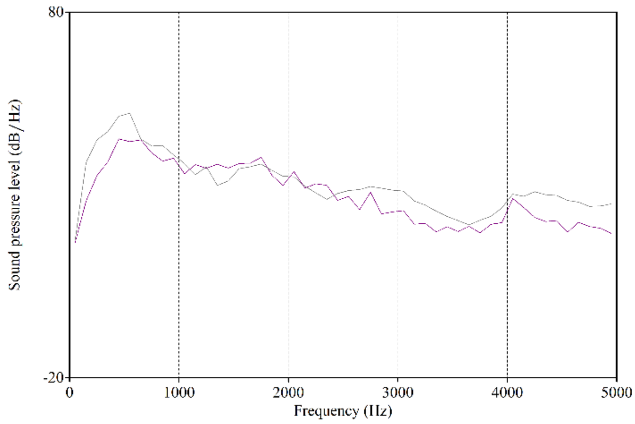

Figure 7. 4a & 4b.

In effect, the mathematical analysis, including the standard deviation, showed that there were some data that exceeded the limit and, therefore, could not be considered representative; these coincided, mostly, in being among the first five data collected. For more information on this subject, please refer to the appendix (2).

Regarding the contour of the spectral curve, the four LTAS extracted appeared to broadly correspond with their two samples, although not to the same extent. In the majority of spectra there was an almost univocal correlation between the two samples, although Figures such as 5 or 7 showed fewer common points. It can even be seen how the two contours in Figure 5 were practically the same, but with differing intensities. However, despite the similarities in spectral decline, the overlap was far from the desired result.

For example, in Figure 4, the contours in the range of two thousand to two thousand five hundred hertz presented completely opposite contours in both samples (a rise in intensity in spontaneous speech and a controlled declining reading). In contrast, in the LTAS in Figure 6, in the frequency range from one thousand to two thousand hertz, as well as above four thousand, there were fewer points of overlap in the decline. Although the contours were similar, the increase in intensity occurred in the sample featuring the controlled reading style, despite what may incorrectly be assumed. This case is comparable to that shown in Figures 5 and 7. In the latter, moreover, the differences in both contour and intensity were markedly more pronounced.

However, from these visual representations of the data, the proportionally direct correspondence

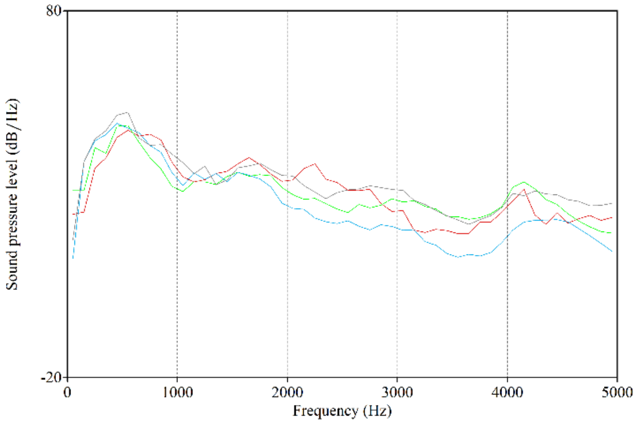

Figure 8. 1a & 2b, 3b, 4b.

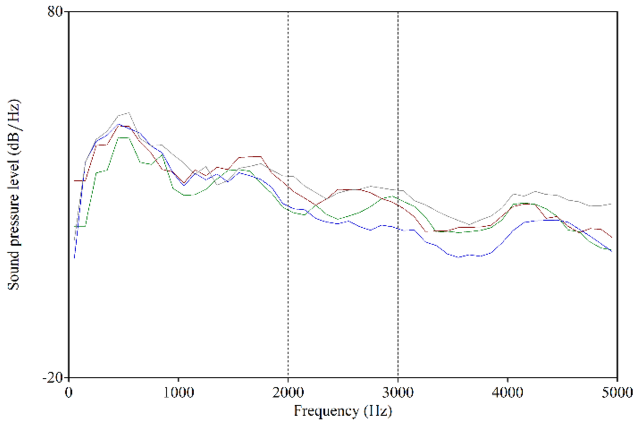

Figure 9. 2a & 1b, 3b, 4b.

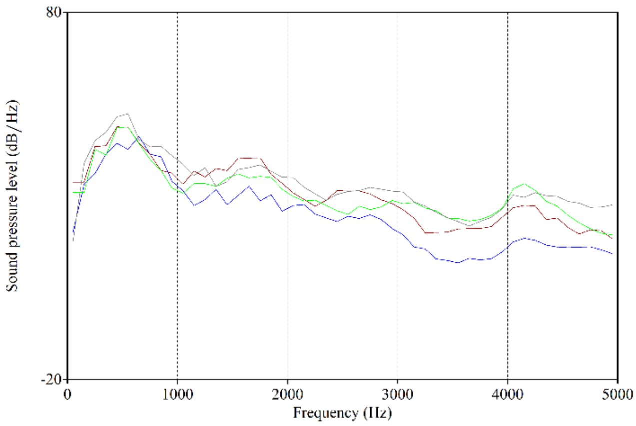

Figure 10. 3a & 1b, 2b, 4b.

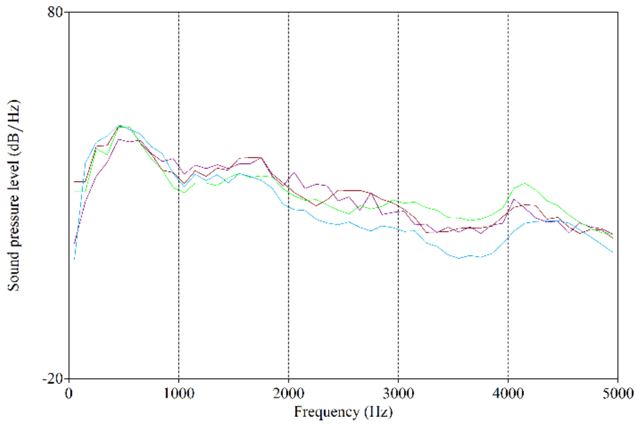

Figure 11. 4a & 1b, 2b, 3b.

between the speech style and increase in intensity was not initially evident. Figure 4 showed that the speech style with the highest intensity peaks was spontaneous speech, while the remaining spectra showed the opposite. Although it was not possible to make generalisations with so little information, the differences in intensity (regardless of speech style) were undoubtedly relevant, so it was deemed more appropriate to take into account corrections that would minimise these features for future research.

In any case, the visual approach to the analysis of pairwise LTAS was inconclusive, so it was deemed appropriate to complicate the analysis a little more with various combinations to see to what extent differences or similarities between LTAS could be considered useful. Therefore, four other images corresponding to different combinations of speech samples from the corpus are presented in Figures 8 to 11, generated so as to examine the extent to which these differences or similarities are relevant.

On the one hand, all the LTAS showed that the lower frequency ranges were quite similar across all samples. It can clearly be seen that it was precisely the ranges below one thousand hertz that showed the greatest degree of proximity to each other, even between different speakers. But this did not end here; it had direct repercussions on the calculation of the ratios to be discussed at a later stage. Initially, everything seemed to indicate that the L_1–L_0 ratio calculation would not be especially enlightening, given that the significant differences seemed to be above the first thousand hertz and that the divergent points were located above the first thousand hertz.

In consequence, greater differences in the mid-high frequency range suggested that the alpha ratio could still be considered a good calculation for speaker discrimination, if not for the fact that, in some cases, the spectral contours of different participants also seemed to closely approach each other, including in the high frequency regions. As shown, for example, in Figure 6, where 2b and 4b, or 2a and 1b (Figure 9), or 4a and 1b (Figure 11) can be seen to overlap almost completely. Logically, these similarities in spectral decline were biased, in the sense that the focus was only on conflicting points, which could have interfered with the final results.

In fact, even if there had been more or less sporadic and more or less generalised overlaps between different LTAS, it would not necessarily prevent the comparison from being productive. Considering that, for example, samples 2a and 1b (Figure 9) converged at high frequencies, the opposite was true at low frequencies; the two contours were quite distinct. In the same vein, it was also noted that 1b and 3b (Figures 9 or 11) closely approached each other in low frequencies, but were rather far apart in high frequencies, meaning that such cases did not seem to carry sufficient weight and basis to rule out H_2, although it was still useful to take these data into account.

