Glottal Source Parameters for Forensic Voice Comparison: an Approach to Voice Quality in Twins' Voices

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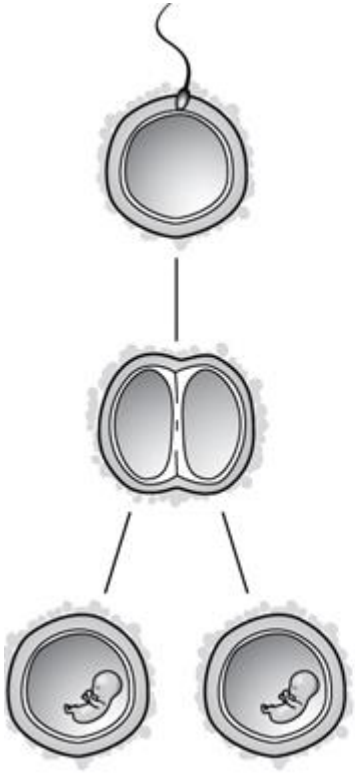
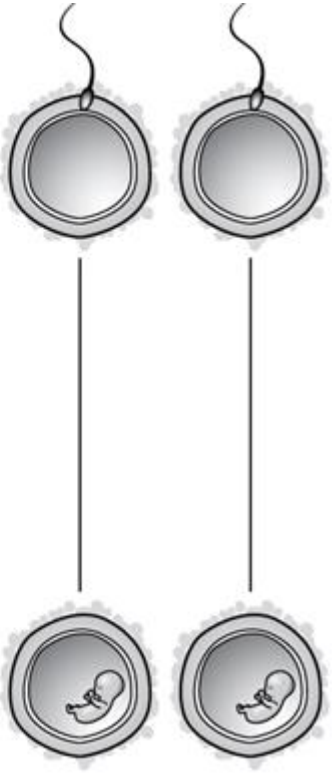
1. Introduction

- **Research on twins' voices**

Monozygotic



