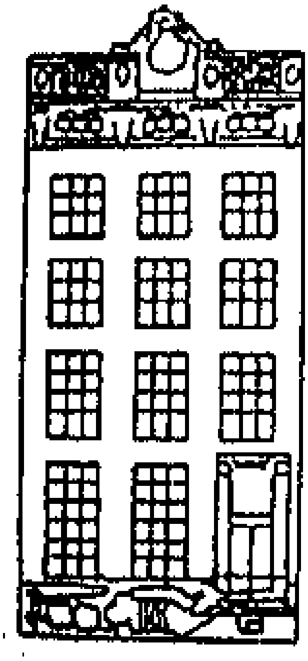
CAN STANDARD ANALYSIS TOOLS BE USED ON DECOMPRESSED SPEECH?

R.J.J.H. van Son
Institute of Phonetic Sciences/ACLC
University of Amsterdam
Herengracht 338, 1016CG Amsterdam
Rob.van.Son@hum.uva.nl



Introduction

Large Speech Corpora aim at

- Natural Interactions
- Field Recordings by Volunteers
- Large Amounts of it *(Months)*
- Internet Distribution

Solutions

- Minidisc Recorders
- Compressed Storage
- Compressed Distribution

Question:

How much Phonetics can be done on Decompressed Speech?

Methods

SPEECH:

125 Segmented sentences, read and retold
8 speakers, 4 male and 4 female (***IFAcorpus***)
Recorded on 2 microphones to CD-audio

TEST CONDITIONS:

Microphone change: From HF condenser (Sennheiser MKH 105) to head-mounted dynamic (Shure SM10A)
Sony Minidisc: *ATRAC3* on Walkman MZ-R909
Ogg Vorbis (40 kbs): *1.0rc3*, 45 kbs effective (factor 15.5)
Ogg Vorbis (80 kbs): *1.0rc3*, 85 kbs effective (factor 8.3)
MP3 (192 kbs): *LAME 3.92*, 204 kbs effective (factor 3.5)

All compressed recordings aligned to within **0.5 ms** of original

Analysis using *praat 4.0.16*:

- Pitch (*Simple*: Auto Correlation)
- Formants 1-3 (*Burg* algorithm)
- Spectral Center of Gravity (first spectral moment)