Finally, before continuing to the next section, it is worthwhile to reflect briefly on the use of the long-term average spectrum in the comparison and discrimination of speakers. It is true that any new technique requires the establishment of parametres that demonstrate the plausible concomitance between numerical data and its correlation with representational data. However, it is also the case that the LTAS method still lacks a literature and clear-cut, categorical tenets, from which it follows that any visual (qualitative) approach to the LTAS method is, presently, at least, orientative. For this reason, quantitative analysis was carried out in order to refine this qualitative analysis.

5.2. Quantitative analysis

This section will deal with the numerical processing of the data provided by the LTAS and will provide a breakdown of the procedure carried out when assessing if the comparison and discrimination would, in fact, be successful, taking into account all of the above. Throughout this section, summary tables and associative schemes are presented, which intend to summarise, to some extent, the vast quantity of information generated from the comparison of LTAS and the use of ratio calculations.

Firstly, Table 2 summarises the uninominal data for each and every one of the eight audios. It shows the unprocessed results of the ratio calculations, as well as the mean, median and standard deviation of the eighty frequency points. A first approximation indicates from the outset that there were more differences in any of the measurements for the same speaker than between two different speakers; this is the case, for example, of the alpha ratio between 2a and 4a, the L_1–L_0 ratio between 1b and 2a, the mean variation between 1b and 3a, the median between 1b and 4a, etc.

Recording	Alfa ratio	L_1–L_0 ratio	Mean variation	Median	Standard dev.
1a	-10.955145245	-15.168100560	25.2141419434	23.1459521069	27.1027978570
1b	-13.176184085	-13.176184085	23.7280434259	21.3458305158	26.2147765416
2a	-9.9170724985	-13.782841214	20.5921812241	20.7308654535	23.3071337675
2b	-11.422762454	-8.8597328820	23.8069717071	24.9111762112	25.9075531579
3a	-16.848607727	-11.498783889	20.5254874758	16.1958609418	22.4956305498
3b	-17.555628059	-10.849447290	21.9491451376	17.0362954510	24.2601136708
4a	-9.612621586	-14.269574461	24.1911375462	21.7235926847	26.1718104040
4b	-12.038900139	-10.937942552	27.2695375838	27.1546459849	28.9512659616

Table 2. Summary table of ratio calculations.

The dendrogram in Figure 12 shows an association between 3a and 3b, on the one hand, and among the other audio samples, on the other. In the second group, recordings 2b and 4b (different speakers in the controlled reading style) were separated from the rest. Within the latter group, recordings 1a and 4a were the most similar (also from different speakers, but in the spontaneous speech style).

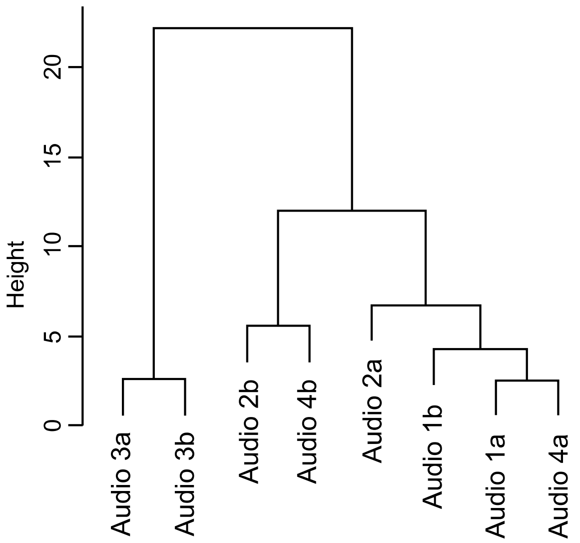

Figure 12. Dendrogram of data from Table 2 [euclid hclust (*, "ward.D")].

Since the overall results were not satisfactory, as is obvious when mixing data obtained from different sources by means of different calculations, it was decided to operate in parts so as to make accurate conclusions with the hypotheses put forward. The results of the Student's *t*-test were not very *meaningful* either, since it appears that none of the pairs reached a relevant level of significance, and greater similarity between different speakers than in the same speaker could be observed (e.g., 2a and 4b, or 3a and 4b, which were more significant than 2a and 2b, or 3a and 3b). See Table 3 below.

For the same reason as above, regarding the dendrogram, it was necessary to repeat it in this case to assess if it was indeed possible for any of the data to shed light on what was really happening in the LTAS comparison. As can be seen in Figure 13, again, participant 3's recordings were correctly matched to each other, but then two groups were formed with 1b and 2b (with 2a later added), on the one hand, and 1a and 4a (with 4b later added), on the other. This dendrogram, although similar to the previous one, better associated the same-speaker recordings with each other, although the styles continued to be confused, and participant 1 was straddling between two other speakers.

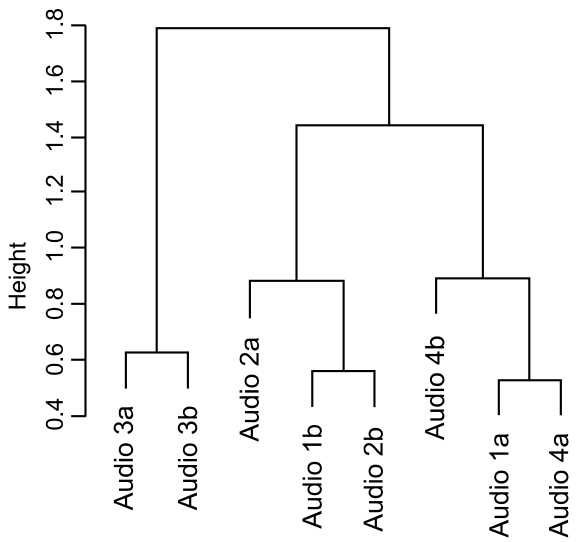

Figure 13. Dendrogram of just the 80 frequency points [euclid hclust (*, “ward.D")].

	1a + 1b	2a + 2b	3a + 3b	4a + 4b
***p*-value**	.124	.092	.092	.114

	1a			2a			3a			4a		
	2b	**3b**	**4b**	**1b**	**3b**	**4b**	**1b**	**2b**	**4b**	**1b**	**2b**	**3b**
p	.124	.125	.121	.092	.093	.089	.091	.091	.088	.117	.117	.118

Table 3. *P*-value results from Student's *t*-test.

At this point, the next step was to process the data obtained from both ratio calculations; the unprocessed results have already been collected above (Table 2). The data is included in the scatter plot in Figure 14 and in the dendrogram in Figure 15; here it was noted that the pairing of participant 3 was, as it had been so far, correct, but the other recordings were paired incorrectly: 2b with 4b, later joined by 1b, on the one hand, and 2a with 4a, later joined by 1a, on the other.

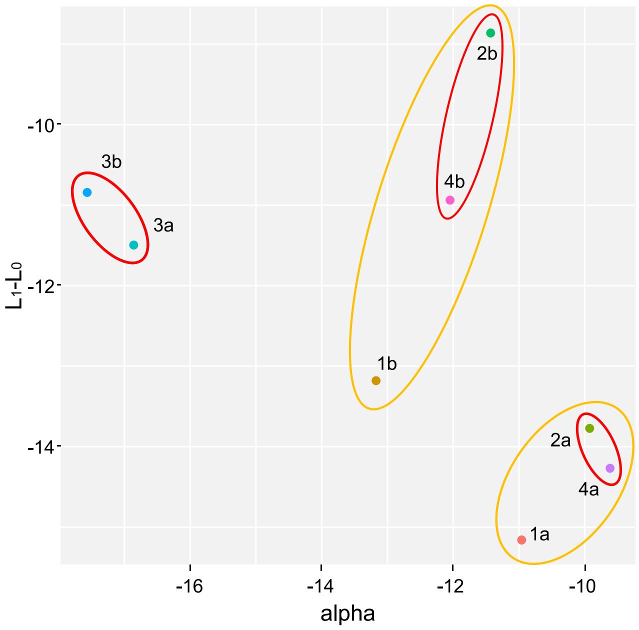

Figure 14. Scatter plot of the ratio calculations.

These same results hardly varied with respect to those obtained in the previous dendrogram concerning the spectral curve comparison. However, the ratios further complicated the matter by not allowing the two expressive styles to be correctly paired; consequently, the two groups, excluding participant 3, only formed one cluster of spontaneous speech recordings and one cluster of controlled reading recordings. In this case, the results suggested that the alpha ratio and the L_1–L_0 ratio were, if anything, less conclusive than the direct comparison, even though all the recordings were randomly mixed without regard to the change in style of a single speaker.

