An approach to likelihood-ratio-based Forensic Voice Comparison: acoustic-phonetic analysis of same-sex siblings

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1. Introduction

Previous studies have shown that the acoustical analysis of very similar speakers, whether they are siblings [1] or twins [2,3] is very useful in Forensic Voice Comparison. Twins speech may be considered the most extreme example of similarity between speakers, due to their shared genetic information as well as their usually shared educational and environmental influences. However, in fact only identical (monozygotic) twins shared 100% of their genes. Siblings could thus be as good examples of little between-speaker variation as non-identical (dizygotic) twins are inasmuch as in both types of kinship each member of the couple shares 50% of his genetic information with the other member.

2. Methodology

2.1. Data collection and acoustic measurement

The speech samples for comparison come from three Spanish-speaking adult full brothers. The background population is made up of 26 adult male speakers, selected from the Spanish Guardia Civil Ahumada Corpus. The segments analyzed, obtained from read speech, are the stressed vowels [á] and [ó] appearing between [p, t, k] and [s]; e.g. [kása]. Automatic LPC formant analysis was carried out in order to obtain F1-F4 mean frequencies. Two different sessions per speaker were analyzed.

2.2. Statistic analysis

In order to calculate likelihood ratios, F1, F2, F3 and F4 mean values were entered into the multivariate-kernel-density (MVKD) formula described in [4] and implemented in [5]. This formula assesses the difference between suspect and offender samples with respect to their typicality in reference to the background population. Under a likelihood-ratio (LR) approach the task of the forensic scientist is to provide the court with a strength-of-evidence statement in answer to the question: *"How much more likely are the observed differences between the known and questioned samples to occur under the hypothesis that the questioned sample has the same origin as the known sample than under the hypothesis that it has a different origin?"* The answer to this question can be quantitatively expressed as a LR, calculated using this formula::

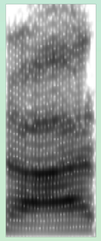
$$LR = \frac{p(E \mid H_{do})}{p(E \mid H_{so})}$$

LR = Likelihood Ratio
E = evidence (the measured differences between the samples of known and questioned origin)
P (E|H) = probability of E given H
H_{so} = same-origin hypothesis
H_{do} = different-origin hypothesis

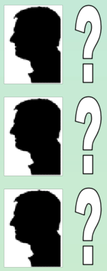
Interpretation of the values obtained:
LR > 1 : the evidence is more likely to occur under the H_{so}
LR < 1 : the evidence is more likely to occur under the H_{do}

3. Results

The LRs for [á] and [ó] are presented in the table below. The largest LR obtained was 91.6, for same-speaker comparisons, indicating that one would be 91.6 times more likely to observe the mean formant differences between the speech samples under the hypothesis that they were produced by the same speaker than under the hypothesis that they were produced by different speakers.



		[á]		[ó]	
SUSPECT	OFFENDER	LR	1/LR	LR	1/LR
1	1	2.39	0.418	26.1	0.0383
1	2	0.532	1.88	0.105	9.55
1	3	0.804	1.24	27.8	0.036
2	2	5.83	0.172	5.39	0.186
2	3	2.11	0.473	49.7	0.0201
3	3	6.19	0.162	91.6	0.0109



4. Discussion and Conclusions

We have presented results of a likelihood-ratio-based forensic speaker discrimination using mean formant frequencies of two Spanish vowels in speakers with presumably little between-speaker differences. Although the LRs obtained are not particularly impressive, we find good consistent-with-fact results for same-speaker comparisons. There are differences between the two vowels in their discrimination effectiveness and there are also different results for each of the brothers.

5. Further research

These are some ways in which it may be possible to improve on the results reported here: (1) A larger amount of tokens per parameter will allow for better LR estimates. (2) Analyzing data from additional vowels may also lead to further improvement in discrimination. (3) We have made use of read speech data recorded in a laboratory setting, so a promising future research line seems to be the use of more forensically realistic conditions, e.g. non-contemporaneous, telephone-transmitted speech data.

6. Acknowledgements

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7. References

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