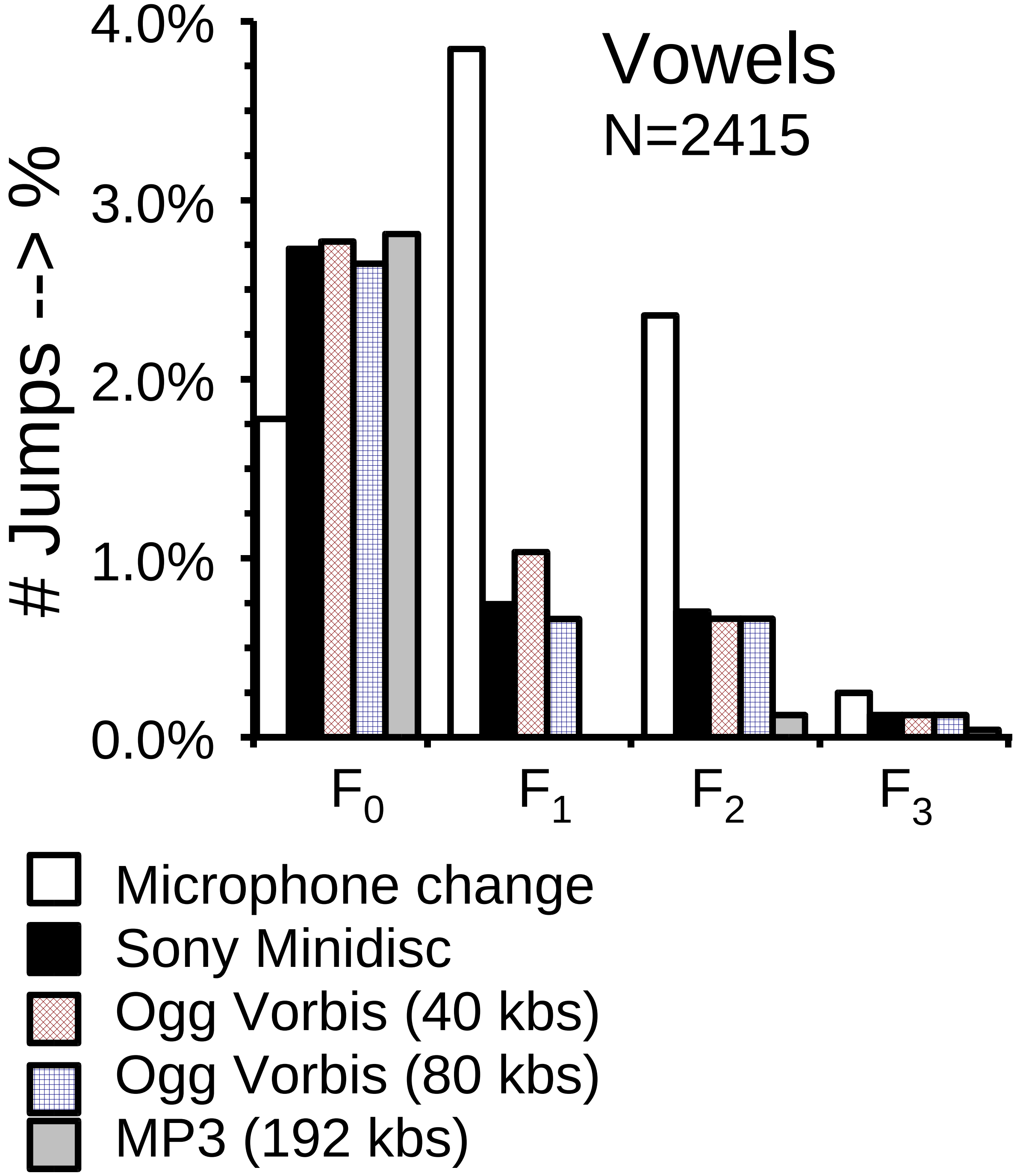
Compare *Decompressed* and *Original* Recordings
Use *Semitones* to Equalize Variances

Jump Errors

- Pitch can pick wrong (sub-)harmonic
- Formants can be mislabeled
- Results in large, "*jump*", errors that have to be handled
- Excluding differences larger than 9 semitones catches most of these jumps

Large Jumps in F_0-F_3

(# differences > 9 semitones)