Dizygotic



1. Introduction

- **Research on twins' voices**

Lundström, A. (1948)

Nolan, F. and Oh, T. (1996)

Johnson, K. & Azara, M. (2000)

Loakes, D. (2006)

Whiteside, S.P. & Rixon, E. (2003)

Künzel, H. (2010)

Ryalls, J. et al. (2004)

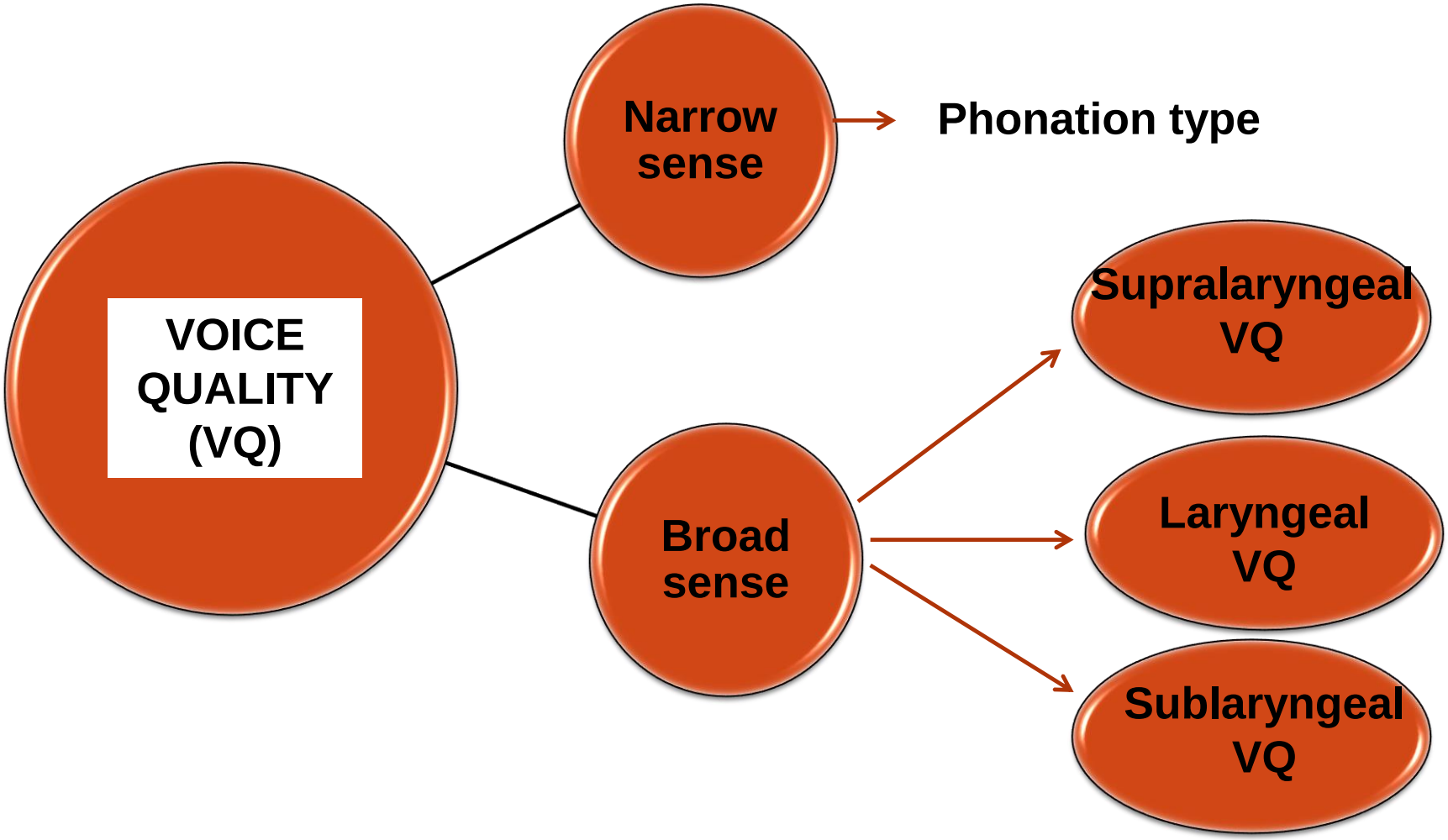
Weirich, M. (2012)