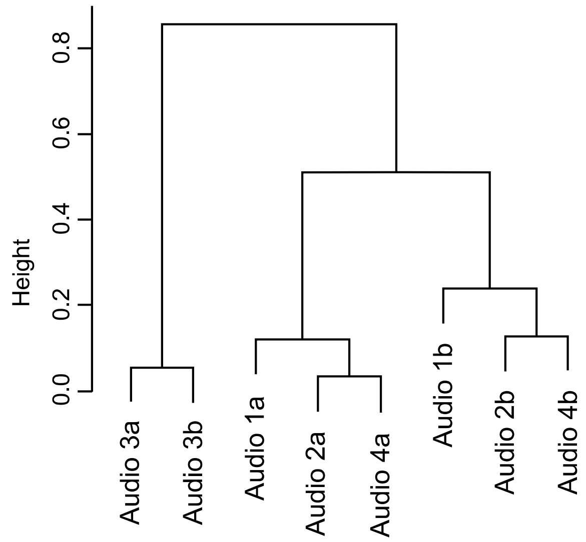

Figure 15. Dendrogram of the ratio calculations [euclid hclust (*, "ward.D")].

The calculation of the remaining data showed that the same happened as was explained previously for Table 2: not all variations within a same-speaker pair were minimal, nor were they maximal between different speakers. Nevertheless, although the variation values within same-speaker pairs were generally lower than those of different-speaker pairs, it did not go unnoticed that, for example, 1a and 2b or 2a and 1b showed less variation than participants 2, 3 and 4. See Table 4.

	1a + 1b	2a + 2b	3a + 3b	4a + 4b
Alpha – L_1–L_0*	0.22	1.30	1.35	3.55

	1a			2a			3a			4a		
	2b	**3b**	**4b**	**1b**	**3b**	**4b**	**1b**	**2b**	**4b**	**1b**	**2b**	**3b**
*****	0.34	4.48	1.12	0.83	2.84	2.76	3.35	2.78	4.24	2.66	2.09	2.04

Table 4. Absolute change in ratios as a product of subtraction.

6. Discussion

6.1. Explanation of results

With all results extracted, having already been presented in the previous section, it is worth making a preliminary reflection before proceeding to an explanation. It should be considered that the two routes followed in the present study have sought to demonstrate, for each sub-hypothesis, the extent to which the use of LTAS could be effective when it comes to speaker discrimination. Whether this was really the case or not will be confirmed below. Logically, the statistical analysis briefly summarised above should be an incentive for further and more detailed research, for which recommendations and amendments, based on this study, will be detailed in the next section (see 6.2).

That said, firstly the three (sub-)hypotheses will be revisited in order to resolve any doubts arising from the data already provided. All three sub-hypotheses addressed the (im)possibility of distinguishing and matching each of the two samples, presented in pairs, to their respective speakers to determine whether, by doing so, a successful identification could be achieved. Therefore, the first hypothesis (H_1) considered was to use ratio calculations (alpha and L_1–L_0, while the second hypothesis (H_2) was based on the direct comparison of LTAS. On the other hand, the null hypothesis (H_0) implicitly stated that none of the above would be feasible for such an undertaking. For the sake of clarity, in the explanation that follows, the order of the hypotheses will be modified slightly.

A tangential synopsis could summarise that both hypotheses (1 and 2) have not been significantly conclusive and, therefore, have been rejected; likewise, the null hypothesis confirms that, currently, it does not seem possible to identify speakers using LTAS, contrary to what was postulated by some of the authors previously referenced in the literature review (see 2). Even so, this result may be indicative of two methodological inaccuracies: the first, of content, relates to the calculations used and the indiscriminate treatment of the spectral curve data with those of the ratios; the second, of form, and derived from the previous one, relates to the undifferentiated processing and, consequently, a lack of specificity or clear distinction.

Therefore, Figure 13 clearly shows that it is not plausible to uphold hypotheses such as the second, if only because, in this case, it has already been proven that intraspeaker variability is not necessarily lesser than the interspeaker variability, as well as having shown that the LTAS contours converge quite frequently at both low and high frequencies. It is true that this does not appear to follow any pattern which could give insight into the reasons behind it. In all likelihood, the results are *anomalous* in large part due to not having considered the corrections which apply to spectral declines so as to reduce the intensity differences that had already been taken into account by Roseano et al. (2015).

Likewise, Figures 14 (the scatter plot) and 15 (the dendrogram) follow the same line marked by Figure 13 and previously by Figure 12, and do not yield positive results for the investigation either. In effect, neither the L_1–L_0 ratio nor the alpha ratio were suitable. The reasons seem to lie in the purpose of the ratios, which were originally meant only as a logopaedic resource when dealing with voice quality. However, the possibility of developing new measurements or modifying existing ones for judicial purposes should not be dismissed. Such modifications can range from applying the same calculations, but correcting for intensity errors which arise due to the recording method, to completely changing the ranges of values used for the calculation, an issue on which there was no consensus among various researchers, even concerning the alpha ratio (see 4.4.2, footnote 5).

Finally, the fact that both hypotheses were rejected confirms that none of the above mechanisms are useful for speaker identification, at least provisionally, in the absence of further research. At the beginning of this section, the causes were hinted at, but there is still one more thing to add: it must not be forgotten that, as mentioned in the introduction, such specific data cannot be the remedy for such an intricate problem, but rather must be part of a multiparametric comparison system that solves or, at least, alleviates the burden of having to rule for or against a total or partial correspondence of two speech samples, with all the consequences that this entails in a court of law.

However, there is one particular case which cannot simply be dismissed, in which the identification was correct not only when using the calculations, but also with the LTAS comparison. This suggests two things: first, effectively, that the method did not turn out to be trivial, since it was able to match accurately in all cases the two samples of the third participant, which indicates that more detailed research could be done. The second indirectly confirms and expands on the research carried out by Marsano Cornejo et al. (2019) regarding smoking habits, since, despite the fact that said participant did not meet all the requirements, the influence of tobacco seems to play the same role even at relatively low levels of consumption.

6.2. Implications for the field of study

Based on what was mentioned at the end of the previous section, it is clear that the field of application of the long-term average spectrum is, essentially, clinical. Although it is the case that the ratios used were drawn from studies in the field of speech therapy, one of the aims of the present study was to try and create a space for them in the area of judicial phonetics. Therefore, this study is presented as a first fully-developed approach to the use LTAS in judicial phonetics. It has been established, then, that the interest in voice quality and its presence in LTAS is an issue mostly focused on rehabilitation or monitoring the treatment of dysphonic voices, contrary to, for example, the statements of Gil and San Segundo (2014) who claim it is in the judicial field, although their focus is on aspects such as *creaky voice.*

Despite this, the implications of clinical advances are also rooted in forensics. Moreover, one of the founding precepts of judicial phonetics is the characterisation of each individual speaker in an abstract way, which takes the form of identification profiles based on a supposed "voiceprint".The field of speech therapy is fully dedicated to this exhaustive description of speaker voices, even though their interest lies mainly in anomalies or speech disorders, and even though its purpose is to correct these anomalies, rather than to apply it to speaker indentification. Note the direct overlap between the two disciplines; only after an arduous process of clinical *singularisation* can they begin to work on judicial comparison and discrimination (in short, speaker identification).

6.3. Ideas for future studies

At this point in the study, the only option is to list the main ideas to be developed in future research, on the basis of this brief study. Although the results do not strongly support the hypotheses, it may be useful to increase the number of participants as well as their characteristics in order to obtain significant results. In an initial pilot study, carried out separately, it was observed that the differences between sexes were substantial enough that it was possible to separate each pair of samples mainly due to the ratios.

It would be interesting, therefore, to test this with slightly more heterogeneous groups of participants, gradually reducing their differentiating features, until the limit between identification and confusion can be determined. This could be done as a test of strength with the inclusion of groups of speakers of different sexes, on the one hand, and within these categories a more diverse age range, on the other. Following this, it would need to be seen in which of them the interspeaker differences are as great, or greater, than those that occur in the intraspeaker comparison. These traits are generally based on biological characteristics such as sex and age, but sociological characteristics such as social status, or linguistic characteristics such as bilingualism versus monolingualism must not be forgotten.

Consequently, another change that could be introduced would be to modify the speaking styles used here. For example, it could be interesting to use two samples of only one of the two styles (controlled reading only or spontaneous speech only), but recorded over time to see whether short-, medium- or long-term vocal changes help or hinder identification. It should then be taken into account that the differences in intensity would be even more accentuated, since the recording process would not be the same; therefore, it would be necessary to work with corrections on the spectral decline if the curve is used, or to use caution when working with the ratios, since aging is a direct cause of voice modulation.