Systematic Differences

Bit-rate 80 kbs and higher

- Pitch < 0.04 semitones
- Formants < 0.04 semitones
- CoG < 0.15 semitones

Bit-rate 40 kbs

- F2/F3 ~ 0.1 semitones
- CoG < 0.5 semitones

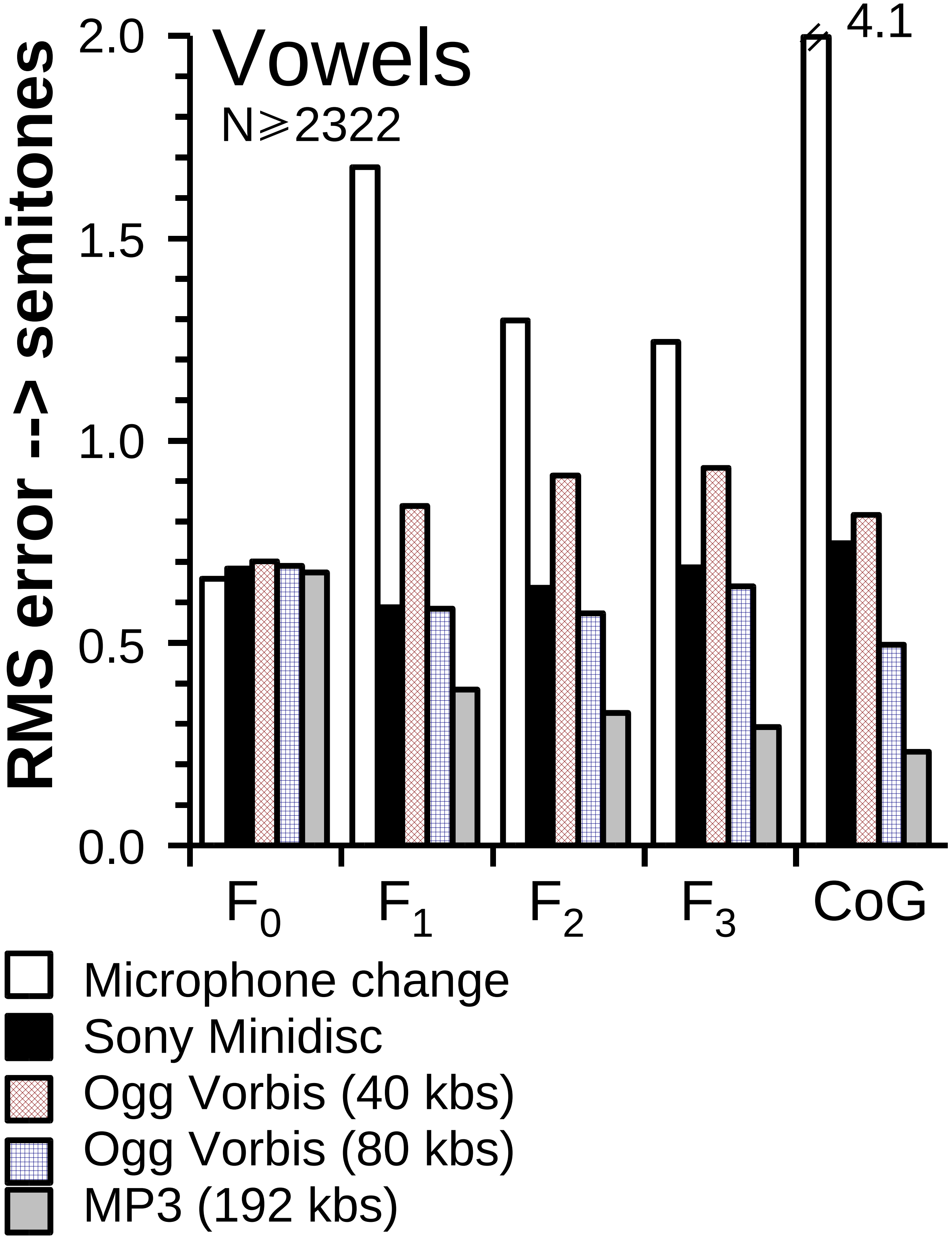
Microphone switch

- Formants < 0.5 semitones
- CoG < 5 semitones (!)