Kovas, Y. et al. (2005)

CONCLUSIONS

1. Introduction

- **Research on voice quality**



1. Introduction

- **Research on voice quality**

Nolan, F. (1983) Künzel, H. (1987) Hollien, H. (1990) Baldwin, J. & French, P. (1990) Rose, P. (2002)	Moosmüller, S. (2001) Evans, I. & Foulkes, P. (2009) Czajkowski, A. & Dellwo, W. (2009)
Jessen, M. (1997) Köster, O. & Köster, J-P. (2004) Nolan, F. (2005) Nolan, F. (2007)	Wagner, I. (1995) Farrús, M. et al. (2007) Gómez-Vilda, P. et al. (2008) Enzinger, E. et al. (2012)

2. Material and method

- **Speakers**

MZ twins	DZ twins	Brothers	Reference population
6 pairs	4 pairs	2 pairs	8 + 10 = 18 sp.
Male			
31.6 years (mean)			
Castillian Spanish			
No voice pathologies			
No hearing difficulties			

2. Material and method

- **Equipment**

Countryman E6i
omnidirectional
flat-frequency response

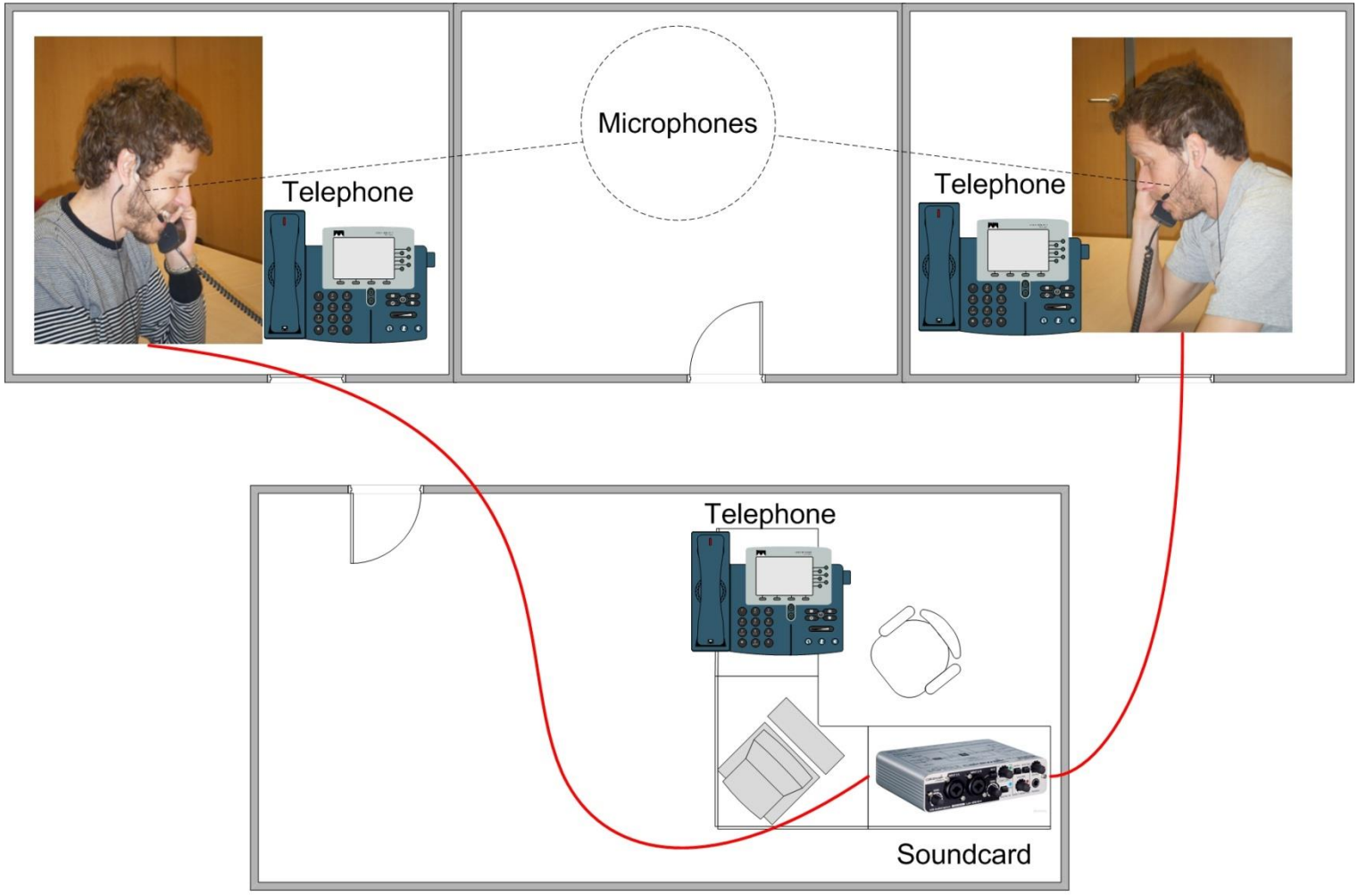
Roland Cakewalk
UA25EX

Adobe ® Audition®
CS5.5

- 44.1 kHz frequency sampling
- 16 bit amplitud sampling
- raw PCM wave files

2. Material and method

- **Data collection**



2. Material and method

- **Data collection**

Morrison, G.S. et al. (2012 in press)

  - 2 non-contemporaneous recordings (2-4 weeks)
  - 4 tasks:
    - Task 1- Conversation with brother/twin [close friend]
      - semi-structured informal conversation
        - Labovian “danger of death question”
        - Loakes, D. (2006)

10 min

    - Task 4- Conversation / Interview with researcher
      - objective: need to remember → hesitation speech (e.g. pause fillers)
      - Foulkes, P., Carrol,G. and Hughes, S. (2004) Tschäpe, N. et al. (2005), Cicres, J. (2007)