Regarding the recording procedure, the results have shown that it is not yet the time to collect voice samples in everyday environments; it would be more convenient to do so using professional microphones and audio interfaces (e.g., cardioid condenser microphones), in a room with minimum environmental noise (measured with a sound level metre). This would guarantee the quality of the speech samples until the resistance to noise is established, therefore avoiding anomalous results, and also controlling the experimental design as much as possible.

This design should necessarily include a differential treatment of the two hypotheses, and therefore use the comparison of the spectral curve separately from the ratio calculations. Continuing with the results collected and explained here, the first method would appear to be the most suitable for the judicial field; discordances in the spectral decline, due to the action of time, are also foreseen. On the other hand, the second method should not be discarded, at least until it is clear where the critical point lies, if there is one, or if they are simply not useful in the judicial application. In the same way, it is important to consider which of the ratios may be more relevant or whether both may be equally relevant and, depending on this, proceed in one way or another.

Finally, it cannot be overlooked that in a scientific work the statistical treatment is key for the theoretical validation of the hypotheses. Therefore, it is essential that in future research different statistical procedures are considered, as well those carried out here, although with a more intensive approach. Cluster analysis (both the dendrogram and other figures) seems to be the most suitable for comparing speech samples; however, when speakers surpass high numbers, it may not be entirely suitable given that in a judicial setting, the most accurate identification possible is sought. In contrast, the scatter plot may be more appropriate where larger quantities of samples from fewer speakers are taken into account. Regarding processing, since the null hypothesis has been confirmed, it would be beneficial to carry out exploratory data analysis to test the criteria of normality and homoscedasticity of the variables studied if results similar to these are obtained in the future.

7. Conclusions

In short, the two nuclear hypotheses, which dealt with the possible speaker identification power of spectral ratios and the immediate confrontation of spectral decline, have been discarded, and the null hypothesis, related to the improbability of successful matching and discrimination of samples, has been reinforced. It was also observed that discrimination was possible for only one of the four participants, the reason for which it is due and the consequence outcome.

Finally, as a corollary, all that is left to be said is that research in this field should continue to further refine the identification process. Since the sample collected for this paper is not significant, and since the results are variable, and even "contradictory" to some extent, depending on the calculations used, it is not prudent to rule outright in favour of one hypothesis or another. Although it has been said on previous occasions, the general impression of the study is that it is not *yet* conclusive and requires further in-depth, consistent research.

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Appendices

Appendix A. Questions used in the interview

This set of semi-prepared questions (which were not completely respected in all interviews for the sake of greater spontaneity) are the following:

a) Knowing that it is a phonetically balanced text, what do you think might be interesting about it?
b) When reading the text, were you more aware of how you were modulating your voice or what the text said?
c) So, do you find the controlled reading methodology useful?
d) After telling you that no segmental features (no specific sound) are going to be taken into account, do you suspect any other phonetic features that might fit in with this work?
e) What recommendation would you make as a research subject to avoid possible nervousness when recording someone?

As can be seen, all the questions were about the text, since continuing with a personal interview would make the speaker suspect that the recording was still going on.

Appendix B. Alpha and L_1–L_0 ratio calculations: spectral decline

Participant 1	Alpha	L_1–L_0	Alpha - L_1–L_0
Controlled reading	-13.17618408561890	-15.16810056070420	1.99191647508530
Spontaneous speech	-10.95514524527800	-13.17618408561890	2.22103884034090
Absolute change	2.22103884034090	1.99191647508530	0.22912236525560
Change²	4.93301353030285	3.96773124371625	0.05249705826032

Participant 3	Alpha	L_1–L_0	Alpha - L_1–L_0
Controlled reading	-17.55562805962180	-10.84944729076610	6.70618076885570
Spontaneous speech	-16.84860772717950	-11.49878388929970	5.34982383787980
Absolute change	0.70702033244230	0.64933659853360	1.35635693097590
Change²	0.49987775048682	0.42163801819519	1.83970412420636

Data Cross	Alpha	L_1–L_0	Alpha - L_1–L_0
1a	-10.95514524527800	-13.17618408561890	2.22103884034090
2b	-11.42276245433630	-8.85973288203890	2.56302957229740
Absolute change	0.46761720905830	4.31645120358000	0.34199073195650
Change²	0.21866585420747	18.63175099288720	0.11695766074414

Data Cross	Alpha	L_1–L_0	Alpha - L_1–L_0
1a	-10.95514524527800	-13.17618408561890	2.22103884034090
4b	-12.03890013916880	-10.93794255234190	1.10095758682690
Absolute change	1.08375489389080	2.23824153327700	1.12008125351400
Change²	1.17452467003226	5.00972516128618	1.25458201447349

Data Cross	Alpha	L_1–L_0	Alpha - L_1–L_0
2a	-9.91707249854376	-13.78284121409910	3.86576871555534
3b	-17.55562805962180	-10.84944729076610	6.70618076885570
Absolute change	7.63855556107804	2.93339392333300	2.84041205330036
Change²	58.34753105967620	8.60479990944697	8.06794063253396

Data Cross	Alpha	L_1–L_0	Alpha - L_1–L_0
3a	-16.84860772717950	-11.49878388929970	5.34982 383787980
1b	-13.17618408561890	-15.16810056070420	1.99191647508530
Absolute change	3.67242364156060	3.66931667140450	3.35790736279450
Change²	13.48669540309320	13.46388483504700	11.27554185710950

Data Cross	Alpha	L_1–L_0	Alpha - L_1–L_0
3a	-16.84860772717950	-11.49878388929970	5.34982 383787980
4b	-12.03890013916880	-10.93794255234190	1.10095758682690
Absolute change	4.80970758801070	0.56084133695780	4.24886625105290
Change²	23.13328708216770	0.31454300524061	18.05286441933630

Data Cross	Alpha	L_1–L_0	Alpha - L_1–L_0
4a	-9.61262158656565	-14.26957446133070	4.65695287476505
2b	-11.42276245433630	-8.85973288203890	2.56302957229740
Absolute change	1.81014086777065	5.40984157929180	2.09392330246765
Change²	3.27660996117348	29.26638591303440	4.38451479661703

Participant 2	Alpha	L_1–L_0	Alpha - L_1–L_0
Controlled reading	-11.42276245433630	-8.85973288203890	2.56302957229740
Spontaneous speech	-9.91707249854376	-13.78284121409910	3.86576871555534
Absolute change	1.50568995579254	4.92310833206020	1.30273914325794
Change²	2.26710224297454	24.23699564920060	1.69712927537643

Participant 4	Alpha	L_1–L_0	Alpha - L_1–L_0
Controlled reading	-12.03890013916880	-10.93794255234190	1.10095758682690
Spontaneous speech	-9.61262158656565	-14.26957446133070	4.65695287476505
Absolute change	2.42627855260315	3.33163190898880	3.55599528793815
Change²	5.88682761482204	11.09977117699240	12.64510248783830

Data Cross	Alpha	L_1–L_0	Alpha - L_1–L_0
1a	-10.95514524527800	-13.17618408561890	2.22103884034090
3b	-17.55562805962180	-10.84944729076610	6.70618076885570
Absolute change	6.60048281434380	2.32673679485280	4.48514192851480
Change²	43.56637338244780	5.41370411252188	20.11649811892150

Data Cross	Alpha	L_1–L_0	Alpha - L_1–L_0
2a	-10.95514524527800	-13.78284121409910	2.82769596882110
1b	-13.17618408561890	-15.16810056070420	1.99191647508530
Absolute change	2.22103884034090	1.38525934660510	0.83577949373580
Change²	4.93301353030285	1.91894345735679	0.69852736214927

Data Cross	Alpha	L_1–L_0	Alpha - L_1–L_0
2a	-9.91707249854376	-13.78284121409910	3.86576871555534
4b	-12.03890013916880	-10.93794255234190	1.10095758682690
Absolute change	2.12182764062504	2.84489866175720	2.76481112872844
Change²	4.50215253652043	8.09344839566791	7.64418057754063

Data Cross	Alpha	L_1–L_0	Alpha - L_1–L_0
3a	-16.84860772717950	-11.49878388929970	5.34982383787980
2b	-11.42276245433630	-8.85973288203890	2.56302957229740
Absolute change	5.42584527284320	2.63905100726080	2.78679426558240
Change²	29.43979692483490	6.96459021892424	7.76622227868293

Data Cross	Alpha	L_1–L_0	Alpha - L_1–L_0
4a	-9.61262158656565	-14.26957446133070	4.65695287476505
1b	-13.17618408561890	-15.16810056070420	1.99191647508530
Absolute change	3.56356249905325	0.89852609937350	2.66503639967975
Change²	12.69897768465860	0.80734915125536	7.10241901161800

Data Cross	Alpha	L_1–L_0	Alpha - L_1–L_0
4a	-9.61262158656565	-14.26957446133070	4.65695287476505
3b	-17.55562805962180	-10.84944729076610	6.70618076885570
Absolute change	7.94300647305615	3.42012717056460	2.04922789409065
Change²	63.09135183101190	11.69726986283420	4.19933496191920

Statistics	Alpha	L_1–L_0	Alpha - L_1–L_0
Mean variation	3.38862443642564	2.72116741518288	2.25213661205283
Standard variation	11.65023178007020	8.65772866009345	7.31142997768998
Minimum	-8.261607343644510	-5.936561244910580	-5.059293365637140
Maximum	15.038856216495800	11.378896075276300	9.563566589742810

Appendix C. Comparative calculations: spectral contour

The detail of the LTAS corresponding to the same-speaker pairwise comparisons of samples can be found on pages 102 and 103. Later (p. 104), the comparison of two pairs of LTAS based on some spontaneous speech samples with other controlled reading samples is collected, as an example, so as not to elaborate with too much data.

