ACCURACY IN THE SINGING VOICE

Pauline Larrouy-Maestri
PhD Student, Logopédie de la Voix, Dpt Scs Cognitives, ULg
Supervisor: D. Morsomme
Managing team: R. Kolinsky, S. Majerus

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I. **Theoretical basis:**
   - Reference model
   - Context
   - Research problematic

II. **Current studies:**
   - Study 1: “Subjective perception of accuracy”
   - Study 2: “Technique: Singers Vs Non-singers”
   - Study 3: Corpus “Joyeux Anniversaire”
   - Study 4: “Impact of performance anxiety”

III. **Collaborations for those studies**

IV. **References**
I. Theoretical basis: Reference model

- Following works from:
  - Peretz (2001)
  - Hébert et al. (2003)
  - Dalla Bella and Peretz (2003)
- Dissociation rhythm and pitch
- 3 frequential subsystems:
  - Contours
  - Intervals
  - Tonal centre
I. Theoretical basis: Reference model

- Evaluation Battery
  - Reception: MBEA (Peretz et al., 2003)
  - Production: Dalla Bella et al., 2009
- **Definition** of singing accuracy:

  - **Voice accuracy**
    - Absolute pitch
    - Relative accuracy
      - Intervals
      - Contours
      - Tonal context
I. Theoretical basis: Context

Prevalence

- **Everybody can sing in tune!** Dalla Bella, Giguère & Peretz, 2007
- Yet according to Pfordresher et al., 2007: this is far from what participants perceive (59% state they cannot imitate a simple melody)
- How prevalent?
  - 4% of population – regarding amusia (Kalmus & Fry, 1980)
  - For 30 years, each author has had his own answer… (Henry & McAuley, 2010)
I. Theorical basis: Context

Investigated factors

- **Stimuli:** synthetic or vocal sound, various registers and pitch directions (Russo & Thompson, 2005; Pfordresher et al., 2009, 2010; Hutchins, in progress)

- **Audio feedback** (Burnett, 1997; Watts, 2003; Pfordresher, 2007; Hutchins, 2010)

- **Pitch memory** (Belin, 2005; Watts, 2006)

- **Vocal training** (Watts, 2005; Bradshaw, 2005; Sonninlen et al., 2005; Wilsonarboleda & Frederick, 2008)
I. Theoretical basis: Research problematic

☐ **Debatable points:**
  - Methods in studying accuracy
  - Precision of analysis tools
  - Evaluative criteria for accuracy
  - Non-investigated factors: technique, emotional state…

☐ **Our questions:**
  - How to measure accuracy?
  - What shall be considered out of tune?

☐ **Aim:** definition of singing voice accuracy
II. Current studies investigating this problematic

- **Study 1:** “Subjective perception of accuracy”
  - Refine perception in different contexts (isolated sounds, musical phrases)
  - Define the relevant criteria to analyze

- **Study 2:** “Vocal Technique”
  - Analysis tools for accuracy
  - Effect of vocal technique

- **Study 3:** Corpus “Joyeux Anniversaire”
  - Prevalence of an accuracy problem?
  - Profiles for “good” and ”bad” singers
  - Comparison of different analysis methods

- **Study 4:** “Impact of performance anxiety”
II. Study 1: “subjective perception of accuracy”
Aims and method

- **Aims:**
  - Refine perception in the context of musical phrases
  - Comparison with an isolated sound
  - Comparison between perception and production
  - Define the relevant criteria to analyze in study 3

- **Method:**
  - Participants: 30 non-musicians (15 women, 15 men)
  - Materials:
    - Sequence creation from JA corpus
    - Sound manipulation with Audiosculpt: creation of errors
II. Study 1: “subjective perception of accuracy”
Materiel: Sequence creation from JA corpus

- Parameters in our sequence
  - Tempo: 100
  - Tonality (equal temperament): F Major
  - Timbre: woman voice filtered as alto (plus light audio processing)

- Compromise between natural, controlled voice (Alcock, 2000)

- Follow-up: integrating increasingly large pitch and key errors
II. Study 1: “subjective perception of accuracy”

Materiel: Sound manipulation

Sequence without manipulation

Ex : altered-down Maj 2\textsuperscript{nd}

Ex : altered-up Maj 2\textsuperscript{nd}

E.g.: downshifting key
II. Study 1: “subjective perception of accuracy”

Procedure

- Production task (glissandi and JA)
- d’ estimation to test discrimination abilities (E prime)
  - E.g. sine tones
  - E.g. complex tones
- Evaluation of perception for each accuracy error within melodic phrases
II. Study 1: “subjective perception of accuracy”

Procedure

- Threshold estimation for each type of error (pairwise comparison paradigm with target)
  - E.g. ascending 2\textsuperscript{nd} Maj interval +20 cents
  - E.g. descending 2\textsuperscript{nd} min interval -60 cents
  - E.g. ascending pitch slope +40 cents

- Comparison of error types (pairwise comparison paradigm without target)
  - E.g. « which is most out of tune between descending 2\textsuperscript{nd} min interval -30 cents and ascending pitch slope +40 cents? »
II. Study 1: “subjective perception of accuracy”

Conclusions

- **Results:**
  - In progress…

- **Discussion and perspectives:**
  - Validity of our task
  - Type of error perceived
  - Which size of error
  - Information about what is worth analyzing to assess accuracy in production
  - Follow-up with “experts”?
II. Study 2: “Vocal technique”