10 min

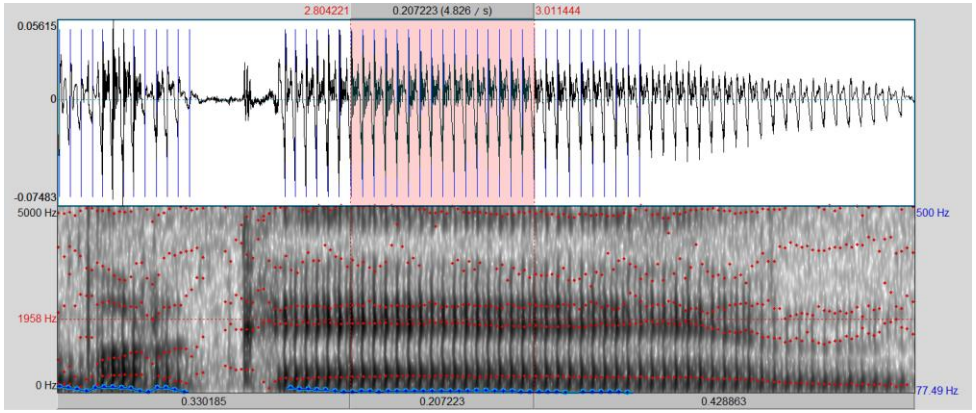
2. Material and method

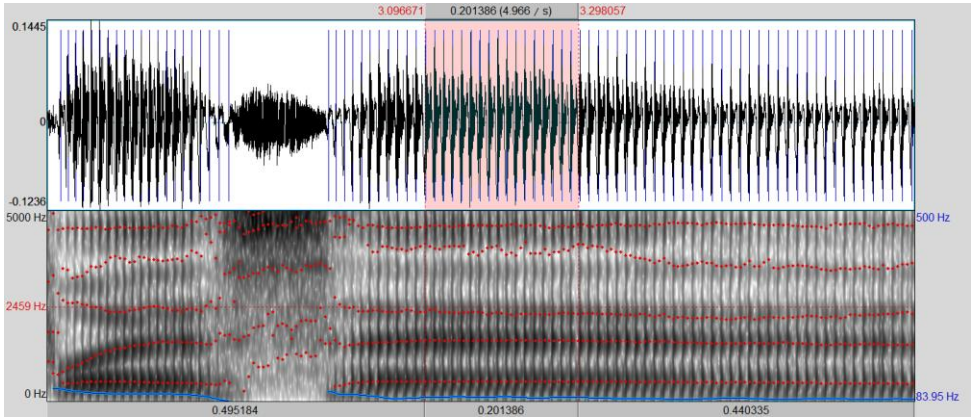
- **Speech material: pause fillers (PF)**

2. Material and method

- **Segment selection:** “eh” [e]

  - while articulating & between silent pauses

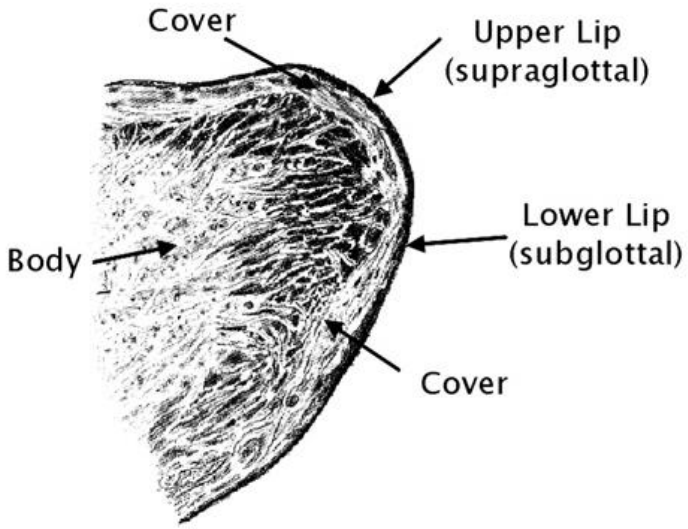




- 160-240 milliseconds
- 557 tokens
- 8.5 tokens per recording session per speaker

2. Material and method

- **Glottal source features**



-**Jitter**: ratio between next cycle duration difference and their mean

-**Shimmer**: ratio between next cycle amplitude difference and their mean

- Biomechanical estimates from the vocal fold **body** and **cover**:

-Dynamic mass
-Losses
-Stiffness

GLOTTEX®
voice analysis system
version 7.0 March 2012

2. Material and method

- **Likelihood Ratio calculation**

- Cross-validated LR
- MVKD (Aitken and Lucy, 2004) - Morrison, 2007

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

Sp. 1 (1st session) - Sp. 1 (2nd session) → **Same-speaker comparison**
Sp. 1 (1st session) - Sp. 2 (2nd session) → **Same-pair comparison**
Sp. 1 (1st session) - Sp. 3 (2nd session)
Sp. 1 (1st session) - Sp. 4 (2nd session)
Sp. 1 (1st session) - Sp. 5 (2nd session)
…..... - ……..
→ **Different-speaker comparisons**

- In each comparison, 3 elements:

SUSPECT **OFFENDER** **BACKGROUND POPULATION**

3. Results

- **Identical (MZ) Twins**

SP	JITTER + SHIMMER	JITTER + SHIMMER + BIOMECH.	BODY (all)	COVER (all)	BODY + COVER
1-2	1.41	2.88	1.33	4.03	2.23
3-4	1.23	23.94	**4.72**	3.70	18.53
5-6	**1.47**	**99.53**	**4.68**	**11.41**	**68.73**
7-8	1.16	6.15	4.03	9.93	5.53
9-10	1.11	**80.89**	3.39	**36.87**	**88.63**
11-12	1.28	0.001	0.011	0.003	0.001