- *Mean var.* stands for the mean of the corresponding 80 values in the *Absolute change* column.
- *Standard dev.* stands for the square root of the corresponding 80 values in the *Change²* column.
- *Correct range of values: Min.* corresponds to the subtraction *Standard dev. – Mean var.*
- *Correct range of values: Max.* corresponds to the sum *Standard dev.* + *Mean var.*

Participant 1				
#	Spontaneous sp.	Controlled reading	Absolute Change	$Change^2$
1	24.604323339	33.767431690	9.163108350	83.962554642
2	25.206453100	33.767431690	8.560978590	73.290354412
3	37.212535041	43.463791223	6.251256182	39.078203850
4	39.941754482	43.744176981	3.802422498	14.458416857
5	45.525780171	48.850687408	3.324907238	11.055008138
6	47.506762227	48.759088895	1.252326668	1.568322084
7	45.883792090	44.390664452	1.493127638	2.229430143
8	46.424713455	41.411541743	5.013171713	25.131890619
9	44.843520345	36.925939338	7.917581006	62.688088990
10	38.748832059	36.285600293	2.463231766	6.067510733
11	34.756082255	33.254983763	1.501098492	2.253296682
12	33.450488574	36.785137340	3.334648766	11.119882393
13	33.973899610	35.215411945	1.241512335	1.541352878
14	35.689745944	37.494830938	1.805084995	3.258331837
15	36.283492521	36.946034398	0.662541877	0.438961739
16	38.317943442	40.207624469	1.889681026	3.570894381
17	40.034872380	40.364406066	0.329533687	0.108592451
18	38.121607199	40.482473987	2.360866788	5.573691991
19	35.523019186	35.905984170	0.382964984	0.146662179
20	33.586626761	33.463998696	0.122628065	0.015037642
21	33.937590961	30.899714326	3.037876635	9.228694447
22	37.056373612	29.066094610	7.990279001	63.844558517
23	38.321905861	27.227787199	11.094118662	123.079468887
24	34.170826671	28.864419001	5.306407670	28.157962355
25	33.255780784	31.481141213	1.774639571	3.149345608
26	31.131595417	31.437661570	0.306066152	0.093676490
27	31.033010188	31.435056849	0.402046661	0.161641518
28	31.432485926	30.575860510	0.856625416	0.733807104
29	27.517377162	28.971983115	1.454605953	2.115878478
30	25.344820740	28.005760693	2.660939954	7.080601437
31	25.625172752	26.286644835	0.661472083	0.437545316
32	20.308845784	23.981174970	3.672329185	13.486001646
33	19.601280685	19.985728087	0.384447402	0.147799805
34	20.508762955	20.072616650	0.436146305	0.190223599
35	20.155545782	20.199180200	0.043634418	0.001903962
36	19.323456715	21.091276670	1.767819954	3.125187391
37	19.290872352	21.188669089	1.897796737	3.601632455
38	22.504627554	21.246612485	1.258015069	1.582601914
39	22.522679887	21.684821129	0.837858757	0.702007297
40	25.148841309	24.298710521	0.850130788	0.722722356
41	28.323464461	26.829479084	1.493985377	2.231992307
42	31.426420962	27.493344630	3.933076332	15.469089435
43	24.447012995	27.333274254	2.886261259	8.330504056
44	21.795080939	23.626604114	1.831523175	3.354477142
45	25.007853726	24.081685713	0.926168013	0.857787189
46	22.186776520	21.445048547	0.741727974	0.550160387
47	23.370296310	19.659098490	3.711197820	13.772989258
48	24.275704134	20.829641900	3.446062234	11.875344920
49	22.921607904	20.589650202	2.331957701	5.438026721
50	23.704206504	18.408424996	5.295781508	28.045301783
51	23.389317641	18.261809556	5.127508085	26.291339162
52	20.184024668	17.824783950	2.359240718	5.566016766
53	20.765398897	17.372560279	3.392838618	11.511353885
54	19.330239177	14.520186559	4.810052618	23.136606185
55	19.877491167	16.452898812	3.424592355	11.727832799
56	19.246108745	12.562679753	6.683428992	44.668223093
57	20.611444043	13.182648867	7.428795176	55.186997770
58	19.568856773	12.967947149	6.600909624	43.572007861
59	16.101589150	11.882590868	4.218998282	17.799946502
60	19.168659993	12.550416837	6.618243156	43.801142469
61	16.049116250	12.096384116	3.952732134	15.624091323
62	15.445302730	11.676217562	3.769085169	14.206003010
63	16.363066383	12.185604632	4.177461751	17.451186680
64	14.375145952	11.571010572	2.804135380	7.863175230
65	19.060114084	11.900376718	7.159737366	51.261839152
66	15.993598065	11.946276663	4.047321402	16.380810535
67	16.066491435	12.646176649	3.420314786	11.698553234
68	17.533300531	12.517894718	5.015405812	25.154295462
69	13.136100677	14.105338776	0.969238099	0.939422493
70	15.008412485	12.192420957	2.815991528	7.929808283
71	13.861111978	13.185987662	0.675124317	0.455792843
72	13.746219734	13.751065824	0.004846090	0.000023485
73	14.042410936	11.706173478	2.336237459	5.458005463
74	14.443658093	13.038401288	1.405256805	1.974746689
75	12.622954909	10.731200018	1.891754892	3.578736570
76	14.332022278	10.614834292	3.717187986	13.817486523
77	10.418046477	8.164295122	2.253751355	5.079395172
78	10.402172453	7.756682887	2.645489566	6.998615044
79	9.006932748	5.400603648	3.606329100	13.005609578
80	5.695525284	3.693600726	2.001924558	4.007701936