Root-Mean-Square Errors

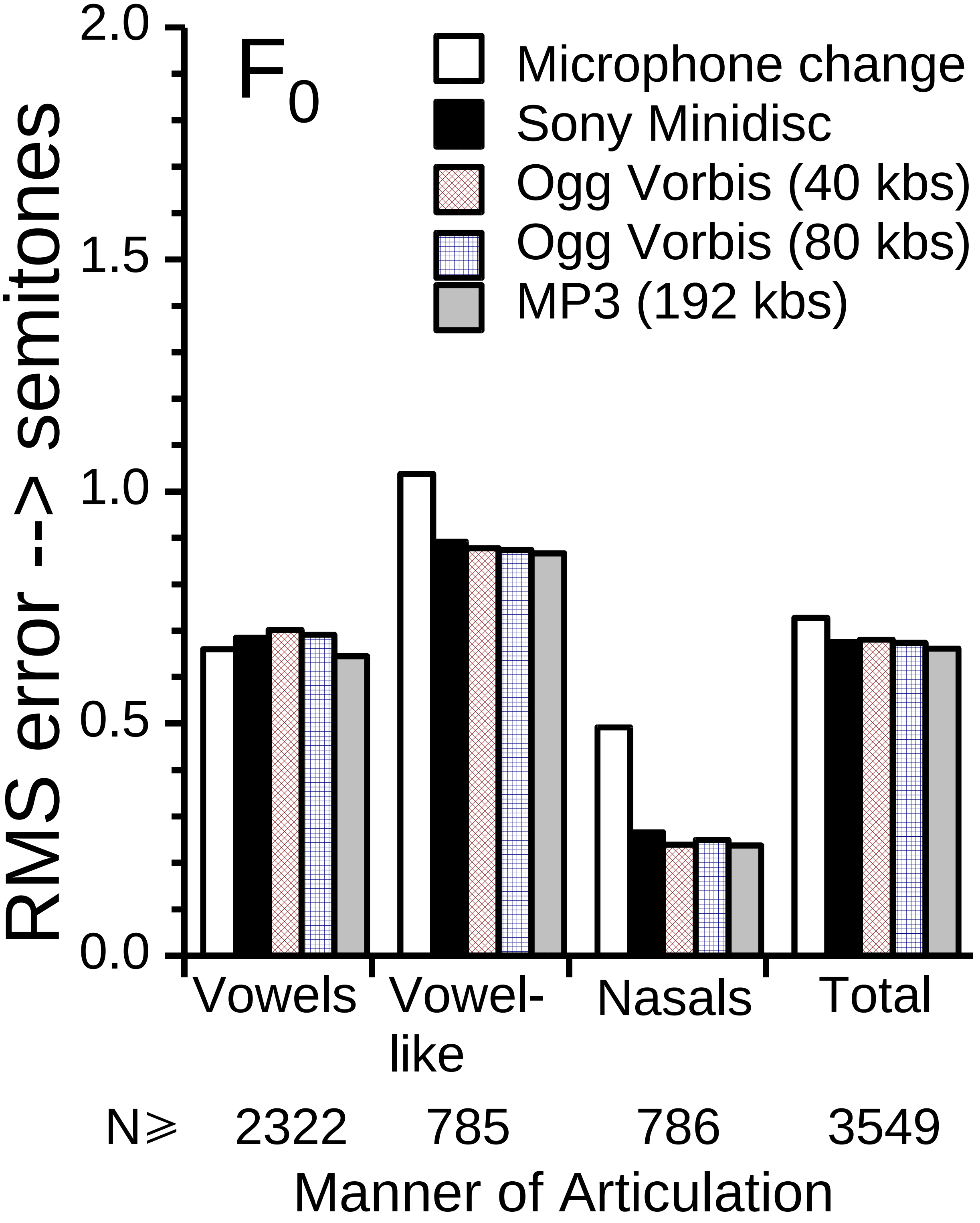
- Systematic Differences are Ignored in this Study
- **Standard Deviation**
  ==
  Root-Mean-Square Error
- Discard Pitch and Formant Differences > **9** semitones (***not*** for CoG)
  (>10 standard deviations of the difference)