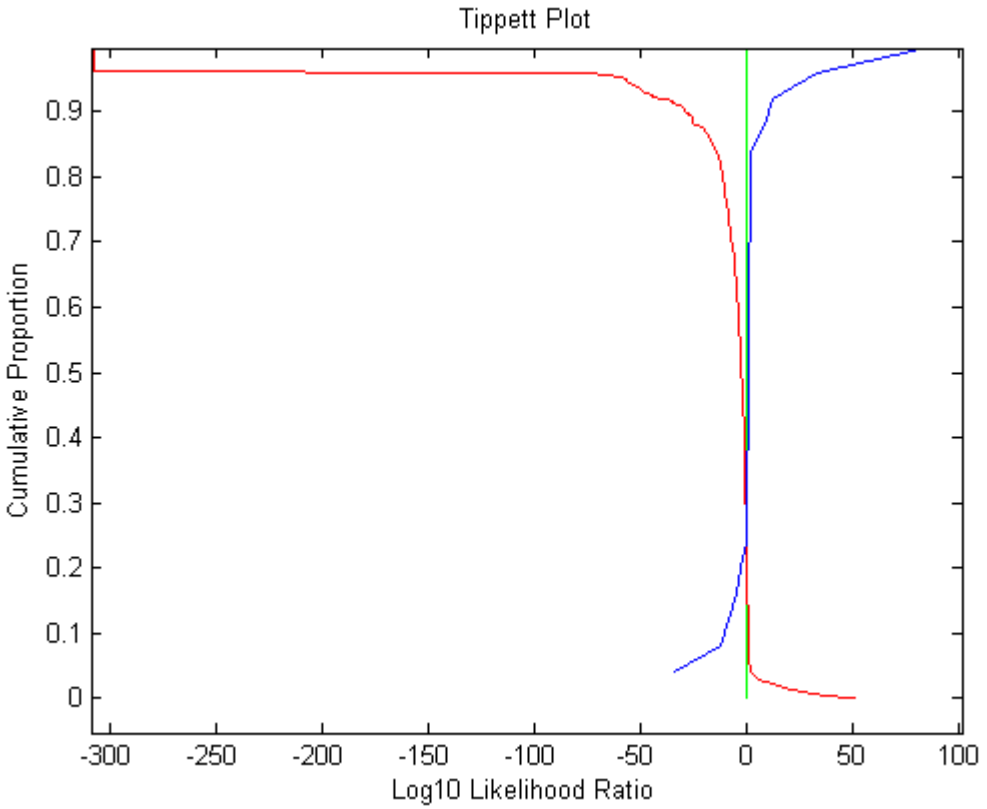
3. Results

- **Non-identical (DZ) Twins**

SP	JITTER + SHIMMER	JITTER + SHIMMER + BIOMECH.	BODY (all)	COVER (all)	BODY + COVER
13-14	0.001	4.59E-42	0.003	3.15E-06	8.69E-21
15-16	1.27	0.07	1.47	2.19	0.78
17-18	1.45	0.17	2.73	0.08	0.18
19-20	1.21	0.92	0.29	2.89	1.34

3. Results

- **Overall performance**



Forensic system:
body + cover
Cllr = 0.706

Forensic system:
body + cover
+ jitter + shimmer
Cllr = 0.655

4. Conclusion

- **Why studying twins?**
  - Low incidence but extreme case of similarity (very challenging conditions)
  - Voice quality perspective: biomechanical estimates

- **Overall better performance:** cover and body parameters
- **Performance in twins:** variation between pairs.

- **Contributions:**
  - Method for eliciting pause fillers
  - Avoid the “observer’s paradox”
  - Ensure everyday interactional style

5. Future research

- **More twins**
- **Siblings**
- **Larger reference population**
- **Other methods for likelihood calculation**
- **Telephone filter**

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Dr. P. Gómez Vilda

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THANK YOU FOR YOUR ATTENTION!