Participant 2				
#	Spontaneous sp.	Controlled reading	Absolute Change	$Change^2$
1	21.419591657	31.034257220	9.614665563	92.441793894
2	21.419591657	31.034257220	9.614665563	92.441793894
3	35.956681533	42.747459221	6.790777688	46.114661612
4	36.752631418	41.193149012	4.440517594	19.718196503
5	45.663831673	48.588607375	2.924775702	8.554312907
6	45.509360319	48.815662950	3.306302631	10.931637088
7	38.849013430	44.264489559	5.415476129	29.327381703
8	38.311507267	40.034445617	1.722938350	2.968516559
9	40.941694686	36.968588126	3.973106559	15.785575732
10	31.710262901	32.181665649	0.471402748	0.222220551
11	29.885230434	30.793052492	0.907822058	0.824140889
12	30.094125104	33.420391752	3.326266648	11.064049813
13	31.531101264	33.455162092	1.924060829	3.702010072
14	34.295238174	32.726485707	1.568752467	2.460984303
15	36.664636158	34.871913567	1.792722591	3.213854290
16	36.908924879	36.086342864	0.822582015	0.676641171
17	36.474188483	34.965257550	1.508930934	2.276872562
18	33.132618378	35.402223201	2.269604822	5.151106050
19	30.383544445	35.090919434	4.707374989	22.159379287
20	26.634849174	31.900350863	5.265501689	27.725508033
21	25.123536108	29.894705473	4.771169365	22.764057113
22	24.463633327	28.688627427	4.224994099	17.850575139
23	27.213234813	28.953485721	1.740250908	3.028473223
24	24.664695372	27.470679050	2.805983678	7.873544401
25	23.371507747	26.021211046	2.649703299	7.020927574
26	24.196640636	25.057585364	0.860944728	0.741225825
27	25.236119267	27.258698392	2.022579126	4.090826320
28	26.740841523	26.367559273	0.373282250	0.139339638
29	28.923651784	27.084241560	1.839410225	3.383429974
30	29.621334482	28.810592133	0.810742349	0.657303157
31	28.211846116	27.943832420	0.268013696	0.071831341
32	26.799763482	28.268547636	1.468784154	2.157326892
33	23.970887418	26.746303858	2.775416440	7.702936415
34	19.805858948	26.051339542	6.245480593	39.006027840
35	20.022683527	24.039783715	4.017100188	16.137093919
36	19.667775232	23.937023754	4.269248522	18.226482943
37	19.924708194	23.263151233	3.338443040	11.145201929
38	20.316266089	23.672608864	3.356342775	11.265036824
39	21.052559748	24.764767058	3.712207311	13.780483118
40	23.192508392	26.716766244	3.524257852	12.420393407
41	27.445260685	31.965722185	4.520461501	20.434572179
42	27.777790328	33.457618986	5.679828657	32.260453578
43	27.461706818	31.531825769	4.070118952	16.565868281
44	26.221560482	28.622915768	2.401355286	5.766507208
45	24.123800058	27.276300445	3.152500386	9.938258686
46	20.409171159	24.724196797	4.315025638	18.619446256
47	19.928781040	22.730106643	2.801325603	7.847425135
48	17.145291939	21.173265147	4.027973209	16.224568170
49	15.512379557	19.878365401	4.365985844	19.061832387
50	14.903515452	19.455903197	4.552387745	20.724234185
51	13.466381191	17.511055864	4.044674674	16.359393216
52	11.568414855	15.825908038	4.257493183	18.126248207
53	10.601185233	13.467431750	2.866246517	8.215369095
54	8.996313774	13.181418875	4.185105101	17.515104705
55	8.148915695	13.634402108	5.485486413	30.090561184
56	9.234604498	12.191258459	2.956653961	8.741802646
57	7.600398859	13.520800918	5.920402059	35.051160536
58	6.957276562	11.611684897	4.654408335	21.663516951
59	7.279971596	13.348412898	6.068441302	36.825979834
60	8.311000832	11.399998970	3.088998138	9.541909498
61	4.396281990	11.739855880	7.343573891	53.928077491
62	9.000419683	13.413887194	4.413467511	19.478695473
63	8.411485020	11.616800869	3.205315849	10.274049692
64	7.857119161	14.386929189	6.529810028	42.638419007
65	10.575347145	10.997405911	0.422058766	0.178133602
66	9.438252618	12.541886447	3.103633829	9.632542944
67	8.041577835	12.205492475	4.163914640	17.338185129
68	8.320639995	11.448583734	3.127943739	9.784032037
69	8.960897815	12.356731495	3.395833681	11.531686386
70	8.157189448	13.117429622	4.960240174	24.603982583
71	9.745873406	12.702300130	2.956426724	8.740458974
72	7.218534120	12.316162035	5.097627915	25.985810357
73	9.736031568	12.140881912	2.404850344	5.783305179
74	10.758778715	12.350815137	1.592036422	2.534579970
75	11.508802811	13.378796541	1.869993730	3.496876551
76	10.624213008	12.550055921	1.925842913	3.708870926
77	8.351743511	11.888201621	3.536458111	12.506535968
78	7.714157565	9.767029003	2.052871438	4.214281142
79	5.945373614	12.215166458	6.269792844	39.310302302
80	4.459383051	8.328540646	3.869157595	14.970380496

	Mean		Median		Variation		Correct range of values	
Participant	Spontan. sp.	Control. read.	Spontan. sp.	Control. read.	Mean var.	Standard dev.	Min.	Max.
Participant 1	25.214141940	23.728043430	23.145952110	21.345830520	3.082223785	3.881481972	-0.799258186	6.963705757
Participant 2	20.592181220	23.806971710	20.730865450	24.911176211	3.534546421	4.011602816	-0.477056395	7.546149236

Participant 3				
#	Spontaneous sp.	Controlled reading	Absolute Change	Change^2
1	20.199704985	12.617393010	7.582311975	57.491454886
2	33.112051670	38.910781711	5.798730041	33.625270083
3	36.133253873	44.619882822	8.486628949	72.022870919
4	41.456645424	46.312197719	4.855552295	23.576388093
5	44.339145643	49.375468062	5.036322418	25.364543502
6	42.740759216	48.049694452	5.308935236	28.184793341
7	46.242420290	46.807851513	0.565431223	0.319712468
8	41.405264944	43.380746782	1.975481839	3.902528495
9	40.709574706	41.519965735	0.810391029	0.656733620
10	34.015326985	35.985822241	1.970495256	3.882851553
11	31.485553767	32.379549157	0.893995390	0.799227757
12	27.403872512	35.869120543	8.465248030	71.660424217
13	29.044846920	34.101608146	5.056761225	25.570834091
14	31.810587042	35.700182916	3.889595874	15.128956061
15	27.606680361	33.481168217	5.874487856	34.509607572
16	30.192186102	36.029470869	5.837284766	34.073893444
17	32.689859640	35.220595474	2.530735834	6.404623860
18	28.654883544	34.194141641	5.539258097	30.683380265
19	30.395623014	32.025582015	1.629959001	2.656766345
20	25.891980635	27.653279244	1.761298609	3.102172791
21	27.410347046	26.207247783	1.203099263	1.447447837
22	27.691106864	25.925227753	1.765879111	3.118329035
23	25.089637974	23.544025533	1.545612440	2.388917816
24	24.052631865	22.579270868	1.473360998	2.170792629
25	23.096299205	22.051997088	1.044302117	1.090566911
26	24.535793386	22.826220975	1.709572411	2.922637829
27	23.920990759	21.332368565	2.588622194	6.700964863
28	24.915424234	20.349196215	4.566228019	20.850438325
29	23.624643392	21.734845120	1.889798272	3.571337509
30	21.172841947	21.254809944	0.081967997	0.006718752
31	19.478298437	20.259042987	0.780744550	0.609562052
32	16.134976798	20.411522584	4.276545786	18.288843863
33	15.657330317	17.127640033	1.470309716	2.161810661
34	12.874040707	16.165377720	3.291337013	10.832899332
35	12.490907102	13.880090586	1.389183484	1.929830753
36	11.813400941	12.877818973	1.064418032	1.132985747
37	13.020622566	13.679890648	0.659268082	0.434634404
38	12.650807864	13.190948460	0.540140596	0.291751863
39	12.963324053	14.178404229	1.215080176	1.476419833
40	14.800391097	16.944950869	2.144559772	4.599136614
41	17.509511930	20.281198187	2.771686257	7.682244709
42	18.537976604	22.464021409	3.926044805	15.413827814
43	17.975001285	22.951010707	4.976009422	24.760669766
44	16.684845170	23.015904700	6.331059531	40.082314781
45	16.149076058	23.147600517	6.998524460	48.979344615
46	16.017541208	22.495640046	6.478098838	41.965764554
47	16.111138675	20.631002496	4.519863821	20.429168962
48	16.194015849	18.716869489	2.522853641	6.364790493
49	15.360545924	16.660906581	1.300360657	1.690937839
50	14.362739058	14.554344511	0.191605452	0.036712649
51	15.607857081	14.651070858	0.956786223	0.915439877
52	15.223519354	12.050842444	3.172676910	10.065878774
53	12.542287008	14.093432128	1.551145120	2.406051182
54	15.087042859	13.135543405	1.951499454	3.808350119
55	12.666996515	13.416211845	0.749215330	0.561323611
56	13.434346542	13.985232251	0.550885709	0.303475065
57	12.642477750	13.534195922	0.891718172	0.795161299
58	13.421479602	13.167355348	0.254124254	0.064579136
59	13.411399431	14.760115431	1.348716000	1.819034849
60	10.371420024	15.589416166	5.217996142	27.227483738
61	12.530129203	14.450625892	1.920496689	3.688307532
62	12.176501162	14.455925338	2.279424176	5.195774575
63	13.691951830	14.180160117	0.488208286	0.238347331
64	13.107939413	14.605764376	1.497824963	2.243479621
65	14.475578854	15.190035439	0.714456586	0.510448213
66	15.966233541	12.975823676	2.990409865	8.942551160
67	17.081963726	13.160164530	3.921799196	15.380508935
68	15.606891382	13.197194878	2.409696504	5.806637242
69	17.206454260	14.538759958	2.667694302	7.116592888
70	17.178258237	14.811788641	2.366469596	5.600178347
71	14.872985358	15.757843006	0.884857648	0.782973057
72	17.033755087	15.361040217	1.672714871	2.797975038
73	13.896513547	15.471636433	1.575122886	2.481012106
74	16.197706035	16.375575993	0.177869958	0.031637722
75	13.962917721	15.107030170	1.144112449	1.308993296
76	11.933259461	14.912994911	2.979735450	8.878823351
77	14.806901379	15.011005908	0.204104529	0.041658659
78	9.249197943	11.710806211	2.461608268	6.059515263
79	11.943459131	11.202288553	0.741170577	0.549333825
80	6.885145045	9.397833123	2.512688078	6.313601378