Aims and method

- **Aims:**
  - Analysis tools for accuracy
  - Effects of lyrical technique

- **Method:**
  - **Participants: 77 women**
    - 63 non-singers, 15 to 75 years old (m: 29.83, SD: 14.99)
    - 14 singers from RSAMD of Manchester (opera section), 19 to 54 years old (m: 24.21, SD: 8.79)
  - **Instructions:**
    - Sing 2 glissandi then “Joyeux Anniversaire” (calmly)
    - For singers, sing a self-chosen melody then JA in stage-like conditions
    - Therefore one Technique-less (TL) condition and one With-technique (WT)
II. Study 2: “Vocal technique”
Acoustical analysis: AudioSculpt
II. Study 2: “Vocal technique”

Acoustical analysis: AudioSculpt

Filtering, marking and analyzing...
II. Study 2: “Vocal technique”
Acoustical analysis: AudioSculpt

Final visualisation of the melody
II. Study 2: “Vocal technique”

Acoustical analysis: AudioSculpt

Result: mean f0 and intervals between each note
For each group:

- **Non-singers**: correlation tempo – accuracy
  \( r = 0.321, p = 0.01 \), the slower the more accurate

- **TL singers**: correlation pitch – accuracy
  \( r = 0.640, p = 0.014 \), the higher the less accurate

- **WI singers**: correlation tempo – accuracy
  \( r = -0.662, p = 0.01 \), the faster the less accurate

Differences between groups in

- Tempo \( (F(2,88)=16.61, p<0.001) \)
- Pitch \( (F(2,88)=165.63, p<0.001) \)

**NB:** Correlation tempo / pitch for the whole sample set \( r = -0.267, p = 0.011 \)
II. Study 2 : “Vocal technique”

Results

- No difference between groups in mean tonal errors
- Difference between groups in mean global errors:
  - Non-singers < TL singers: Effect of expertise on accuracy
  - WT singers < TL singers: Effect of lyrical vocal technique
  - No difference between: Non-singers – WT singers
II. Study 2: “Vocal technique”
Discussion and perspectives

- Correlations “Tempo / Accuracy” thus better control of tempo required

- Big surprise: singers with technique are utterly out of tune!
  - Difficult to effectively analyze this vocal technique
    - Use of resonators
      - Large harmonic content
      - Missing or masked fundamental in some cases
    - Vibrato: no regularity in F0
  - Software tools unadapted to voice analysis when lyrical technique is involved
II. Study 3 : “Corpus JA”

Aims and method

**Aims:**
- Creation of database “Joyeux Anniversaire”
- Prevalence of an accuracy problem
- Profiles for “good” and “bad” singers
- Comparison of different analysis methods

**Method:**
- Participants: 166 non-singers, 14 to 76 years old (m: 29,93)
  - 57 men, 14 to 76 years old (m: 32,4)
  - 109 women, 15 to 75 years old (m: 28,6)
- Gathering of objective and subjective data
II. Study 3: “Corpus JA”
Objective and subjective data

Objective data:
- About glissandi and JA
- Same analysis process as for Study 2

Subjective data:
- Biographical questionnaire: personal information, estimated musical training
- Subjective questionnaire: self-evaluation, information on voice (singing and spoken, self-assessment thereof) movement, vocal abilities, notion of accuracy…
- Evaluation of sample recordings by 18 judges (voice experts, singers, composers, repeaters)
II. Study 3: “Corpus JA”

Results

- Data gathering OK
- Acoustical analyses OK
- Result formatting OK
  - Interval between each successive notes
  - Identification of contour errors and interval errors magnitude
  - Mean error in each performance
  - Estimation of tonal errors
- Experts evaluation OK
- Analyses in progress…
II. Study 4: “Impact of emotional state on the singing voice”

- Theoretical context:
  - Emotional state yields physiological and psychological modifications (Langendörfer, Hodapp, Kreutz & Bongard, 2006)
  - Repercussions on voice (Harrigan, Wilson & Rosenthal, 2004), particularly on intensity and frequency variations
  - Thus impact on accuracy

- Aim: observing relationships between performance anxiety and singing production (and improving the production model)
II. Study 4: “Impact of emotional state on the singing voice”

☐ Method:

☐ Participants:
- Students from Royal Conservatories of Belgium
- Non-singers yet able to read music and sing well enough

☐ Material:
- Score: simple melody in F Maj
  - one octave range
  - same structure, tempo, key and intervals as JA
- Biographical, subjective, Spielberger and coping questionnaires
- Heart rate monitoring
II. Study 4: “Impact of emotional state on the singing voice”

- **Procedure:**
  - Score learning in music theory courses
  - 3-step recordings
    - 2 quiet situations
    - During the exam, in front of a jury
  - Analysis of objective (heart rate, acoustic features) and subjective (perception of performance anxiety, coping strategies, self-evaluation, experts judgments) data

- **Hypotheses:**
  - Differences between the different phases
  - If so, analysis of accuracy error type

- **Results:** data gathering in progress
II. Four studies: Research problematic

- Estimate a prevalence of accuracy trouble and observe different profiles (study 3)
  - Relevant criteria to analyze singing voice production (study 1)
  - Analysis tools for accuracy (study 2)

- Impact of emotional state on the accuracy in the singing voice (study 4)
III. Collaborations for those studies

- Bachelors and Masters Students from Université de Liège
- Battery of singing accuracy evaluation: S. Dalla Bella’s lab
- Collaboration with CRFMW (Centre de Recherche en Formation Musicale de Wallonie)
- Royal Conservatories of Belgium
- Collaboration with Yohana Lévêque, PhD Student with D. Schön and A. Giovanni (Study 3)
- M. Schoentgen’s lab in ULB
- Seminars at IRCAM
- 3-month research residency at BRAMS 😊

Thank you!
IV. References


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