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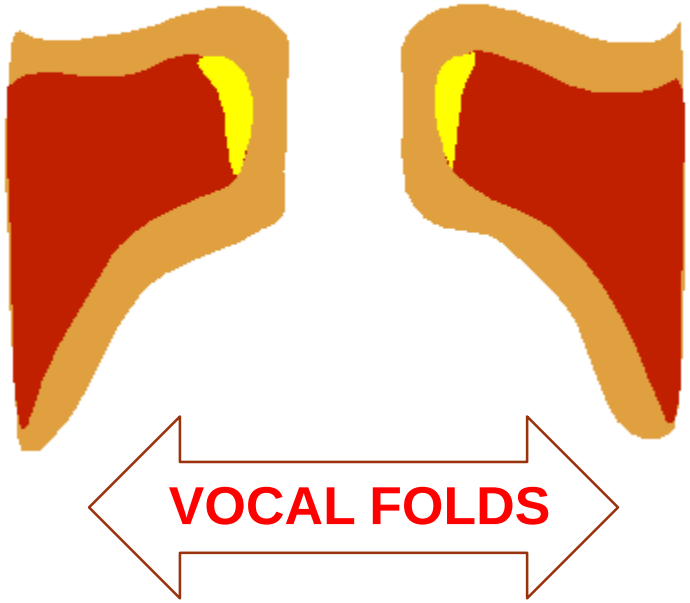
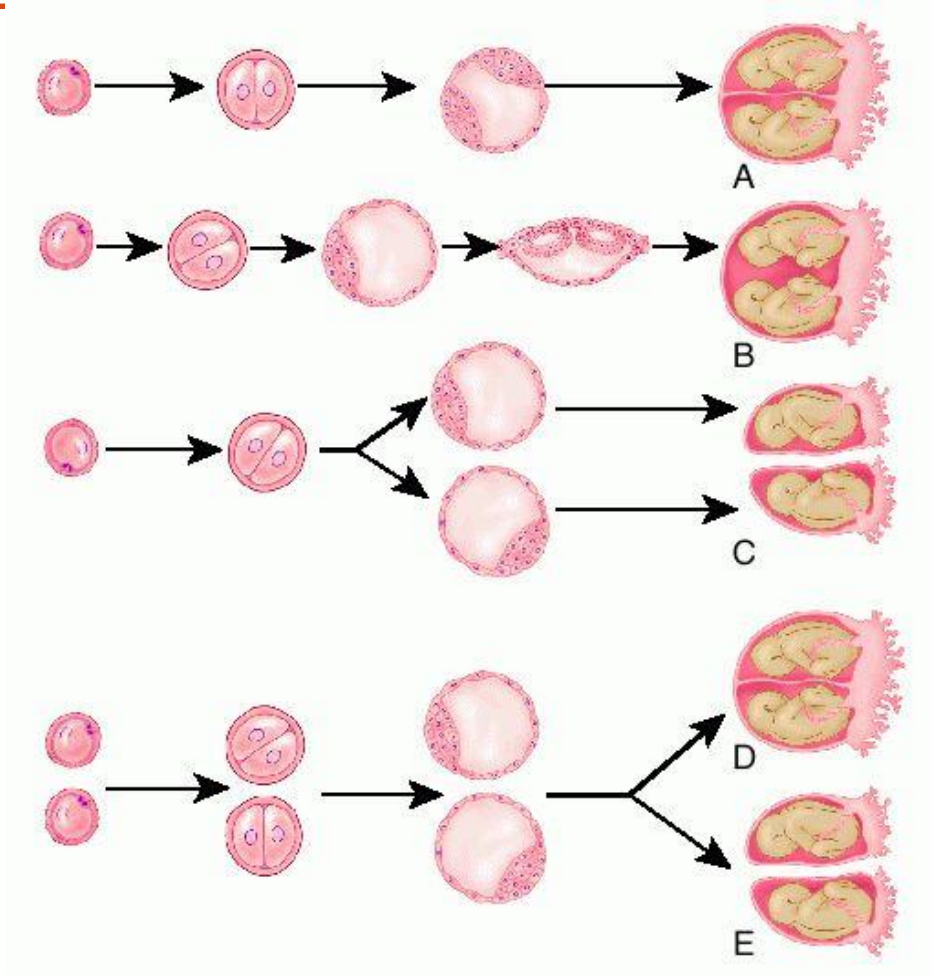
2. Research on Twins' Voices

2.3. Parameters analyzed

Glottal source features:

biomechanical estimates of
vocal fold **mass, stiffness** and **unbalance**



2. Research on Twins' Voices