Participant 4				
#	Spontaneous sp.	Controlled reading	Absolute Change	Change^2
1	16.982539570	17.656482154	0.673942584	0.454198606
2	28.349166664	38.855809000	10.506642336	110.389533172
3	35.361335027	45.103024991	9.741689964	94.900523357
4	39.100661433	47.398391061	8.297729628	68.852316983
5	45.355529261	51.610063734	6.254534473	39.119201473
6	44.665307693	52.425382738	7.760075045	60.218764702
7	45.089289323	45.398428295	0.309138972	0.095566904
8	41.540627549	43.431597070	1.890969520	3.575765727
9	39.327928607	43.558427234	4.230498627	17.897118635
10	40.103092632	40.962606989	0.859514357	0.738764929
11	35.878618438	38.646922633	2.768304196	7.663508120
12	38.339613733	35.600050279	2.739563454	7.505207920
13	37.346135515	37.716232483	0.370096968	0.136971766
14	38.431981252	32.679790287	5.752190964	33.087700891
15	37.412886724	33.907449349	3.505437376	12.288091195
16	38.621617444	37.235984111	1.385633333	1.919979734
17	38.681034478	37.752163696	0.928870781	0.862800928
18	40.339874189	38.521275585	1.818598604	3.307300882
19	35.383771123	36.737536971	1.353765848	1.832681971
20	32.670787584	35.202598597	2.531811013	6.410067004
21	36.400106440	35.025863222	1.374243218	1.888544421
22	31.899510623	32.378108139	0.478597516	0.229055582
23	33.099425158	30.615263604	2.484161554	6.171058627
24	32.679231751	28.829274680	3.849957071	14.822169449
25	28.567867100	30.491498113	1.923631013	3.700356273
26	29.629006975	31.272137925	1.643130950	2.699879319
27	26.027596521	31.513686607	5.486090085	30.097184424
28	30.791523088	32.320327418	1.528804330	2.337242680
29	24.851830368	31.875215146	7.023384778	49.327933737
30	25.400832106	31.351144770	5.950312664	35.406220797
31	25.782785860	31.093084645	5.310298785	28.199273186
32	22.049318224	28.419695732	6.370377508	40.581709590
33	22.229534061	27.268735346	5.039201285	25.393549592
34	19.924647200	25.604702922	5.680055721	32.263032997
35	21.370683493	24.157560570	2.786877076	7.766683838
36	20.005761684	23.058449967	3.052688283	9.318905753
37	21.461123321	21.843463402	0.382340081	0.146183938
38	19.684132542	23.122478811	3.438346269	11.822225068
39	21.986062048	24.198665889	2.212603841	4.895615758
40	22.464005019	26.501513705	4.037508686	16.301476388
41	29.061411463	30.269149067	1.207737604	1.458630121
42	26.575889131	29.633289549	3.057400418	9.347697318
43	23.923121508	30.956322257	7.033200749	49.465912773
44	22.760982819	30.110853908	7.349871089	54.020605020
45	23.006901922	29.919649481	6.912747559	47.786078814
46	19.800812672	28.586560544	8.785747871	77.189365660
47	22.536784103	28.084869930	5.548085827	30.781256346
48	21.410570849	26.935842133	5.525271283	30.528622756
49	20.977035390	27.040556624	6.063521234	36.766289757
50	19.532233661	27.566879407	8.034645746	64.555532260
51	19.575761940	26.398677301	6.822915361	46.552174023
52	19.555007503	24.948940515	5.393933012	29.094513339
53	19.403228522	23.398416189	3.995187667	15.961524493
54	20.088736671	22.978728636	2.889991965	8.352053560
55	20.829076273	21.800964334	0.971888061	0.944566403
56	19.518120534	21.542881200	2.024760666	4.099642606
57	16.309184917	20.630685541	4.321500624	18.675367642
58	16.984461530	18.339186995	1.354725465	1.835281084
59	19.985407746	18.427387286	1.558020460	2.427427754
60	16.087254834	17.905806448	1.818551613	3.307129971
61	18.291793400	18.857580491	0.565787091	0.320115033
62	14.235819515	18.156214676	3.920395162	15.369498223
63	14.628484951	17.596280485	2.967795534	8.807810332
64	12.824303345	15.273720134	2.449416789	5.999642606
65	13.281039945	15.958361773	2.677321829	7.168052174
66	11.906553576	14.419038897	2.512485321	6.312582488
67	11.602220156	14.342556368	2.740336212	7.509442553
68	12.702946471	14.702395430	1.999448958	3.997796138
69	9.833848619	15.295295534	5.461446915	29.827402408
70	12.040195590	16.513750144	4.473554554	20.012690351
71	11.948448799	16.337160209	4.388711410	19.260787838
72	12.940275826	17.742843422	4.802567596	23.064655510
73	12.231564934	17.380261184	5.148696250	26.509073074
74	13.497666108	16.702269941	3.204603833	10.269485728
75	11.793968603	17.079088366	5.285119762	27.932490899
76	12.751481126	14.863136508	2.111655382	4.459088452
77	14.286761169	15.087850812	0.801089643	0.641744616
78	11.699273783	14.439608727	2.740334944	7.509435605
79	10.708335299	13.152575311	2.444240013	5.974309240
80	8.877256665	10.846283076	1.969026411	3.877065006

	Mean		Median		Variation		Correct range of values	
Participant	Spontan. sp.	Control. read.	Spontan. sp.	Control. read.	Mean var.	Standard dev.	Min.	Max.
Participant 3	20.525487480	21.949145140	16.195860940	17.036295450	2.637058000	3.352208159	-0.715150159	5.989266159
Participant 4	24.191137550	27.269537580	21.723592685	27.154645980	3.735396585	4.419554869	-0.684158284	8.154951455

