Prosody can help distinguish identical twins: implications for forensic speaker comparison

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BACKGROUND & OBJECTIVE

- **Background:** Voice similarity of identical twins attracts the attention of forensic specialists (also in forensic studies):
  - Why? widely assumed that twins’ voices are very similar → especially difficult recognition (e.g. [1])
  - However: hardy comparable results across studies
  - because of different number of speakers, speaking style and forensic comparison methods
  - so, how to assess the relative importance of different systems or the value of a set of acoustic features over others?
- **Some exceptions:** Twin Corpus [2] (highest t(68)=2.16); some twin pairs and speaking style (see Materials & Method)
- **but still different comparison methods/system output**

MATERIALS & METHOD

- **Subjects:** 24 speakers from the Twin Corpus collected by ESS [2]
  - 12 monophonic (MZ) twin pairs
  - male; aged 20-36
  - native speakers of Standard Peninsular Spanish
- **Task:**
  - participant - researcher spontaneous conversations
  - over the phone (~10min)
- **Speech material:**
  - 2 mins min speech * 24 speakers
  - Inter-Pause (IP) stretches per speaker: 31 (mean); 6 (SD)
- **Corpus annotation:**
  - Manual transcription
  - Semi-automatic alignment and segmentation at the phonetic and syllable level using EasyAlign

RESULTS

- **PCA analysis:**
  - 8 components extracted
  - 1st variable selected per component (highest loadings):
    - ΔV · varcoC · nC · meanCLn · ΔSylLn · varcoP · nPVI-C · nPVI-V
- **Dissimilarity measures (ED) and significance tests (t test)**

### Statistical analysis:

1. **Principal Component Analysis (PCA)**
   - In order to reduce the number of variables
   - Rotation method: Varimax with Kaiser normalization
2. **Dissimilarity measures and significance tests**
   - Following method described in [8] for twin speaker comparisons
   - Both analyses based on only 8 measures after PCA:
     a) **Euclidean distances**
        - based on the 8 prosodic measures together
        - z-score normalized & rescaled to 0-1 range
        - lower values indicate ‘more similar’ → higher values indicate ‘more different’
     b) **Independent t-tests**
        - based on the separate prosodic measures - two-tailed tests with Bonferroni correction

### Discussion

- Overview, we observed variation in the temporal patterns exhibited by twin pairs. As highlighted by the ED, very few twin pairs are really similar (twin pairs 06 and 12) when considering the 8 prosodic characteristics.
- Upon further examination, t-tests revealed which features contribute the most to distinguish between twins.
- Interestingly, both intensity and duration measures allow twin differentiation - depending on the pair.
- The finding that varcoP can distinguish twin pair 04 is particularly relevant, as these speakers were misidentified by the MFCC-based ASR system. The system based on glottal source features gave LIR = 0 (no decision). (See Table 1)

CONCLUSIONS

- Rhythmic variability exists even between extremely similar speakers (i.e. identical twins).
- Prosody offers idiogenic information, possibly complementary to that provided by forensic systems based on vocal tract and glottal characteristics.
- Some of the investigated measures proved useful to tell certain twins apart where other systems had failed to distinguish them (see Table 1).
- Future hybrid approaches should consider adding prosodic measures for a better characterization of speakers and hence for more reliable forensic comparison systems.
- In terms of methods, PCA seems a good method for dimension reduction, especially with highly correlated measures.

- **Limitations:**
  - The method used to investigate how similar/different twin pairs are follows previous studies on twins [8] but differ from common forensic approaches / output (e.g. EER, LLRs).
- **Future work:**
  - Calculate weighted Euclidean distances.
  - Explore different ways to combine the output provided by several forensic comparison systems.
  - Take into account typological aspects from similarity measures.

**REFERENCES**


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