RMS Errors in Pitch, Formant & CoG



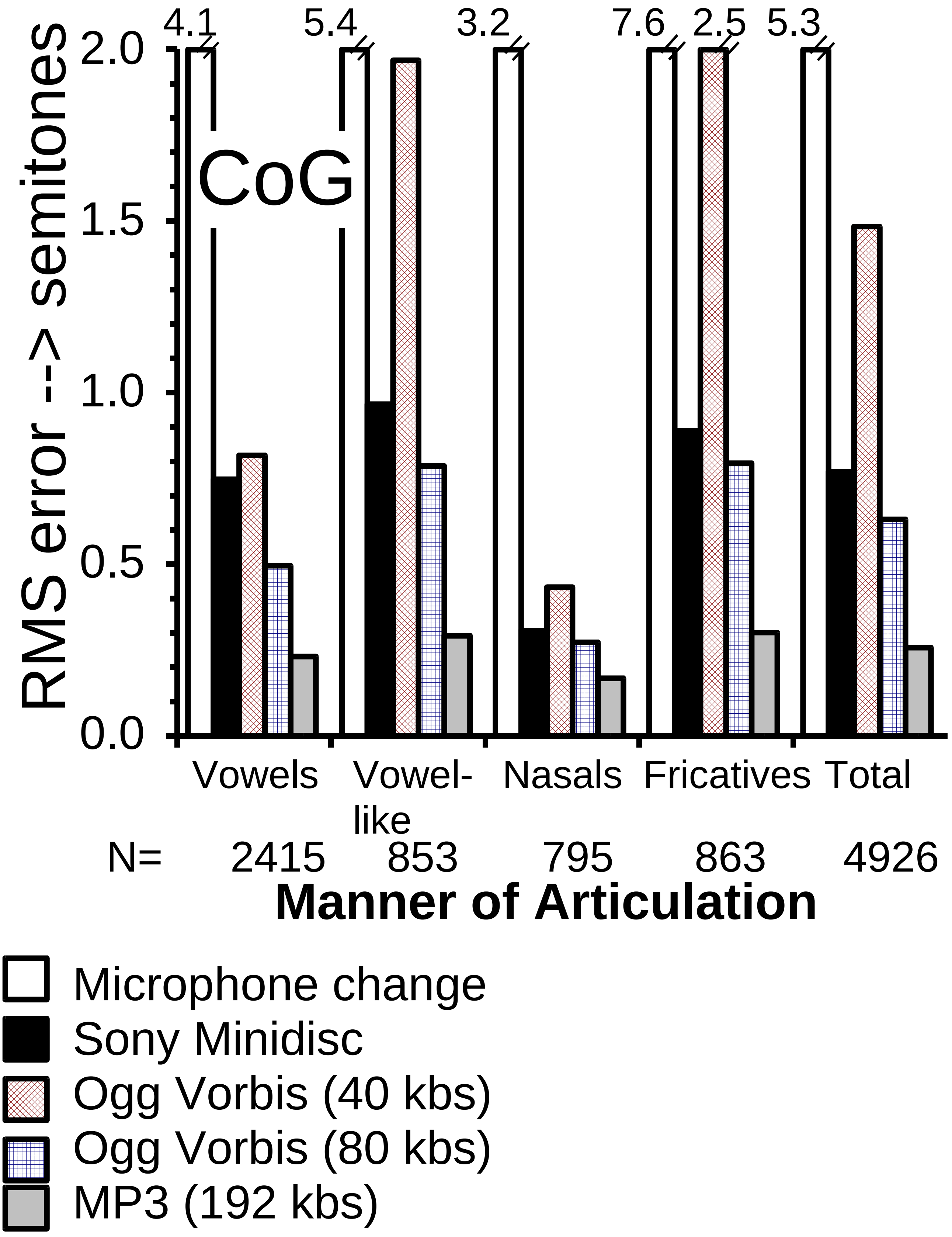
RMS Errors in F_0

(All Sonorants)



RMS Errors in CoG

(all continuants)



Cascaded Compression

Field situation:

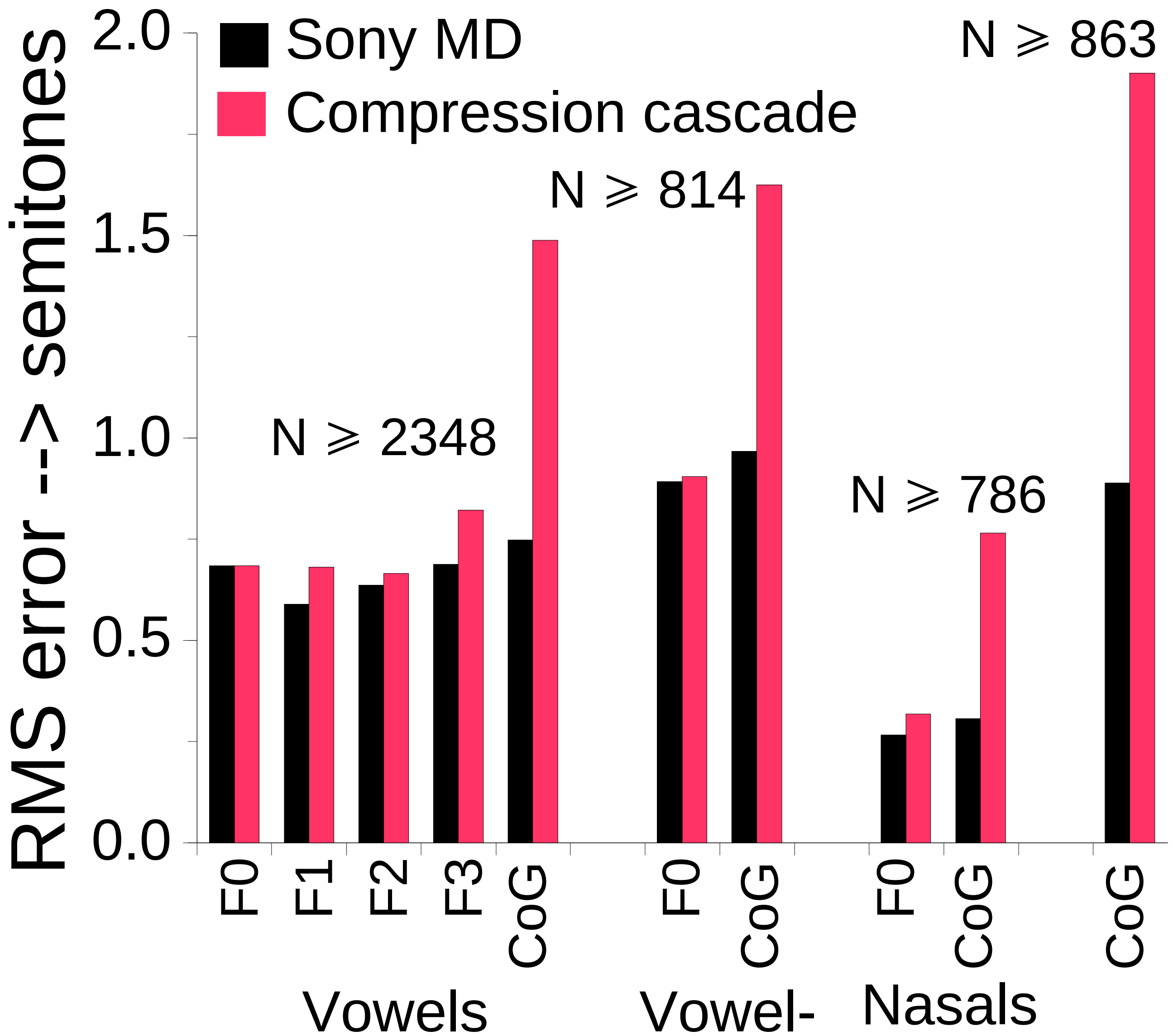
- Record on Minidisc
- Transmit/Store/Distribute with 80 kbs Compression
- Archive with 192 kbs Compression

Simulated with:

CD-audio (Original)
->Sony Minidisc
-> Ogg Vorbis 80 kbs
-> MP3 192 kbs

Cascaded Compression

Sony MD > Ogg Vorbis (80kbs) > MP3 (192kbs)



Pitch and Formants:

Weakest Link Determines RMS Error
(i.e., Sony Minidisc)

CoG:

Total Error = Sum of Component RMS Errors

Discussion and Conclusions

- Decompressed Speech can be used for *Pitch*, *Formant*, and Whole Spectrum (*CoG*) Analysis
- RMS error < 1 semitone (<6%)
  - Vowels < 0.7 semitone
  - Nasals < 0.3 semitone
  - Holds for Low bit-rates (40 kbs) for Pitch and Formants
- Repeated Compression *Combined* Error
  - Pitch & Formants: Weakest Link
  - CoG: *Sum* of Component RMS Errors Solution: (Partial) Translation of Formats, i.e., No Decompression
- CoG Strongly Affected by
  - Low bit-rates (40 kbs)
  - Repeated Compression
  - Microphone Choice