Spontaneous sp. + Controlled reading Comparation				
#	1a	4b	Absolute Change	Change²
1	24.604323339	17.656482154	6.947841185	48.272497131
2	25.206453100	38.855809000	13.649355900	186.304916482
3	37.212535041	45.103024991	7.890489950	62.259831655
4	39.941754482	47.398391061	7.456636579	55.601429071
5	45.525780171	51.610063734	6.084283564	37.018506485
6	47.506762227	52.425382738	4.918620511	24.192827729
7	45.883792090	45.398428295	0.485363795	0.235578013
8	46.424713455	43.431597070	2.993116386	8.958745697
9	44.843520345	43.558427234	1.285093110	1.651464302
10	38.748832059	40.962606989	2.213774930	4.900799441
11	34.756082255	38.646922633	3.890840378	15.138638851
12	33.450488574	35.600050279	2.149561705	4.620615523
13	33.973899610	37.716232483	3.742332874	14.005055336
14	35.689745944	32.679790287	3.009955656	9.059833053
15	36.283492521	33.907449349	2.376043172	5.645581156
16	38.317943442	37.235984111	1.081959332	1.170635995
17	40.034872380	37.752163696	2.282708683	5.210758932
18	38.121607199	38.521275585	0.399668386	0.159734818
19	35.523019186	36.737536971	1.214517785	1.475053450
20	33.586626761	35.202598597	1.615971836	2.611364976
21	33.937590961	35.025863222	1.088272261	1.184336514
22	37.056373612	32.378108139	4.678265473	21.886167836
23	38.321905861	30.615263604	7.706642257	59.392334880
24	34.170826671	28.829274680	5.341551991	28.532177668
25	33.255780784	30.491498113	2.764282671	7.641258688
26	31.131595417	31.272137925	0.140542508	0.019752196
27	31.033010188	31.513686607	0.480676419	0.231049819
28	31.432485926	32.320327418	0.887841492	0.788262516
29	27.517377162	31.875215146	4.357837983	18.990751888
30	25.344820740	31.351144770	6.006324030	36.075928353
31	25.625172752	31.093084645	5.467911893	29.898060467
32	20.308845784	28.419695732	8.110849947	65.785886869
33	19.601280685	27.268735346	7.667454661	58.789860976
34	20.508762955	25.604702922	5.095939966	25.968604140
35	20.155545782	24.157560570	4.002014788	16.016122360
36	19.323456715	23.058449967	3.734993252	13.950174592
37	19.290872352	21.843463402	2.552591050	6.515721070
38	22.504627554	23.122478811	0.617851257	0.381740176
39	22.522679887	24.198665889	1.675986003	2.808929082
40	25.148841309	26.501513705	1.352672396	1.829722610
41	28.323464461	30.269149067	1.945684606	3.785688587
42	31.426420962	29.633289549	1.793131413	3.215320266
43	24.447012995	30.956322257	6.509309261	42.371107061
44	21.795080939	30.110853908	8.315772969	69.152080069
45	25.007853726	29.919649481	4.911795755	24.125737540
46	22.186776520	28.586560544	6.399784024	40.957235549
47	23.370296310	28.084869930	4.714573620	22.227204421
48	24.275704134	26.935842133	2.660137999	7.076334172
49	22.921607904	27.040556624	4.118948720	16.965738562
50	23.704206504	27.566879407	3.862672903	14.920241956
51	23.389317641	26.398677301	3.009359660	9.056245565
52	20.184024668	24.948940515	4.764915847	22.704423029
53	20.765398897	23.398416189	2.633017292	6.932780058
54	19.330239177	22.978728636	3.648489459	13.311475334
55	19.877491167	21.800964334	1.923473166	3.699749022
56	19.246108745	21.542881200	2.296772455	5.275163712
57	20.611444043	20.630685541	0.019241498	0.000370235
58	19.568856773	18.339186995	1.229669778	1.512087764
59	16.101589150	18.427387286	2.325798136	5.409336968
60	19.168659993	17.905806448	1.262853545	1.594799077
61	16.049116250	18.857580491	2.808464241	7.887471392
62	15.445302730	18.156214676	2.710911946	7.349043578
63	16.363066383	17.596280485	1.233214102	1.520817021
64	14.375145952	15.273720134	0.898574182	0.807435561
65	19.060114084	15.958361773	3.101752311	9.620867396
66	15.993598065	14.419038897	1.574559168	2.479236573
67	16.066491435	14.342556368	1.723935067	2.971952116
68	17.533300531	14.702395430	2.830905101	8.014023690
69	13.136100677	15.295295534	2.159194858	4.662122434
70	15.008412485	16.513750144	1.505337659	2.266041468
71	13.861111978	16.337160209	2.476048231	6.130814841
72	13.746219734	17.742843422	3.996623688	15.973000902
73	14.042410936	17.380261184	3.337850248	11.141244279
74	14.443658093	16.702269941	2.258611848	5.101327481
75	12.622954909	17.079088366	4.456133456	19.857125378
76	14.332022278	14.863136508	0.531114230	0.282082326
77	10.418046477	15.087850812	4.669804335	21.807072526
78	10.402172453	14.439608727	4.037436274	16.300891668
79	9.006932748	13.152575311	4.145642564	17.186352265
80	5.695525284	10.846283076	5.150757792	26.530305832

Spontaneous sp. + Controlled reading Comparation				
#	4a	1b	Absolute Change	Change²
1	16.982539570	33.767431690	16.784892119	281.732603456
2	28.349166664	33.767431690	5.418265025	29.357595886
3	35.361335027	43.463791223	8.102456196	65.649796403
4	39.100661433	43.744176981	4.643515548	21.562236641
5	45.355529261	48.850687408	3.495158147	12.216130470
6	44.665307693	48.759088895	4.093781202	16.759044532
7	45.089289323	44.390664452	0.698624871	0.488076710
8	41.540627549	41.411541743	0.129085807	0.016663145
9	39.327928607	36.925939338	2.401989269	5.769552447
10	40.103092632	36.285600293	3.817492339	14.573247761
11	35.878618438	33.254983763	2.623634674	6.883458905
12	38.339613733	36.785137340	1.554476393	2.416396857
13	37.346135515	35.215411945	2.130723570	4.539982933
14	38.431981252	37.494830938	0.937150314	0.878250710
15	37.412886724	36.946034398	0.466852327	0.217951095
16	38.621617444	40.207624469	1.586007025	2.515418282
17	38.681034478	40.364406066	1.683371589	2.833739905
18	40.339874189	40.482473987	0.142599799	0.020334703
19	35.383771123	35.905984170	0.522213047	0.272706466
20	32.670787584	33.463998696	0.793211112	0.629183868
21	36.400106440	30.899714326	5.500392113	30.254313401
22	31.899510623	29.066094610	2.833416013	8.028246300
23	33.099425158	27.227787199	5.871637959	34.476132320
24	32.679231751	28.864419001	3.814812750	14.552796318
25	28.567867100	31.481141213	2.913274113	8.487166056
26	29.629006975	31.437661570	1.808654595	3.271231443
27	26.027596521	31.435056849	5.407460328	29.240627197
28	30.791523088	30.575860510	0.215662578	0.046510348
29	24.851830368	28.971983115	4.120152747	16.975658661
30	25.400832106	28.005760693	2.604928588	6.785652946
31	25.782785860	26.286644835	0.503858975	0.253873867
32	22.049318224	23.981174970	1.931856746	3.732070486
33	22.229534061	19.985728087	2.243805974	5.034665249
34	19.924647200	20.072616650	0.147969450	0.021894958
35	21.370683493	20.199180200	1.171503294	1.372419967
36	20.005761684	21.091276670	1.085514985	1.178342784
37	21.461123321	21.188669089	0.272454232	0.074231309
38	19.684132542	21.246612485	1.562479943	2.441343572
39	21.986062048	21.684821129	0.301240919	0.090746091
40	22.464005019	24.298710521	1.834705503	3.366144281
41	29.061411463	26.829479084	2.231932379	4.981522145
42	26.575889131	27.493344630	0.917455500	0.841724594
43	23.923121508	27.333274254	3.410152746	11.629141754
44	22.760982819	23.626604114	0.865621295	0.749300227
45	23.006901922	24.081685713	1.074783791	1.155160196
46	19.800812672	21.445048547	1.644235874	2.703511610
47	22.536784103	19.659098490	2.877685613	8.281074487
48	21.410570849	20.829641900	0.580928949	0.337478444
49	20.977035390	20.589650202	0.387385188	0.150067284
50	19.532233661	18.408424996	1.123808666	1.262945917
51	19.575761940	18.261809556	1.313952384	1.726470868
52	19.555007503	17.824783950	1.730223553	2.993673544
53	19.403228522	17.372560279	2.030668243	4.123613511
54	20.088736671	14.520186559	5.568550111	31.008750344
55	20.829076273	16.452898812	4.376177461	19.150929167
56	19.518120534	12.562679753	6.955440781	48.378163463
57	16.309184917	13.182648867	3.126536050	9.775227672
58	16.984461530	12.967947149	4.016514381	16.132387771
59	19.985407746	11.882590868	8.102816878	65.655641353
60	16.087254834	12.550416837	3.536837997	12.509223017
61	18.291793400	12.096384116	6.195409284	38.383096190
62	14.235819515	11.676217562	2.559601953	6.551562158
63	14.628484951	12.185604632	2.442880319	5.967664251
64	12.824303345	11.571010572	1.253292773	1.570742776
65	13.281039945	11.900376718	1.380663227	1.906230946
66	11.906553576	11.946276663	0.039723086	0.001577924
67	11.602220156	12.646176649	1.043956493	1.089845159
68	12.702946471	12.517894718	0.185051753	0.034244151
69	9.833848619	14.105338776	4.271490157	18.245628157
70	12.040195590	12.192420957	0.152225368	0.023172563
71	11.948448799	13.185987662	1.237538862	1.531502436
72	12.940275826	13.751065824	0.810789998	0.657380421
73	12.231564934	11.706173478	0.525391457	0.276036183
74	13.497666108	13.038401288	0.459264820	0.210924175
75	11.793968603	10.731200018	1.062768585	1.129477066
76	12.751481126	10.614834292	2.136646834	4.565259694
77	14.286761169	8.164295122	6.122466048	37.484590503
78	11.699273783	7.756682887	3.942590896	15.544022975
79	10.708335299	5.400603648	5.307731651	28.172015277
80	8.877256665	3.693600726	5.183655939	26.870288898

Mean		Median		Variation		Correct range of values	
1a	*4b*	*1a*	*4b*	Mean var.	Standard dev.	Min.	Max.
25.214141940	27.269537580	23.145952110	27.154645980	3.395191818	4.164377292	0.769185474	7.559569110
4a	*1b*	*4a*	*1b*	Mean var.	Standard dev.	Min.	Max.
24.191137550	23.728043430	21.723592685	21.345830520	2.597119919	3.661928626	1.064808707	6.259048545